Powers of Perceptual Control:

An Inquiry into Language, Culture, Power, and Politics

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We thought we understood everything
but then we got more data
and saw how naïve we were.
Malcolm Collins (quoted in Science 9 Nov. 2018, p626)

Every sentence I utter must be understood
not as an affirmation, but as a question.
Niels Bohr

The first principle is that you must not fool yourself.
And you are the easiest person to fool.
Richard Feynman

Volume 4

Stabilities and Instabilities,
Truth and Lies

We live how we do, They live as they do.
They are not Us.
What's the Problem with That?

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This is a work in progress, and the Table of Contents may not be up-to-date.

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**Introduction to Volume 4

Volume 4 is concerned with collections of people generally larger than families, up to nations and international relationships. In this volume the effects of rattling on organizational structures is more important than in earlier volumes. Larger organizations have more complex substructures than do the smaller ones we have hitherto considered. These smaller organizations are components of larger ones. Most larger organizations have a structure consisting of the relationships among the smaller ones. the smaller ones themselves are often affected by changes in the larger following episodes of increased rattling, but sometimes restructuring of the larger has major effects on the smaller, such as when a dictator eliminates potential opposition, such as by imprisoning or executing leaders of other policital parties.

We consider cultural long term stabilities, such as the five-thousand year suppression of women by adherents of the major monotheistic religions. More generally, we consider why it is very common for some groups in a larger society to control for acting submissively to members of other "superior" groups. Most individuals control for behaving as expected for their status as members of particular groups. Most mammalian groups contain an alpha male and possibly an alpha female. The "alphas" may be the only ones in the group allowed to mate. The alpha male, like a human dictator, may be challenged by lower-ranked males. If the challenge succeeds, no matter what the species, the successful challenger is likely to control for separating the loser from the group.

If a high proportion of members of a group have difficulty controlling some perception, their self-image control does not allow them to perceive that they are themselves at least partly responsible. It is easier to control one's self-image perceptions by saying that other active controllers are responsible than to accept Cassius's (Shakespear, Julius Caesar) claim "*The fault, dear Brutus, is not in our stars, / But in ourselves*".

The perceptions of "Us" and "Them" are pervasive. Seldom is a middle ground acknowledged to exist. As US President George Bush the younger said "*either you are with us or you are against us*". Neutrality was not an option in his mind. We claim that in many, the existence of a middle ground holds a society together, whereas in its absence the society tends to fragment, because it is through a healthy middle ground that individuals in a "lower" group can control for moving to a higher group. We consider three Us-Them dichotomies, in income disparity, rural and urban individuals, and the famous Battle of the Sexes. Another Us and Them category is the native versus immigrant (or long-settled immigrant versus new immigrant), and the resident versus refugee.

We then discuss Government. Convention and written Constitution both influence what is and is not proper for a Government to do.

Part 9: Organizations, Formal and Informal

We have extended the concepts of protocol and collective control from dyads to entire communities. Collective control stabilizes the forms of protocols, and induces newcomers to adapt to the community's roles, rituals, and common beliefs rather than the reverse. We asked in Chapter II.14 about the distinction between the language used in interactive protocols and the "official" form of the language used in more formal, non-interactive, communication, as well as the manner in which formal definition influences the drift of language over time and the splitting of a formal language used informally into mutually unintelligible daughter languages. Now we enquire about the development of organizational structure in an initially unstructured community.

First we consider some of the implications of Perceptual Control Theory in this, so far amorphous, collection of communities. Just as the structure of a hierarchic control system emerges through the operation of evolution and reorganization within an individual organism, so a structure emerges within communities of organisms, more complex perhaps than within an individual (which is complex enough), but apparently almost inevitable if PCT is anywhere near being a correct theory of psychology. As in an individual, tensegrity properties emerge almost inevitably.

Organizational structure may develop out of broken symmetry in an otherwise uniform group, much as Cora's development of meaningful interaction with baby Ivan developed out of a broken symmetry in Ivan's sounds and movements, and her actions that influences Ivan's controlled perceptions of hunger and pain. In sufficiently large communities it ceases to be true that everyone must be a jack of all trades, and specializations emerge, with different people taking on different roles, in the same way words emerge from baby Ivan's undifferentiated "jack of all trades" first cry.

It may at first seem far-fetched, but roles have much the same function in community structure as do the "words" in Ivan's communication with Cora. Each Role facilitates control of some perception by some other community members often enough that the coordinated performance of various roles becomes stylized in a way analogous to the way that in the syncon world common and useful synx trajectories become stylized to form "words" and "phrases".

In one of Henry Ford's assembly lines, the roles are as simple as fitting a specific bolt or installing a wheel on the car passing by on the line. Each car is influenced by the same sequence of roles. Other, more modern, car manufacturers may use workgroups that collectively perform roles that result in producing functional components of the finished car. The entire car is then built from these components. The work groups may have specialist roles that work with elemental components, but if those components were like words in Henry Ford's assembly line, they are words connected by a functional syntax in the workgroup method of production.

Just as with formal language, when one interacts with a specialized Role, protocol actions that display one's state are more formal and predictable than when one interacts with a known individual. Conversing with a particular person, one may perceive that they have background knowledge that an anonymous performer of a Role cannot be assumed to have. In performance of a protocol, available background knowledge may be used rather than having to be communicated, resulting in protocols whose purpose may be invisible to an external Observer, a situation that does not occur when the interaction is with a Role understood by the Observer.

Specialized roles also are packaged with some particular background knowledge that can be taken for granted as being held by the specialist Role-player, and that is also known to the Observer familiar with the specialized Role. Cryptic communication with a Role is more difficult than with a person playing the Role. A cashier, for example, is assumed to know how to work the till and to know when someone wants

to pay for something. These abilities and the overt displays in the corresponding protocols do not change when a different person comes to pay for something.

An outside Observer who is a member of the culture perceives that the cashier knows these things and when someone is observed placing store items in a particular way on the checkout counter, the Observer perceives that a “Buy-Sell” protocol is being executed. Of course, the particular items and the layout on the counter may actually convey a secret message, but that message is not a message to the cashier Role. It is a message to the person playing the cashier Role, perhaps when they are playing a different Role, such as “spy”.

In this part of the book we consider networks of environmental feedback pathways that form an ecology, and develop the “infrastructure” maintained by collective control. The “rattling” measure begins to become ever more useful in consideration of organizational structure. The elements of infrastructure typically are atenexes accessible to persons playing particular roles, and their side-effects may rattle other persons. We consider the effects of rattling on the stability of the rattled organization, including the atenexes on which community collective control relies.

The stability of these atenexes under collective control permits them to be used in the creation of newly controllable perceptions, while often also providing the “rod” structures on which the resilient tensegrity properties of the culture depend. The atenexes may be embodied in tangible structures, or they may be intangible, as are the collectively controlled forms of the language used in the community. As we noted in Volume III, language and money, perhaps more than anything tangible, are the most important components of community infrastructure.

Chapter IV.1. Rattling, Crumpling, and Society

We return to a pair of concepts introduced in Chapter II.5 and Chapter II.6 respectively, in connection with individual reorganization — "rattling" (Chvykov et al., 2021), who related rattling to a measure of diffusivity, and "crumpling" (Andrejevic et al. 2021), which we linked to the conscious development of categorical perceptions and the building of new perceptual functions in the analogue perceptual control hierarchy. Now we extend their consideration into the realm of social organization, whether the units of the society be human or some other species, or a combination, such as a human and a dog working together as a shepherd.

As I have emphasized a few times throughout this book, everything in it should be viewed from many angles. One of these angles is to see every claim I make as a question awaiting an answer. But that is only one angle. Another angle you should examine is whether the consequences of accepting any particular claim are as I assert them to be.

Two of my assertions that may seem hidden are firstly that Chvykov et al. (2021) are as correct as is PCT itself, and that long-term trends of organizations toward low rattling configurations are, absent other considerations such as limits on resources such as energy or technical ability, as inevitable as is the modular hierarchic form of perceptual control organizations. A secondly, less important, assertion is that crumpling is a valid metaphor for the separation of classes of objects according to the ranges of perceived property values that affect their usabilities as atenfels for different purposes. In social systems, this same effect of crumpling separates individuals and collectives who perceive the same situation differently, but as we shall see, the consequences go much further than that.

We will look a little further into the consequences in the next Chapter when we discuss abrupt changes — "phase changes" — in the forms of societies. On a larger scale, much of the rest of this book looks at aspects of a centuries long sequence of phase changes, from loose association, to Role-based regularization, to rule-based Administrative structure, to Authoritarian Bureaucracy, to Dictatorship, and by revolution back to an earlier stage with different players taking similar Roles for the cycle to start all over again. The development of Role-based interactions is the first stage of this cyclic attempt to reduce rattling over the whole society. The cyclic revolutionary part of the cycle can be seen as a method of "simulated annealing", heating the organization to move it out of a local, but not global, rattling minimum.

No experimental evidence of which I know has any bearing on the validity of any of these assertions. Both depend only on a network or ecology of logical or mathematical consistencies. Over the millennia, many such claims, even those made by such geniuses as Aristotle or Euclid, have been shown to be demonstrably wrong or not universally true after having been generally accepted for many lifetimes as self-evident or because they were asserted by someone who had been proved to be usually correct. For now, however, I can offer nothing better than apparent internal consistency in support of my claims. And so we proceed.

IV.1.1 Aggregations and organizations

In this Chapter we treat collective activity as a close analogy to the abstraction level of "neural bundle-neural current", and consider why rattling and crumpling might justify such abstractions in the context of large numbers of interacting individuals.

Any aggregation of independent units can be described as "an organization". When we were considering the organization within an individual, the general form of the organization was simply the set of interactions among control loops within the individual in the perceptual control hierarchy and through

the category interface to conscious thought processes. The possibilities for a social organization are vastly more complex, as they include the organization within every individual living control system that is part of the social group, plus all the relationships that might occur among the individuals.

Clearly we cannot describe every individual relationship possibility even in a group of as few as five individuals, let alone in groups of thousands or millions, though every individual relationship has its own contribution to the organization. What we must do is to find some motifs of social organization, together with useful statistical measures, of which rattling is one. Only in this way can we make sense of the billions of dynamic relationships in the social ecology.

Just as with the neural system in a single brain, each individual, whether each single synapse or a complete living control system, has many relationships with others of its kind. The hundreds or thousands of relationships that each neuron has with other neurons are only a tiny proportion of the number of possible relationships that it could have had with the other tens of billions of neurons in the brain. The same is true of human relationships, even in the age of the internet. In principle any one of us could make contact with every other person, and through intermediaries perhaps we come close to doing so.

When we talk about control loops and hierarchies, we are not talking about the workings of any set of neurons working as separate individuals. We are instead using a purely abstract construct, the neural current through a bundle of neurons averaged over times that are long compared with the firing rates of individual neurons, or over a sufficient number of neurons to allow reasonably stable averaging over shorter periods. Neither represents the actual activity of neurons and their relationships among themselves within a “neural bundle”. Nor does the “neural bundle-neural current” construct permit examination of probability-related perceptions such as, among others, strengths of beliefs or reliability of identifications (Chapter I.12).

The concept of a Role is a kind of abstraction loosely analogous to a neural bundle. Collective Control (Chapter III.1) is another, analogous to neural currents in individual control loops. Here we are talking about rattling, and we will find that having individual persons playing Roles form a big part in reducing organizational rattling both within individuals and between individuals, so we will also discuss them in this Chapter (Section IV.1.7).

In practice, apart from a few tens or low hundreds of other people we know, we are more likely to interact with the Role someone is playing than with the person playing it. As Chvykov et al. (2021) demonstrated mathematically, in simulation, and in physical demonstration, the structure of an aggregation is more likely to diffuse toward a low-rattling, better-organized, part of the space than toward a high-rattling state. Sometimes changes are in the opposite direction, and few are direct. One could think of it as an optimizing process akin to a stochastic version of Powers’s “e-coli” optimization procedure for reorganization.

The unit elements of the organizations studied by Chvykov et al. consist of self-energized entities they called “smarticles”. Smarticles have only one mode of interaction. One smarticle hits another and changes its lateral kinetic energy for movement over a bounded flat surface. We, on the other hand, are interested in interacting control systems, each of which is an organization of control loops. A control loop is rather more complex than a smarticle, but we claim that organizations of control loops behave like organizations of smarticles in that both kinds of organization drift erratically toward lower rattling regions of their description spaces.

Smarticles have only one way to influence each other’s motion, and that influence on average increases the kinetic energy of the affected smarticle. Control loops can act in ways that increase and ways that decrease each other’s susceptibility to rattling from external sources — their Quality of Control (QoC). The effects of the output of one control loop on the disturbance to another have four possible

ways of affecting the disturbance (Figure III.2.2, repeated as Figure q36.1). Type 1, the most common if the interactions are random, adds to the disturbance variance, one can shield the other loop from some of the effects of the external disturbance, while the other two can improve the QoC of the other loop by enhancing its precision of perception or its power and precision of action.

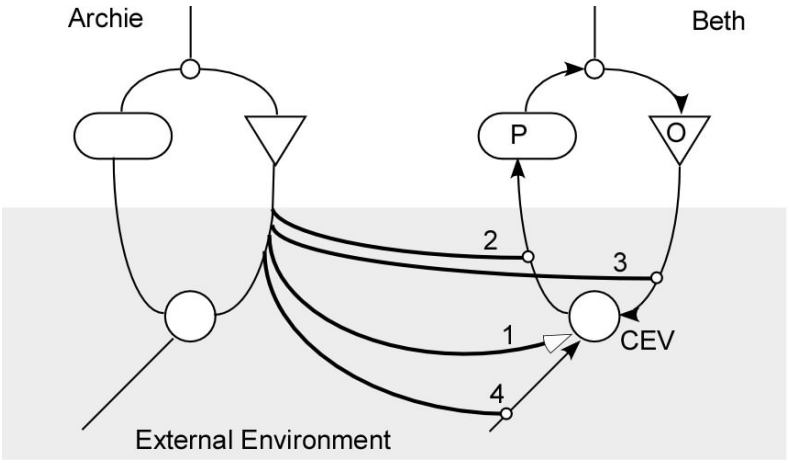

Figure q36.1 (repeat of Figure III.2.2). Different ways Archie's actions might influence Beth's ability to control some perception. (1) Directly influence Beth's CEV, (2) Change Beth's ability to perceive her CEV accurately, (3) Change Beth's ability to influence her CEV, (4) Change the ability of external disturbances to influence Beth's CEV. The diagram shows Archie's influences as side effects of his controlling some perception, but the same possibilities exist if Archie controls his perceptions of those influences.

These latter three can all decrease the total rattling summed over the organization that includes the affected loop (Beth's in the Figure). Whereas the smarticles of Chvykov et al. reduced their total rattling by moving away from each other within limits imposed by physical boundaries, control loops can sometimes reduce their rattling by moving conceptually closer together, enhancing the mutual benefits of their interactions.

All of this applies equally to the organization of control loops within individuals or within entire social groups. Social organizations, like organizations of smarticles, seem to drift preferentially toward "low-rattling" organizational structures, while sometimes moving the opposite way, temporarily increasing their total rattling. The tendency of beneficial interactions to draw control organizations together may lead these structures to form separate groups of "us" and groups of "them" that might come into conflict. Conflict would be expected to increase the rattling experience by the organization that includes both conflicted parties, but as we will see, the inverse is not necessarily true. Low rattling need not mean no conflict.

Crumpling was treated in Chapter II.6 and Chapter II.7 as a metaphor for the construction in a person's individual perception, conscious or non-conscious, of a world that consists of discrete categories of "objects", both tangible and abstract. A political party is an abstract object, as is the collection of its laws and principles, written or unwritten. A document on which those laws and principles are written is a tangible or concrete object.

An object has properties, many of which are available to perception if the object is tangible because they affect an organism's sensory apparatus. As a species evolves or an individual matures, these patterns

of sensory effects cohere into functional groupings, many of which can be varied by actions on the environment that can be used for perceptual control if their effects are consistent enough to be built into the synaptic connections among neurons. The same "Gestalt" principle of consistent configuration of perceivable properties applies to abstract objects, whether the properties are perceived by individuals or by a complement of GVCs (Giant Virtual Controllers).

The application of the crumpling metaphor to social systems is less direct, since no individual has direct access to what any other individual can and does perceive through their senses or imagination, no matter what the species (at least, we know of no telepathic species). The only way we can perceive what they may be perceiving is through their action outputs, their behaviours in controlling their perceptions, perceptions we must infer from their actions in controlling against disturbance to them if they are controlled. We talked about this in Chapter 2, right at the beginning of the book, when we talked about one semi-formal process called "The Test for the Controlled Variable", the "TCV".

Not all controlled perceptions are in a loop defined by "neural currents". Indeed, a neural current is a kind of collective behaviour imperceptible from within the loop that uses it. Likewise, when w are talking about Collective Control, the controlled perceptions and their reference values may not be those held by any individual member of the collective. They are virtual perceptions of some state of the universe that is affected by the combined actions of the individuals. In the Real Reality versus Perceived Reality duality, the Collective controls perceptions only in PR, but as always, the effects are in RR as well.

Categories are perceptions that have developed in the perceptual control structure the kind of abstract structure we have sought as an analogy of "neural bundling". If Collectives can control virtual perceptions of different kinds defined by Collective perceptual functions, then Collectives should also develop category perceptions, which should ordinarily reduce rattling within the Collective.

Category is not an abstraction built by the theorist to simplify the description of what happens in a society of neurons, it is an abstraction the theorist perceives that the perceptual control system to have built to simplify its own operation — reducing rattling that would occur between analogue control loops that contain similar perceptual input functions.

If the theorist is correct in this, then we might expect societies to develop analogous structures that reduce rattling by cotrolling similar collective virtual perceptions. And they do. We give such structures names such as "political parties", "cabals", "terrorist organizations", "patriots", "protesters", and so forth, groups that act as though they were controlling a hive-mind perception.

Regardless of whether one individual can truly discover what perceptions another may have or control, in a collection of individuals, the actions of each will affect least some of the others intentionally or by their side effects. We will follow the implications of rattling and the crumpling metaphor on the resulting forms of organization throughout this Chapter and the rest of the book.

IV.1.2 Rattling Averages and Extremes

Later we will deal with the formation of "grand networks" of beneficial interactions together with outlier minor networks and isolates. In this Section we consider PCT mechanisms that could lead to extreme results often represented by these relatively isolated formations.

While over an aggregation or organization as a whole, Type 4 pairwise interactions increase while Type 1 interactions decrease, instances of the opposite change may happen. Occasionally, people in a group will collectively control their individual perceptions in ways that, deliberately or through side-effects, act in ways that exacerbate the disturbances to perceptions controlled by other people. More often group members are likely to shield other group members than to disturb them, even accidentally, as time

goes on. The rattling experienced by individuals on average tends to be reduced more often than to be increased.

“On average” matters here. The smaller the group we consider, the more deviant from the general average its own group average is likely to be. At the limit of a two-individual group, they may strongly disturb each other quite deliberately and come into direct conflict over certain perceptions they control, while still fitting into the larger group.

How might this be self-consistent? To address that, we should look at why a “near exponential” distribution crops up almost wherever we look in the rattling analysis.

Think of the “average man”. Does there exist a man who is of average height, average weight, has hair of average colour and length, sleeps for an average length of time per night, earns an average income, spends an average amount on household expenses every week, has average lengths of fingers, got average marks in every class in every grade through school, and so on? I doubt it. Most people are near average in most of their properties, but far from average in some. Looking at the other side, for any property an individual can have, such as height, most people are near average, but some few are far from average, being either very tall or very short. Even these are probably near average in many of their other properties.

When we think of interactions within an organization in equilibrium, the same applies. For interactions between the two individuals in conflict, their conflict is usually about one or two of the many perceptions each controls. given that they are members of this stable organization, most of their interactions will be of near the average kind, tending to reduce rather than increase each other’s error velocity uncertainties. Only the relatively few perceptions involved in the conflict have increased error values because of their interpersonal disagreement.

Whatever you look at, almost always most of the examples will probably be somewhere near average, but there will be some that are more extreme. We are most interested for the moment in the total rattling caused by one individual to another over all the perceptions the other controls. Almost always, across all pairs of individuals in the stable organization, this total will be small but non-zero, but between some pairs of individuals at least one causes considerable rattling to the other: “I like or at least tolerate most people I meet, but I just can’t stand that guy. He grates on my nerves whenever I see him.”

How rapidly would this trend occur? That is something that cannot be measured in clock time of days or years. It would be measured in numbers of interactions. The denser the group population in space (prior to the development of rapid means of communication, from roads to the internet) the more rapid the interactions. Indeed, on average the local interaction rate would be proportional not to the overall size of the congregation, but to its local density.

The availability of rapid communication methods changes this calculation somewhat, since some forms of interaction can occur across continents, once on a time-scale of weeks or months, now in milliseconds, but the principle remains the same. More interaction density leads on balance to more concentrated, denser, local groupings within which the trend is toward local rattling density reduction. Interactions that tend to cause increased rattling (particularly but not exclusively Type 1 in Figure IV.1.1) will tend to be reduced in intensity.

IV.1.3 Rattling Averages and Localized Density Variation

We continue to ignore the crumpling metaphor, and expand our discussion of rattling. Rattling and crumpling concentrate on very different aspects of perceptual control, rattling on dynamic changes in perceptual control structure, crumpling on categorical perception and its feedback relationship with the

analogue hierarchy. This complex relationship, foreshadowed in Chapter 9 and developed in Chapter II.6, needs more than a passing discussion when we move to the social domain, in which interactions among collectives are added to the interactions within each individual to form the entire organizations that are rattled or crumpled.

Rattling is a measure of uncertainty, akin to variance (Chvykov et al., 2021). Like variances, two uncertainties can be added to measure a joint uncertainty, provided the two variables concerned are unrelated. If they are not, the degree to which two variances are related is a measure called "covariance". The equivalent for uncertainty is "Mutual information", how much the uncertainty of one variable is reduced if the other is known (Chapter 10). The total rattling of an organization is the sum of the rattling of its units less the mutual information among its units.

Put another way, if two control loops (within an individual or in two individuals) are equally rattled when examined individually, the more similar the pattern of changes in their velocities of error values or of output values (internal or external rattling, Chapter II.5), the less the total rattling of the two considered as one organization. The "low-rattling" organizational principle of Chvykov et al. (2021) says that the organization of the two will tend to increase their similarities of velocity changes, reducing the total rattling of the organization as a whole. The same would apply to the relationships among many control loops. The more similar their velocity profiles, the lower the total rattling of an organization that includes them. The trend would then be toward the construction of like-minded groups that do not have much within-group rattling. The mechanism by which this would happen is not important except to note that there would be one (or more).

Now we introduce the concept of rattling average and rattling density. The "organization" consists of the individuals of interest at the moment, who could be any subset of the population. It might be of all the red-haired people, all those born on New Year's Day, all those who walked past a certain sign in 2014, or any other group. Some of these subset organizations, however, incorporate on average more pair-wise side-effects among their individual members than do others. Only those with substantial mutual side-effects have much potential for reducing total rattling through changes in organizational structure. They are the ones that interact most strongly, and are most rattled if their interaction energies mostly disturb each other's CEVs, rather than shield them or improve each other's Quality of Control (QoC).

Each CEV is, of course, the environmental equivalent of one scalar perception of one property of some object. The object is described by not only the properties that define it, but also by the perceived values of those properties, some of which may be easily controlled, some not. A living control system constructs many perceptual functions that produce perceptions of the properties of objects, the more the longer the control hierarchy has been maturing. As with so much associated with rattling statistics, they will not all be equally above or below average in how severely they are rattled. Most will be at the lower end of the distribution, with a few perceptions being strongly rattled, even in the calmest of close-contact groups, such as families.

Sibling rivalries and fights are so common as to be an expected part of growing up. We would expect that to be the case, because siblings interact with each other perhaps more than they interact with anyone else once they have matured enough to be independently mobile. The more interactions there are between them, the more likely it is that some of them are in the form of conflict over control of some property of their mutually accessible environment such as a toy. Conflicts increase external rattling inherently, and internal rattling indirectly.

The total rattling of an individual is the sum of the rattling in all the individual's control loops, allowing for the mutual information provided by the internal connections among the loops. The total rattling of an organization is the sum of the rattling in all the individuals in the organization, allowing for the mutual information provided by their social connections. Each individual has an interior rattling total,

and as a consequence contributes energy to either the suppression of rattling in the other individuals by beneficial side or direct effects or to the enhancement of their rattling by contributions to their disturbances.

The situations are parallel. The rattling of perceptions within individuals and within social organizations are both statistical summations over regions of observation, such as the number of controlled perceptions sampled or or of the time durations over which the summations are performed. The smaller the number of samples, the greater, on average, will be the variability among them.

We must keep in mind that the quasi-exponential long-time equilibrium form of any significant property of an organization includes localized parts of the organization in which this perceptual property are being strongly rattled compared to the rest.

The keyword here is “localized”. What does it actually mean in this network context of pairwise interactions? When we are talking about where objects are located in space, it is easy to describe what we mean by the word. We could say “with a half-hour walking distance” or “within a 10 km radius” or, given the networks of 20th century travel possibilities, “accessible within 6 hours”. It is more difficult when there is no necessary spatial implication of what is more and less local.

There is a hint, however, in the comment above on sibling rivalry, which mentioned the frequency and strength of interactions among siblings as compared with their interactions with others. We could measure the distance between two intervals by the rate of interactions among them in which an action by A affects the ability of B to control at least one perception. The same could be said of the distance between B and C, but since there is no reason to think that A affects B in the same way as B affects C, there is no implication that If A is close to B and B is close to C then A must be close to C. It might be so, but not by virtue of the connection through B. A will be close to C if A’s actions frequently influence C directly.

These influences are one-way. B’s actions may seldom influence A, even if A’s actions frequently influence B. Consider the different influence that a dictator Q has on random member of the public, X, as compared to how often or how strongly an action by X is likely to influence Q. So we have to think of there being two interwoven networks in which traffic moves asymmetrically, like vehicular traffic on a city road network at morning or evening rush hour. We can, despite the asymmetry, treat there as being a simple distance between A and B by summing the two one-way frequencies of effect into one total frequency f(A,B). The distance between A and B would then be crudely measured as 1/f(A,B).

Over the entire network that defines the organization, there will be regions in which clusters of individuals are closer to each other in that the members of the cluster tend to interact frequently within the cluster and regions where they are farther apart on average, with fewer and more widely distributed interactions. These clusters and distances define “locality” within the network.

Just as in describing areas in spatial location, we can talk about network area as the number of nodes within a certain network distance, however one defines network distance. In this case, the question would be how strongly an unexpected action by A would rattle B. We could call this distance “rattling distance”, and the smaller the rattling distance, the more strongly an unexpected action by A, whether by side-effect or by design, would rattle B. This distance is not, however, clearly delineated, since it would depend on what perception or perceptions A’s actions disturbed in B. Some might be greatly disturbed by a particular action on the part of A, while others would hardly be disturbed at all. Overall, however, if we remember how rattling is measured, we can actually talk about total rattling within an individual.

Rattling is measured by the velocity of change in the uncertainty of the derivative of perceptual error. The uncertainty of a variable has no meaning unless the universe of possibilities is meaningful. For example, this uncertainty might be among the velocities of rates of change of the derivatives of errors in

other perceptions controlled by the individual, or it might represent a spike in that measure for the same variable over extended time, or it might be across individuals over time, among a wide range of reasonable possibilities. In practice, however, there is little point in mentioning the rattling measure unless the fact that it is additive has been used to talk about average rattling over some population, whether it be a population of individuals in a society, a population of social groupings, or perceptions controlled at a particular moment or over time by one individual.

Over a network, then, it becomes reasonable to talk about rattling density within some subset of the nodes of the network, and if the arguments for the "magic number" six (Section II.8.8) have any validity, the most coherent subsets of social groups who become simultaneously badly rattled would be strongly interacting groups of about six. Many such groups might consist of leaders in their own section of a social network, and if those leaders are rattled, their actions might be unexpected to their followers, who might not be, but probably are, in coherent — intercommunicating — groups.

One of the properties of a rattled and reorganized organization described by Chvykov et al. (2021) is that after everything settles down, not every element of the organization is in a low-rattled state. There is a distribution similar to a declining exponential, in which most elements are little rattled but a long tail contains a minority who remain rather rattled and a very few that are strongly rattled. If this is an organization of individuals who communicate with each other, these few are individually unlikely to act in ways that further disturb the larger organization, but are quite likely to form coherent groups that might act coherently to do so.

One of the properties of the sub-organization that is a coherent group is that the interactions within the group are unlikely to be strongly rattling, because strong intra-group rattling interactions increase the likelihood that the group will split apart, forming subgroups that have less rattling interactions within the groups, but greater rattling interactions between groups, member-by-member. These interactions can be reduced by communication separation. One way to achieve lower rattling is to cease interaction between such groups, increasing the network distance between them. We see this pairwise effect quite often, when someone says "I'm not talking to him" or, in the case of groups like the American Pilgrim Fathers, by physically moving away from England to avoid unwanted interactions, or when one nation withdraws its ambassador from another.

Type 1 interactions are not the only possible kind. Avoiding them only brings the mutual rattling influence down to what it would be in a community of isolated individuals. As we described in Chapter III.2, however, if the community is large enough it becomes almost inevitable that some beneficial homeostatic side-effect loops will form. Each such loop reduces the rattling in all the controllers that participate. These homeostatic loops are important in maintaining a group's coherence even when the individual members do rattle each other to some extent, affecting perceptions not stabilized by participation in the homeostatic loop.

Although the side-effects and direct effects of any one action on another individual are about a single perception, not about the whole organism, nevertheless we are here most concerned with the total rattling of whole organizations of whole organisms, not how that rattling is distributed among the many perceptions each organism controls. We could make the same argument about rattling density variation within an organism, and on occasion we may do so. Here we are concerned only with societies of whole living control systems, whether they be bacteria, trees, ants, fish, or humans.

In Section II.8.8 we discussed some of the implications of the possibility there might be an organizational "Magic Number", and that the number in question might be about six. Now we can think of this as a natural size of close groups and of clusters of such groups, organized this way because of within and inter-group rattling. In Kauffman's (1993) toy universe experiments with on-off cells whose state was influenced by the state of N neighbours , the "magic number" applied simply to the number of

interactions that affected the state of a cell, he found that if there were more than six interactions on average, the whole "universe" became chaotic, whereas if there were fewer, it tended to freeze in some state. His six-interaction groups did neither, but were in a intermediate state in which they were responsive but not chaotic — a state sometimes known as "the edge of chaos", where systems are responsive but do not "run away" in constant flux.

Members of a network community of largely beneficial interactions, which we have assumed have around six members, will be less rattled by external contributions to their individual disturbances than they would have been when off by themselves, because a large proportion of what would be disturbances either are shielded by other community members or improve their ability to control perceptions of CEVs affected by disturbances from inside or outside the community.

The creation of homeostatic loops reduces the mutual rattling to lower than would be experienced by the same number of isolated controllers, so the low-rattling tendency would lead toward this kind of collaborative group structure, which also appears to be a tensegrity structure, in which internal divisive effects are compensated by the homeostatic attractive effects (as well as by the natural tensegrity of a hierarchical perceptual control structure discussed in Chapter I.8). The organization of the loop members will have its rattling further reduced if some or all of the side-effects are converted into intentional effects. We will observe a large-scale version of this in Chapter IV.3.1 on Social Punctate Evolution.

It is important to note that the creation of beneficial side-effect loops, or even the emergence of a single beneficial "grand network" of groups through their leaders (Section II.2.2), is most unlikely to include all of the interacting members of the organization. Some of those left-out might even have their rattling increased by the formation of the grand network. Others will participate in their own small homeostatic loops, networks, or clusters.

We will increasingly see the effects of these "outcasts" of society in later chapters of this Volume. Their products, that serve them in stabilizing their local homeostatic loops or networks, are likely to have Type 1 effects on members of the main "grand network", because if their interactions were mutually beneficial they would be members of the grand network rather than being separate, off in their own small homeostatic network.

The interest of this for us is that these most rattled of the extremely rattled are the ones most likely to lead a less totally rattled extremist group in whatever configurations of perceptions they collectively control that as abstract objects experience large and unpredictable errors. Chapter IV.4 discusses active "revolution", which can be seen as a way such extremely rattled groups may try to approach a less-rattled state. Before we get there, however, we have several things to discuss in intermediate Chapters, about how such extremely rattled states may arise — the mechanism, rather than just the result to be expected from the "low-rattling" principle.

IV.1.4 Rattling and the Stiffness of Conflict

Does rattling relate to stiffness and tensegrity between and among modules or individuals? The rattling measure (the rate of change of the *uncertainty* of the velocity of variation) is related to the variability of variation, rather than to simple variance, whereas stiffness and tensegrity are instantaneous values of a structure. Rattling and velocity are "time-binding" measures, meaning that each requires two or more samples taken at different times (or places in the organizational structure in the case of rattling).

Nevertheless, just as the holder of the flagpole in Section I.8.1 must hold tighter in a variably gusty wind, so will a direct conflict probably be enhanced if the "bone of contention" is increasingly rattled by externally introduced influences. The resulting stiffness, which is not itself a controlled variable at that

level in the control hierarchy, will on average be enhanced as a consequence. Accordingly, rattling can affect the current value of stiffness, and thereby the energy stored in associated tensegrity structures. It works the other way, too. The flag holder would reduce the internal rattling (steady the flag against gusty winds) by increasing an associated stiffness measure.

What perceptions does the flag holder in the gusty wind control? One obvious pair of possibilities is that she is trying to hold the staff vertical in both X and Y against the disturbances of the wind, now violently from the West, now for a moment calm, and briefly strongly from the Northeast. If she puts too much effort into opposing the strong West wind, when the wind relents, she will herself tilt the flagstaff westward when the wind suddenly calms. Similarly, she will be unprepared for the gust from the Northeast, and the flagpole will tilt to the Southwest before she recovers. The parade watchers will see a flagpole waving around, not at all what the pole-bearer wants them to see.

As we discussed in Chapter I.8, direct conflict induces probably the simplest form of collective control (McClelland, 1993). Conflict does not even need to be between different individuals or control units. It necessarily occurs between muscles that flex and extend joints, because neurons cannot fire at negative rates (Section I.8.1). Because of the inability of nerves to fire at rates below zero, conflict is intrinsic even to a single system that controls any perception that could have either sign in Perceptual Reality. Such a conflict leads to the emergence of the "stiffness" motif of PCT.

Opposing tensor and flexor muscles are required to hold a joint angle at a given angle. This opposition is a classic conflict that produces the joint angle as a collectively controlled environmental variable (CCEV), and the conflict induces an emergent stiffness orthogonal to the direction of collective control. This stiffness opposes the effect of orthogonal forces, so when the flag holder is controlling to oppose a North Wind, the sensitivity of the flagpole tilt to the sudden shift to a Westerly direction will be inversely proportional to the stiffness — the summed tension in the tensor and flexor muscles used for North-South control.

No matter how strongly and stiffly the flag holder holds the flagstaff, she cannot reduce the effects of the variable winds to zero. She is being rattled like a winter leaf by the wind as her control hierarchy suffers variable error variability in all directions. The uncertainty of that variation in error variance is a measure of how rattled those elements of her perceptual control hierarchy are. In general, we can take the uncertainty of error velocity as a measure of the internal effect of rattling "drivers", the wind in the flag carrier's case. Drivers more generally are the combined effects from within the organization (side-effects and intended effects) together with external disturbances from outside the organization.

Chvykov at al. (2021) applied rattling theory only to organizations of non-living entities, including the interacting self-energized "smarticles" they used to illustrate their theory. This limitation is unwarranted, as we discussed in Chapter II.5. The foundational concepts of rattling theory apply equally whether or not the entities in an organization are living. Organizations are more likely than not to "diffuse" toward regions of low rattling in their description space, no matter what the unit members of the organization might be.

We must recognize, however, that it would be possible in principle for a living control system to control for perceiving the rattling measure of an organization with a reference to increase it, especially if the affected organization happened to be an opponent of the controller's own organization. We might use as an example the influence of Russian internet services to rattle the US election organization during at least the late 2010s and early 2020s, or the attack by highly rattled "insurrectionists" on the US Capitol building on January 6 2021 in an effort to prevent the certification of Biden as the President-elect.

IV.1.7 Crumpling Facets: Roles Reduce Rattling

The headline for this Section is: *Roles Reduce Rattling* — which might be considered the "Three Rs" of social structure building.

A Role is an abstract object that has a usually small and well specified set of protocols the Role-player must be able to use as the Role's only ways of interacting with players of complementary Roles. A Role is played by a person, but while playing the Role only the actions specified by the Role and communicated through a protocol can be performed, and those only when specific perceptions are disturbed. Other perceptions controlled by the person playing the Role are not part of the Role, though during the course of a Role-counter-Role interaction, personal perceptions may be disturbed and result in out-of-Role actions.

A significant difference between a Role interacting with a person who knows how to play a counter-Role and an interaction between the same two persons not playing Roles is that these two persons may meet only once in a lifetime, but the Roles they play may interact hundreds of times in a day. The playing of a Role and its complementary counter-Role involves control by the persons of the relevant perceptions using well-defined actions intended to be perceived as a step in the Role-to-Role protocol by the person playing the opposite Role.

For example, a person playing the Role of airline check-in agent must ask the person who seems to want to play a flyer on a plane serviced by that agent a set of questions and to receive in response certain documents on paper or in a device such as a smart phone. If the traveller has played the Role of Air-Passenger before, the protocol will be executed smoothly, but as with every Role, including an actor's on-stage Role, a person must either be taught how to play it, or learn it by experiencing interactions with players of the complementary Role.

Role-player persons are thus stochastic collective controllers of actions performed by players of the counter-Role. This relationship is reciprocal, since a player of either Role in an interaction usually controls for perceiving particular actions — including language — by the player of the complementary Role. The actions incorporated in the Roles on each side of a Role-played interaction depend on the success each player has in playing the Role, and while the results are subject to the random "noise" effects associated with all stochastic control, the protocols tend toward refinement, and hence reduced uncertainty and reduced rattling of the perceptions involved in the playing of the Role-pair in an interaction.

There is yet another significant difference between a Role and the person playing it. Another person, any other person, is inscrutable, as we just described, but a Role is not. What a Role does is to provide a White Box in which both Role and counter-Role can be described and analyzed. The counter-Role and the Role use well-specified communication protocols that can be taught, and with content much restricted as compared to the wide-ranging content that could be passed in person-to-person communication between the two players of the Roles.

For example, communication between the Dentist Role and the Patient Role consists mainly of the Dentist identifying the Patient's problem and then communicating to the Patient how to act while the Dentist fixes the problem. In contrast, the person playing the dentist may interact with the person playing the patient in an unlimited number of ways. Either might comment on the beauty of the blossoms in a nearby park, or enquire about a holiday trip the other might have taken, but these specific interactions are not part of the Role of either Dentist or Patient. The Dentist Role might use them as a means to control a perception controlled as part of the Role, such as perceiving the patient person to be less nervous, but their form is not part of the Role.

When we were talking about individuals and the crumpling metaphor, facets were a division of an analogue perception into categories of otherwise similar objects, distinguished only by differences in the atenfels they could act as in control of higher-level perceptions. Now we see that Roles take the same place in interpersonal interactions. The continuous variation in the perceptions controlled by the Role-players is restricted to categories of perception within the classes specified by the Roles.

The Dentist is not concerned with more than that the class of perception that brought the Patient into the office is “toothache” rather than “tooth fell out” or “regular checkup”. The dentist (the person playing the Dentist Role) might enquire about the level of toothache, but unless the answer would affect the choice of treatment, the Dentist would not. As with the category perception in the individual, the Roles are distinguished by their component action possibilities.

Roles are social analogues to objects in individual perceptual control. Various properties of an object can be perceived, and many of those perceptions can be controlled. Each perception belongs to come category. When a Role is considered as an object, the analogy to the object’s controllable perceptions is the set of protocols (Chapter xII.13ff) the Role can perform and that other people expect it to perform if they play the complement Role. One of the requirements for proper execution of a protocol is to identify what category of protocol the initiating partner wants to use. In other words, a protocol in use is an instance of a category, and as with instances of other categories, the details of its performance may differ from instance to instance while remaining in the same category of protocol.

When Arthur deliberately or accidentally begins an interaction with Belinda, each of them has considerable uncertainty about what disturbances will affect which perceptions controlled by the other. That is the reason for the initial Interrupt and R-Display acts of a complete protocol. The initiator, Arthur, shows Belinda that he is controlling for perceiving her to act as a continuer for a particular protocol. At any one level, in every protocol interaction, two complementary Roles are being played, “Initiator” and “Continuer”. At a higher level, once these Roles have begun to be played, they can form part of the support for more complex Roles, such as Cashier and Purchaser, Doctor and Patient, or Teacher and Student.

These labels identify Role categories, which are just like categories of individual perception. The protocol set used by the Role define it as an abstract object, in the same way that the controllable property set of perceptions define the complete object consciously perceived by an individual as a diamond, a house, a soft toy, or anything else.

Just as with categories in individual perception, The “facets” that are labelled as Roles can be further “crumpled” and fragmented. A Teacher may be a Math teacher, a History teacher, a Gym teacher, but in an old one-room schoolhouse, there is only one person playing all the Roles that are fragments of the Teacher Role, and probably not playing them all as skilfully as would a specialist. However well or badly the Role is played a person who interacts with the Role will be less uncertain about the perceptions that the Role will disturb than would have been the case when interacting with the person rather than the Role.

We will look a further into this in the next Chapter when we discuss abrupt changes — “phase changes” — in the forms of societies. On a larger scale, much of the rest of this book looks at aspects of a centuries long cycle of phase changes, from loose association, to Role-based regularization, to rule-based Administrative structure, to Authoritarian Bureaucracy, to Dictatorship, and by revolution back to loose association for the cycle to start all over again. The development of Role-based interactions is the first stage of this cyclic attempt to reduce rattling over the whole society. The cyclic revolutionary part of the cycle can be seen as a method of “simulated annealing”, heating the organization to move it out of a local, but not global, rattling minimum

IV.1.8 Crumpling and Individual Facet Networks

To repeat in plain language, *Roles Reduce Rattling*.

The headline statement should be qualified by noting that it is not always true. There are conditions in which it might not be the case for a particular perception in a particular individual, for a particular individual as a whole organization of control loops, or for a particular group of individuals or even an entire society. Whenever we deal with rattling, we run into the rattling distribution issue, which is an observation that the equilibrium distribution is long-tailed, with most instances being at the low end but some few taking on high and even occasional extreme values. A long-winded "headline" should therefor read "*Roles almost always reduce overall average rattling in a social organization*".

Different organizations have different ways of reducing the rattling caused by interactions among their units, and as we discussed in Chapter II.5, reducing their total rattling is what organizations tend to do, not because of any actual forces, but simply because they are more likely to drift toward rather than away from configurations in which they experience reduced rattling. There's always an actual mechanism, even if that mechanism may not always reduce rattling either on average or in the average member of the society. Any mechanism that increases the uncertainty of the velocity variation of any variable increases the range over which that variable can vary, and thus increasing the range over which it may be susceptible to external forces. More rattling, more opportunity for the organization to drift into a new configuration.

Always, the equilibrium structure toward which the organizational mechanism tends to drive individual rattling values is long-tailed while the total organizational rattling is at a minimum. The same is true for rattling within each individual member of the organization, when individual elements of the individual structural organization, such as control loops or biochemical interactions, are taken as units of the organization, or of synaptic connections if a group of neurons is taken to be the organization of interest. If there is a mechanism that changes the rattling associated with interactions among members of the organization, that mechanism will usually tend to change the overall organization toward a low-rattling state, while concentrating the remanent rattling in a long tail of the rattling distribution over members of the organization.

One common mechanism for reducing rattling caused by interactions among members of the organization is to segregate the members into modules in which the members of a module interact with each other within the module more than they do with members of other modules. For the moment we will ignore Roles, though the interactions among members of what we will call a Role Network also form an organization, as we are using the word. We will also temporarily ignore the creation of Roles as mechanism for rattling reduction, to concentrate on the effect of module formation.

Before the days of electronic communication, module memberships were biased by physical separation. More recently, one's membership in some modules tends to be biased by the rattling caused by direct interactions with other people through social media. Interacting with someone with whom one usually agrees will rattle one less than interacting with someone with whom one usually disagrees. Accordingly, modules in social media ted to be segregated by the differing belief structures of their members. Modules separated this way are, at any scale, the "echo-chambers" that are so disturbing to many social network analysts.

In Chapter II.6 we talked about creasing only as partitioning facet-objects according to ranges of perceived values of a perceptual variable. When the perception is held by one individual, its current value is in only one of the sub-facets. This is not true when the perceptions are in two different individuals, who might differ one which side of the crease they perceive the facet-object to be, to which category the

perception belongs. Here we have introduced yet another possibility, which is just where the discriminating crease lies, or even if both individuals have divided a similar facet similarly.

Several times just above we talk about “individuals” or “members”, without taking into account that these are entire people, not controllers of a single analogue or categorical perception. People — *living control systems* — have many, many different perceptual functions, each producing perceptions that they might be able to control. People in communication have learned to perform several protocols through which they communicate with other people.

From an exterior point of view, a person is functionally an object, a bound collection of abilities, just like an inanimate object that has properties that might be perceived and some of which might be controlled (Chapter 11). The inanimate object, or Object of Object Oriented Programming, or Black or White Box discussed in Chapter 11 and subsequently, contains simple functions, some of which are themselves performed by less complex component objects, Objects, or Boxes. The “functional object” that is a person capable of controlling many perceptions is, if the foregoing part of this book is to be believed, contains component controlled perceptions rather than only simple functions. We have called them “atenfels”, environmental properties that perceptual control loops can use, lower level control loops in the perceptual control hierarchy.

Protocols involve at least one communicative partner. Each person-object has a limited set of protocols they can use as Initiator and a complementary set they can use as Continuer. As discussed in Chapter xII.13, all protocols have the same syntax of belief control. Where they differ is in the content they convey, the *matter* of the communication, which is always for control of some perception controlled by the Initiator of a communication. To control that perception may not require overt action on the part of the Continuer, though it usually does, even if it a slight as a little tilt of an eyebrow to indicate that the Continuer understood what she understood the Initiator to have intended to communicate.

Protocols do not exist in a single brain when they are active. Each involves a hierarchy of supporting protocols that work with the perceptual control hierarchies in the communicating individuals to enhance the likelihood of communications being understood as they were intended. Correct communication can occur only if the parties share some categories of perception together with language in which those categories can be encoded and decoded. Accordingly, just as with the set of potential property perceptions that define an inanimate object, or at least a category of inanimate object, so the set of usable protocols define a person as a “social object”, or at least as an instance of a class of social objects capable of using the same set of protocols.

Unlike the properties of an inanimate object, the full set of protocols an individual is able to use in different social contexts is not available to every other individual, or often to any other individual. However, a subset of protocols is likely to be available to be used with a subset of other people, such as members of the same profession, players of the same sport, people living in the same town, and so forth. Some protocols, for example, are used by lawyers in a courtroom in communicating with the presiding judge, and by nobody else with nobody else.

For any one individual, there are categories of other individuals with whom different sets of protocols are commonly useful, and for any one of these sets there are many pairs of individuals who can use the same set of protocols to communicate. These skeins of available communicative links connect categories of individuals into close-knit groups we might call “clusters”, such as people in the category “lawyer” with people in the category “judge”. The larger the skein, the more close-knit the cluster, and the more likely it is that individuals in the cluster will have similar reference values for perceptions controlled through the use of the skein of protocols that define the cluster. The lawyer-judge skein and cluster is, for example, looser and less populated than is the “Greek-Speaker-Greek-Speaker” cluster.

We comeback to Roles as opposed to persons. The interactions between the persons who play the lawyer Role and the Judge Role are quite different than those between the same persons who who might discuss a recent soccer match over a drink at a party. The "skein" of protocols that the two Roles may use is smaller than the skein of protocols between the same two persons outside the courtroom. But a Role is nevertheless, like a person, an "object" in the Black Box-White Box sense. It is just a smaller object than any of the various people who may play it.

Roles, or at least the protocols they may use in different circumstances, are analogous to facets in the crumpling metaphor, just as perceptual categories are when the crumpling metaphor is applied to an individual. In the individual metaphor, a crease across a category facet distinguished two objects. Similarly, a distinction between two similar protocols can separate a Role played by a "person-object" into two better defined Roles, just as a difference between the value ranges of an analogue perception can fragment a category into distinct sub-categories. Remember that protocols differ only in the content they communicate. What we are saying here that protocol boundaries are defined by perceptual catgory boundaries in the two protocol partners.

Earlier, we talked about the difference across a crumpling crease between facet-object categories perceived by two individuals (I say it is red and you say it is blue) creating conflict, we did not emphasize that direct conflict is not only between two perceptions with different reference values for perception of "the same" environmental variable, as in the paradigmatic demonstration of conflict (McClelland, 1993). Conflict can be between two individuals who perceive the same Real Reality situation differently, even though they might have the same reference values for their perceptions of the "same" aspect of Reality. The crease (or bend) separates the individuals just as much as it separates the perceptual categories.

This conflict is manifest as misunderstanding in communication. Irene may ask Carl to paint something "red", but Carl doesn't do it. Instead, he may ask what object Irene wants to be red, because he perceives as already red the object Irene seemed to indicate. It may take a while before Irene and Carl determine that the problem is not the selection of object to be painted, but that they perceive the "same" spectral colour differently — that the object "is" not any colour, but in this light produces a perception of "red" in Carl, but not in Irene. The misunderstanding may persist even when Irene and Carl agree on what paint to use, if Irene suggests making the paint deeper red, less pink, or some other modification while remaining puzzled that Carl thinks the object is red when it obviously isn't.

Such misunderstandings increase the rattling locally within the Irene-Carl dyad, each subsequently being more uncertain than before about how the other may use a protocol and any Role that uses that particular protocol. Another way of saying the same thing is that each trusts the other less than they did before the red-paint problem arose, at least in their use of language to describe colour.

IV.1.9 Hypernode Analysis as a Measure

In the last part of Section II.1.8 we introduced the concept of hypernode analysis (Bjørke, 2006; Bjørke, Nilson & Varga, 2010), in which the in-link and out-link similarities among nodes (what other nodes they connect to) are used sequentially to form a series of ever less differentiated, larger, "hypernodes". Now we use the same Hypernode analysis to analyze similarities and differences between the categorical structures of two or more perceptual "crease patterns" — or rather, the dual networks of those crease patterns — that distinguish individuals such as Adam and Beth, among others. For the purposes of this discussion I call these dual networks the "individual networks" or "individual category networks".

The analytic process of building hypernodes is functionally the direct inverse of the facet-object fragmentation process represented by the crumpling metaphor. Starting with the smallest fragments,

hypernode analysis looks at how their configurations have been built from less fragmented larger facets. That, however is only one way we will use Hypernodes in a social context.

Crumpling crease formations within an individual distinguish categories of objects that person considers to be different with respect to a purpose. Two hard rocks may be “the same” if you just want to crack a nut against a boulder, but those rocks may be very different to a mining prospector looking for traces of cobalt, and different again to a prospector looking for gold if they are “the same” to one seeking cobalt. The purposes determine what perceptions are fragmented, whether it be hardness, fragility, visual flecks and stripes of colour, density, weight, or anything else in which the rocks might differ perceptually.

Bjørke (1996, 2003, 2006; & Myklebust, I., 2001), introduced hypernode analysis for the purpose of creating road maps that were appropriate to their displayed scale. Large scale maps would include very minor roads, while small-scale maps would show only major highways. Bjørke used mutual uncertainty (entropy) as a measure of difference in his algorithm. Ideally, we should, too, but since I am interested here in the concept rather than the algorithm, I will just refer to similarity or difference. We will apply it first to the two rocks, and then more generally.

In a hypernode analysis, the two rocks would be grouped more closely together, the more perceptual property value ranges the rocks share, the more closely would they be grouped together. The categories determined by the different possible uses of the rocks to different people might differ only in the precise perceptual values at which a particular category is fragmented in the minds of different individual users, but have the same label, as for the hardness range required for a sparkly sequin on a party dress as compared with the range required for a sparkly diamond to scratch glass, but the nature of the perception of hardness and the direction of difference between hard and soft is the same for both objects and for whoever is doing the perceiving. However, the perception of “hardness” is less relevant to a prospector for cobalt in the rocks than it would be for one seeking expensive gemstones embedded in the rocks.

In Bjørke’s road-map hypernode analysis, the utility of the map would be different for a farmer wanting to drive a tractor among the fields of a farm than for a commuter wanting to find a quick route between home and work, and different again for a long-distance truck driver. Different uses would carry different weights in the analysis, and the use of a hypernode analysis that took this into account would result in the generation of different categories of map, such as a tourist map of a city, a load-bearing map of routes for heavy transport, or a map of most scenic rural highways. The map as an object — an atenex — is defined by the atenfels it makes available for control of different perceptions by different categories of people, people playing different Roles.

The construction of a map for players of a particular Role may well not be optimum even for that Role, even when done using hypernode analysis. If the map is in electronic form rather than on paper, it is always open for improvement, and if its users provide feedback on what cold be better, collective control by the Role-players is likely to result in maps better fitted to their purpose.

There is an issue with this, however, which is the definition of who is a player of a particular Role that might want to use the map. As with most definitions, the answer is that it depends on whether you consider how much and for what different reasons one might use the map. Someone playing the Role of “farmer” probably knows the layout of the farm pretty well, and would never use a map of it. A map is used by someone less familiar with the farm, such as a family member living in the city, or a potential purchaser.

This problem suggests that hypernode analysis might be useful not only for grouping into categories the objects people perceive by the properties they control using those objects as atenexes, but also for grouping people into categories, which are Roles defined at different levels of precision. For example, at one level a person might be a medical person, at another a medical doctor (excluding, for example,

nurses), at another a surgeon, and at a yet more precisely defined level the person might play the Role of osteopathic surgeon. Hypernode analysis would group people into these successively refined Roles by the commonalities of what they do when interacting with the tools of their trade and with other people.

Over history, such roles begin very loosely defined. For many centuries in Western Europe the only "surgeon" was the barber. The Role could be defined as a person who would be called on to cut some part of a person, whether it be flesh or hair. At some point, these two possible categories of action began to be performed by different individuals. Much later, people who treated people with different kinds of ailments could be distinguished by whether they dosed patients with potions, cut into them to bleed blood out of them, cut into them to physically manipulate bones and joints, manipulate bones and joints without cutting, and so on and so forth, at every stage offering new networks of relationships among persons and tools that would be amenable to hypernode analysis.

If all this sounds much like the splitting of categories into sub-categories, it should, because when one looks at it historically, that's just what it is. But when one performs a hypernode analysis the analysis combines a base collection of individuals into ever *less* refined categories. The perceptual category fragmentation looks for differences, the hypernode analysis for similarities. Although similarity seems on the surface to be the opposite of difference, two objects may be different because of just one of their perceptible properties, to be similar they must share many perceptual properties and perceptual value ranges defined by category fragmentation. What makes objects, concrete or abstract, similar are unfragmented categories in common. What makes them different is category fragmentation based on the actions using sub-category ranges in control of a controlled perception.

The Bilateral Model Cooperative (BLC) of Reading (Taylor & Taylor, 1983) is based on just this split between precise difference and crude similarity. We suggested that the former was mainly performed by the left hemisphere of the brain, the latter mainly by the right. Now we see that these so-called "LEFT Track" and "RIGHT track" correspond to category fragmentation (LEFT track) and hypercard analysis (RIGHT track). In the BLC model, they work collaboratively in the brain. In later Chapters we will ask whether something similar might apply in the first principles modelling and analysis of social structures.

Just as the analogue hierarchy has levels with many-to-many interconnections, so does the category network. Small facets built from larger ones signify different consciously perceptual object types — categories of objects — and the same perceptual types may be properties of many types of objects. For example, most[1] tangible objects have the property of weight while their intrinsic property of mass is not directly perceptible. The Hypernode analysis would coalesce into single larger hypernodes packages of protocol properties (facets) that frequently co-occur as facets of a person-object. These packages define specialized collectives of persons, such as club members, academic professors or coal miners.

For example, Hypernode analysis usually would not, at an early stage, coalesce tangible objects with abstract objects, but it might coalesce them at a later stage when the hypernodes are mostly larger. Seen in this light, hypernodes may seem like ways of classifying classes of objects, and sometimes they may be just that. Other times, and this is our interest here, they coalesce people into hypernodes at many different stages in the analysis, because people with different experiences build different individual networks.

Our example "child brought up in the desert" knows nothing of what I know about the differences between major and minor city roads and their usage in "rush hours", or the meanings of patterns of white and yellow paint on the roads and red, yellow, and green traffic lights. Nor does a child brought up in a tropical jungle, but that child will perceive differences and develop categories that neither I nor the desert

1. Since weight depends on the gravitational attraction of a mass toward the Earth, it is seldom considered to be a property of objects moving through outer space.

child will ever have. A Hypernode analysis would coalesce us into a hypernode only at a rather late stage on hypernode building.

A large hypernode contains (or consists of) several smaller hypernodes — two in each minimal stage of the analysis for a large network with analogue-valued links, many accumulating over successive stages of the analysis. A large facet-object breaks into two facet-objects separated by a crease in one facet of the original facet-object after a minimal crumpling episode. After many experiences, the child's world is represented by many kinds of objects, each kind distinguished from similar kinds by the metaphorical separation of two range of acceptable value for one perception.

We can use the hypernode strategy to compare Adam's and Beth's individual category networks quantitatively. Each network now contains many fragmented perceptual value ranges, many of which are shared, some of which are not. At their bases and probably for a few levels above, we have assumed their perceptual control hierarchies were evolutionarily determined to be the very similar. At a high level, their different life experiences suggest that the details of their "crumplings" — episodes of discovery of different subclasses of what they had perceived as one category — would differ.

At intermediate levels we can see the effects of rattling and crumpling converge, rattling as a bottom-up creation of new perceptual functions from repeatable structures of existing perceptions. In the analogue perceptual control hierarchy of an individual, we have seen (Chapter II.5) how new levels build from old (the "chair" example) by controlling the higher level entity rather than the lower level components separately. The higher level has no intrinsic internal rattling, and therefore contributes less to the total rattling of an organization that includes perceptions of chairs than would separate control of perceptions of the components of all the chairs involved.

On the other hand, some child who had only experienced and learned to perceive chairs as wholes might not perceive that chairs all have consistent organizations of components such as one back, one seat, and three or four legs put together in a consistent configuration. Such a maturing child would build a "chair" perceptual function, and might fragment (crease by crumpling) the chair into classes of chair according to their different uses before perceiving that all these fragmented facet-objects — types of chair — have the same configurations of similar facet-objects — types of chair components such as legs, seats, backs, and perhaps arms.

Adam and Beth would have both gone through this process of what, in the context of learning to read, Taylor and Taylor (1983) called "three-phase learning", but Adam and Beth might not both have encountered the same kind of objects while growing up. For example, someone accustomed to sitting on a tatami mat might never have encountered a chair, and might not even guess how one was might be used if one appeared in their dwelling. In the other direction, if someone who had always sat on some form of chair visited a tatami-mat user's dwelling, and was asked to sit, might look around for a chair. Not seeing one, such a person might ask "Where can I sit?".

As we described very early in the book (starting in Chapter 4), experience in perceptual control through the environment determines what perceptual functions and what categories are built and maintained by effective perceptual control. By Chapter 11 we were calling the process "reorganization". Here we are at Chapter IV.1 still discussing reorganization, but now in a social context, trying to assess how similarly and differently two individuals might have reorganized and might continue to reorganize when we look from the viewpoints of rattling and crumpling.

"Three phase learning" is likely to occur at all levels of a perceptual control hierarchy. The issue of concern here is whether the second, "crumpling" phase is likely to result in similar facet creasings in both Adam and Beth. Considered without the contexts of their social and physical environments the answer is "highly unlikely". Their historical social contexts must be included. But this returns us to the question of

whether and why they might perceive some things categorically differently (or similarly) though their analogue values for the creased perception are the same.

When we considered that question earlier, we had not considered any historical contextual effects on crumpling. Now we can use the contexts of Adam's and Beth's individual histories. We saw an instance of the importance of historical context in the chair-tatami example, where each saw the same room, but one saw "sitting places" while the other did not.

In the original crumpling experiment of Gottesman et al. (2018) analyzed by Andrejevic et al. (2021) the crumpled "paper" was of uniform strength everywhere except along creases caused by prior crumpling episodes. When we use the crumpling metaphor for the "creasing" of facet-objects whose other properties may also be controllable in the analogue perceptual control hierarchy, the assumption of uniform resistance to creasing over whole domain is highly dubious.

Quasi-mathematically, the reason why the paper sheets all crumpled in different configurations of creases is that the paper is everywhere locally symmetrical across the sheet, meaning that it has no preferred location or orientation for the first crease. Some very trivial irregularity must break the symmetry and allow the crease to appear somewhere in the sheet. After the first crease, however, the symmetry is broken because that first crease does have a particular location and orientation, different for every new sheet of paper.

The facets on either side of the first crease retain the same kind of symmetry across their surface except near the boundary crease, which formed from an over-stressed bend. If one started with several new sheets and carefully replicated that first crease in all of them, the symmetry over most of the facets would suggest that for several creasing iterations, with replicas made at each stage, new creases would appear at different places and locations in every crumpling episode.The category creasing that influences the further creasing that emerges in a child's perceptual control as the child matures has no such wide-ranging initial symmetries that would randomize the early crease configuration of the child's development — the perceptual subdividing of a broad category into useful subcategories.

As we have said before, categories and sub-categories are useful only in that they differ from other categories and sub-categories in how they can be used in perceptual control, as atenfels for controlling other perceptions. Those "other perceptions" may be of the natural environment, in which case variations among environments will influence what sub-categories make a difference.

A child born into a desert environment is likely to perceive differences in types of sand that behave differently in the wind, differences that would be quite imperceptible to a child who grew up in a rain forest, a farming society, or a big city. The perceptual symmetry of sand is broken before the desert-born child experiences any crumpling pressure from the need to act appropriately in different conditions. Mother and other protectors eliminate that need for the most part, at least in reasonably stable families. But Mother and other older people already have a well-fractured "sand symmetry", and do not perceive all sand as "just sand".

The child's initial facet fragmentation creases will form where the environment biases them to occur, and will be broadly similar, though not identical, in most children brought up in similar environments. The same is true for social environments, though these are different for any two children, even genetically identical twins, whose environments were not identical even in the womb. The creasing metaphor now must use paper pre-crumpled in complex configurations of bends and creases that bias the ways creases are developed from the child's experiences.

With this understanding, hypernode analysis can be applied to Adam's and Beth's networks considered as a single organization, because their individual "creasing configurations" will have been biased by what they have learned through experience in similar or different kinds of natural and social

environments. The similarities, at least some of which were provided genetically because they are both of the human species, provide nodes that at some level a hypernode analyst would identify as the same, if Adam and Beth both linked to it in their individual networks.

Hypernode analysis provides the similarities in the way their networks cluster nodes similarly in successive stages of creating ever more compressed Hypernodes. The differences between their networks are shown in the links that remain after each stage of Hypernode building. The amount of similarity and difference can be seen in the depth of Hypernode development that must be done before two nodes in the personal networks merge into one Hypernode. Higher the proportion of nodes merged at each stage of Hypernode development, the more similar are the individual networks that represent the way an individual perceives the world.

Hypernode analysis was originally based on uncertainty rather than on simple identity or difference between two nodes in their patterns of links to other nodes. Now we have networks within individuals, networks of links that connect to common features of some space derived from the categories built by two individuals, and we can extend this last to collections of an indefinite number of individuals.

The Hypernode analysis then may have a stage at which entire individuals serve as Hypernodes, and the Hypernodes that are built indicate groups and organizations of groups of individuals. Quite probably, a very late stage in this Hypernode building process might result in two or three very large Hypernodes with perhaps a few maverick small ones. The implication is that there are social groups that perceive and act on the natural and social world similarly within the group but very differently between groups.

At this point we can leave consideration of the Hypernode analysis of groups formed because the large-scale creasing configurations of the members were biased by the natural and social environments in which they grew up. The smaller-scale creasing configurations will also be biased, but by social interactions in which differences in perceptions that cause side-effect disturbances will be “corrected” by collective control that tends toward rattling reduction, to which we now return.

IV.1.10 Rattling Interactions and the Environment

The environment, both physical and living, is seldom uniformly hospitable, no matter what kind of living control system we consider. Most land organisms need access to a water supply from which they can drink. Water usually can be found associated with flowing rivers that in some places expand into pools or lakes. Watering places are inherently dangerous, both from the probable proximity of predators and because of the probable encounters with groups of the same kind of organism who might be antagonistic.

In most regions that we do not classify as “wetlands”, the banks of rivers and lakes are a very small part of the total area of the habitat of most animals, which implies that land-based groups will tend to congregate much more densely there than elsewhere. The same is true for many birds, and of course water is where aquatic and amphibious organisms will be found. In other words, almost every living control system at some time or other must find drinkable water, with a few desert-living species as exceptions that find their water in what they eat. Only at the banks of these watercourses can most land-based organisms find the water they need if they are to survive.

Organisms liable to be eaten are likely to form well-organized groups subject to low internal rattling because of the beneficial kinds of interaction, particularly of Type 4, which are shields that can reduce the effects of particular kinds of disturbance, in particular the chance of being eaten while at a watering hole. Sometimes we call this effect “safety in numbers”, a name that describes an effect, not a mechanism. The mechanism is the reduction of rattling associated with the ability of each individual to drink more freely

than might otherwise be the case, because of the shielding provided either deliberately or inadvertently by other group members. Predators are usually fewer in number than prey, so in a group of prey, the predators may eat a few, but most remain untouched.

For primate groups, including groups of humans, the situation at watering places is similar. If isolated groups tend to move apart and to experience increased disturbance when members of different groups meet, gathering at watering places is likely to involve conflict. Each group controls for access to water, and at the same time for avoiding the other group. If few such groups exist, maybe one of them could find a different watering place, and each could treat one of them as "ours", a possession owned by the group as a whole as a "Grazing Commons" (Section III.10.2). If not, and several groups of necessity share the same watering place, it might become an overgrazed commons with an ever diminishing water supply, as is the case for many river-supplied cities in dry surroundings such as the southwestern USA, as well as agricultural regions that use water pumped from subterranean aquifers today.

In Volume 1, we referred occasionally to the concept of tolerance. In connection with rattling, we treated tolerance rather like glue or friction that dissipated some of the rattling energy from a disturbance that would otherwise need to be countered by directionally opposed energy from each control loop it influences. Without tolerance, control of the many controllable perceptions would lead to much internal conflict because of limitations on resources such as the individual's number of hands. Now, dealing with social interactions, this considerations does not apply, but tolerance becomes even more important as a means of reducing rattling of the organization by interactions among the individual living control systems that constitute the society.

We may still consider tolerance as analogous to friction in that it dissipates uncontrolled energy introduced by disturbances, but it can also be seen as a direct means of lowering the rattling effects of interactions. These are the same thing seen from different viewpoints. Tolerance lowers the rattling effect of the disturbance on the error signal of even a single control loop. When we consider rattling of the complex organization that is an individual social being, evolution and reorganization jointly have brought the individuals of the species into a low-rattling local optimum in which they tend strongly to control in ways that maintain their individual biochemical homeostatic dynamics within survivable bounds.

This local optimum in the rattling "landscape" is different for different species, but for each species can be taken as point in the very high-dimensional "landscape" space. Tolerance is likely to be a substantial factor in the survival of organizations within a larger ecology. Intolerance leads to high rattling, a condition away from which organizations tend to diffuse.

As we also saw in Volume II, attainment of a low rattling optimum and a long-term equilibrium state for an organization does not imply that each individual organzation member is in a low rattling state (Chvykov et al. 2021). Instead, there is a distribution of rattling states that resembles a declining exponential, with most individuals experiencing low rattling, while a few who form the long tail of the distribution experience high rattling values. The same is likely to be true of most distributions we examine, including the distribution of tolerance values within the control systems of a living control system and the distribution of average tolerance values of the individuals in a group.

If we now consider gatherings around watering holes that are shared by different species, some of whom would like to eat others, a stable arrangement of the relationships among the individuals must develop over evolutionary time. The predators cannot permanently occupy the watering holes and simply wait for the prey, because the prey would tend to go to other, less desirable, watering places, removing the food source for the predators. The same would be true among antagonistic groups of the same species. Apart from separation, one of two approaches to low-rattling would be likely to happen over time, time-sharing or local truce.

Again we have the likelihood that the low-rattling optimum will approximate an exponential distribution of localized rattling, whether of individuals or of subgroups that internally are little rattled. Not all predators will time-share faithfully, or participate in a truce. Some will be likely to “go rogue” and eat their fill of thirsty prey, while not all prey will be eaten if they go together to drink. But a few prey will not conform and will experience high rattling, of which the highest level is experienced by the prey individual that goes alone to drink and is eaten while doing so. Looking from outside, we might call such an animal a “risk taker”.

Again, over all the different species we might expect their average “caution” to conform to a quasi-exponential distribution, some species on average being more liable to risk-taking or unpredictable aggressive behaviour, while most tend toward caution and temporary tolerance.

These tendencies should be expected to apply to both time-sharing and truce. So long as the low-rattling equilibrium exponential distribution applies, a few members of whatever the distribution covers will be mavericks, controlling their perceptions differently from the majority of their group. In the solid-liquid-gas metaphor, the mavericks are the gas molecules that hover as a vapour over the mass of liquid or solid. They are rare, but important.

The maverick predator may eat a maverick prey animal that is controlling for perceiving itself adequately hydrated in safety. For the maverick prey animal and for its nurturing parents, drinking had always been safe, because of the low rattling optimum created by time-sharing or tolerant truce, but in that “always” stretch of time, the maverick prey animal had never encountered a rogue predator. Both are few among the many followers of the customary modes of predation and hydration, alone or in supportive groups, and the mavericks have results that differ from the customary results.

Chapter IV.2. Social Ecologies and Tipping Points

The difference between separating individuals and separating categories is not subtle. Individuals are active entities, living control systems who can perceive each other and act on each other, as can the "smarticles" of Chvykov et al.(2021). Categories cannot, even if they are categories of individuals. They are abstractions with no active ability to change their environment. But what of collectives, rather than individuals?

In this Chapter we examine effects of rattling and crumpling in social ecologies on both large and small scales. We start with the social equivalent of what palaeontologists and evolutionary theorists call "punctate evolution", and like to treat as a problem. We see it not as a problem, but as an almost inevitable consequence of the autocatalytic creativity discussed in Chapter II.2.

Later in the Chapter we focus down on smaller social units, including the family, and we see how rattling reduction and crumpling can generate social tensegrity. We deal with the rattling reduction created by the existence of roles and Role networks, and with Collective Control and semi-formal organizations. We start with a general discussion of Phase Changes and their application to the history of social evolution.

IV.2.1 Cultural Phase Changes: Social Punctate Evolution

Up to this point, we have talked about the sudden effects of autocatalytic and homeostatic loop closures as a whole. But what does such a loop closure do to the elements and complexes of which such a loop is composed? Does it cause shock waves, or does it pass un-noticed until some time later? Let us talk a bit about phase changes themselves, since not all are created in feedback loops.

The idea of a Phase Change probably comes from the freezing, melting, boiling, subliming, or condensing of tangible material such as water. For millennia people have known about these changes, in which a body of water suddenly becomes a solid (in cold climates) or boils away into visible steam (when cooking over an open fire). It must have seemed somewhat magical for a new hard and sharp material to appear out of nowhere, like Macbeth's dagger, when before all that might have been visible was some wetness from rain water.

But of course, none of it is magic at all, once you understand that water in any of its forms is composed of many molecules, and that "temperature" is determined by how fast these molecules move around bumping into each other. Molecules or atoms of any single kind may at different distances attract and repel each other, so when they move very slowly these combining opposed forces are likely to hold an individual molecule into a low-energy "potential well" like a geographic valley or a shallow bowl, as part of a regular structure we sometimes call a crystal.

Once the crystal begins to form because enough of the molecules are moving slowly enough to permit some to take on a regular structure, that initial structure will favour others falling into step if they are not moving fast enough to escape the potential well in which they find themselves. A molecule can settle for a while in its individual potential well until another molecule hits it with sufficient energy to drive it out into the open again. When the temperature is low enough that more molecules will settle into potential wells than will drive out molecules that previously settled, the water is in the act of freezing out of its liquid or gaseous form (which depends on the ambient pressure).

Freezing is one kind of phase change. It happens as a result of environmental change, external to the material whose phase changes from liquid to solid. Heat is transferred to or from the material to somewhere else. The phase change we are interested in is of a totally different kind, affected by internal

interactions, possibly but not necessarily together with environmental effects. Nevertheless, this second kind of phase change has a very similar observable effect as does freezing a liquid — restricting subsequent changes in its elementary components.

What we are talking about here is the closure of an autocatalytic or homeostatic loop in a "soup" of preexisting components. When closed, such a loop has the emergent property of stability, together with the creativity we discussed in Chapter II.2 and Chapter II.3. None of the component processes that together form the loop necessarily have those properties though they might have, if they are themselves closed loops of simpler constituent processes (Section II.2.4).

The closure of the loop can be seen from outside the loop, but not necessarily from inside it, in one of its components. The components are unlikely to be individually affected by the fact of loop closure. They came together to form the loop because they did what they do, and if they changed what they did, they would no longer fit the same way into a stable loop. As Kauffman (1995) pointed out, the components don't all form individually into a stable loop. As part of the process many will form and re-form into variable clusters of components that work comfortably together for a while before disturbances from their environment act to break them into smaller clusters. It is such clusters that finally come together to form the complete loop.

In Chapter II.2, we talked about the formation of such loops as "constructive revolutions", which, seen in retrospect, they are. The inventive creations they may produce are often like nothing seen before, even though their precursors may have been "inventions before their time", such as the toy steam turbine and other inventions demonstrated or described by Hero of Alexandria[2] in the first century C.E. Those creations did not come together to form stable loops, any more than did the aeronautical designs of Leonardo da Vinci 1500 years later.

For Leonardo, one missing part of a stable aeronautical loop was a light, compact, power source. Another was a source of light but strong supporting materials. He nevertheless was able to design a functioning hang-glider. But none of his aeronautical inventions were developed over the next five centuries into the 2000s, and the aeronautical revolution had to wait another four centuries before a stable creative loop of required elements were available to the Wright brothers.

The phase changes of autocatalytic loops, both sociological and technological ones, turn out to be prominent in the history of the last several thousand years of human history, the research field of archaeology. Archaeology is the study of ancient, often prehistorical, human existence, largely over around the last ten or fifteen thousand years, because the hints of earlier human existence that remain today are relatively few and far between. Much older, and the study begins to be called palaeontology. Over this last few thousand years, what can the many "digs" scattered over the world tell us, and can PCT coupled with rattling theory and the crumpling metaphor explain why they find what they do?

Archaeologists worldwide have found signs of human life in almost every region of the Earth's land surface and nearby environments now underwater. They are unlikely to find the ephemeral traces of gatherings at watering places until some such gathering becomes at least semi-permanent. Traces of nomadic groups are distributed over the landscape that might have been traversed by the small family groups mentioned above, and might be in the form of isolated objects lost or discarded by the travellers. Some would be clustered around frequent gathering places such as watering holes, where even nomads would need to gather occasionally.

More detectable would be traces of the effects that dangerous nomads might have had on the settlements of more sedentary groups, such as habitations associated with crop agriculture and drinking places. Villages are unlikely to burn to the ground because of accidental fire. But such singular events do

2. See <https://en.wikipedia.org/wiki/Hero_of_Alexandria>

not provide much evidence about the ways of the nomadic groups beyond their interactions with habitation clusters like villages.

Let us ignore what archaeologists cannot easily study, and ask about the evidence they have accumulated worldwide, in light of different considerations we discussed both about PCT and about rattling. In Section II.2.4 we introduced the concept of "revolution" as a consequence of autocatalytic invention. There, we introduced the "Seshat" database of worldwide archaeology (Turchin et al. 2018). Seshat contains evidence that no matter where in the world the archaeology is done, the same or very similar clusters of rapid changes are found together.

According to Peregrine (2017), using 15 features from Seshat in a Principle Components Analysis, two principal components stand out: Regional population density is strongly loaded on the first, and technological development on the second. I will label the first two principle components with those names, even though others of the fifteen criteria also contribute to their values.

Using just those two dimensions to describe what is really a rather high-dimensional descriptive space, a very similar pattern of punctuate evolution of society occurs all over the world, though any specific evolutionary jump occurs in different places at very different times. In very early times, characterized by Peregrine as more than 10,000 years ago, population densities are low, technology is very limited, and there are few or no fixed habitations.

As time continues, a jump occurs at much the same population density in each region. As population increases, so does technology, and the different populations at different times arrive at a state Peregrine calls "Cluster A", characterized as "*sedentary, agricultural, and inegalitarian but non-state. These reflect the creation of a new adaptive peak based on agriculture.[…]As agricultural lifestyles spread into new environments, and societies faced the emerging challenges of sedentary life, variations with conflicting constraints appeared, reflected here in a rugged adaptive landscape. One of those new variations was the new peak that emerges between 2000 and 4000 years ago— a new peak representing the simple states[3] of Cluster C*." (Peregrine, 2017)

Peregrine also notes that in the most recent time-slice, at 2000 years ago, there is a hint of an emerging Cluster D, with higher population more advanced bureaucracy, more formalized laws, and advanced technology. His analysis does not reach the time of the Industrial Revolution in Europe. Cluster C, however, has already incorporated a jump in structural formality, encompassing written laws and the means of enforcing them in addition to the earlier less formal moral authority of the Collective.

Peregrine's "Clusters" within his 200-year separated time slices do not imply that all the global archaeological sites reached the same stage simultaneously. Quite the contrary. They imply that when a society grows to a certain population density level, its probability of jumping rapidly to a new stage increases, and when it does jump, it jumps to the same relationship between population density and technological advancement (with a slight variation in Meso-America).

In Section II.2.2 we applied Kauffman's (1995) catalysis-to-autocatalysis population argument to the establishment of novel self-stabilizing homeostatic loops. Put simply, the argument is that however unlikely some class of event is to occur, if there are enough opportunities, it will almost certainly occur eventually. Kauffman considered the interactions among elements or molecules in a primeval "soup", and considered the likelihood that among the 92 chemical elements there are 8,464 possible pairwise reactions involving exactly two atoms. Many of these reactions will occur, even if very rarely in some cases, as will subsequent reactions that add another atom to make a three-atom molecule such as H_2O, water, or KCN, Potassium Cyanide.

3. By "state" Peregrine refers to a particular kind of political system that defines an Authority or aristocracy, and that includes a bureaucracy and formalized rules of behaviour.

Considering the 92 elements and their 2-way and 3-way possible reaction products, it may be very unlikely that any specific element or product will catalyze (increase the reaction rate of) any specific reaction, but almost inevitable that some few will catalyze some reactions. When that probability increases to a point where stable autocatalytic loops appear, as they almost certainly will, a kind of phase-change occurs, in which the autocatalytic loop is stable so long as the feedstock is not totally depleted.

In Section II.2.2 we applied Kauffman's argument to creative processes in other domains, in any of which one invention adds new possibilities to a "soup". The invention might be technological, as the word implies in general conversation, but it might be in other areas such as in human interactions. In the last Section, we discussed how this would be likely to work toward rattling reduction when ordinarily isolated groups interact in the dangerous concentrated environment of a watering place.

Rather than "rattling" each other by conflicts, the tendency toward an equilibrium state would be toward reduction in direct effects or side-effects of control actions on each other's controlled environmental variables, those Type 1 mutual effects would be diminished while effects of mutual shielding from rattling (Type 4 interactions) would be enhanced. For example, one group might post a lookout to spot the approach of a predator, who could reduce the overall average rattling by alerting both groups rather than just the group to which the lookout belonged.

Watering holes are places of high population densities. The Seshat analysis described by Peregrine (2017) considers average population densities in people per square mile (or kilometre) over regional scales. Contributing to that average, though, are wide variations in local densities, from the extreme density of a few families travelling together to the zero density of large areas with no human inhabitants at the moment of interest.

It is within the small areas of high population density that autocatalytic invention is most likely to occur. At the moment (say from the mid-1980s through 2020 at least, consider the rapid hardware and software advances emanating from Silicon Valley in the USA as compared to the relative technological lack of invention in rural regions of the central US plains. In the late 18th and most of the 19th centuries, the creative regions might have been west-central England for mechanical invention and London for financial invention.

It seems not unlikely, as of 2020, that the centre of invention in the world will be in the densely populated regions of China and India. Furthermore, if we follow the example of older phase changes, the core theme of a new innovative homeostatic loop will not be the application of new forms of silicon technology, but something quite different.

Nevertheless, Alphonse Karr's[4] epigram "*plus ça change, plus c'est la même chose*" seems to apply from the mists of archaeological antiquity through the present, or, if the thesis of Section II.2.2 is at all correct, from as far back as the beginning of life on Earth. Evolutionary jumps, whether in biological, social, or technological, etc. domains may all stem from the closure of autocatalytic homeostatic loops.

In the case of the Seshat database, at least as analyzed by Peregrine (2017), the first big jump involved a creative homeostatic loop that incorporated at least these variables (Peregrine's labelling): *Ceramic production, Presence of domesticates, Sedentarism, Inegalitarian (status or wealth differences), Density > 1 person/mi^2 specialists*[5]*, Reliance on food production, Villages > 100 persons.* The "Villages over 100" variable is usually but not always included in the first jump, which I think is fair to call a phase

4. https://en.wikipedia.org/wiki/Jean-Baptiste_Alphonse_Karr

5. The word "specialists" seems misplaced. In Peregrine's list of specialties, he includes both Ceramics, appropriate to this first jump, and Metal Working, which is not, while he does not include agriculturalists, who seem essential to his variable "Reliance on food production".

change in social organization. The point here is that it is no stretch of the imagination to see how the existence of each of these factors helps support or requires the existence of at least one of the others.

To be a professional shoemaker, for example, one needs access to a tanner and a maker of specialized tools. But as we saw when we first discussed a phase change involving the appearance of new levels of side-effect loops, there are always precursor structures. These are inventions that will be likely eventually participate in a new homeostatic loop, but appear "ahead of their time" and are ignored or actively opposed and dissipate into the mists of time. Such ahead of their time inventions are ahead of their time because they do not support other structures currently "floating in the soup".

The steam turbine of Hero of Alexandria in the first century CE was a pretty and amusing toy, but not an engine that could be applied to do anything useful at the time. It was nearly two thousand years before steam turbines were used in a stable technological ecology, but when they were, they used exactly the same principles as had been used by Hero.

Consider villages, for example. No doubt individual early hominids constructed shelters against bad weather and nest-like structures for sleeping, just as do most great apes today. If they were travelling in clans of family groups, such structures would be as mobile as today's Mongolian yurts, assembled when the group collectively controlled for staying in some place and deconstructed whenever the group collectively controlled for moving.

Why might such a group move? Perhaps because of depletion of their local food resources, perhaps because they used domesticated animals that needed to change their grazing areas because of seasonal variation. Whatever the reason, a group of portable shelters as light as yurts is unlikely to yield much archaeological evidence about the social structures of the group. If, however, the group does not move as a whole, it might be useful to them to build more permanent structures, and these might well leave archaeological evidence that is reported as being traces of a small village.

Earlier we emphasized the importance of potable water to all living control systems, humans not least among them. The most likely place for a settlement (a place where people settle, a calm place of low rattling) is where the inhabitants as a group can control access to fresh water. They collectively, though possibly not individually, may control a perception of that stretch of river bank or oasis access to be "ours". It would be a "grazing Commons" (Figure III.9.2).

For a possession to be "ours", it cannot be "mine" to any individual member of the group. It is a collectively controlled perception, controlled by a Giant Virtual Controller (GVC) that exists within no particular individual group member, but that is the result of many group members each individually controlling some related perception. The existence of a static village is one observable result of several group members controlling for being there rather than for moving from place to place as the food or water supplies become depleted.

A necessary requirement for the group to remain stationary for years at a time is that they continue to be able to access food as well as water. One of the Seshat variables associated with the first big cultural jump is called "*Reliance on food production*", or agriculture. Whereas an individual or small family group might be able to live indefinitely on wild resources within hunting and foraging range of some fixed place (an underused grazing type of Commons), a larger group might soon find the resources depleted (an overused grazing Commons).

Collectively controlled agriculture increases the growth rate of the local food Commons, but requires (as well as being required by) a stationary cadre of farmers among the group. These might be family members looking after a small garden plot for feeding themselves, or they might, after a phase shift, be professional farmers producing food for the community members. Both before and after a phase shift that supports specialization, agriculture requires a water supply, just as does every individual group member.

Vegetation is not the only source of food for an individual family. Humans are omnivores, and eating other animals and fish is an effective energy source, attested by palaeontology to go far back in human evolution. Hunting is a specialized ability, but animal food is more reliably obtained from a domesticated herd. The beasts of the herd, like their human predators, need water to survive, and since herbivores are safer for their herders than large carnivores, the herds will also need grazing land, which requires water. Large stationary human groups may not have been the first to domesticate grazing herds — nomadic herders still exist today, and presumably existed before some groups took up a sedentary agricultural lifestyle — but the existence of domesticated herds would have resulted in lower rattling caused by variations in food availability than would a reliance on hunting wild game.

We can use similar intuitive arguments to explain why a tendency toward low rattling combines with commonly controlled perceptions to produce similar suddenly stabilized clusters of inter-related effects (ecologies) in so many widely separated parts of the world. Each of the mutually supportive relationships might have occurred by itself, but only when the results of one support another, as, for example, agriculture might support herding of large herbivores, and the links of support form a homeostatic loop, would they together produce an explosively rapid burst, a revolution, of cultural practice.

Homeostatic loops are by their very nature cradles of invention (Chapter II.2), and some invention would have been necessary even before completion of any loop. Agriculture requires people with specialized knowledge of the difference between foraging for, say, grain now and producing it for storage over the non-growing season. Beast-herding requires someone with specialized knowledge of interacting with the wild form of the beasts to bring them into an accessible herd. Today's use of reindeer by Laplanders in the north of Finland is a vivid example.

Returning to the theme of phase shifts and the development of roles, we have seen that the development of specialties goes hand in hand with the development of roles. Whereas, for example, any household with access to clay and a fire could mould a form of pot in which to make a stew, some might make better pots than could other home-potters. To impress someone you had invited to dinner, if you knew that the Clay household produced particularly pleasing pots, you might go to them and trade something for one of their pots to use in front of the guest. That transaction would be with a person, the Clay family's potter, not with an as yet nonexistent Role labelled "Expert Pot Maker".

Madam Clay might teach her children to make especially nice stew-pots, and when they grew up and had families of their own, many of them would also be able to provide nice pots to other villagers. It might not matter to a villager which Clay child produced the nice stew-pot, but their pots were all nicer than home-made ones, so why continue to make pots at home when you could get one from one of the Clays? A "Clay" would have become a Role rather than, or as well as, being a person in the village who could reliably trade you a nice pot in exchange for some other benefit. At this point, a "Clay" need not be of the Clay family, nor need all Clay family members be adept at potting. Many names in English-speaking places suggest that some ancestors had a specialized skill — Carpenter, Taylor, Plowright, Brain, or Farmer, for example, few of whom now ply the suggested trade.

The same kind of transition between being interacted with as a person to being perceived as a Role-player would lower the rattling experienced by both the "Clay" and the person who, to the Clay, would be playing the Role of "pot-wanter". The organization of the village would trend on average toward an increase in interactions between simple Role-players rather than between the more complex persons playing the roles.

In Section III.3.1 we treated Role-playing as a means of controlling a perception of oneself as belonging to a group and being trusted by the members of the group to act like a group member. The approach to Role-development taken here seems at first sight very different. There is no need for any of the different "Clay" pot-makers to perceive themselves as part of a group that has any particular within-

group interactions, as opposed to interactions that might occur between them as persons belonging to the same family. They may well be perceived as playing the "pot-maker" Role by people playing (as they perceive them) the Role of their clients, but they may not perceive themselves as belonging to a "pot maker" group. Nevertheless, if a potter does present herself as a "Clay", but is relatively unskilled, the quality of her pots might reduce a pot-wanter's trust that a random Clay will produce a nice pot when asked.

The individuals who play the pot-maker Role may be in competition but are not necessarily in conflict, because there is no environmental variable over which they have direct influence. They compete for the trade when someone as yet unknown will come to one of them to ask for a pot, but they have no direct control over which of them that future client will ask. They control only their own pot-making, at least until a new "advertising" specialty comes into being.

Initially, the place that will be taken by advertising is occupied by word-of-mouth reports of their skill *as a pot-making person*, not as a Role. When some future person plays the Role of "pot-wanter", the different pot-makers control for that future unknown Role-player to come to them, not to any other pot-maker. They must make either better pots than the competition, pots that trade for less valuable barter goods, or invent pots of a new kind that allows a client person to control some different perception. Perhaps they might make a pot that works better for brewing beer than does the stew-pot all the other pot-makers are making.

If the new beer-brewing pot catches on with some (as yet unspecialized) beer brewers, other pot-makers will start making them, perhaps slightly differently so that they are in some way easier for the beer brewers to make good beer. Maybe the people who acquire the new and better beer-pots and learn to use them most effectively can begin to trade their beer, rather than having everyone brew their own beer at home. Thus begins a new specialty, one invention building on another and over time improving it.

Every such stage is, on average, likely to reduce the combined rattling experienced on average over the whole village, as the new specialist and client Roles usually make life calmer for both. Each uses less energy for control if someone else controls that perception by way of communication protocols. The florescence of technological invention, however, cannot continue long unless the village population increases, because a given population can control for the benefit of the society only the limited number of the perceptions that must be controlled in order to make a limited number of different useful things.

Most of all, there is a less obvious specialized requirement, for someone who can perceive and control the deployment of the abilities of the various group members to the collective needs of the group rather than of themselves. The very occurrence of the cultural phase-shift requires such a specialty, a specialty we call "leadership" or "management".

Technology and specialization can increase the intensity of use and the variety of Roles only if the population is sufficient. But when technological intensity and variety increases sufficiently, new homeostatic loops, technological loops, will form, leading to previously unlikely inventions built on those already stabilized and made available within each new loop They create localized cultural phase shifts that will be similar but not identical in different parts of the world, depending on the regional environment. Whatever and wherever they are, they are likely to increase the speed and variety of change quasi-exponentially, eventually, after reaching some threshold rate of change, increasing rather than decreasing individual and thus organizational rattling.

Rattling and PCT seem, at least qualitatively, to account for much of the archaeological data analyzed by Peregrine. But Seshat offers much more, and the question remains as to whether Rattling and PCT can account for what Seshat may yet reveal as its scope grows.

A specialty not mentioned by Peregrine is that of warrior. In Section III.8.3 we argued that because random interactions are far more likely to be of Type 1 (disturbance-augmenting) than of Type 4 (shielding), the approach of both unknown individuals and unknown groups would probabilistically increase the average local rattling within a group. A stationary group in a village would presumably collectively control for maintaining its food and water supply, whereas a nomadic group might collectively control for seeing those supply sources as atenfels to help its control of the needs of its own members. The two groups would be in a conflict over a common CCEV.

The stationary village would need specialized defenders, whereas the nomads would require specialized means of overcoming the defences. Good defence means reduced rattling in the village while denying the nomads the means of reducing their group rattling, while good attack implies reducing the rattling average over the nomad group while greatly increasing that of the village group, to the extent that the village culture, and perhaps its physical structure, might be destroyed utterly. The cultural homeostatic loop of the first "great leap forward" that created the village would be broken.

The situation described here forms the plot of the Japanese movie by Akira Kurosawa originally distributed in the USA as "The Magnificent Seven"[6]. In Kurosawa's film the village did not have specialized warriors, and the villagers were not acquainted with the ways of warriors, so they were subject almost annually to raids by nomad warriors controlling for possession of the village crops. The village hired seven specialized warriors called "samurai" to defend them against the anticipated next nomadic attack. These samurai succeeded as village defenders, breaking the cycle of repeated nomadic raids.

Added rattling caused by conflict would not be inevitable when a stranger tries to enter the little village either individually or as part of a group. If the supply of whatever resources the stranger or strange group requires is plentiful, the village group may experience very little added rattling by tolerating the stranger's use of their supplies. They might even find that the errors in their individual self-self-perceptions are reduced by giving away their surplus resources to the needy strangers, as a moral imperative. The villagers might as a result feel less error with their controlled self-perceptions (both kinds) as well as experiencing lower rattling when they collectively perceive the strangers becoming friends rather than potential antagonists.

The aliens as a group likewise experience less added rattling if they are able to negotiate with the villagers to their mutual advantage, each being able to control better overall (thereby increasing their joint worth) as a result of the trade. If this mutually beneficial trade occurs as a PCT trade motif, it also reduces the rattling of a conceptual organization that incorporates all the members of both groups. The groups become "friends" rather than "foes".

Remember always that better control or increased tolerance of any perception by any individual implies less rattling experienced as an uncertainly variable velocity of change in error for that perception. Both good control and wide tolerance of deviation between reference and perception reduce the average variance of the error variable in that control loop. The mutual support connections that form the cultural homeostatic loop that "flashes" into existence at the phase shift also, after a brief rattling shock, reduce the average rattling experienced by individuals who are components of the loop. Briefly returning to the solid-liquid-gas metaphor, some component of a multi-component liquid has frozen, while other components in the mixture (of perceptions that might be controlled) remain fluid.

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6. Kurosawa's film was retitled "The Seven Samurai" for US distribution after an American remake was given the original English-language title.

IV.2.2 Long-term Cultural Stabilities: Battle of the Sexes

Can PCT explain why countries in the northern part of Europe are more likely than those in the south to have female political leaders? I believe it can, but to show how it may requires a long story, extending over several millennia of the solar insolation cycle's effects on regional climate. I call my explanation a "Just So Story" because much of it is neither supported nor (so far as I know) refuted by academically accepted evidence, though it may not always agree with published interpretations of that evidence. All my sources are secondary.

In using these sources, I have tried to avoid the what appear to be main theses or hobby horses of the authors. I do, however, take note of secondary observations that seem to correspond with those of other authors. In other words, I have sought the conceptual equivalent of homeostatic side-effect loops that extend through these sources. Linguistic analysis, largely of proto-Indo-European, also adds to the story. With those caveats, here is my Just So Story of a conflict between two cultural stabilities that seems to have lasted some five or six thousand years, and that was initiated by a regional climate change due to shifts in solar insolation patterns. We call it "the Battle of the Sexes".

We can start in any of many places in deep time, perhaps 8000 years or so ago, shortly after the establishment of the agricultural revolution in the Fertile Crescent that ran from the Levant through what is now northern Syria and along the valleys of the Tigris and the Euphrates to the Persian Gulf. At that time, the Sahara desert, Arabia and Mesopotamia were much wetter than they are today. The Sahara was a savannah with lakes and rivers akin to today's Serengeti. The Nile was probably an especially fertile valley, and Mesopotamia (the Land between the Rivers — Tigris and Euphrates) was also fertile, if locally swampy. The rivers were not the only source of water for vegetation. as they were subject to an annual monsoon.

The general form of religion was what is sometimes called the Goddess religion, apparently a misnomer. Then, as now, the visible Universe had three divisions, the sky, the surface of the earth to a depth accessible to human activity, and the subsurface where the roots of most plants live. Humans could act to influence what they perceived on any exposed surface, whether the exposure was natural or was caused by human (or animal) digging. Humans could control their perceptions of the surface and of events on it, at least to some extent.

At that time, humans could not act to influence either the sky or the subsurface. What happens in either part of the Universe might have results perceptible on the surface, such as vegetation that grows from sub-surface roots, springs that emerge from underground, and so forth. These, like the menstruation of women, are cyclic events, as is the waxing and waning of the moon. It was natural for cyclic, predictable, underground events to be associated with women, and hence to be under the active control of a female power, or Goddess. On the other hand weather might one day be a pleasant sunshine, on another a killing blaze of sun, a soil-replenishing gentle rain. or a torrential downpour. These erratic and sometimes violent possibilities we call "weather" were the natural domain of a male "Sky God".

Both Sky God and Earth Goddess were associated with avatars. For the Goddess some avatars were rivers with their annual flow rhythms, egg-laying birds, who laid their eggs in Spring, monsoons as opposed to showers. The predictable cycles of these events contrasted dramatically with rainstorms controlled by the Sky God. Spring and Neap tides were governed by the Goddess's Moon, and so forth (Gimbutas, 1984, 2001). Humans could not directly influence any of this, since their domain was to work on the surface of the land rather than either above or below the surface, but maybe they could ask the God or Goddess nicely and perhaps the deity would oblige. Humans would not know what "nicely" implied, but if there was a drought that broke after they had, say, performed a rain dance or offered the deity a sumptuous meal, maybe the deity would oblige again. The triadic division of responsibilities of

who controlled what made as much sense as any other explanation of the natural world at the time. Sometimes this arrangement is today called “animism” for the many avatars of the God or Goddess.

If one can call the rituals of supplication by the surface-controlling Humans to the Sky God and the Earth Goddess a religion, I would prefer a name like “Trinitarian” if that name were not used by a branch of Christianity. So let me call it the “Old Religion”, which includes animism in the forms of the avatars of the Goddess and God.

Men performed their rituals for communication with the Sky God on high places, culminating in the great pyramidical ziggurats that created high places on densely populated flat terrain. Women performed their rituals of communication with the subterranean Earth Goddess in underground places, often natural caves hidden from the men. The Goddess was responsible for the cycle of birth and death, whether of plants or of animals. Good things as well as bad came from both Sky and Underground, rapidly changing in and from the sky, but more slowly and rhythmically from Underground. The rapid changes that enhance rattling measures were, paradoxically, normal when caused by the Sky God or his avatars, while the predictable rhythms of life and death would have less uncertainty so long as the rhythms remained undisturbed as humans would perceive them. Neither source of variation would much change the organization of society

Into this long-lasting arrangement of perceptions and their control by humans, either directly or through one or other deity, comes climate change induced by slow solar insolation changes. No living thing lives long enough[7] for even stories of earlier similar times to survive, so nobody understands that this, too, is cyclic. But the slow changes of insolation can produce rapid changes of climate as a result of earthbound events such as floods from broken ice-dams or shifts in storm tracks.

The effects are unexpected, and rattling. The pastoral Sahara and regions along the same latitudes dry up as the monsoon tracks shift their latitudes, providing rain elsewhere. Clearly the Goddess was reneging on her responsibilities continuing with her control of death, but not of birth, at least for vegetation. That would be, to say the least, unexpected. Why would she do that? Obviously, the way women have been asking her in their underground rites must have annoyed her, so that she withheld her monsoon and destroyed her annual bounty of food in the unnatural drought. Physical evidence attests to a 200-year drought around 2000 B.C.E, with a global distribution, but this is probably not the drought that would have affected the perception of the relationship between women and the Goddess.

There was an earlier drought connected with the drying of the Sahara some 2000 years earlier, before the population of the region had collected into fortified cities. This might have been the so-called 8.2 ky event at around 6200 BCE: “*In West Asia, especially Mesopotamia, the 8.2-kiloyear event was a 300-year aridification and cooling episode, which may have provided the natural force for Mesopotamian irrigation agriculture and surplus production…*”[8] By the time of the invention of cuneiform writing and the use of that writing for heroic sagas, those epics that have come down to us via Assyrian transcriptions were records of old legends, often about the ancient city of Eridu and its then ancient hero-King Gilgamesh.

These epic sagas are heavily, but not exclusively, weighted toward stories of war between city-states and individual heroics. They name the heroes. But notice — Sumeria is in southern Mesopotamia, and such stories do not appear even in later cuneiform tablets dated about 2350 BCE from more northern regions where the land remained fertile, such as the 17,000 tablet fragments (since reassembled into 2500 complete tablets) discovered in the bureaucratic archives of Ebla (near what is now the Syria-Lebanon-Israel border), or in the Assyrian archives relating to trade with what is now Turkey (a millennium or

7. Around 27,000 years.

8. https://en.wikipedia.org/wiki/8.2-kiloyear_event (Retrieved 2021.10.02)

more before “The Assyrians came down like a wolf on the fold”). Trader correspondence talks about such problems as the high tariffs imposed on through trade by the Queen of some intermediate city — not a King.

The Ebla tablet trove covers some century and a half of Eblaite government business. At least as translated by Pettinato (1991)[9], they tell of a kind of politics very different from the God-King rulers of the Southern cities. They tell also of the peaceful trading interactions among neighbouring, as well as distant, cities in the area that remained fertile. In contrast, the cities of the South were severely disturbed by climate change and reorganized to become warrior societies. I will spend a few paragraphs here to contrast what I understand from Pettinato with what is known about the southern part of Mesopotamia at the same time.

The archives, to the extent that Pettinato can be relied on for a fair translation, describe an important political distinction between north (fertile) and south (arid, irrigated agriculture). Whereas the southern cities were each ruled by an autocratic and usually self-aggrandizing God-King, Ebla had no King or other kind of single leader[10]. Instead, various of Ebla’s affiliated regions had a governor, who elected from among themselves a kind of Prime Minister or senior governor for a seven-year non-renewable term. How the regional governors were selected is not clear, but they clearly were not entitled to govern autocratically.

Ebla did engage in war, but only when attacked by the warlike and aggressive cities further south. Its relationships with more northerly cities were covered by trade treaties and exchange of what we today would call embassies and consulates within which the laws of the other city would apply rather than the laws of the host city.

These Eblaite interactions with its neighbours seem to me to define a trading network much like the European Common Market before it became the European Union. Compromise in case of disagreement seemed to have been much preferred to war, but this did not work against an aggressive neighbour such as Mari, not far to the south, on the northern fringe of the war-based southern cities whose objective was domination rather than co-existence.

The Ebla archives describe two wars against Mari, both initiated by Marist aggression, but won conclusively by Ebla with much carnage, after which Ebla imposed an Eblaite governor on the Mari. In the South, the objective of war was to dominate the agricultural hinterland of the city, often to commit genocide against the inhabitants of the loser, and to capture the God of the city and take it home. The God in action might have been in the sky, but its earthly embodiment was the city God-King. A statue of the God, would be removed from the defeated city and either destroyed (killed) or taken home by the victors who then had access to the loser’s food supplies.

The reader might well ask what all this has to do with PCT and cultural stability, since the droughts of interest happened millennia earlier. The stability of interest is the different status in religious communities of women and related phenomena such as the conceptual existence and locations of Heaven and Hell between the fertile north of Mesopotamia and the arid south. Even though the Wikipedia article disagrees on many points with the Pettinato interpretation of the archived tablets, it does agree on the status of

9. The Wikipedia article “Ebla” (Retrieved 2021/10/04) tells a very different story. Being the result of an added 30 years of research, it seems reasonable to believe the various authorities cited in the article rather than Pettinato’s 1991 interpretation of the archives.

10. The Wikipedia article does refer to Kings of Ebla, but it credits the power to a vizier rather than the King. The description of Ebla’s wars with Mari is also different, in that Wikipedia says Mari beat Ebla most of the time. Ebla had first class defensive fortifications, which are not mentioned in the Wikipedia article.

Eblaite women, to whit: "*Women received salaries equal to those of men and could accede to important positions and head government agencies*."

This was not true of the more aggressive southern cities, where the long-ago failure of the Goddess had resulted in male suppression of the ability of women to control many perceptions. In those cities, the reason for the need to suppress women's access to their Goddess might well have been long-forgotten, just as today the historical ecological and health reasons for different religious dietary laws are unknown and of no interest to those who profess the religions in question. In those southern cities women had little worth, while male children grew up to perceive that, in Jane Elliott's terms (Section IV.5.4) they were "better" than women, and entitled to mistreat them.

Most particularly, since a man cannot be sure that a child is his whereas a woman almost always knows whether a child is hers, when the male became culturally "better", the father would have needed to segregate the mother from other men if he was to be sure that a male child would be his.

A consequence of the need to suppress women was that power was necessarily restricted to males, and if authority was to be passed down within families, it would have to be patrilineal, from father to son, rather than the easier to confirm matrilineal, mother to daughter, line. A matrilineal society seems to have been the norm in regions not afflicted by the long-ago period of drought. A child born into a matrilineal society will perceive that people are unrattled if inheritance is passed down from the mother rather than the possible father, but would be unexpectedly disturbed, and hence rattled if the father asserts that he has the right to control a perception that he has the authority to determine her legacy.

Physically, individual men are likely to be stronger than their mates, which implies that the unexpected perception is that the woman in a stable couple would perform the physically demanding tasks. That might be rattling for someone controlling for others to behave "like the rest of us". In practice, in polities north of Mesopotamia, even including the aggressive and warlike Hittites, the King's mother was a dominant political power.

There is no need to go into details of the various political domains over the millennia before the period of the Ebla tablet archive discovered in 1974. For the most part they are largely unknown to us, but the salient point is that by the time of the epics, around 2500 BCE the city states each had a monotheistic male god and a male ruler. The epics themselves talked about long-ago times, and assumed that the political situation had been much the same then, so the God-King concept was not a novel idea.

We have no such epics, no statues or wall images from the fertile north, and we do have data that tell us that women had senior roles that were as important as those of men, but different. For example, men might plan and execute wars, but their mothers and mates would need to approve the wars before they were executed. Trade to mutual advantage was preferred to war seeking dominion over others. Indeed, according to Pettinato, when Ebla successfully defended against aggression by Mari and conquered the aggressor, they only temporarily installed an Eblaite governor before restoring Mari to a native governorship.

Military aggression toward rich traders tends to win despite the counter-example of Mari and Ebla, and this was no less true 4000 years ago than it is now. Monotheistic patrilineal cities under a successful aggressive ruler controlling a self-self-image as an Empire Builder were often later called "The Great", like Sargon around 2000 BCE and the Macedonian Alexander of 1500 years later (neither of whose empires much outlasted their creators). The result was an irregularly advancing wave of aggressive militaristic male-dominated cultures such as Judaism and Christianity, and later Islam, in which women were suppressed or at least had a second-class existence.

In the context we will describe in Chapter IV.6, women would have been perceived as "worse" than, and therefore subordinate to, men of any age. They still are, in many societies culturally descended from

the great Saharan-Arabian-Mesopotamian climate change, though much less so where remnants of the polytheistic, animist, gender-equal cultures survived to ameliorate the severity of the invading monotheists who worshipping their male God, who, like the post-aridification city-Gods of ancient Sumer insisted on their worshippers worshiping “no God before Me”.

The progress of militaristic monotheistic male-God Christianity into Europe came slowly from two directions, the Byzantine Roman Empire after Justinian’s conversion, and not much later, through Ireland by way of Saint Columba. The British Isles were much earlier than the Nordic and non-Roman northern part of Europe to be Christianized than were the parts of Europe incorporated in the Roman Empire. As one might expect, Christianity came sooner to urban areas than to the hinterlands, where pagan (meaning rural) customs continued.

This difference between urban and rural communities (which we discuss from a political point of view in Section IV.3.6) may be most clearly attested in Ireland, whose patron saint is St. Patrick. St. Patrick’s main accomplishment was to drive the snakes out of Ireland. Those snakes cannot be literal, because Ireland never had any actual snakes. Snakes were, however, a prominent avatar of the Goddess who had so betrayed the Sumerians thousands of years earlier, so it is reasonable to presume that Patrick and collectively his Christian followers drove the pagans, or heathens (worshippers on the heath) out of Ireland.

Snakes were just one of the avatars of the Goddess, because of their cyclic shedding and regrowth of their skin, along with many other “cyclic” avatars described by Gimbutas (1974, 2001). Apart from the many other hints at a long-lasting commonality of religion from India to Ireland, we are led to understand that the early or “old” religion had a very similar basis over much, if not all, of the geographic area overtaken by Christianity prior to around 1000 A.D.

The “old religion” territory lasted in Nordic and peri-Baltic areas much longer than elsewhere in Europe (as late as around 500 years ago in Latvia and perhaps Estonia), and it is noteworthy that these are precisely the countries most likely to have or have had Female leaders in recent times, including today.

According to Fleitmann et al. (2022), much later drought across southern Arabia may have set the stage for the failure of the long-standing Himyar polity and the initiation of Islam, which apart from the Sunni-Shiite division also has a stable long standing structure, spread, like Christianity, by both physical and moral superiority over a wide area of the world.

If my “Just So Story” is anywhere near correct, climate change has had consistent and dramatic effects on the lives of people around and north of the Mediterranean Sea for at least five or six thousand years, in many aspects of everyday life, in cultural tolerance as opposed to culture or religion-based warfare of dominion, and so on.

This is not to say that the changing overall level of violence within a culture is related to the same climate change — not at all. We would expect that to depend on a general tendency toward reduction of organizational rattling (Chvykov et al., 2021) we discussed in Chapter II.7 and in Chapter IV.1. What the “Just So Story” describes is just one of many inter-cultural interaction effects that may have altered the overall total rattling measure, generally in the direction of reducing it.

IV.2.3 Rattling, Phase Shifts, and Roles

The first major cultural phase shift, according to Peregrine's (2017) analysis of the Seshat data, is very similar in its content all over the world, with a notable exception we have hitherto ignored, the jungles of Meso-America. In that region, only the domesticated animal component of the great phase shift is included until a second even greater phase shift occurs that includes all the components of the worldwide one, except that their villages apparently skip the 100-person stage and appear abruptly in the archaeological record at the 400+ person stage.

When the big cultural transition occurs, so does the need for specialists, such as herders, farmers, lookouts, makers of ceramic pots, and warriors, not to mention leaders for at least some of the different specialties, as well as a village leadership that can coordinate the activities of the different groups of specialists.

Even in a village of not much more than 100 people, few people may know the abilities of everyone else, or the current states of whatever aspects of the environment those others perceive and influence by perceptual control. Separation of capabilities and responsibilities into Roles that distinguish between practitioners of one specialty and another reduces the likelihood of interpersonal conflict, and therefore reduces the average rattling experienced by the villagers. Before the first phase shift, most people "did for" themselves, but some might acknowledge that someone else was better at some jobs than they were. Perhaps, as we described above, the "Clays" next door made lighter, more lovely, cooking pots than we could make in our house. But we weave better cloth than they do. Maybe we could arrange for them to make pots for both houses, while we make cloth for both.

This same separation between the requirements of different specialties increases the relative similarity of competence patterns among practitioners of the same specialty. The pattern of similarities defines a "Role", as we discussed in Section III.3.1, and is likely to produce a single node at some level of Hypernode analysis (Section IV.1.9). Within a specialty, anybody can claim that they play the same Role of specialist, or so it may be assumed by someone looking for "a shoemaker" or "a potter" without knowing the persons concerned other than from their self-advertising.

In modern times, many professional societies provide certificates of competence that exclude persons who have not passed some kind of entrance qualification. I, for example, was accepted as a "Professional Engineer" by a legally designated authority on passing several tests and examinations. In the early villages shortly after the first big cultural phase transition, few if any such tokens of competence would be expected. In their place would be word of mouth, identifying "Arthur" as being good with animals, while "Bertha" might have a "green thumb" and usually be able to rectify visible problems in the village crop.

When a villager wanted a someone to play a "Herder" they might call on Arthur or anyone else who had a reputation as a good player of the Herder Role. As local population grew, so might finer distinctions develop within the broad specialties. In Chapter II.6 and again in Chapter IV.1 we called these refinements "Category fragmentation" or "Crumpling creases".

Once the villagers had become largely sedentary, they could no longer move to find stuff that in their earlier nomadic time they might have moved *en masse* to far places to get. Two important specialties might arise from the newly sedentary nature of the group, the old hunter-forager action patterns that once was a general task of most group members would become a specialty, a set of skills learned by fewer and fewer children. The new speciality might be called "wild food provider", and it might be an important new specialty to go along with the new "farmer" or "herder" specialties. Before the cultural phase shift, everyone would be expected to have some competence in all these domains, and be Jacks and Jills of all trades, but masters of none.

The second important new specialty would be that of the long-distance trader, who might be an individual who travelled from village to village or who perhaps visited nomadic groups to exchange wares that might be easily obtained at home for wares that home did not have but a distant village might. The long-distance trader might, on the other hand, lead a whole group that itself formed an organized "mobile village" to take many animals carrying trade goods by known trails to other villages that were likely to need what the trader was able to supply, in exchange for something useful at home. In the recent Sahara desert before the time of mechanized traffic, similar travelling trade groups were called "caravans". Caravans required yet another set of specialties involved in managing motel-like stops in the desert, called "caravanserai". And so it goes, one invention demands another.

"Foreign trader" classes of specialties would originally have used barter, which required the trader, the supplier, and the recipient to haggle over the relative values of the items traded (Section III.9.4). For either, the specialty would be highly skilled if the trader were to succeed in enhancing his or her own worth while persuading supplier and recipient that the each were doing the same, which might well be the truth. Many perceptions would need to be controlled during the trip through unpopulated wilderness areas, if only for self-protection against brigands. The "mobile village" trader might hire some specialized warriors for his village, for example.

Whenever a specialized Role evolved, the "soup" out of which the first cultural homeostatic loop grew would grow richer because of the new roles spawned by the new loop. These new roles would be the "inventions" of the creative loop (Section II.2.4). Sooner or later new loops and shortenings of the original loop would arise, just as in the case of Kauffman's (1995) chemical autocatalytic creative loops. Each new loop would represent another cultural phase shift, while loop shortenings would be likely at least to result in shocks (Section II.7.4) that reconfigured the affected Role ecology (network).

The nature of creativity being somewhat inconsistent, although globally there was some similarity among the different "second jump" phase shifts, there was not as much commonality as in the first jump. Although population density played its expected Role, these second-jump phase shifts seem to have depended more on technological innovation, often including metal-working.

A striking observation is that although the population and technology principal components in the Seshat data are independent across regions, individual sites over time show a common trend. The denser the population, the more evidence of technology development. The more people live in a community or nearby, the more technological specialization is likely to be evident, and the more precisely defined will be the specialized Roles.

We have seen this before, under very different circumstances, in Kauffman's (1995) autocatalytic "elemental soup". In Section II.2.2 we used Kauffman's approach to argue for the almost inevitable development of beneficial side-effect loops once a population controlling their own perceptions grows large enough, where "large enough" is in the region of low hundreds, the general size range of the earliest villages at the time of the "first jump" cultural phase shift. Figure III.36.1 repeats Figure II.2.3, with appropriate changes to the caption.

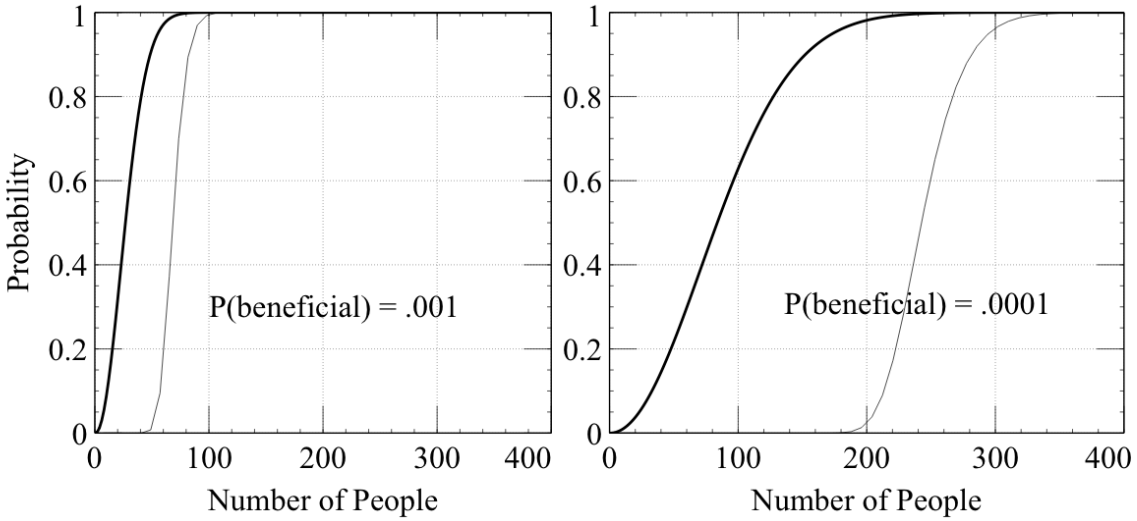

Figure IV.1.1 (Figure II.2.3 repeated). The probability that the actions of one person controlling one perception will be helpful to another person controlling some perception (heavy curve) and that there will be at least one loop (light curve) in a population of given size, if the probability is (left) 1/1000 (right)1/10,000 that a random such interaction is helpful.

In these Figures, the important point to note is not the actual numbers, but how quickly the probability that a coherent loop exists becomes almost inevitable as the population grows. These are, of course, idealized situations, not least in that in them the interaction probability between individuals is equalized across the whole population, whereas such a situation would be very strange. More probably, there would be relatively dense knots of friends living near each other and sparser interactions between people living at opposite ends of the village. The principle would be the same, though as we noted in the last Section, the effect would be for new side-effect loops to concentrate preferentially in regions of higher population concentrations.

The likelihood that a potentially beneficial action would be actually helpful would be much greater if the person who would benefit was a close friend than if that person were someone less frequently encountered in the course of a day. The uneven interaction density over the entire population is also something we have seen before. It occurs throughout our consideration of rattling, including in the seminal study by Chvykov et al. (2021).

Here we note only that before a new beneficial side-effect loop is completed, the many side-effect interactions that are inevitable in a dense population result in a high level of rattling, but after the side-effect loop completes, the rattling of the loop members suddenly decreases. In addition, the interactions of loop members with other controllers become substantially less uncertain, and those "wild" controllers tend on average to be less rattled by the members of the new loop.

The low-rattling equilibrium state toward which organizations trend on average is not a state in which all component elements of the organization experience similarly low rattling, but a quasi-exponential distribution in which most do, but a few, in the long tail of the distribution, experience high or very high rattling. One possible cause could be that the stable dynamics of the new loop result in a permanent

inability of some controllers to find a means of controlling their perceptions as well as they sometimes could before the loop formed.

As an example, think of a local “kingpin” whose activities might be curtailed by the formation of a police force created to enforce new laws, which overall improve the ability of the kingpin’s previous minions to control their perceptions. Many would have found their rattling reduced, while only the kingpin and his relatively few henchmen found it increased. The total rattling over the organization of the population would have been reduced, many having reduced rattling, but leaving a long tail of a distribution in which the kingpin experiences much higher rattling, and his henchmen experience a smaller overall rattling increase.

In our early villages, or indeed in any community, low rattling implies that an individual is content with “doing things the way they have always been done”. Rattling implies change, and only a few who experience worse perceptual control as a consequence of the change will be rattled enough to become possible contrarian activists. Those outlying people on some perceptual dimensions experience considerable difficulty in controlling some perceptions consistently, or at all. They are the ones who may control for things to return to “being done the way that was good enough for granddad” and who act to change the organization of society back to the old form, in which they had been less rattled. They “want back in” to the mythical “golden age”.

Change may occur if enough of the population is highly rattled (unhappy with the current state), but as we just described, it well occur if new homeostatic loops form among perceptions controlled by individuals in the population. In the early cultural phase changes, the stabilities that create the first phase change must be in place before the second and subsequent ones occur. In Peregrine’s diachronic cluster analysis, staging points appear solidly as “Cluster A” and “Cluster C”, with a hint at the most recent slice 2000 years ago of a new “Cluster D” emerging along with higher population densities and more advanced technology.

In a very different conceptual environment, though the one from which the rattling analysis began, average rattling is analogous to temperature. Temperature is determined by the average energy one atom or molecule may supply to another when they interact. At any moment, some molecules carry a lot of energy, but many more carry little until they meet one of a higher energy. In the interactions among the molecules, energy transfers from one to another and though at a given temperature, the distribution of energy among the molecules remains unchanged, but the identity of which molecule carries how much energy keeps changing. The same is true of the rattling structure of an organization. The distribution of rattling among the controllers who interact through intended effects and side effects will maintain the same distribution at equilibrium, but the identities of which controllers experience much or little rattling will change within this equilibrium distribution.

A slow cooling of a hot, perhaps even molten, material has a name “annealing”. Annealing gives the material time to settle slowly into a structure with relatively little strain, whereas rapid cooling, or “flash freezing” ensures that the internal structure contains appreciable strain. The completion of new homeostatic side-effect loops is sudden, causing shock waves of rattling even though the members of the new loops experience a substantial decrease in rattling because of the stability of the new loop. In this it is equivalent to flash freezing, which may reduce rattling somewhat because of its frozen structure, but which remains a far-from-equilibrium situation, in which further societal change is likely to happen in the future.

As we shall discuss in Chapter IV.7, populist revolutions such as the English Civil War of the 1640s or the French Revolution of the 1790s, or even the Brexit that concluded at the start of 2021, “flash-freeze” a new organization of their society, and do not settle into a new low rattling state quickly after the shockwave. Such revolutions are usually followed by long periods of considerable instability. The

American Revolution of 1776 was relatively quick to stabilize, perhaps because the revolutionaries did not control for changing the organization very much, but even it has proved not immune to rattling stresses in different periods since, including at the time of writing this book.

On a global scale, increased rattling caused by such changes as the Industrial Revolution and the resulting planetary climate change has been claimed to be causing a "Sixth Extinction", as many known species seem to be going extinct. Vaidiyanathon (2021), in a survey of ecological data entitled "The World's Species are Playing Musical Chairs", suggests that this may not be true. Instead, what may be happening is a combination of the effects of rattling shock caused both by climate change and dispersal of alien species into settled local environments (humans being an example so obvious as to be easily overlooked), accompanied by a continuous "annealing" process in which once rare species become more common and once common species become rarer, some going extinct.

The result, if human incursion and climate change could be stopped, would not be expected to be a return to the pre-existing ecology, but to one having the same equilibrium distribution of species densities, with different species being common or rare. However the continual increase in the environmental rattling of the global ecological organization does not necessarily mean that the species distribution at any moment will look the same as a settled equilibrium would look, either locally or globally. We will run into this problem again when we get into a discussion of political power and governance.

IV.2.4 Tensegrity and Rattling

According to Scarr (2014), tensegrity may be the most consistent and important mechanical property of life at all scales, from the very molecules of which living control systems are composed up to the overall structure of each individual microbe, animal, fish, or growing tree — and, we might expect, social group. In the higher dimensions of perceptual control structures, we argued in Chapter I.8 and Section II.1.8 that hierarchic perceptual control systems are likely to exhibit the key tensegrity properties: controllable flexibility from stiff to floppy, strength against localized external forces by distribution of the imposed energy through the entire structure, and resilience against random failures of individual components.

That is a considerable lists of benefits realized for tensegrity-based structures in contrast to structures founded on more rigid principles. Even a single control loop can be very rigid or very loose, depending on its loop gain. Changes of loop parameters can alter the overall surface appearance of elasticity and fragility of hierarchic control in PCT tensegrity structures. Tensegrity pervades both the concrete and the abstract elements of life, and now we begin to ask about whether tensegrity might be a generic property of social organizations. Does the development of tensegrity cause an organization to trend toward reduced rattling?

Even without considering protocols, which many social species do not seem to use in the reciprocal form that defines a protocol in this book, the actions of each individual has both direct and side effects on the abilities of other individuals to control some of their perceptions. Figure III.10.1 shows four kinds of effect. Among pairs of individuals chosen at random who have not experienced any previous direct5 influences of one on another, by far the most likely effect is Type 1, in which the cross-influence from one to the other is an increase in the disturbance magnitude and variability of the affected member of the pair — an increase in the magnitude of its individual rattling.

The "smarticles" of Chvykov et al. (2021) do not control anything, but they do move physically within their space, changing the structure of their physical organizational relationships preferentially in a direction of lower rather than higher rattling. They tend to move apart, and become spatially organized as

a group only because they are physically constrained to stay within a defined space. Our individual living control systems are not, at least not for a long time yet beyond the bounds of the surface of the Earth, but they have needs that can be satisfied only in special parts of the environment, such as watercourses. Such places concentrate individuals and require them to meet more often than they would by chance over the entire space over which they might move.

At the other extreme, consider a naive individual roaming solo across a landscape populated by living control systems of all kinds, from bacteria, shrubbery and trees, to scurrying worms and rodents and large carnivores and herbivores. Not having encountered any of these before, our hypothetical individual does not perceive the differences between edible and toxic vegetation, or between approachable and dangerous animals. Such an individual would be unlikely to survive long.

Living control systems produce descendants who may become mature individuals capable of producing further generations of descendants. Either they produce many immature individuals at a time, of whom very few will survive to maturity, or they produce only a few, and stay with them as a family group while the newcomers grow ever more complex perceptual control hierarchies. Our hypothetical roaming solo individual may be very unlikely to survive to produce descendants, but one or two of a large brood of siblings might be lucky.

Families are different, in that they shield the young from too much rattling and provide them with food-energy until they can find their own. A family contains at least one adult who can shield the children from many sources of disturbance (Type 4 interaction) while they grow their perceptual control hierarchies. The young are much more likely to survive in a family than in isolation.

Now imagine instead of our naïve individual roaming the landscape alone, a single family roaming the landscape together as a group. The parent or parents control for their own avoidance of lethal danger and that of their children. The children are “a hassle” to look after while the parents teach them how to stay close, which vegetation to eat and which will kill them, how to avoid dangerous predators, and crucially, how to find water they can drink safely, without getting eaten in the process.

With their parents, the children individually are much less rattled than they would be if they were alone, but some of their rattling has been transferred to the parents. The family has at least one tensegrity property as a module of close interactions that tend to self-organize into low-rattling configurations — tend to, with no guarantees! Not all sibling groups get along well with each other, and not all children always get along with their parents. Conflicts within families are commonly observed, and as we have seen, the approach to a low-rattling equilibrium always implies the existence of highly rattled outliers, along just about any dimension of variation along which the organization may change.

The dimension of variation of most interest in this section is population density, which we are beginning to approach. At any one moment, a family lives in a fairly small space, even if we include the range over which its members forage or hunt for food, and no matter whether it is a nomadic or a static space. That small space is densely populated by other members of the same species of living control system. When families meet at a watering hole or elsewhere, the meeting increases the average population density over areas the size of the total area taken up by the families who meet, an area that now does not include hunting and foraging space, because that is not the kind of activities in which they are currently involved — assuaging thirst and being wary of potentially lethal predators.

Quite probably some pairs of families who meet at the riverbank will have seen each other before Apart from having to share shore space in order to drink, they have not been rattled much if at all by the side-effects of the actions of the other families. There may be some repulsion between them at first meeting, but even that is likely to be more than balanced by perceptual control actions such as having one or two adults keep watch for known predators such as crocodiles or lions while the others drink and the

children of the families play together. Various nature-based TV documentaries have shown animal species such a meerkats acting in this way, letting the group know of the approach of a predator, or of the approach of another group of meerkats, which the adults mass to drive away, reducing the rattling induced by the unexpected appearance of the other group.

"Safety in numbers" applies well beyond the watering hole. A small group of families that can perceive dangers or resources and can act collectively to reduce errors in their perceptions. If they keep together in their wandering as a group, their interactions will trend toward reduction in rattling that might be caused by the side-effects of their individual actions on each other. The mere fact of being a larger group makes them better able to control perceptions in which the disturbances might be caused by unfamiliar other groups of the same species. In the tensegrity view, these "safety in numbers" interactions are wires in tension.

When the average population density over the landscape is very low, such meetings among groups are improbable, as are the meetings of free-moving molecules in a low-density gas. As the total population grows, however, one of two things may happen. Groups may become larger, or intergroup interactions may become more frequent. Whichever happens, it begins to become sensible to talk about rattling of one group by another, as well as about the rattling among individuals that initially led to the formation of groups when the population density was lower. This kind of rattling is reduced by repelling tendencies between the groups, or in the tensegrity view "compression members" or rods.

For a single individual in such a group, all the members of the invading group of meerkats are to be repelled, so they are pairwise linked across groups by tensegrity "rods", while within each group, the members are linked by "wires". This is, of course, a great oversimplification of any real set of inter- and intra-group rattling effects, but it makes the point that when an interaction such as that of a child being protected by its parents reduces rattling, it serves as a tensegrity wire, and when reducing the likelihood of that interaction occurring reduces rattling, the interaction acts like a rod in compression. As Starr (2014) described for biomechanical structures, so we seem to be suggesting that social structures may be composed of tensegrities made from tensegrity components, rattling and tensegrity being closely linked.

This new organization built from smaller sub-organizations that trends toward low-rattling is an organization of groups that each has reached a quasi-stable low-rattling state, rather than of the individuals within those groups. The inter-group interactions form an organization of organizations, which can be seen as creating new collectively controlled influences of the four kinds shown in Figure III.10.1. Just as the individuals in one of the basic interactions trend to adjust their inter-individual control effects and side-effects to minimize rattling among them, so would the interactions among the basic groups tend to reorganize to form tensegrity structures among nodes composed of less rattled groups on average. But as always, the restructuring is likely to increase the rattling experienced by some of the subgroups, members of which may perceive their own group to be "left out" while the change benefits most other groups.

Groups tend to collaborate and cooperate, implying perceptual control attractive "wires" among the members, but they do not do so without some side-effects that disturb other group members or cause conflicts. These effects are repellent, analogous to tensegrity "rods". The same applies to groups that meet each other. Between them are both attractive and repelling tendencies. Without trying to examine the details, since we assume the rattling theory to be correct in asserting that organizations are more likely to trend toward rattling reduction than the reverse, and since we have shown how tensegrity in an organization reduces rattling, we can safely assert that social organizations that persist will tend toward becoming tensegrity structures.

IV.2.5 The Physical Environment and the Social Environment

Imagine either the perceptual side or the output side of the control hierarchy within an individual, and think of only one single controlled perception, which has a simple numerical value representing a rate of neural firing. A much simplified diagram of the output side of the hierarchy might look like the stream flow in the sandy delta of a river mouth, branching and recombining until it reaches the environmental sea (Figure III.10.2 right panel). The perceptual side would have a similar branching pattern, but the flow would converge upward (Fig 33.1 left panel).

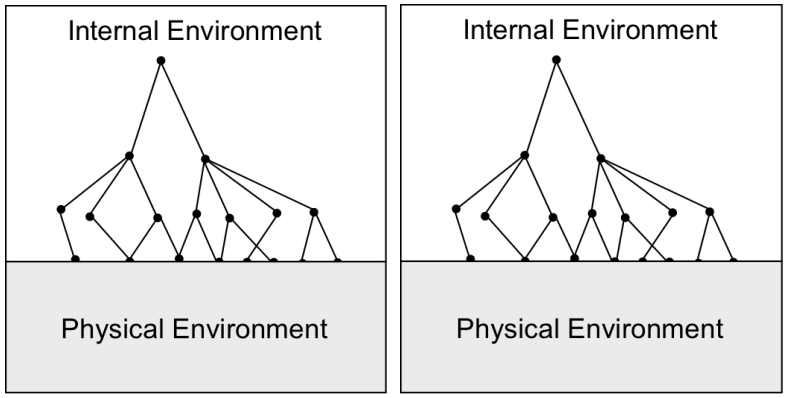

Figure III.10.2 The branching and recombining paths by which environmental effects on the sensors eventually result in a perceptual value (imagination connections omitted) or equivalently in reverse, the paths by which the output of one control unit reach the muscles that influence the environment. Each node in this network represents an intermediate level perceptual function.

Protocols are a way of creating high-level connections to another person, which means that we can modify this diagram by showing the "stream in the delta" to include branches that influence or are influenced by other people in the person's local "social environment" (Figure III.10.3).

A person's social environment consists mainly, but not exclusively, of all the people this person meets or communicates with while controlling the perception at the top of the Figure. Other people, such as the parents of an adult, may have communicated previously in ways that have influenced the person's perceptions or choices of actions, but these are usually not considered to be intrinsically members of the person's current social environment.

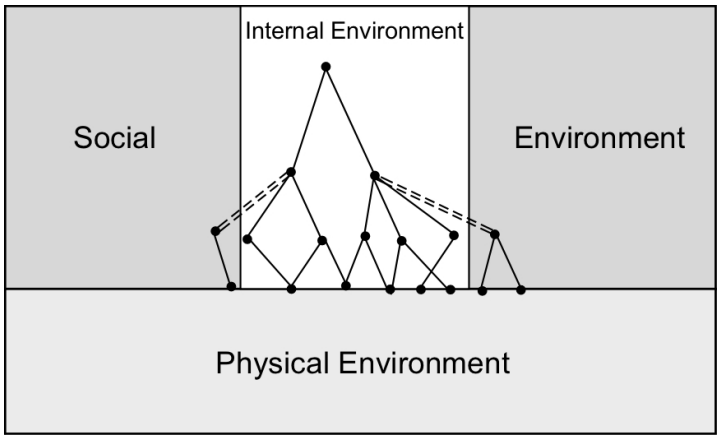

Figure III.10.3 Control of a perception in a social environment, showing that some paths may connect with the social environment through protocols (dashed lines). The cartoon applies equally to either the perceptual or the output side of the control hierarchy. Nodes in the darker grey areas belong to perceptual control hierarchies in other people.

We are talking about perceptions controlled by persons, not perceptions whose reference values are set by the roles they are playing. Roles, as such, may have prescribed what perceptions a Role-player should control with what reference values, but it is the person playing the Role that controls those perceptions.

Figure III.10.3 can be seen as representing the perceptual side of the person's hierarchy if you think of protocols as transferring information from one person's perceptual function output to the input of one or more of another person's perceptual functions, much as lower level perceptual function outputs provide inputs to higher-level ones within the individual. The dashed lines then represent perceptions produced by some contact from their own sensors and used as input to a perceptual function somewhere in our central person's perceptual hierarchy.

Figure III.10.3 can equally be seen as a sketch of the output side. Protocols initiated by the central person could provide part of the input to another's perceptual function at some level of the hierarchy, as they do, for example, when someone helps the central person to achieve some goal. The protocol in that situation displays to the helper what the one needing help wants. If the helper controls for actually helping, the initiator's display allows the helper to set a reference value for some perception whose control action produces the helpful result.

The input to the central person's perceptual hierarchy from someone else may not be directly from the person's sensory system. It might instead be based entirely on information that person got from others in their own social environment. For example, the perception of Harvey, the "Invisible Rabbit", (Section III.6.4) by anyone other than Mr. Dowd depends on the passing of information about it from one person who believes it to exist (or from many such people) to another, thereby enhancing the likelihood that the recipient of this information will come to perceive Harvey existing invisibly and inaudibly near Mr. Dowd.

Different people live in different physical and social environments. No matter how much they live and play together, even genetically identical twins have different experiences of their shared environment. They must reorganize differently, at least in some details. The difference among unrelated people in their genetic endowment and their experience of their environments must be much greater, even if because of

collective control they may have reorganized similarly enough to be considered to belong to the same culture and to speak the same language (Chapter III.2).

When there are many people to be considered at a range of distances from the central person (M in Figure III.10.4[11]), such that A talks to B, B to C, C to D, … , W to X, X to Y, and Y to Z, it is likely that A, B, and C perceive the social world in much the same way as each other, as will X, Y and Z, but the ABC.. group may differ greatly from the ..XYZ group on how they see some aspects of it, while L, M, and N may see both groups as wild-eyed extremists along some perceptual dimension.

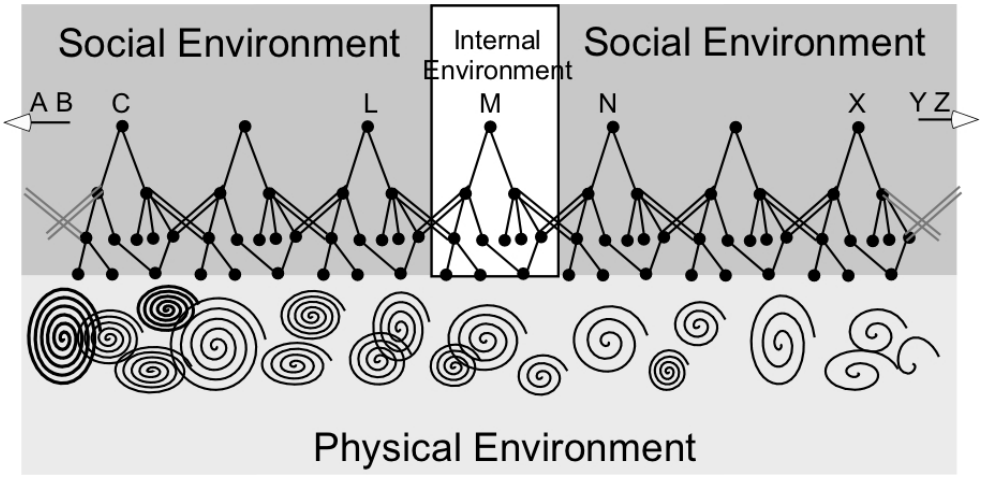

Figure III.10.4 A larger social environment in which different people perceive the environment differently, but communicate with each other so that the perceptions in those who communicate frequently resemble each other more than they resemble perceptions in others with whom they communicate less.

XYZ, LMN, and ABC see different "Invisible Rabbits"in their respective environments. The situation is formally identical to the one we discussed earlier (Section III.2.6) about the languages used by Andy, Beth and Charlie being unintelligible to Xavier, Yolanda and Zeke, while the language used by Lou, Mike and Natalie could be understood (with difficulty) by both groups (Figure III.10.4). Actions by M will probably rattle L and N much more than they rattle more distantly connected people, no matter what the perception M is controlling. Rattling theory argues that the evolution of the organization toward a low-rattling structure will happen quicker among L, M, and N than among, say, A, M, and Z.

The connections among these people are shown as pairwise one-to-one connections, as though they were permanent. They are not. They come and go as different perceptions are controlled by any one person. The links shown in the Figures represent often used, but not permanent, links, unlike the hard-wired links through neural synapses within an individual brain. This is especially true of vocal protocol connections, which use the physical environment, for example by producing pressure vibrations in the air that the partner hears as sound and perceives as language. The effects of voice connections in the physical, though not the social, environment are especially ephemeral. The sound vanishes while it is being heard, but its effect on the hearer might last a lifetime.

Not every effect of an action on the environment is ephemeral. In fact, very few are. The long-lasting effects of most can be perceived after the actor left the scene, sometimes thousands of years ago, as with

11. Figure III.10.4 is based on a diagram provided by Kent McClelland (Personal Communication 2017.13.27)

a builder of the Great Pyramid or of Stonehenge. Archaeology depends entirely on the discovery and interpretation of these long-lasting effects.

One type of action that is often intended to have a particularly long-lasting effect is writing, which can be (and ordinarily is) used for information transfer from one author to many readers over a long period of time, in contrast to a speaker who can pass information only to the few others currently within earshot (Figure III.10.5). Some people now can read writing produced by Sumerians 3500 years ago, and in my long-ago schooldays, many students had to read the writings of Julius Caesar in the original Latin.

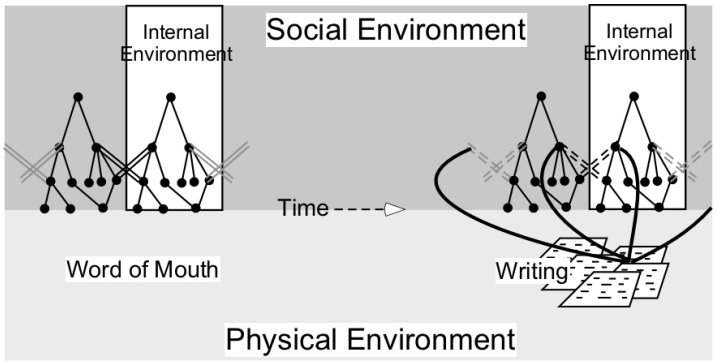

Figure III.10.5 After the invention of writing, the range of communication expanded greatly both in numbers of others reached by one message and in the time scale over which the communication could be effective.

Lasting effects of action have the generic name "stigmergic" (e.g. Grassé, 1959; Heylighen, 2016a, 2016b). Stigmergic effects, by their very nature, are one-way communications to an unknown number of later living control systems, not necessarily human. Installing a fence impedes or prevents the passage of the local animals, for example. Stigmergic effects do not involve feedback loops back through the original actor, even though the original action that produced them may well have been the part of a real-time feedback loop. The stabilities described by McClelland in the extended quote that introduces Volume 2 can be seen as stigmergic effects of the original creators of the controlled environmental variables, but not of their maintenance in the second feedback loop of the "create-maintain" motif (Section III.8.2).

Of course, the linear sequence suggested by the ABC..LMN..XYZ labelling in Figure III.10.4 is ridiculously oversimplified, not least because people have many connections that form complex networks. The complexity of these networks is increased greatly by writing, since one person influences many others rather than just the few present during the action, if indeed there were any. The number of links per node, the link density, is greatly increased by writing, as may be the rattling experienced by the readers.

Old writing can have big influences on currents social structures, as do for example the writings of Isaac Newton and Karl Marx. Nevertheless networks in which the people are rattled by the writings they read usually can be partitioned into modular clusters defined partially by having read similar writings. These modules are parts of the network within which the participants have more connections than they do from one module to another. A family might be one such module, as might be the membership of a book club, a street gang or a town council, or even the entire citizenry of a nation.

Modules in the network of interconnections consist of people whose actions affect each other more often will approach local low-rattling organizational structures more rapidly than will an organizational structure whose members are interact mainly by less frequently used connections. As we said earlier, the

rate of approach to a low-rattling equilibrium stat is measured in numbers of interactions, not in a clock time measured in minutes, days, or years.

Overall, the pattern of interconnections in many networks, both in the brain and in the external environment, often has a structure like the "small world" form. This form is scale-free, suggesting that modules consist of similar networks of smaller modules, more tightly connected within a module at any scale than between modules at that scale. In the "Six degrees of Kevin Bacon" game, the entire game world consists of the cast lists of Hollywood movies. The game consists of finding the fewest movies in which a randomly chosen performer was cast along with someone who was cast with … who was cast with Kevin Bacon. That network approximates a scale-free one, as do many networks that evolved rather than being designed[12].

In a hierarchical modular structure, the shortest paths of this kind are likely, but not guaranteed, to be within a module. Inter-module paths between an element of one module and an element of another add at a maximum the number of links upward to a common "ancestor" module and back down to the target module, but may be fewer if direct lateral inter-module links among "sibling" or "cousin" modules exist.

The arguments about mediating influences will apply for modular networks in the same way as for the oversimplified linear chains with which we started this discussion, particularly if there are intermediary modules whose members are likely to communicate with members of two other modules whose members seldom communicate with each other. The intermediate module then would take the place of the "LMN" group of the linear examples.

In Chapter 9 on lateral inhibition, we saw how individual controllers may easily tend to push each other apart, creating flip-flop structures that may convert similar analogue perceptions into discrete choices. In the last Chapter we showed a similar effect of rattling reduction by increased separation between different groups. Here we take a different approach to the same result, by treating a module as though it were a single (high-dimensional) perception.

We start from the consideration that a stable module must be inherently homeostatic, each member shielding all the others from external "rattling disturbances". Such homeostatic modules will be likely to separate into separate low-rattling regions of their common space, since interactions between their members (side-effects if their members are control loops) are likely to contribute rattling disturbances. Remember that homeostatic loops and networks must contain inhibitory processes if they are not to destroy themselves because of explosively accelerating positive feedback loops.

On the other hand, there always is the possibility that these side-effects shield elements of a neighbour module. In the winter-leaf analogy, if the two piles (stable modules) are close enough, they may join so closely as to become effectively a single module. When, as now, we are considering fear of outsiders, the drawing apart is the more interesting effect.

So far, these sketches represent either the collective construction of a perceptual state or the collective action to control some perceptions cooperatively. The implication is that there might be collective action to control a collectively constructed perception of some kind of organization, beyond that implied by the collective control discussed in Chapter xII.13. This "collectivity" of quasi-common perception and coordinated action might not be perceived by the participants. To perceive the emergent beginnings of this kind of organization might require a trained outside observer[13].

12. https://en.wikipedia.org/wiki/Six_degrees_of_separation, Retrieved 21.02.06

13. An "outside observer" person might nevertheless play the Role of a participant, such as a person who participated in a protest movement while at the same time collecting data about it.

Despite not necessarily perceiving the existence of these different modules or sub-networks, people in the “ABC” group and the “XYZ” group might easily find themselves in conflict. They might, for example, have very different perceptions of the way their environment is or the way their environment works, while at the same time having the same reference values for the way they want it to be, or they might see their worlds similarly, but have different reference values for the way they want it to be.

The situation becomes even more difficult for ABC and XYZ to reconcile if they not only perceive their nearly common environment differently but also have different references for how it should be. In such a case communication between the collectives would normally be at cross-purposes, neither knowing what the other was talking about.

At a minimum, not knowing what each other perceives or the language each other uses to display their controlled perceptions is rather like a colour-blind person talking about aesthetic colour balancing with a normal-sighted person. The use in a protocol of language about anything one perceives but the other perceives differently prevents either from bringing their own perceptions of the other toward their reference values. The effect could be the same as a direct conflict, at least from the viewpoint of either collective. Even though the incipient organizations might be invisible to the participants, nevertheless their memberships in different clusters could easily lead to “Us versus Them” perceptions, which are the main theme of the next Chapter.

We will soon develop the invisible emergent modular communication structures into informal organizations that have boundaries perceived by the members, and perhaps also by non-members. These boundaries are perceptions controlled by the group members. They distinguish people who are members of the organization from people who are not, with little or no middle ground of partial membership.

In large informal organizations, members may choose to carry identification in the form of colours or patterns of clothing items, tattoos, special jewellery, or even behavioural displays such as secret handshakes (a form of protocol display) so that other group members will easily identify them as belonging to their own or some “other” informal or formal organization. In English society it used to be a social faux pas for a man to wear a necktie in the colour patterns of a school he did not attend, or a sporting club to which he did not belong.

These visual identification, or such others as “secret handshakes” or gestural symbols, serve as what we have called “R-display” (Section II.12.5). They show readiness to participate in communications using protocols specific to the identified group.

IV.2.6 General Environmental Rattling

When the parameters of climate change, such as the daily range of temperature on a given date in Mytown, the likelihood of weather events beyond the normal range must increase, and that increases the average rattling experienced by everyone in Mytown who is not isolated from the weather

If one resident of Mytown is highly rattled by unexpected changes in the ability to control some perceptions, this does not imply that all are. Usually when we consider distributions associated with rattling, we find them to be long-tailed, with most instances being in the low-effect base of the distribution, and fewer and fewer in the extremes of the tail. In the case of weather uncertainty, most people are somewhat protected by their living environment, their house or apartment, for example.

Some, however, are homeless or travelling when an unusual event such as a storm occurs, or their residence might be damaged by the storm. They experience rapid uncontrollable changes in disturbances to some of their perceptions, which is to say that they experience increased rattling. A traveller might, for example, be rattled by the unexpected cancellation of a flight on which they were booked, or a landslide

across a road they were using. In such environmental changes, people become unable to control some, often many, perceptions by the means they had reorganized to use. They have to revert to conscious problem-solving control (e.g. Friston's Free-Energy approach; Friston 2010) in order to find new ways of controlling those particular perceptions.

Almost by definition, there have always been days of unusual weather everywhere in the world, and they will sometimes result in rapid excursions in disturbances to some perceptions controlled by living control systems, including humans. Unusual weather, however, is far from the only environmental cause of added rattling. A few others were listed above, and they range in scale of how local or widespread their effects, how frequently they occur, and how violent the added rattling they induce in the average affected individual living control system.

Global warming leads to an increase in the frequency and severity of extreme weather events, whether they be unexpected winter cold periods, late summer hurricanes, regional droughts or floods, monsoon failure or extreme rainfall, or other unexpected weather phenomena. Pandemics lead to unexpected illness and death, unexpectedly altering the structure of families and social or political groups. Large earthquakes destroy infrastructure on which people depend, as well as unexpectedly killing people in the affected area, and so forth.

Physical environments are not the only parts of a person's environment containing objects with properties the control. Unexpected closure of a large unit of a corporation causes rattling among employees and the local businesses frequented by those employees. Failure of a popular supplier of fertilizer rattles farmers and other growers who have been using that product regularly. Environmental changes unexpected by an individual rattle that individual's ability to control some perceptions, and add to the total rattling of any organization of which that individual is a member.

These two examples show mechanisms by which income inequality, which translates into inequality in the range and power of controlling one's perceptions, can cause widespread rattling among people of lower "worth" (Section III.9.3). Since the "high worth" (powerful) people who cause that increased rattling are also members of the organization called society, they are not immune to the effects of the increased rattling in increasing the likelihood of major reorganization of that organization. We will follow this line of thought further when we discuss Government and Revolution (Chapter IV.9).

To different extents, environmental rattling affects everyone in an organization, raising the total rattling of the organization in a way that is not reduced by mechanisms that reduce rattling caused by pairwise interaction within the organization. Some general environmental rattling, such as that caused by climate change or by pandemics for which vaccines are available, may be calmed by collective control of perceptions related to the causes of the rattling, but others, such as earthquakes and hurricanes, we can do nothing about collectively or individually.

In Chapter IV.6, we will discuss "Us and Them" in some depth. For now we may just recognize that when someone is unable to act in a way that can reduce the error in some controlled perception, they will try novel possibilities. We have called that "reorganization" (Chapter 11), and suggested that conscious control is often involved, at least in humans and possibly other animals (Chapter II.8).

In Chapter IV.1, we returned to rattling as an index of where in the hierarchy rattling is likely to induce, but not cause, reorganization. Powers intuited that increasing control error tends to be accompanied by reorganization in the region of the perceptual control hierarchy where error is most persistently increasing or where the currently available actions do not cause it to decrease. We have now reached the same conclusion as Powers by a quite different route. Rather than appealing to his powerful intuition, we appealed to the Chvykov et al (2021) "Low rattling" principle. Now we shall see that similar arguments affect social structures subject to widespread rattling.

IV.2.7 Ecologies of Persons and Roles

What is an "ecology"? The word "ecology" usually refers to a stable network of interactions among the animals and the vegetation in a defined habitat. Sometimes it refers to the network of interactions among microbes in a microbiome. Always it refers to a quasi-stable network of mutual influences among members of the ecology. The ecologies we discuss in this Chapter are ecologies in which the interacting participants are people, often playing roles. Such ecologies are often called social systems, in which many of the mutual influences are through the use of a network of related protocols.

Any ecology can be seen as a homeostatic network, stable if its functioning is not interfered with from outside. An ecology, though likely to be modular, has no intrinsic structure in the sense of a hierarchy or specific roles that are allotted to individuals. Human social ecologies, however, have a kind of skeleton that helps to stabilize them, in the form of a network of roles. In Section IV.2.1 we saw how a practitioner Role develops in conjunction with the development of a technological specialty.

The creation of new specialties is a feature of the phase change jumps in cultural structures found to be a characteristic of archaeological findings world-wide (e.g. Peregrine et al., 2017). These networks of inter-related specialties tend to appear as self-supporting ecologies only when the local population grows sufficiently large, according to Peregrine usually a bit over 100 in any one population centre[14]. A population centre has only a vague definition, but whatever the most useful definition, the core concept is that communication among its inhabitants is quick and frequent compared with communication between them and people living outside the population centre.

Specialists are similar to the lower layers in an individual perceptual control hierarchy, in that a single specialist may provide services for many different clients who control their own individual perceptions using the product of the work of the specialist. Toward the end of Chapter III.6, for example, we saw how a specialist who develops and propagates a tradeable "universal IOU" could enhance the abilities of a wide range of people by replacing barter trade with money-based buy-and-sell. Money, according to the Seshat analysis of cultural phase changes by Peregrine et al. (2017), is a component of the cultural jump into his time-resolved "Cluster C".

If the argument of Chapter III.9 us anywhere near correct, individuals are replaced first by Roles, when then might be collected into institutions such as banks, within which work individuals who perform Roles Roles that to the client are related, in the sense that an interaction with one of the bank's Role-players is likely to facilitate a subsequent interaction with another. Institutions reduce the average rattling among their clients as compared to that experienced when the same Roles are performed by scattered individuals.

As we saw in Section II.4.9, within an individual a random collection of perceptual control and other loops is likely to develop into a hierarchic organization that includes homeostatic biochemical loops that interact with the individual's perceptual control hierarchy. Now it seems that on a slower time scale, a similar development would be true of a previously unorganized social group. Specialty roles connected in homeostatic loops would work together like the elements of Kauffman's (1995) autocatalytic loops, or the side-effect loops of Chapter xII.14. The new novelties could become specialties and roles in a next generation of creative autocatalytic loops at a higher level of the Role hierarchic structure. Like perceptions of properties, these loops would tend to coalesce into collectively controlled institutional structures such as banks, or family shops into supermarkets, and so forth.

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14. Is it just a coincidence that this population level is close to the number of different entities in an autocatalytic "soup" at which it becomes highly likely that a new autocatalytic loop will form and stabilize the production of increasingly complex structures (Section II.2.2)?

Such creative autocatalytic loops will be more likely to survive if they turn out to be useful in augmenting rather than diminishing the worths of persons (not roles) in the community. If the products are not useful in improving people's range or quality of control — their average worth — those loops are likely to die of resource starvation. The situation is strikingly similar to the "use it or lose it" life and death of the synaptic connections associated with the compound neural-biochemical homeostatic loops discussed in last three Chapters of Volume 1, which are components of the "Mechanic's Toolbox" of reorganization.

The greater the worth of an individual, the lower the rattling density average among that person's perceptual control loops (including the boundary-crossing homeostatic loops that involve Powers's "intrinsic variables"). Averaged across a community, what applies to the creation of novel perceptual functions during reorganization applies in the same functional way to the creation of novelties and corresponding specialized roles. If they are useful in lowering the rattling density average over the community organization, they will be more likely to survive than if they tend to raise it.

No invention was ever made by a Role. It is made by a person, who perhaps also has a Role of making the invention available for development to a defined group of others[15]. By definition, an invention may be copied and refined, but is not something that can be made to order, though there may be invention factories such as the laboratory of Thomas Edison, or the Bell Laboratories of the mid 20th century, in which several persons contribute to the refinement of an original invention.

As we pointed out in Section III.10.6 in connection with localized geographic regions like Silicon Valley, it is in this kind of "high population density" places that disparate concepts are most likely to find compatible ideas with which to combine to form new "idea molecules" in the Commons of Ideas (Section III.10.5). The population in question is not of people as such, but of ideas that may float in the Commons of Ideas "soup" for a while and then disappear or that may catalyze other idea combinations in a newly formed creative homeostatic loop.

The same localized enhancement of population density was advanced as a requirement for the creation of Kauffman's (1995) pre-life creative autocatalytic loops, as many researchers have proposed (***REFS***). Dispersed in the open ocean, two molecules of particular kinds might encounter and react with each other to produce a more complex, but almost all of those more complex molecules would be likely to have been formed and subsequently to have disintegrated long before the basic atoms were joined by a newly created catalyst molecule. In the dense surfaces of shallow evaporating pools, catalyzed encounters would be much more probable.

The function of high-density populations of people who produce creative ideas would be effectively the same. New creations — inventions — that continue to exist would do so if they participated in autocatalytic loops that produce material that can reduce the rattling in at least modules of people in a community. My own encounter with the rattling research described by Chvykov et al. (2021) catalyzed the writing of several novel ideas in several Chapters of this book, but whether the results offer either feedstock resources or catalysts for further invention must depend entirely on chance, just as would the products of catalyzed reactions in Kauffman's autocatalytic creation process.

If invention is both a result of and a contributor to major and minor cultural phase changes, it is part of a positive feedback process. We have learned to be wary of positive feedback processes, which tend to explosive results. In this book, we first considered them in terms of the "Bomb in the

15. As a personal note, my father was hired as precisely this kind of "inventor" in a commercial company, a position and Role he held throughout his working life, except for brief periods when he was asked to initiate and lead invention factories (Research Laboratories) for the company.

Hierarchy" (Chapter 6.5). The Bomb decreases the Quality of Control (QoC) of affected regions of a perceptual control hierarchy in an individual.

That part of the hierarchy experiences more rattling than it would in the absence of the hidden positive feedback loop, which in turn suggests that the slow process of reduction in the average rattling of the hierarchy by reorganization would eventually eliminate the hidden danger. The same would be true of a hidden positive feedback loop in an ecology. The ecology is less stable if such a loop exists than if it is broken.

Being hidden, potentially disruptive positive feedback loops are never obvious to a casual analyst. For example, a microbial ecology is stable in a healthy person, but if it contains a hidden positive feedback loop, a bacterium that is usually innocuous may grow exponentially if some other part of the ecology is disturbed. The person (or other living thing) may become very sick, or even die.

The issue here is that the time-scale of a control loop is faster than the time-scale of effects such as the Bomb that involve several or many control loops, and these processes are faster than the progress of reorganization. A positive feedback loop that is released by reduction in the effects of the negative feedback loops that ordinarily hides it will usually lead to an explosion that occurs very rapidly as compared to the reorganization that might, in time, have eliminated it.

A primary positive feedback process is the creative autocatalytic loop itself, or rather the proliferation of creations that may form further creative autocatalytic loops. Functionally, the process is not unlike the progress of an infection in which one infected individual may infect others. As with an infection, the more susceptible individuals the infected one contacts — the denser the network linkages around the infected individual — the more likely it is that the infection will continue to epidemic proportions rather than that it will die out.

So it is with inventions. The denser the network of potentially inventive people with access to the initial invention, the more likely it becomes that the invention be used in another invention that participates in a loop that enhances to likelihood of the first invention surviving. As with the Seshat archaeological data, the epidemic effects of the initial invention might lead to an explosion such as a cultural phase change.

Increasing population density leads to increasing rates of new inventions and their incorporation into novel creative loops. In the absence of conscious control (Chapter II.5) of this process, neither an infectious pandemic nor a pandemic increase in the rate of invention will stop before it runs out of susceptible (creative) people to infect. However, as we observe, one persistent invention is itself the group that resists change. If an invention embodied in some concrete or abstract object allows many people to control some perception that had been more difficult to control, those people will tend to incorporate instances of the object class among their arsenal of atenfels, and having the object available, may use others of its properties as other atenfels. The object class or instance becomes an atenex.

Every variation in the "winds of change" affecting the "leaves of controlled perception" is likely to increase the rattling experienced by an individual. Every invention that changes what perceptions an individual can control or how a perception may be more readily controlled initially increases the rattling, not only of the individual, but in the collective organization of individuals who have access to the object. This is particularly true of changes in communication possibilities.

That individual may maintain an achieved low-rattling condition by acting to resist change, whether or not that action is consciously the means for controlling a perception of change, or just has the side-effect of reducing change. Adherence to a religious group can sometimes lead to a reduction in the rattling of change, such as by Mennonites who do not use motorized transport, and who ignore changes of dress fashion, or by people of all faiths we call "religious fundamentalists".

Such change-resistant groups are often called “backward”, and the religious beliefs that lead them to resist change as at the least “misguided”. But from the combined viewpoint of PCT and rattling theory, their existence seems entirely to be expected among a larger society, most of whose members have other ways of reducing the rattling they experience.

Although members of religious fundamentalist groups may shield each other from rattling caused by innovations, they are not shielded from disturbances to other perceptions they may control. Nor are they alone in organizing as a group to avoid “foreign influences”. Catholic Europe was not shielded by their avoidance of innovation from the innovative weaponry of the invading Mongols of the 14th century, nor was isolationist Shogunate Japan shielded from the arrival of American warships in 1853 after some seven centuries of resisting the influence of foreigners (apart from a short period of trading with the Portuguese in the latter half of the 16th century). We will return to this topic in later Chapters.

IV.2.8 Collective Controllers and Organizations

Collective Control in general was the theme of Chapter xII.13, where a short taxonomy was described. There we did not discuss how Collective Control related to organization except insofar as it is implicit in the taxonomy. The Low-Rattling theory of Covykov et al. (2021) helps make explicit that Conflictive Collective control is very likely to transform into at least Collaborative Collective Control, and then into Coordinated Collective Control.

Hitherto, when we have used Collective Control, it has been to illustrate the stability of a CCEV under the influence of a Giant Virtual Controller (GVC). The interesting question here is orthogonal. It is about what happens to the members of a GVC, and how that affects the organization of the GVC as opposed to the effects of its Virtual Control.

In Conflicted Collective Control, each member of the collective controls a perception independent of what perceptions any of the others might control. The members belong to a collective only insofar as their actions in executing these controls influence some property of the environment that it is quite possible none individually perceive. Figure II.28.1 illustrates this possibility for two controllers. McClelland introduced the concept to the PCT Community in (McClelland 1993). His two controllers were aligned on the same axis, but acted in direct opposition. Even though the example of Figure II.14.1 shows the two effects nearly co-aligned, they are in conflict in the orthogonal direction.

When we introduced Stochastic Collective Control in Chapter xII.13, several controllers acted in different directions around a 360 degree circle. But they all were deliberately controlling the same object’s location, two properties, x, and y, that could not be dissociated from the object. Change one, and almost certainly the other would change as well. Any action by one member of the collective that changed the location of the object would have a side-effect that added vectorially to the disturbances experienced by almost all the other controllers. Their collective actions trying to bring the object to its target location would rattle each other, increasing the variance of errors in their perceptions of the object.

This kind of Collective Controller has no organization. Collective Control is just what happens if by chance several control loops are controlling perceptions produced by perceptual functions that are in some way related in that they have effects on the same environmental function. None of the controllers need be aware of this relationship, or even of the existence of the other controllers. Nevertheless, they rattle each other by their disturbing effects on the CEVs each other controls.

These rattling interactions suggest that inadvertent Collective Control, without organization, is not a calm place in the organization description space. Covykov et al. (1921) would argue that some organizational structure would be likely to appear as the organization drifted toward a calmer region.

What, in this context, do we mean by “organizational structure”? Quite simply, the more you can tell about one member from knowing something about other members, the more structure the organization has. Having more structure does not imply that the organization is in a calmer region of its description space, but it is likely to be so most of the time. If the members of the organization are control loops or individuals who are living control systems, much of the effect of structure on rattling has to do with how likely it is that the effects of an interaction will increase the error variance of at least one of he pair, and the variability over interactions of that effect.

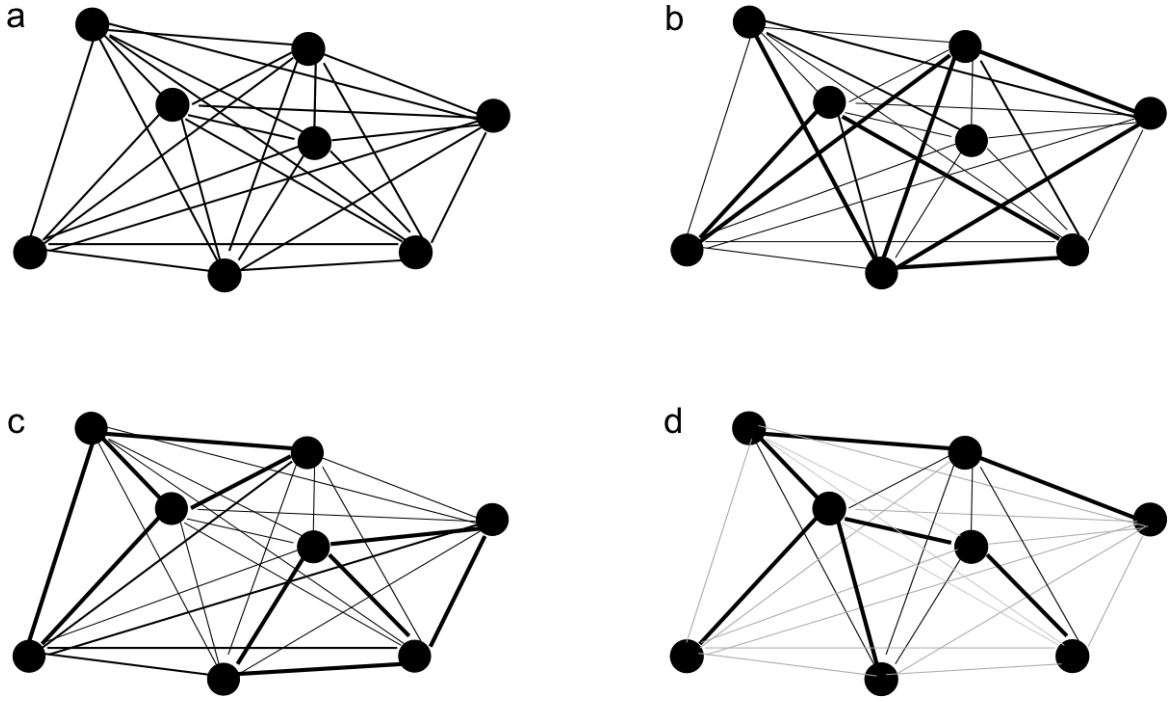

Figure x34.1 Collections with different amounts of organization. Entities of the collection are black dots, their average strengths of pairwise interactions by lines of different weights. (a) No organization; all interactions of equal probability or strength; (b) Some organization; not all pairwise interactions equally probable of of equal strength; (c) More organization; the entities form two clusters or modules. (d) Yet more organization; little interaction occurs outside of the tree structure.

The nature of each interaction is not shown in Figure x34.1, but if one interaction more often than by chance leads to another, then the uncertainty associated with the organizational structure is reduced beyond what the network diagram indicates. Low rattling theory suggests that the majority of links that are reduced in strength or occurrence probability are ones that are more likely to rattle their connected individuals heavily than ones that help their connected individuals to control effectively.

In Collaborative Collective Control each member of the collective is acting to achieve some common end. They do not control perceptions that directly relate to a Collectively Controlled Environmental Variable (CCEV), as they do in Conflicted Collective Control, but control perceptions that enhance or enable the collective to control the variable in question. How this coordination is achieved will be highly variable, depending on the perception to be controlled, but one common feature is that the coordinated actions tend to enhance the ability of other members of the collective to control useful variables. In our

“Short Taxonomy” we used a simple example, in which two people both want a pole to be set upright in the ground. One holds the pole upright, while the other hammers it into the soil.

The individual wolves in a hunting pack do not all try to chase down and bite the fleeing prey, but they do coordinate their motions in such a way that not only would the prey control for avoiding all of them but also their movements would not disturb perceptions controlled by their pack-mates. Instead, their actions would aid control by the wolves whose job was to bite and incapacitate the prey. For the wolves, if not for the prey, a chase by coordinated collective control brings their organization into a much calmer region of their description space than would a free-for-all-chase in which every wolf controlled for biting the fleeing prey, each getting in the way of the others in a “too many cooks spoils the broth” mode.

Wolves individually reorganize so as not to interfere with each other during a chase. A young near-adult that might try to take part but did get in the way would quite probably get nipped by one of the chase team. An analyst might say that the young wolf increased the rattling experienced by the impeded individual and hence by the collective. Such rattling would be substantially increased for the pack as a whole if the interference allowed the prey to escape, so that the pack went hungry.

A dramatic human example of Collaborative Collective Control (apparently mixed with some Coordinated Control0 occurred on December 6, 2020, when a number of supporters of Donald Trump invaded the US Capitol building with the objective of preventing the formal certification of the election of his opponent, Joe Biden, as the winner of the election for President.

Mixed Collective Control may require a little explanation, but first we should show how Coordinated Collective Control applies to the calming of an organization, or perhaps how a tendency toward lower average rattling tends to lead toward Coordinated Collective Control.

At its stable extreme, Coordinated Collective Control does not involve persons as components of a organization. It involves roles that may be performed by people, animals, or machines. The control system of a Role is defined as tightly as is the script of a stage play. When the person playing the Role perceives a certain situation, they are supposed to perform a certain action. Some roles and some situations give the player little choice about the action, at least at the levels at which the Role-description specifies it, whereas other roles and other situations give the player wide liberty. For example, when a soldier in uniform encounters a superior officer also in uniform, the soldier is supposed to give a crisp salute with a precise configuration of hand and arm, and the officer is supposed to return a more casual salute. The officer has much more liberty in the form of the salute than does the soldier if both play their roles well.

To interact effectively with a Role, one must play a complementary Role. The interaction uses a protocol that defines the pairing, a much calmer interaction than would be a similar interaction between the persons if they were not playing the roles. The famous 1969 “Dead Parrot” episode of *Monty Python’s Flying Circus* illustrates the point. A customer (Role) enters a shop where he recently bought a parrot, but he found that the parrot was dead and expects a refund. The shop-clerk Role would be expected to offer a response that depended on the shop’s refund policy for defective merchandise, but the shop-clerk person does not. Instead, he insists that the parrot is not dead, but merely sleeping, and cannot be dissuaded from this assertion. In the course of the interchange, the customer gets increasingly annoyed, becoming more and more rattled.

Had the shop-clerk played the Role, the customer might have objected to an “*all purchases are final*” policy, but a denial of an observable fact is something else. The customer has a reference to perceive the shop-clerk as perceiving that the parrot in indeed dead, and has no atenfels for correcting the existing error in that perception — the shop clerk does not agree that he perceives the parrot to be dead.

IV.2.9 Toward Formal Organizations

In Section IV.2.1, the development of specialties as a consequence of the growth of villages led to equating "specialist" with "Role". Someone good at making shoes would be likely to play the Role of shoemaker, especially if other specialties such as leather-tanning, thread-spinning and making fine needles had developed so that the shoemaker did not need to tan the shoe-leather or make the tools to sew together the pieces of the shoes.

In that context, a "Role" would come to exist only when a homeostatic loop stabilized the organization of the village, creating a cultural "phase change". A phase change in the evolution of culture is analogous to an evolutionary jump in biological punctate evolution, and probably occurs for the same reason — completion of a homeostatic loop in the network of ecological relationships. Is the evolutionary emergence of a formal organization a manifestation of the same effect? We will discuss formal organizations themselves in Chapter IV.3. Here we discuss their pre-formal development, at least the early development of those formal organizations that were not designed from scratch to fulfil some function.

In some ways, the "formal" aspect of a formal organization looks rather like the skeleton that provides the rods used by the gross tensegrity structure of our body. The formal organization is a structure of roles with prescribed forms of interaction — an "organization chart" — but the persons who play those roles are likely to have many inter-personal interactions with other persons playing unrelated roles. The ecology of inter-person relationships is the organizational flesh that forms around the skeleton formed by the ecology of inter-Role interactions. An effective formal organization needs both skeleton and flesh, working in coordination.

Forgetting for a moment the skeleton-flesh relationship, and considering the relationship between formal and informal organization, we can ask whether the difference between them is the existence of the double network of roles and persons (Section IV.3.1) in a formal organization. Both formal and informal organizations include roles played by persons, so that is not the distinction. Is it that formal organizations have a written set of rules and written job descriptions of roles to which people may refer and that could form the environment within which legally trained judges make decisions?

It cannot be that, either, since in many organizations we would definitely call "formal" there are no written rules, but there are many conventional norms for who controls what. Until the late 20th century, the UK structure of government had no written Constitution, and depended entirely on accepted norms

that had evolved since the Norman Conquest of 1066 through civil wars (initially between rival Kings and then between King and parliament), non-violent revolutions, and for two centuries calmer organizational changes, usually in a direction of lower rattling.

Although laws a-plenty had been written and rewritten over these nine centuries, those laws were not constrained by anything except the power of the current rulers to require or prohibit particular actions. As always, those actions might be for control of a variety of different perceptions, some of which might easily be controlled by actions not prohibited by law, while others of which the law prevented or inhibited control, leading to increased rattling of the individuals who were controlling those perceptions.

We will discuss the formation of the resulting political revolutionary group organizations in Chapter qIV.10. Here, the question is whether, being written, these laws in themselves create formal organization. They do not, though the content of laws might describe particular formal organizations, perhaps in the licensing or incorporation of business companies.

Even in organizations with formal written roles and rules, those rules are coupled with many unwritten norms that have equal, if not greater, weight in determining what people playing different roles should and should not do. At least, this would be the case in formal organizations that evolved from informal ones, though perhaps not in designed organizations. We will concentrate on the evolution of organizations, and refer back to the work of Chvykov et al. (2021), on the tendency of organization structure to diffuse toward rather than away from low-rattling regions of the available organizational description space.

Let us go back to the first cultural jump identified in the analysis of the Seshat data by Peregrine (2017). In Section III.10.6 we argued that the jump was the outward manifestation of the closure of a homeostatic loop that consisted of mutual support of one specialized occupation on another, of a shoemaker on a tanner, for example. Instances of such linkages between persons with these skills would not have been new, but their stabilization by combining in a loop was.

The homeostatic loop created an organization of roles, not persons. If Thomas retired from tanning, Ted could provide the tanned leather to Susan the shoemaker, and if Susan transferred her business from Ted to Tammy, Ted could still provide the tanned leather to Sam for his shoes. These interchanges would provide satisfactory results for the shoemakers only if the tanners were competent, and the leather was of consistent quality. If a new person, Terrence, started to claim he could make good leather for shoemakers, Terrence is dealing with the Role of shoemaker rather than with Susan or Sam. They, in turn, would not know whether Terrence was actually a competent tanner.

These potential changes of person in the shoemaker-tanner transactions would depend on the acquaintance of each shoemaker person with each potential tanner-person. Each shoemaker could perceive the quality of the leather produced by Thomas, Ted, or Terrence if they tried using the different leathers. Just because Terrence claimed to tan good leather for shoes did not mean that Susan or Sam perceived him to do so. They already knew whether Thomas or Ted made leather more suited to their own shoemaking technique, and potential shoe-wearers would have known whether Susan’s or Sam’s shoes were more to their liking.

Thomas and Ted would have been able, perhaps better even than Susan or Sam, to perceive technical nuances of difference between the leathers produced by their personal techniques. Terrence was a different matter. From their point of view, Terrence initially would have been a disturbance to perceptions they controlled, a rattle-driver in the labelling used by Chvykov et al.(2021), increasing their rattling experience. They could reduce the rattling they experienced in at least two ways, depending on which perception was most rattled by his appearance.

If the worst-rattled perception was their perception of the amount of leather shoemakers (as a Role) required from them, Terrence would be perceived as a competitor to be driven away. On the other hand, if the worst-rattled perception was a perception that people who did not know them would perceive tanners (as a Role) as producing leather of unreliable quality, their error-correction action might be to examine the leather produced by Terrence, and accept it as being or not being within the tolerance bounds of their perception of its quality for shoemaking. If it was within their tolerance bounds, they might accept that Terrence was a qualified tanner, and if it was not, they might try to warn potential client shoemakers that his leather might not be good enough for their shoes. Thomas and Ted would be organizing their own relationship as an informal guild.

Guilds are organizations that in Mediaeval times became very formal, with strict rules prescribing who could join and label themselves as practitioner specialists in roles such as Tanner or Goldsmith. But we are talking about their earliest beginnings as possible sub-organizations within the larger reorganization created by the completion of the homeostatic loop or ecology that created the first cultural jump in the punctate evolution of societies. Guild-like actions by the tanners Ted and Thomas in accepting or rejecting Terrence reduced the rattling they experienced as compared with what they would experience if they acted separately, creating a three-way competition. Their proto-guild is a calmer place for them than would have been a competitive world. The same would not be true for a rejected Terrence, though it would be for an accepted Terrence who joined the guild.

As the village increased in population, it would become increasingly different for shoemakers to keep track of the leather quality of individual tanners, or of villagers generally to keep track of who made the most comfortable and long-wearing shoes. There would be no such problem in perceiving roles such as "guild-member-certified tanner".

If a shoemaker in such a more populous village wanted good leather, she would not need to gather opinions from other shoemakers as to who produced it best. Instead she would seek a certified tanner rather than a person who had a good reputation. Not having to search implies a reduction in her rattling experience. Using a certified Role leaves her in a calmer place than if no such quality requirement was associated with Role membership.

If there were no Tanner guild in her village, she might even travel to the next village to get leather — or ask a "certified Trader" to include it in his trading circuit. In such ways might entire villages begin to act as units in the organization of larger regions, cooperating on this or that specialized ability. Suppose that minerals in the water supply of the neighbouring village made the leather produced by their certified tanners better than the local product. Local villagers might accept local leather for everyday shoes, while patronizing for their special shoes shoemakers who advertised using the other village's leather.

These proto-guilds are informal. They are simply collections of persons who agree that they are all capable of playing a particular Role. They may have norms of behaviour, set by perceptions controlled by relevant GVCs, among which are actions to be performed in order to certify a person as to being able to control well the perceptions required for performing the Role defined by the proto-guild, such as tanner or shoemaker.

Since the perceptions controlled by the guild's GVCs change little when one member leaves the guild or a new member joins, they may outlive the guild members by many generations. Ritual performances that were useful long ago may survive as guild show-pieces or as secret ceremonies that have no value beyond their effects on the self-images of group members, enhancing their perceptions of belonging and being seen to belong to the guild. The performance has its use otherwise only to enhance its own propagation, its required costumes may be the form of dress fashionable centuries but being necessary for the maintenance of the ritual, which would not survive in modern dress. The ritual has become its own stable ecology, stabilized only by the longevity of the informal guild organization.

Chapter IV.3: Formal Organizations

Informal organizations or groups may well include people perceived as “leaders” who set references for collective control by group members. They may develop ephemeral differentiated roles such as the holder of a pole and the hammerer who drives the pole into the ground. But their structures are fairly fluid, without the stability of having their actual structure either be the object of a set of collectively controlled perceptions, or be specified by an Authority that is more permanently conferred by collective control, as, for example, by an election.

Formal organizations are different. They consist of roles that interact according to some structure that may be collectively controlled directly to conform to some collective reference structure, or that may be specified by some collectively controlled Authority. The Authority might be a written set of rules to which the members and others can refer, in the same way as they might refer to a dictionary to see how a word should “correctly” be used.

Whereas an informal organization is primarily about the persons (or other organisms) who are members of the organization, a formal organization is more about roles and the expected protocols that convey “truths” during interactions among those roles. As is said about the military, a subordinate salutes the uniform of a superior officer, not the person wearing the uniform, whom the subordinate may despise. The subordinate Role salutes the superior Role, but the subordinate person does not salute the superior person.

Most formal organizations have specific protocols associated with the Role of “leader”, who has a function in the organization analogous to that of a comparator within an actual control hierarchy. The leader compares some state of the organization with the desired state and initiates actions to reduce any discrepancies. Other kinds of formal organization have specified roles, which may differ from one kind of organization to another, but “leader” is usually among them.

IV.3.1 Organizations as control systems

A sports team may be informally organized by a group who come together to play, but once created by collective control, the teams are formal. For example, a player belongs to one and only one team, and that team may have a “coach” or a “captain” who guides what other members of the team try to do. Whether in sports or in the wider world, a formal team usually has a leader.

Teams usually have objectives; one hockey team tries to score more goals than another, a mine rescue team tries to save trapped miners. But can a “team” have an objective? Our discussion of collective control suggests that it will inevitably have one. Of course, the team objectives may simply be those of the members of the team, but then again, they may not. Working as a team in which the members have different roles in support of some common objective is different from being in a group of many people who all act in the same direction on the same CCEV while controlling independent perceptions of it as a CEV.

To play on a team is to perceive oneself as belonging to the team, which implies using team-relevant protocols in interactions with other team members. A soccer player may signal another team member that he would like to move in some particular way, or to receive the ball, or any of the variety of other interactions that together form a cohesive team. An attacking forward has a Role quite different from that of the goalkeeper; the team requires both.

How can we say that a collective has an objective, when the individuals control only their own perceptions and may sometimes not even realize that the collective exists? Of course, members of a team

usually perceive the existence of the team and have a common goal for its success, but that is not true for all collectives.

There are two possible general answers. One is collective control (Chapter xII.13), in which the Test for the Controlled Variable would identify some function of environmental variables as corresponding to a controlled perception, as a result of the combined control actions of individuals who control similar perceptions to form a Giant Virtual Controller (GVC). The other is that some organizations may have objectives in the same way a person does, because they are structured like control systems. Every control hierarchy has purpose — its top-level reference value.

The idea that organizations can act as control systems has been controversial because PCT tends to emphasize the private internal nature of perception and its control. Indeed, in a CSGnet message, Bill Powers quoted Mary Powers (from a message dated July 31 1991[16]):

> *It's interesting to hear (see) the howls of protest over the idea that society exists only in the minds of individuals. A rather large disturbance to a rather precious reference signal, apparently. Almost as offensive as the idea of controlling perceptions instead of commanding outputs.*
>
> *The question is, where are the social control systems? Control systems exist in cells, and in the collection of cells we call individuals, and in cells and individuals we can specify chemical and neural mechanisms that perform control functions. But while in a society certain individuals may be construed as having certain control functions (input, comparing, specifying standards, acting), the consequences of such "functions" are communicated to other individuals only as perceptions, not as signals from one function to another as in an actual control system.*
>
> *Are there phenomena that cannot be explained assuming only individual hierarchical control systems? What are they?The idea that social control does not exist is simply that it isn't floating there between people. It does exist, in reference levels, in individuals, where it is constructed during learning and growing up. The people who have not incorporated the rules of their society into their control hierarchy are called children […] or sociopaths.*

Mary Powers's main point is in her comment: "*while in a society certain individuals may be construed as having certain control functions (input, comparing, specifying standards, acting), the consequences of such "functions" are communicated to other individuals only as perceptions, not as signals from one function to another as in an actual control system*". However, Bill Powers (1980, quoted in Powers, 1992) points out that people may choose to accept as reference states for controlled perceptions values communicated to them by other people, who thereby take on the Role of "managers".

In a 2005 presentation[17] to the CSGnet Annual Meeting, I argued that protocols and collective control allow for the creation of organizations that *are* control systems, complete and entire, with people as their functions and protocols performed by people as their transmission channels, in the same way that neurons provide the functions and transmission channels in the individual brain.

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16. I have failed to find the Mary Powers message in the CSGnet archives, and rely on the extract quoted by Bill Powers (dated Sun, 3 Jul 2005 11:35:00 -0600).

17. The Powerpoint presentation is available for download from http://www.mmtaylor.net/PCT/CSG2005/CSG2005cSocialControl.ppt

To treat the "control systems exist only within individuals" argument effectively, we must return to a discussion of what constitutes a control system. We have described protocols and collective control, both of which conform to the viewpoint in the quoted passage. What Mary Powers did not present was the idea of the Giant Virtual Controller, a construct that was not (so far as I know) presented to the PCT community until the CSG annual meeting in 1993 (McClelland 1993). Now I will argue that true social control systems can and do exist, even without reference to a GVC. What follows is largely quoted from the cited presentation I made to the CSG meeting in 2005.

We start with an examination of what constitutes a control system, or rather, an elementary control unit from which more complex control systems can be built. The functional diagram of a generic control system was described in Volume 1. We now ask about the essential properties of the ECU structure (Figure 1.2 and Figure 4.3, shown slightly differently in Figure IV.3.1). They are:

1. *The specific organization (a negative feedback loop).*
2. *Separation of "inside" and "outside", the loop passing through both.*
3. *"Channelling" of influences in the inside (signal paths).*
4. *Ability to transform specific states of the outside into a signal on the inside (perceptual input).*
5. *Sufficient power to influence the outside in a way that affects the perceptual input more consistently than by pure chance.*
6. *A reference or goal state for the internal state produced by the perceptual input.*
7. *A way of comparing the reference state with the perceptual state.*
8. *Asymmetry between the ability of the inside to affect the outside and the outside's ability to affect the inside (usually this refers to the power levels at input and output).*

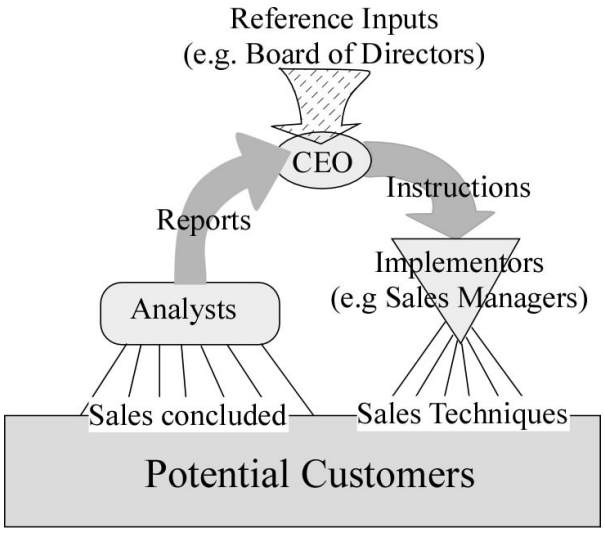

Figure IV.3.1 A sketch of a company as a control system. It is shown as a single level, but each path would consist of many levels of control, eventually broken down into protocols for information exchange among the people who work in the company and between the sales staff and the potential customers.

What is *not* required in order to make a control unit?

1. *Specific materials*. A control system may be embodied in physical materials, or in the logic of a computer program. If it is physical, its materials may be biological or inorganic, nanoscale or megascale.
2. *Physical layout*. There is no restriction on the way its output influences the "outside" environment.
3. *Single-valued "signals"*. The perceptual states it controls may be scalar or vector, nominal or numeric, fuzzy or crisp.

The following questions and answers seem to follow from these requirements (and non-requirements) in respect of possible control units constructed from independent control systems that are not necessarily all in a single body.

Input: There must be a way of transforming some condition in the outer world into a state that can be compared with a desired state. *Could a structure consisting of independent control systems do this*? YES

Comparison: There must be a way of comparing a perceptual state to a reference condition. *Could independent control systems do this*? YES

Output Action: Given the result of a comparison, there must be a way for action to be evoked. *Could independent control systems do this*? YES

Conclusion: The "Parts" of a control system could themselves be constructed from independent control systems. (The basic Powers HPCT structure uses independent control systems this way in creating the perceptual signal and the output signal of a high-level unit through the operations of lower levels of the hierarchy).

If we ask the same questions in respect of entire humans instead of independent control systems, the answers are similar:

Input: There must be a way of transforming some condition in the outer world into a state that can be compared with a desired state. *Could a human or humans do this*? YES

Comparison: There must be a way of comparing a perceptual state to a reference condition. *Could a human or humans do this*? YES

Output Action: Given the result of a comparison, there must be a way for action to be evoked. *Could a human or humans do this*? YES

Conclusion: The "Parts" of a control system could be humans

Next we consider how humans might "fit" into the structure of an ECU. If the "Parts" are individual humans or groups of humans, could they be organized to form a single control loop or a system of control loops?

Could a human input transformer communicate to a human comparator a state it computed? YES

Could a human comparator communicate to a human action executive in a different body the difference between the desired state and the state computed by the human input transformer? YES

Could a human action executive influence the world "outside" so as to affect the state reported by the human input transformer? It depends on the powers available to the human action executive, but there clearly are situations in which the answer is "YES".

Conclusion: The signal and action pathways required to form a control system could exist when the "parts" are human.

If all the parts required to form a control system could be human, and all the signal paths and action paths can be organized in such a way as to form a control system, then social control systems might exist. Do they?

A commercial company seems likely to be an example, as suggested by Figure IV.3.1. There are people who look at sales figures and report them to decision-makers who compare the figures to target values. The decision makers command actions depending on the difference between the actual sales figures and the target values, such as advertising, product redesign, price changing and so on, and those actions affect the sales figures reported by the people responsible for doing so, creating a feedback loop.

One presumes a neuron knows nothing of the function it performs in the control system. Even less would an electronic filter know its function. Do the human components of a social control system need to know their function? Can they?

Humans can perceive consciously more than one thing at once. It would be quite possible for the professional price-shopper to be a social analyst and to perceive the structure of the control system of which she is a part. But that knowledge does not figure in her efforts to learn the selling prices of competing products and to report the results. She CAN know, but she need not. *No one person is the controller. The company is.*

Finally, we can ask whether all social structures are control systems. Control systems require the following properties. Do most social systems have:

1. *The specific organization (a loop)*. YES
2. *Separation of "inside" and "outside"* NO
3. *"Channelling" (signals)*. Often YES, *but many don't; they distribute signals*.
4. *Perceptual input function*. MAYBE (it often happens that one person reports an interpretation of the world to other people, but seldom is that a responsibility of the person within an arbitrary social structure).
5. *Power* MAYBE
6. *A reference or goal state* NO (The people in them may, but the social system does not unless it has a particular organization, which most don't. On the other hand, the actions of the individuals may generate a Giant Virtual Controller, which does have a reference state for the perception it happens to control, which may be quite unlike any perception controlled by many of the individuals.)

7. *A way of comparing the reference state with the perceptual state*. N/A
8. *Power Asymmetry* POSSIBLE YES (in most social structures, some people are more powerful or influential than others, but whether the more powerful people are ordinarily distributed asymmetrically within the social system is an open question).

True social control systems with purpose and perceptual control can exist, but an arbitrary social structure is unlikely to be a control system. Unlike control systems, most social structures do not control specific perceptions, though the people in them clearly do. Because of collective control, however, many social structures may appear to outsiders as though the structures are controlling some perceptions that the individuals do not.

In all of this, we ignore the effects of rattling and the dynamic tendency of social structures to tend, over time, to become organized in ways that reduce the rattling on their average member, while leaving some to experience high levels of rattling. Dynamic variation of organizational structure is not what interests us here, the possible forms of social structures that a PCT-based sociologist might observe at a moment in time. We will return to the dynamics later.

The Giant Virtual Controller that appears in collective control is not truly a social control system, but is a way of interpreting the effect of several controllers independently influencing the same environmental variable, the CCEV. In contrast, in a true true social control system, different people communicate with each other so that they can take on roles specifically to perform the various functions of a control loop, such as perceptual functions, transmission links, comparators, and the like.

One thing social control systems seem to lack is a reorganization system driven by errors in a set of intrinsic variables, or, as we suggested in Chapter II.5, as a consequence of being part of a homeostatic loop that also involves intrinsic variables. Such intrinsic variables may exist, perhaps in such factors as the good will that public Giant Virtual Controllers have for the company, but how they might affect the internal structure of the company is not at all clear.

Rattling may well tend to drive reorganization (Chvykov et al., 2021), but rattling is an effect, not an intrinsic variable. Our biological intrinsic variables were organized in dynamically stable homeostatic loops and networks of a nature different from the synaptic connections among the neurons that we hypothesize to form the perceptual control hierarchy. What might be an equivalent in a social structure? Might we speculate that the ability of the biological individuals to stabilize their own internal intrinsic variable dynamics, such as to keep themselves and their children well fed and healthy, form homeostatic loops among the individuals as well as within them? We return to this speculation in Chapter IV.4.

Perhaps there do exist intrinsic variables that determine the survival of evolving structural patterns of businesses or other social control systems, such as the welfare of individuals in the society, but if there are, they are unlikely to be determined by anything equivalent to genetic descent. The only intrinsic variables influencing social control structures are those affecting the organization and survival of the structure itself.

A society in which most of its individuals are unable to control for their own survival (dangerously strongly rattled) will indeed die if it does not reorganize, but what corresponds to the “useful” and “not useful” or “harmful” controlled perceptions in an individual? Within an organism, a perceptual unit whose operation is not helpful in maintaining the intrinsic variables is likely to die “without complaint”. In a large society, is there anything analogous? People may commit suicide, but do companies? I do not think we have answers to these questions as yet, though we can find within the society organizations that seem to persist.

IV.3.2 Organization, Employment, and Unions

An organization may control for "the employees" to be happy as a means of controlling for them to be controlling for the organization to be successful. "The employees", in this case, are perceived by the organization as a collective controller that has a mood that it can display. But there is an inherent conflict if the organization does this, between the organization's requirements for the employees to accept certain reference values if it is to control its own perceptions, and the employee's own perceptual control.

The organization cannot survive as an organization if the employees have freedom to control what they want to reference values that are internally generated, but the employees will not be happy if they are too constrained by the demands of the organization — if, for example, the added ability to control that they gain from their pay is much less than the loss of control they sustain by doing company work rather than their own. The situation seems to be liable to evolve into a tensegrity form that incorporates both intrinsic conflict and intrinsic cooperation within its structure. Where are the conflict-based compression "rods" and the cooperation-helping tension "wires" in a social organization?

If the employees are unionized, then they form another organization, in the same way that individuals use coordinated collective control to advance the aims of a political party. The protocols then connect not the individuals or the roles, but the two organizations. The union is responsible for acting to increase the happiness of its members when they play their roles in the company. In this case, the same person plays roles in two collective controllers that may be in conflict in respect of some controlled perceptions, for example pay rates, vacations, work schedules, and so forth.

These specific examples are of perceptions that are likely to be controlled by each individual person who is an employee of an organization and by the organization, though not necessarily by any particular individual playing a Role in the organization's control structure. Let us call this employee "Vernon". By joining a union, Vernon relinquishes personal control of these perceptions, on which he has little influence as compared to the influence available to the organization. Instead, like Vicky in the political context of the next Chapter, tries to influence instead the reference values for them of the GVC that is the union.

Vernon, however, is in a different situation from Vicky. In Vicky's case, the CCEVs on which the political parties disagree are usually matters that directly influence the abilities of many members of the general public to control their perceptions. Vernon's union controls, in possible conflict with the organization, CCEVs that are the environmental correlates of perceptions directly controlled by their members using the union as an atenfel. Vernon also influences at least some of those variables using the organization as an atenfel. For example, by improving the effectiveness of the organization (not the individuals playing roles in the organization's control structure), Vernon both enhances the likelihood that the organization will survive and not defect, and increases the likelihood that he will be promoted or at least be given a raise.

Not all organizations as control structures have the same intrinsic variables that influence their "health". Some have as a top-level controlled perception, though not necessarily an intrinsic variable, the quarterly profit. Behind this is likely to be the ability of company directors to control a perception of their personal wealth, and this is a function of share value. Share value or perhaps the rate of increase (or decrease) of share value might be seen as an important intrinsic variable.

A non-profit, has a "mission" that defines a top-level variable, and an intrinsic variable might simply be the level of error in the results of its activities. For example, it might have a "mission" to enhance the abilities of children of low-income families to experience and perform classical music. The more such children take advantage of the work of the organization, the less the error. Nevertheless, the success of this effort cannot be an intrinsic variable, because the survival of the organization does not depend on it

other than indirectly. The organization survives if it can raise enough money to acquire instruments and pay workers who are not volunteers. Money, therefore is not simply an atenfel, and as with the profit-making company, the directors ability to control their perceptions of the success of the organization depend, in part, on the balance between the organization's income and costs.

Money made control of many perceptions much easier than before. That, by the definition of "worth" in Section 6.2, is its worth. One of the perceptions plenty of money might make easier for a person P to control is the building of a team to perform some task P wanted to be performed. P no longer would need to find some specific thing each team member wanted in exchange for taking on a Role in performing the task. Instead, P could offer money in trade for the team member's acceptance of P's reference values for aspects of the environment that P wanted to control. Each team member would be willing to exchange a certain amount of money for the performance of the Role of "contractor" or "employee", and could use that money with a range of other people to get what P would have been unable to offer. which often might be more money.

Money therefore acts conceptually not unlike a transportation network hub, connecting arbitrary sets of possibilities in a way that individual point-to-point short-haul railway lines could not do. It is a catalyst for the development of new possibilities for perceptual control, but in a different way than is language. Language increased the range of possible protocol types that could be distinguished from one another, enhancing the possibilities for collaboration, whereas money made it unnecessary for someone to find a protocol partner with a specific combination of wants and things to offer. Since most people would exchange an appropriate amount of money for whatever things or skills they could offer, there was no need to seek someone who wanted one's own things or skills. Money enhanced the development of roles that could be used in protocols; such protocols and their corresponding roles might well be called "social inventions".

Unions within a company, as opposed to large national unions of which the employees of a company are a small component, have an intrinsic variable that is critical to their survival, the profitability of the company. For the union, if the company does not survive. their members will be less able to control their own perceptions, because they will not be paid, and money is, as we have noted, a major atenex in an industrialized culture. In the next Section we see that this interaction is a component of one or more homeostatic loops that together form a network that is very likely to have variables that behave chaotically.

IV.3.3 Unions, Organizations, and the Stock Market

In individual organisms, feedback loops enmesh perceptual control variables and intrinsic variables (e.g. Section II.2.5). The same is true for social control structures such as formal organizations. These loops may be homeostatic, and in a stable organization they will be, whether the organization is a publicly traded company, a small non-profit, a founder-owned research centre, or whatever. We will argue that they incorporate both the perceptual control aspects of the organization and its intrinsic variables. We start by considering our symbolic employee-union-member, Vernon.

In the case of Vernon and his membership in the union *because* he is an employee of the organization, at least one homeostatic loop passes through him, the union, and the organization. Let us say that for Vernon the variables involved in this loop are his control of his pay rate and his effectiveness as an employee playing a Role for the organization. The loop is homeostatic because if it were not, then either these variables or some others in the loop would reach externally based limiting values, one of which would probably be that his pay rate would reach zero as the company went bankrupt or defected.

Vernon may control for maximizing his income, but the union acting on his behalf cannot do so, because it must also control for the organization to continue to pay its employees. The organization's health is an intrinsic variable for the small union, even if it is not for a large union with which the small one is affiliated, perhaps as a "local". If the union's demands are excessive, the organization might fail. Seldom, however, do companies open their books so that the union (as a collective) could determine what kind of effect different pay levels might have. Without this knowledge, it is impossible for the union to determine whether its demands are fair, too small, or excessive.

The organization, on the other hand, cannot control for maximizing its income by means of paying its employees a wage substantially below what they could earn elsewhere, however much its profit might increase if it were to do so. The conflict between the union's efforts to increase pay rates and the organization's effort to reduce them provides the necessary inhibitory stage that permits the loop to be homeostatic. Vernon's control for effective Role-playing enhances the organization's profit or availability of money. The organization's available money is the controlled variable in the conflict with the union over pay rates, the union's activities enhance Vernon's pay rate, completing the loop.

Vernon's pay rate is not the only variable in a homeostatic loop that passes through the organization and the union. Working hours and conditions are another. This loop is more complex, in that it passes through Vernon's social environment as well as his Role-playing environment in the organization. Vernon may control for being paid more by working longer hours and being seen as "a company man, a good team player", but if he also controls for having good relations with his family, he has an internal conflict of McClelland's "classical" kind, in which two controllers influence the same environmental variable, "hours worked".

The union may also control the "hours worked" variable, creating the kind of "going up a level" resolution formalized in the MoL psychotherapy approach (Section I.8.7). If the union sets working hours in bargaining with the company, Vernon no longer has a conflict, since he is no less a "good company man and team player" if he works only the agreed hours.

Limiting Vernon's hours of work, however, affects Vernon's ability to control his pay by working long hours to demonstrate his value to the organization. All these effects are linked into a network of homeostatic loops, with in the background Vernon's own intrinsic variables as an organism, the union's intrinsic variables as a means for its members to enhance or maintain their "worth" (ability overall to control their perceptions), and the organization's intrinsic variables, whatever they might be. All of these intrinsic variables are incorporated in the network.

In the network that might be homeostatic, Vernon has very little individual influence, but many "Vernons" have a strong influence on both the company and the union, not only through their abilities to control their perceptual variables, but also through their collective side-effects, which may provide catalysts or anticatalysts to different places in the network. So we should ask whether there really is anything sensible to say about the long-term behaviour to be expected.

One thing we can say is that at least some processes in the network are non-linear, but so long as the network absorbs only small disturbances from external sources, it acts as though it is linear, which implies that under these small disturbances it will either "explode" and destroy itself or will return to a state very like its state before the disturbance. This is not true if the disturbances are large enough to create non-linear effects anywhere in the loop. In that case, there is a third possibility, reorganization.

It is useful to remember the discussion of control tensegrity in the latter part of Chapter 1.8. There we argued that any control structure of at least two levels is almost certain to exhibit tensegrity properties, including, in particular, the sharing of stresses among controllers at the lower of the two levels. There we were interested in only one perceptual control hierarchy within one body, whereas now we are dealing

with interacting collective controllers, at least two in number — Vernon's union and the company, though there may be other collectives involved, as in the play "Lysistrata" by Aristophanes, in which the women collectively deny sex to the men until they resolve the conflict between national collectives that engages the men.

For the women in Lysistrata, the virtual perception being controlled is the state of the conflict that engages the men, not whatever virtual environmental variable is the one whose virtual reference value differs between the two city-states in conflict. The women need to control the loop gains (most probably) of the virtual collective control loops that determine how important it is to the men that they control whatever happens to be the overt bone of contention.

In the conflict between a union and the management of a company, the workers' production may fall to near zero in a strike, which alters the narrative environment or "narrative soup" (Chapter II.10) within which potential users of the company's product control their conscious perceptions.

IV.3.4 Protocols within Organizations

Protocols are the communication "wires" between individuals. Whether they are used to get someone else to perform some action or simply to convey information that reduces the mutual uncertainty between people, they always convey information. In the functional description of an organization as a control system, all the "wires" represent protocols, though, as in any control diagram that necessarily simplifies the interconnections among neurons, the functional "wire" may well be implemented in many stages and parallel pathways, with human or machines acting as intermediate staging points and re-transmitters.

Many organization-specific protocols exist because the organization itself is perceived by its members or by others as performing a Role, as though it were a person. If the organization is a business, the Role might, for example, be that of constructor, transporter, or retailer. In a "transporter" Role, many protocols used within the organization might be special to, say, vehicle maintenance and replacement, while others would be associated with loading and unloading, and so forth.

These component functions do not affect the perception of the organization as a control unit, any more than the different types of cells in the brain or the supporting control loops in a hierarchy affect the control functions implied by the Theory of Perceptual Control. The roles in the group often correspond to elements of an ECU, such as sensors, Perceptual Functions, Comparators, Output functions, and even connecting "wires", and the actions of a formal organization are often spoken of as though the group was a person: "The XYZ Company said today that it would …".

Any one person might be capable of playing all of the roles in a formal group, but for one reason or another, each person usually controls perceptions appropriate to playing a specific Role in the organization. The Boss is "The Boss", not because she is the best player of other roles in the organization, even if she has demonstrate such versatility, but because others within the organization perceive her as playing "The Boss" Role at the moment.

"The Boss" Role is not so much a person as a collectively controlled environmental variable, a CCEV, which, as McClelland points out in passage quoted in the introduction to Volume 2, allows certain protocols used in interactions with the Boss to work as atenfels and prevents others from working. At some point, the person playing "The Boss" Role leaves, and someone else becomes "The Boss" while the organization's structure and the functional protocols remains unchanged by the substitution.

This statement may seem to justify the frequent claim that members of an organization are simply interchangeable "cogs in a machine", the "machine" being defined by an organization chart. Bosses seldom see their own Role this way, and it should not be read this way for any Role in the organization,

because the actual performance of a Role depends on the person having an appropriately reorganized control hierarchy — having the right skills for the job — and no two people have exactly the same set of skills. Each player of a Role, no matter how well defined the Role might be, is different. The person playing the Role may be doing so in support of control of any of a variety of possible higher-level perceptions unrelated to the organization. This makes no difference to the place of the Role in the structure of the organization.

To be "playing a Role" is a reference value for a set of controlled perceptions that might contribute to self-image. Once that reference value has been established, disturbance to the "Playing the Role" perception result in outputs that provide reference values to the various controlled perceptions that, down the hierarchy, produce the appropriate actions. Some of these would, for example, be for the forms of protocols appropriate for interactions with people playing other roles. Some might be for physical skills, such as riding a bicycle on busy streets, if the Role is "city courier". Whatever those controlled perceptions are, reorganization is needed before the person becomes a skilled "Player of the Role" — meaning that she controls the Role-perception well and largely unconsciously.

This applies equally to "The Boss", "The Janitor", "The Accountant", "The Salesperson", or "The Receptionist". Furthermore, the Role-players, as persons, must control some perception for which playing the Role is an atenfel. The possibilities for such a perception are many. Which is effective in a particular case determines how the Role-player is likely to act when the perception is disturbed. For example, if the person's controlled perception requires the acquisition of money, then when someone offers more money if the person would join a different organization, the Role-player might jump ship. If, however, a controlled perception is the success of the organization, then the offer of more money would not disturb the controlled perception and no action would be necessary to correct the non-existent error.

The forms of other protocols as potential atenfels depends on the individual Boss as a person. If a low-level staff member disturbs, say, CEO Lily Adams's self-image perception by addressing her as "My dear Lily" rather than as "Maam" or "Ms. Adams", she might correct the disturbance by some action the staff member finds unpleasant, but which is an action for which the CEO Role has the right (Chapter III.2). Even if the person playing the low-level staffer Role was a person who in life outside the organization often called the person Lily Adams "My Dear Lily", the player in the low-level staffer Role cold not when addressing the CEO Role played by the same person.

In a different organization, say a small startup, to be addressed as "My Dear Lily" might not disturb a perception the CEO Role would be expected to control. It might disturb a perception Lily Adams controlled, and CEO Lily might stop to see why the staff member used that form of address. She (as opposed to the CEO) might even expect it in that company, depending on how the members of the organization had reorganized as a consequence of her actions when she had been similarly addressed in the past. If their protocols had been successful after saying "My Dear Lily", then they probably would not have reorganized. but if their protocols had not worked, they probably would have reorganized, and might not use that form of address again.

No matter how "My Dear Lily" works, CEO Lily is still playing the Role of "Boss". When Joe controls for perceiving himself as belonging to the organization, he must perceive himself to be playing a particular Role. That Role should have a reference for acting as CEO Lily or some other Authority to whom she has given the right wishes. Of course, depending on what CEO Lily wishes, to act in that way might conflict with acting to control other perceptions in the person Joe, but if it doesn't, a Role-playing protocol will work in which CEO Lily allows him to see what she would like Joe' Role to do, and in that Role he allows CEO Lily to see that he is doing it. That protocol might be called "Giving and taking orders" if Lily implements it in a direct way, or more gently and generally, "doing what someone else wants".

“Lily” has been described as the CEO, or the Boss. To describe her this way is to suggest a number of different things others would expect Lily in the CEO Role to do, both within and outside the organization. Her failure to do them would cause disturbances to the “Boss” Role perceptions in those others. Among the things Lily may (or must) do because Lily is perceived as CEO, she has the right to disturb some perceptions as parts of protocols, which, if disturbed in the same way by someone playing a different Role would not be perceived as part of a protocol. For example, if Lily told someone playing the Role of secretary “Please take a note”, the secretary’s action would probably be to take a note of what Lily said next. Lily and her secretary have a set of protocols they both know and which will work for them most of the time.

On the other hand, if someone playing the Role of office messenger said to Lily’s secretary “Please take a note”, it might disturb the same perception in the secretary, but the action to remove the effect of the disturbance is more likely to be to say “Get lost” or something similar, because the secretary Role takes notes for the CEO Role but not for office messengers.

“Get Lost” might be an action in a protocol loop or it might not, depending on the organization and the individuals. Whether it is or not depends on what perception the messenger boy was controlling by his action in speaking in that way. If hearing “Get lost” removes the error in that perception, then as a person he was executing a protocol, in which the secretary person was a possibly unwitting partner. If he really wanted the secretary to take a note, he was not playing his office messenger Role properly.

Of course, since both “Please take a note” and “Get lost” are actions observable to an outsider — behaviours that are controlling some perceptions — they may not mean to the actors what the observer thinks they mean. They might, for example, actually be moves in a flirting protocol.

IV.3.5 Trust and Leadership

One class of protocols worth identifying is the set of protocols used between a leader and those being led. When an organization is seen as a control system, the signal paths that are shown as lines in an organization chart are implemented by the actions of people controlling certain roles perceptions to reference values supplied from roles higher in the organization against disturbances produced by the actions of other people performing different roles. Such a structure can work only if the perceptions controlled are Role-appropriate and their reference values change as they would if they were supplied directly by a reference input function.

In a large organization there are many levels of leadership. A leader at one level is a subordinate to a leader at the level above. As in the control hierarchy of a single organism, each leader except the highest accepts reference values from above and except for the lowest provides reference values to the level below. Even the top-level leader or CEO will accept reference values from the company Board of Directors, in the form of policy directives.

The Board of Directors performs much the same function as does a fitness evaluation function in evaluating the effects of reorganization in an individual perceptual control hierarchy. If it seems appropriate the Board might even change the person playing the Role of CEO, since one of the functions of a CEO is often to reorganize the control structure of a company.

Similarly, lower-level “perceivers” of different kinds of data, such as sales volume at a particular store, provide data to higher-level perceivers, such as one who analyzes and reports geographical trends in sales. In the organization, “leader” is a Role, as is “perceiver” or “manager”, and the person who is a leader or manager leads because someone with a collectively controlled right to do so has appointed that person to perform that Role.

The Authorized Role of "Leader" does not mean the same as "leader" considered as a function within an organization. A functional leader need not have any authorized position, though the two concepts have a lot of overlap. A group may be functionally led by someone other than the authorized leader if the authorized leader is not trusted. The ship's crew may in practice defer to the First Mate rather than the Captain if they perceive the Captain to be weak and indecisive, and the First Mate may allow this to happen by interpreting appropriately the Captain's orders and by suggesting effective orders to the Captain. The Captain retains the authorized Role of Leader while the First Mate performs the function of leader[18].

Here is a PCT description of trusting in the stability of the environment: *Trust may perhaps be treated as control in imagination using a world model in which one outcome of an action is much more likely than any other. In that world model, "planning" degenerates into a single path by which the desired perception* ***will*** *be produced*. In interpersonal relationships it means much the same, with the necessary inclusion in the world model everything that we discussed on social trust in the previous section.

What was not mentioned there was how feedback loops akin to protocol loops might occur in trust relationships among individuals. If John trusts Jane, does that imply Jane trusts John? Of course not, but does John's trust in Jane enhance the likelihood that Jane trusts John? If John trust Jane, does this enhance the likelihood that John also trusts Jane's friends and associates? Leo the Liar uses "Yes" answers to such questions to enhance the stability of the coterie of those who have incorporated his Big Lies into their World Models.

When we deal only with arbitrary individuals Jane and John rather than their friends and associates, the only considerations are the protocols they use in their interactions. If each perceives the other only as an instance of a Role within the culture, the trust is simply that the other will perform the Role correctly. Most "customers" will pay for their goods when dealing with someone who seems to be a cashier, for example, and will find their perceptions disturbed if the cashier, instead of accepting the proffered payment, begins to act in ways more suited to a cabaret performer. However, if the interacting individuals see each other as persons, their trust will depend on the results of past interactions with each other specifically, not between their roles.

That trust might extend beyond the protocols they use. They might not even interact deliberately at all. Jane might trust that John will catch the 6.45 bus every weekday, because she sees him at the bus stop from her window, not because John has told her that he tries to catch that bus. She may not even know who John is, other than as someone unknowingly playing the Role of "familiar figure". If John is not there one day, Jane may assume that there was a conflict or an impediment that prevented John from being there, rather than that John is unreliable. Maybe the next time he does catch the bus, she will introduce herself and ask him what happened. Only then will they be using any protocols.

The only reason for the "leader" Role to exist is that simple collective control is subject to the vagaries of the reference values of the individual participants, such as squabbling about how to achieve what all the participants want to achieve. By accepting the reference values proposed by the functional leader, most conflicts can be avoided. As Benjamin Franklin is supposed to have said to a group plotting the American Revolution: "*We must all hang together, or most assuredly we shall all hang separately*".

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18. . Such an arrangement is unlikely to be stable, and might even lead to mutiny. If the Captain controls for retaining the Role of Captain but perceives the First Mate as undermining his authority (not his Authority), a conflict will exist, exactly as it would if one tried simultaneously to control the position of one's car in its lane and independently the angle of the steering wheel. A weak and ineffective autocratic leader will lose staff quickly this way. Trust works in both directions.

An organization that has reference values coordinated by a leader is rather more powerful than a group for which the participants' reference values are uncoordinated and subject to the vagaries of their own internal higher-level perceptual control operations.

When one of the people executing a protocol is playing the "Leader" Role and the other is playing a "subordinate" Role, the situation is the same as with any other roles. Each trusts the other to play the Role properly. A new person promoted into a leadership position is supposed to play the Role, just as a new actor in a play will speak the same lines as did the actor being replaced. The new Leader and the new actor may not play their roles exactly as did their predecessors, but the lines (protocols) are the same. Orders issued by the Leader are to be taken on as reference values by the subordinates (especially if the Role is of military leader) no matter who occupies the position at any moment.

It is as a functional leader perceived as such by those being led, rather than as an "authorized Role only" Leader that trust matters. Different persons playing the same Leader Role are likely to function differently, meaning that they control different perceptions or control perceptions differently. Some "micromanage", meaning that as part of controlling some variable for which they are responsible, they betray distrust in their subordinates, because they try to control also perceptions of lower-level conditions that the subordinates are supposed to be controlling. They specify the actions to be performed rather than the results to be achieved.

Since the Leader who has been promoted from within the organization probably would control the perceptions supposed to be controlled by all the roles through which he rose better than can the current occupant of the Role, the person newly playing the Leader Role may find perception he used to control well in the former Role now being what he sees as poorly controlled. If he is tempted to continue controlling them at the same time the newly promoted subordinate is controlling them, at the very least the subordinate is likely to experience a disturbance to his or her self-images, or at least the other-self-image.

In some circumstances micromanaging is known as "helicopter parenting", not allowing the growing and learning child the opportunity to learn from the successes and failures of methods of perceptual control. In more dramatic circumstances, the new technological ability of the generals to see the ground details of the Vietnam war allowed them to attempt to control the actions of small military units directly, bypassing the chain of command. This micromanagement has been said to be one reason that the USA lost the war so badly.

Other leaders assume the subordinates can control the perceptions for which they are responsible, without monitoring to see whether this trust is justified. They, too, run the risk of failing. Their failures happen because they "fire and forget" their commands to the subordinates, and assume that the subordinates correctly report the success of the commanded operations if they report at all.

IV.3.6 "Trust but Verify"

Former US President Reagan used the phrase "Trust, but Verify", which is a middle way between the extremes of micromanagement and "Fire and Forget" management. In PCT terms, to "Trust but Verify" is to expect the competence or trustworthiness of another, but to "Verify" by observing whether the trust appears to have been well-deserved.

The leader's trust in the subordinates depends in part on whether they had previously controlled for following the leaders instructions. Whether they do depends on whether being led provides an atenfel for perceptions they control, and whether they succeed depends on their personal skills and the collection of perceptions they control more than on the Role they play. As McLelland (2020) points out, the stability of

a collectively controlled atenfel is what makes it available for general use. If one plans a trip and has a choice of routes, one of which uses regular roads while the other is shorter but uses a certain bridge that occasionally is closed to traffic without warning, one is likely to choose the route that avoids the bridge (unless the resulting detour would be very short if the bridge happened to be closed).

Similarly with following a leader. If following the leader provides atenfels for the subordinates to control their own perceptions by controlling for what the leader wants controlled, they are likely to try to do what the leader wants. If not, they will not. The perceptions they control by following the leader may have nothing to do with the perceptions the leader wants them to control. They may be controlling a perception of money in the bank, something they can influence by playing the Role of subordinate in a way satisfactory to the leader. They control "Role-reference" values rather than personal reference values. To play the Role to the satisfaction of the leader is an atenfel for controlling their personal perceptions.

One possible set of perceptions a subordinate might control, as most people probably do, is the properties of their self-images — perceptual Objects with several controllable properties. If being seen by others as a valuable team member is a reference value, then controlling a perception by others of self as helping the leader achieve the team's goals is likely to be a part of the subordinate's control hierarchy directly supporting control of that other-self-image perception. The leader will trust such a subordinate, at least if the subordinate is competent.

On the other hand, if "competence" is a self-image property of which the subordinate controls the perception, and the leader disturbs that perception by showing mistrust — perhaps doing so by micromanaging — then the subordinate is likely to act so as to reduce the error introduced by the leader's actions. Those counter-actions are not likely to enhance the leader's trust in the subordinate. Each comes to mistrust the other.

Trust in the leader by the subordinate depends on how the leader's actions serve to bring the organization's CCEV as a Giant Virtual Controller near its reference profile and keep it there while minimally disturbing those of the subordinate's controlled perceptions that are not part of the collectively controlled perception profile. Another way of saying the same thing is that a good leader gets the job done while keeping the team members happy.

Trust, as with control of perceptions of inanimate CEVs, depends on the fact that certain actions almost always have a consistent effect, which allows one to save much time and attention by using "command" modes of operation, leaving actual control to the higher levels of perception. A leader who can ask someone to do a job within that person's competence does not need to monitor the progress continually if that person has a consistent history of doing what is asked or of reporting when problems occur in doing the job. "Reporting problems when doing the job" but not reporting very much about it other than that the job is going well is part of trust. The perception that the subordinate will report problems allows the leader to avoid continuous monitoring, thus enhancing the subordinate's perception of being trusted.

Trust also works in the opposite direction. If the leader consistently interprets a problem report as a sign of the subordinate's untrustworthiness or incompetence, and allows the subordinate to perceive her displeasure, the subordinate will trust that this will happen. The subordinate probably will reorganize so that problems are not reported, even when they are intractable. The leader's perceptions will fail to reflect the reality perceived by the subordinate.

At the other extreme, the subordinate might be able inadvertently to get the leader to reorganize and become a micromanager. If the subordinate can trust the leader to help the subordinate resolve the problems, all of which are reported, the subordinate need not develop the expertise required for solutions of problems in this domain. At both extremes, the subordinate perceives the leader not to trust him, but

the extremes differ in what the subordinate trusts the leader to do to control against a disturbance caused by a problem report.

In an intermediate situation, the leader trusts the subordinate to report only problems that are truly beyond the subordinate's ability, and the subordinate trusts the leader to help with the solution rather than to act so as to disturb the subordinate's self-image perception. These reports of problems have the status of "alerts", rather than being a part of the moment-to-moment controlling done by either leader or subordinate.

The existence of alerting systems as a component of the perceptual control hierarchy is an aspect of "Trust but Verify". The leader may need to know the states of many more things than can be simultaneously monitored without assistance. Of these, in many situations most change very slowly if at all, and it would be a waste of time and effort to keep monitoring them. The alternative is to set a simple alarm that is triggered when one of them leaves its tolerance zone.

So long as these variables are within their tolerance zones, they do not contribute to the errors in perceptions the leader controls. If there is a trusted system whereby a subordinate, perhaps a machine, can alert the leader when some variable is nearing a tolerance bound, the leader can ignore that variable, assuming that its value matches its reference value closely enough, and leaving its control to the subordinates. The leader then can devote more time and resources to the control of higher-level variables. A leader can do this only if the subordinates are trusted to control those variables they are asked to control, and to alert only when the variable cannot be adequately controlled at the lower level.

Conversely, the subordinate is likely to restrict the alerting to those emergency situations if the leader is trusted to be controlling the higher-level variables well. In plain language: "*I'm not going to bug him to check that I'm doing what he wants, because he was clear about what I should achieve, and I perceive myself to be achieving it. But if I find I'm failing in doing what he asks, then I will let him know, because I know he will not fault me for it*."

Trust is developed and maintained in a positive feedback loop. The more the leader has in the subordinate, the more the subordinate is likely to have in the leader, and vice-versa. A leader with a high level of trust is a good functional leader. It is part of an autocatalytic network that is not a homeostatic network, but is self-limiting because "trust", the catalyst, is not infinite supply.

Most of us assume that "nobody is perfect". If that is true, then our level of trust depends not on any absolute value, but on our tolerance for the purpose at hand. Indeed, most of us would find quite a few of our controlled perceptions disturbed by a friend who never uttered a little white lie such as "You are looking great!" when they may not actually believe that to be true.

We might well control for not encountering such a person, preferring others who might tolerate our imperfections or even tell us they do not exist. The absolute truth-teller may be correct, but we may find that the truths being told disturb our controlled self-image perceptions in ways difficult to correct. We might even perceive the truth-teller to be not one of "us", since most of the people we encounter are not perfect truth tellers who we trust will tell us the occasional white lie.

Chapter IV.4. Social Reorganization

In Volume 3 we used rattling theory with living control systems to account for the hierarchical organization of the perceptual control hierarchy within individual. We argued that a low-rattling structure of perceptual control loops is a hierarchy of modules, rather than of individual controllers. In the previous Chapter we applied rattling theory to apply to social organizations, organizations of living control systems. We continue that theme in this Chapter.

"Smarticles" flap their own arms, whether or not their flapping arms hit other smarticles. Those "hits" are the rattling effects of one smarticle on another, and for a fixed population of smarticles, the tendency is toward organizations that minimize the total rattling across the whole population. In Chapter III.8, we pointed out that the population of control loops is by no means constant, so we replaced total rattling with local rattling density. Local density almost always varies across whatever measure is of interest. Only over large populations does the average of the measure smooth out.

When we are considering individual living control systems, regional population density is important to organization. If individuals seldom encounter one another, the side-effects of their control actions have few effects effects on others. Organizational structures hardly exist, except possibly in places where the environment more or less requires normally isolated individuals to converge, such as watering places. Such a population is rattled only by variable external wide-ranging influences such as regional rainfall, temperature, or wind, not by each other. The population is similar to a gas, in which molecules move independently except for their occasional encounters. Watering places might be seen as analogous to cold surfaces on which dewdrops might collect from the water vapour in the air above.

At the other extreme, when a crowd of people are packed closely together, no individual can easily move in a direction or at a velocity much different from the crowd average. Side-effects of the actions of one individual propagate to several other neighbouring individuals and beyond. The population is organized much like a solid.

Much of the rest of the book, however, is concerned with phase changes analogous to those between solid, liquid, and gas. In a liquid, local organizations exist, unlike a gas, but are made and unmade as time goes by, unlike a solid. This kind of simple analogy fails when we recognize the quasi-solids such as tensegrity structures or the "liquid crystals" important in display technology, but is nevertheless a useful basic guide if it is not taken too literally.

We return our focus toward Perceptual Control Theory as the driver of the trend of disorganized groups of interacting entities toward low-rattling organizational structures. We will not ignore rattling theory (Chvykov et al., 2021), but we will refer to it less in what follows. Instead, we will concentrate on PCT and what it does.

Most of the cases we will look at have immediate effects on the rattling density distributions of the organizations involved. The reader will, I hope, see many of them without further explanation.

IV.4.1 Role Networks and Person Networks

We will ignore for now the possibility that a social ecology might contain explosive hidden positive feedback loops. Those almost certainly increase rattling, even when they remain latent, because they reduce loop gains and are likely to reduce the Quality of Control. If they do increase rattling within a control loop as compared with the rattling that the loop would experience in their absence, they are likely to be deleted before they emerge from hiding, as a part of the local reorganization that PCT expects to be

ongoing throughout the perceptual control structure. We will ignore the Bomb in the Hierarchy in this Chapter.

For now, we will discuss stable networks of roles and persons, and how they may develop into informal organizations. In particular, we explore the nature of networks of roles as a "skeleton" for the more complex network of interactions among persons who may easily change from playing one Role to another. Here, we do still need to consider rattling theory, at least a little.

A worker is a person, but "Worker" in a job is a Role, as are "Cashier", "Janitor", or "Manager". Each Role could be played by any person competent to use the atenfels required for the Role. Among these atenfels is a set of protocols that are useful when interacting with other roles during the performance of the specific Role, but are not very useful when the person who plays the Role acts instead as a person, or switches to playing a different Role. The Role-defining set may also include protocols the cashier-person might use when playing other roles that are outside the Cashier-defining set, but are disallowed to the Cashier Role.

Each Role is defined by the particular protocol set used in playing it. If we refer back to the "White Boxes" of Chapter I.11, a Role corresponds to an entire White Box, while its protocol set corresponds to the functions used by the White Box. They link the roles that might provide their reference values to the roles that provide their perceptual input values, both connections being made by protocols rather than the "neural wires" of a perceptual control hierarchy. Roles are "objects" in the sense of Section I.11.8.

A person playing a cashier Role uses a restricted subset of the "Cashier" protocols in communicating with a person playing a Customer Role. These may be called Cashier-Customer protocols. No one one such set of Role-linkage protocols defines either Cashier or Customer Role. Each Role uses other protocols when interacting with different roles, such as Cashier to Manager or Customer to Product Advisor. The complete set of Role-pair protocols used by a Role do define the Role. The more protocols there are in the set, the more tightly defined is the Role "object".

A Cashier protocol set is, to some extent, dependent on the organization in which the cashier-person works. A random person cannot come in off the street and play the Cashier Role without also being given the appropriate set of protocols to use in interacting with roles played by other members of that particular organization, such as a Boss Role or an Accountant Role.

The Cashier Role is not a Seller Role. Nor is the Boss Role. A Seller Role is played by an Owner, which the person playing the Cashier or Boss is unlikely to be except in a small shop. The Owner's Seller Role may be implemented by players of other roles within an organization, just as control of a perception in a perceptual control hierarchy is implemented through control of lower-level perceptions.

A Customer, however, is usually a Buyer, which implies that the definition of a Customer Role implicitly includes a possibly distant relation with a Seller as well as with a Cashier. Buyer-Seller protocols may exist explicitly in a small business, but even then they are distinct from Cashier-Customer protocols performed by those same two persons. On the Customer side, too, the protocols may be implicit, the actual performance being executed by an Agent Role.

Even if we ignore the possible layering of Role performances within a person, almost any Role will have some kind of relationship with more than one other Role. Each Role becomes a node in a network of Roles in which the links are the set of protocols used between this Role and another. The Cashier Role has links not only with the Customer Role, but also with the Manager Role and the Treasurer Role in the organization of the shop. Of course, in a small Mom and Pop shop, the same persons play all the Roles, but in a larger organization, or a chain of shops under the same ownership, different persons are assigned to play a much larger variety of Roles. Another way of saying that the Role is defined by the set of protocols available for it to use is to say that it is defined by its place in this network.

Persons perform roles by controlling perceptions based in the structure of the Role, but since the Role determines the performance, it is not a pair of persons but a pair of roles that interact, with persons using Role-appropriate protocols as the mechanism of their interaction. Each person can play many roles, and in the different roles will interact with a different set of roles, each of which could be played by several different persons.

A person network is associated with a Role network, but like the flesh overlying the bones of the skeleton, the person network in an organization is not totally constrained by the roles the persons play. The roles within the organization are unlikely to include, for example, lunchtime badminton games between friends in different parts of the organization. Such games are interactions in the person network, but not the Role network.

The conformation between persons and the set of roles they have learned is a much lower rattling organization than would be the same set of interactions among the same persons if the protocol being used had to be renegotiated every time they meet for the same purpose, such as the Customer and Cashier executing a PCT trading motif (Section III.7.6). Each Role eases control of some perception in each party (person) by use of beneficial interactions of Type 2 and Type 3 (Figure III.10.1).

Figure III.10.2 suggests how interactions among persons ride along interactions among the roles that they may play. This Figure ignores any interactions like the lunchtime badminton games that depend on specific persons, such as friends or family members. The players of roles are indeed specific persons in any one interaction, such as person A playing "Customer" in an interaction with the "Cashier" played by person C, but the next time person A plays the same Role, the partner Cashier could be an entirely different person X.

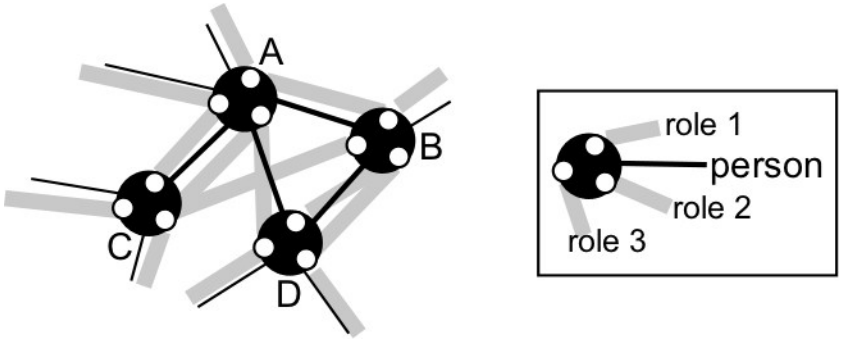

Figure III.10.2 A small portion of a network of interacting persons and Roles. In the interactions among these four persons, each plays a variety of Roles, of which three are indicated by the white dots in the black discs. Person A uses only one protocol with persons B and D, but interacts with C in two unrelated Roles with different sets of available protocols. B, in one Role, interacts with D in two Roles, using a different set of protocols for the two Roles of D with which B's "Role 2" interacts. B in "Role 3" interacts with C's "Role 2" and C's Role 2 also interacts with A's "Role 2".

Figure III.10.2 shows four persons who sometimes interact with each other. Each person may play several roles, of which three are indicated, not necessarily the same three for everyone. For example, A in "Role 3" and C in "Role 1" might be rugby players on the same team, and C in "Role 2" might be a cashier in a shop frequented by A in a "customer" Role (A's Role 2). B, playing one Role (medical doctor), interacts with D who plays two different roles (patient and medical colleague). B and D might be doctors who interact as colleagues, but D might also be a patient of B. D (in Role 3, "cashier") might

accept money for service, so A uses his "customer" Role 2 protocols in some interactions with D. A might well be a patient of Doctor D, but to simplify the diagram A's "patient" Role is not shown. Finally, A and B, playing their respective "Role 1", may interact, A as priest and B as parishioner.

Notice here that in Figure III.10.2, the same Role is played by different persons in several cases. B and D each play the doctor Role, D and A may play the patient Role, A and B play the "customer" Role, while C and D play the complementary "cashier" Role, at least in its sense of trading money for goods or services. Although the networks connecting persons depend on the interactions among the Roles the different persons play, the inverse is not true for the network of Roles. That network looks very different, and does not depend on the persons playing the Roles (Figure III.10.3).

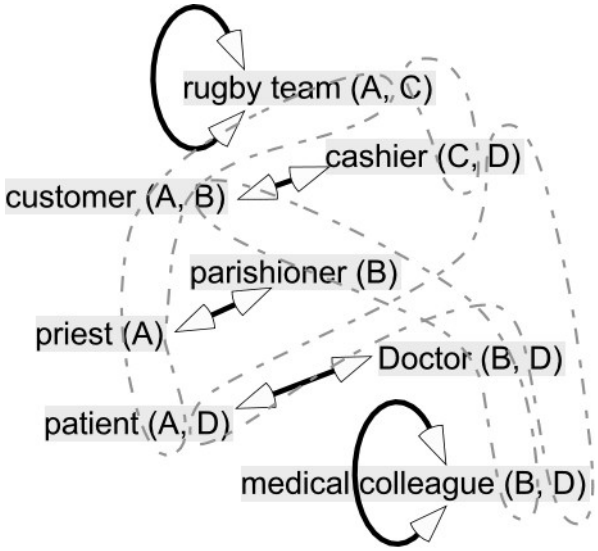

Figure III.10.3 The network of the roles that participated in the person network of Figure II.14.1. This particular network consists of isolated segments, each consisting of one Role and its complement, which might be itself. The Role pairs in this network are connected only through the persons that play the Roles.

Figure III.10.3 shows the network of roles that participate in interactions among the persons shown in the interaction network of Figure III.10.2. Unlike the highly connected network of Figure III.10.2, the network of Role interactions is deeply fragmented. Person A in the Role of priest does not interact with person B in the Role of doctor, but does interact with person B in the Role of parishioner. The set of protocols that would be used between priest and parishioner are very different from the protocols that priest A would use were he to become a patient of doctor B.

Persons seem to have a very similar relation to roles as do perceptions at one level in the control hierarchy to perceptions at one level below. Several roles combine in a person to define the kind of person he or she might be. The rugby-playing priest A who goes shopping where the rugby-playing cashier C works is a different kind of person from the fee-accepting Doctor D who appears to have too few patients to afford a secretary, and whose interactions with Doctor B are both collegial and as a patient. If we were to list all the roles played by any of these persons, we probably would wind up with a very good idea of their personalities, their health and physical state, their family lives, and much else.

Like the language spoken by individuals, the available roles are collectively controlled within a society or culture. When Marcel went to live among the J's (Section II.14.5), he would have had to learn what roles translate well from his native "M" culture to the foreign "J" culture. Diplomats are usually

trained in the protocols appropriate for use with Roles in foreign cultures to which they may be despatched. If they are not, and use protocols appropriate in their home culture, they may cause offence — rattle perceptions controlled by their foreign contacts. The Roles available in a culture must be performed as they exist in the culture, as virtual artifacts like the subtle connotations of words that at first seem to be direct translations of each other.

Is a "Shaman-priest" Role a translation of a "Doctor" Role? Maybe. Both interact with the Patient Role, but does a Shaman-Priest interact with Nurse, Secretary, and Tax Accountant? If not, how valid would the translation be? Is "Shaman" instead a good translation, perhaps, of "Priest"? Both minister to the mental well being of members of their flock, but the "Priest" Role does not interact with the "Patient" Role (though medically trained persons who are priests may also play the Doctor Role).

It is probably better not to imagine "Shaman-Priest" as a translation of any Role in a contemporary Eurocentric culture. It is a full Role in cultures where it exists, because of collective control by members of that society who control some perceptions better if it exists.

Mr. Dowd's invisible rabbit (Section III.7.4) has a similar function for people other than Mr. Dowd. If you, personally, do not control any perceptions better by using any of your roles to interact with a person playing the Shaman-Priest Role, then for you the existence of the Shaman-Priest Role is at most a disturbance (an increased source of potential rattling) to your controlled perceptions of the way the world is.

A protocol is a link between persons who use them even when playing a Role. Even though we talk about roles being defined by the set of protocols they can use in their different interactions, those protocols are actually executed by persons playing the roles. Some perform their Role more predictably than others might do. My aunt, for example, always tried to use the checkout line served by a particular cashier at the supermarket, because she thought that person was a good cashier. Although multi-way protocols among more than two persons can exist[19], the vast majority are either two-way or between one person such as a lecturer and an anonymous crowd who often can be treated as one collective entity in an analysis of the protocol.

In Section I.8.6 we saw how the expected structure of an individual control hierarchy leads to tensegrity properties. In such a structure, higher layers provide overlapping structural rigidities "rods" against which the lower-level control systems provide tensions "wires". In Chapter III.1.8 we argued that for similar reasons the tensegrity property applies to coordinated and collaborative forms of collective control. Can we apply some of the same arguments to the network structure we have just described, consisting of persons, roles, protocols, and individual control hierarchies? Do these Role networks and person networks have tensegrity properties, which would imply that the social structure of the the local culture — family, club, profession, town, nation, etc. — will exhibit resilience against some kinds of disturbance? We argued this point from the point of view of rattling theory in Chapter. Now we do it again, basing the argument on control tensegrity.

In the set of roles performed by a person we have the equivalent of the set of reference values supplied to lower perceptual control levels by one higher-level output. The person determines the configuration of roles, and the roles determine the configuration of protocols, so we do have the equivalent of the tensegrity "rods". But do we have an equivalent of the wires in a physical tensegrity structure?

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19. A three-way protocol is illustrated and analyzed in my Chapter for LCS IV (Mansell, 2020). A committee meeting may offer a more complex example of a multi-way protocol interaction, but this has not been analyzed to see whether it is better seen as a complex set of two-way protocols used in sequence.

In both the individual control hierarchy and in coordinated and collaborative collective control, the "wire" tensions are the tendencies for controlled perceptions to move toward their respective reference values. These "tendencies" are not like the tendency of a ball to return to the bottom of a bowl. Their mode of action is different, in that they pass energy and entropy to the environment in the process of reducing the entropy of a specific small part the environment. Some of the energy supplied to the rest of the environment is manifest in the side-effects of the control action, and some of these side effects influence other, apparently unrelated, control loops.

Later in this chapter we will discuss why it is that among the many possible loops of side-effects there are almost inevitably some that are mutually beneficial. By the normal process of evolution, these beneficial loops have a higher probability of long survival than do loops that make individual control more difficult. Beneficial side-effect loops are a special case of the homeostatic loops and networks we discussed in connection with the Commons of Ideas, but differ in that no controller in the loop acts with the purpose of assisting control by another, whereas the homeostatic structures in the Commons of Ideas typically involve control of atenfels that do assist control, quite possibly by others.

As an abstract construct, beneficial side-effect loops may seem far removed from the question of how persons, roles, and protocols might together form a tensegrity structure, but it is not. The question to ask is "*Why does a particular constellation of protocols come together to form a Role, and why does a particular constellation of roles tend to recur across persons*?"

The PCT answer, I propose, is that the side-effects of perceptual control that occur when using the protocols involved in a Role tend to be part of a mutually beneficial loop within a particular culture, and the same is true of the side-effects of playing the different roles within a person. Playing a set of roles that have detrimental mutual side-effects that reduce control quality is likely to result in conflicts within a person's individual control hierarchy.

We call such a situation a variety of names, including "hypocrisy", "being two-faced", and "a tormented individual", or say things like "You would never suspect a respected person like that do do such a thing", and "He was living a lie". These problems might occur because a Role uses protocols that, within the culture, have mutually detrimental side-effects, or because the person plays roles that do.

Persons with such mutually detrimental side-effect loops among their roles or among protocols within a Role are, on average, less likely to be able to control their highest level perceptions, such as one or other kind of self-image (self-self and other-self), than are persons who play a set of roles that form mutually beneficial side-effect loops.

For example, our rugby-playing priest may have good physical health, which helps his mental abilities in treating the problems of his parishioners, while experiences with the parishioners may help his perceptual abilities in interpreting the ongoing play of a rugby game. Playing rugby may make him a better priest than if he were sedentary, while playing the priest Role may help his performance on the rugby field, if only slightly. However, within the culture, there is a conflict between playing those two roles, if his rugby team is scheduled to play on a Sunday.

The argument here is that protocols within roles, and roles within persons, have average tendencies toward mutually beneficial arrangements because controlling better increases the likelihood that control actions will benefit the stabilities of intrinsic variable dynamics. These tendencies in social interactions are akin to the tendencies of control to bring perceptions toward their reference values, and to the tendency of reorganization internal to individuals to create perceptual structures that can be well controlled in a specific environment. Whereas control of perceptions happens rapidly within an individual, these average tendencies are manifest slowly and only over a population of individuals, and may be violated within individuals.

As we proceed to investigate larger communities and the differences among cultures, we will see that similar tendencies are likely to recur and produce tensegrity effects that promote the resilience of the social structure. Tensegrity-like systems occur at all scales of time and population size, but their structures are determined more by the processes of evolution than of the reorganization that occurs within individuals because of the evolutionary development of intrinsic variables that must be maintained within life-supporting bounds.

Everything we have said in these last few paragraphs could easily be referred to a tendency toward reduced rattling averaged over the organization, a tendency we already suggested would tend toward building tensegrity structures. In general, this will prove true when we consider the structure of an organization of any size, but for the most part we will follow the PCT trail, which offers a mechanism to produce the effects measured by the average rattling over the organization.

No evolutionary equivalent to an intrinsic variable exists that might sustain the integrity of a culture, partly because cultures do not survive because of the generation to generation changes that can lead to increased fitness of those later individuals. They survive by continuous change and adaptation without the essential limited lifespan associated with procreation. We can call the fast phase changes of organization within a structure, or the slow incremental changes that happen in small steps “evolution”, but those processes are very different from the evolutionary processes that modify species species by the varying abilities of individual descendants of living members of the species to survive to produce descendants of their own.

Be all that as it may, we must return to a less free-floating consideration of large cultures and spans of time, and think again about mechanisms by which organizational structures come to be, starting with the kinds of groups we call “informal organizations”. The population of an ancient village might have been such, but within the village smaller informal organizations may develop along with roles and specialties.

For example, a few bread bakers and beer brewers may choose to share favourite recipes and yeasts, to the benefit of all of them. That kind of collaboration is quite different from the shoemaker-tanner interactions that form part of a homeostatic loop that causes a “culture-jump” when the loop closes, but by collaborating, bakers and brewers both control some perceptions a little better with or without the phase-shifting created by the big homeostatic loop and network.

IV.4.2 A Hierarchy of organization

At several places we have used terms such as “atom” and “molecule”, and discussed how more complex molecules being built from combinations of simpler ones. We also talked about the high-dimensional nature of the space of description of an organization. If we refer back to the organization and reorganization of a perceptual control hierarchy, the description space includes all the parameters that describe the interconnections among the different ECUs (Elementary Control Units), including zero values that indicate no connections. The number of such links and variables that describe different perceptual and reference functions is the dimensionality of the description space.

When we dealt with the tendency of the average rattling over the entire perceptual control organization to decrease over time in an environment of given variability of disturbance variation to the different perceptions being controlled, we argued that the rattling experienced by an individual could be averaged over the error variability in the individual ECUs, taken over the entire complicated structure of perceptual control processes. In our analysis, we came to two conclusions, neither of which were in themselves novel.

One conclusion was that local rattling density variation within the larger structure would lead to variable rates of approach to a low-rattling region of the description space, higher rattling density leading to faster local approach than in less densely rattled regions. This result corresponded with Powers's intuition that reorganization would be locally concentrated in parts of the perceptual control hierarchy where the Quality of Control (QoC) was poor. The second conclusion was that an approach to a low-rattling region would indeed lead to the construction of a hierarchy of perceptual controllers, which we assumed would be of the "molecule type" we call an ECU.

Putting these two together led to the conclusion that a perceptual control hierarchy in an environment of moderate variability would tend toward a modular structure in which the network of interconnections approximated a "small world" network. Can we apply similar arguments, or perhaps even the same argument, to social structures of relations among individuals? I think we can.

Let us begin by recognizing that the relations between any two individuals involve several different controlled perceptions — all the perceptions controlled by each individual by acting on the environment. Some of those controlled perceptions may incorporate perceptions of the state of the other individual, and some of these may be components of communicative protocols. All of the ones that incorporate perceptions of the state of another act in some way on the other's ability to control one or more perceptions, as suggested in Figure III.10.1.

To the other individual, these actions may be either beneficial or detrimental to the QoC of the affected control loop. The same is true of actions performed by one individual in control of perceptions that do not include anything about the other individual. These actions have side-effects that can also affect the QoC of any or all control loops in the other individual in the same four ways.

Considering only the organization of these two individuals, the tendency toward reduced rattling rather than the reverse could occur only if, on average, those interactions that increase rattling (primarily Type 1 interactions that directly affect the variance of the disturbance to a controlled perception) would be reduced in strength, whereas those that were beneficial would be strengthened — I repeat "on average". Reduction of Type 1 and other potentially detrimental interactions can be achieved by distancing the two individuals from each other, but this also reduces the beneficial interactions. Even between two individuals, it seems we may be creating a tensegrity structure of interaction of the kind that might be exemplified by "I love him, but I can't stand it when he leaves the cap off the toothpaste."

As we noted early in our discussion of the work of Chvykov et al. (2021) in Chapter II.4, one of their findings is that the average rattling over an organization occurs not when all individual rattling values are equal, but when most are low or very low, while some few at the tail of the distribution can be arbitrarily high in a distribution like a declining exponential.

When many different perceptions are controlled by an individual, all of which may affect the QoC of any or all of the perceptions controlled by another individual, and the other equally influences the QoC of the first, the tendency toward low rattling must usually include some rattling-enhancing components. Among these "maverick" elements of the low-rattling distribution, some may involve direct conflict over the value of some environmental variable (such as the state of the toothpaste cap). Again, we seem to be edging toward tensegrity as a probable property of even dyadic interaction.

Let us now add a third individual to the mix. Re-using the names Adam, Beth, and Cal from the graduate-student cartoon of Figure III.3.4, Adam and Beth have established the kind of stable dyadic tensegrity relationship we have been discussing, but Cal's action in performing a greeting protocol directly disturbs the perception of a greeting protocol controlled by Adam and Beth (Type 1 interactions) that had a different reference profile. Adam slaps Cal and indicates verbal displeasure, increasing Cal's rattling experience.

This three way Adam-Beth plus Cal interaction is a prototype of the change in average rattling occasioned by the attempt of a newcomer to be accepted into a stable group. The original group has settled into a low-rattling organization that has a boundary between those who are members of the group and use the evolved forms of interaction that result in, on average, low rattling among the group members, and those who do not know the interaction modes — usually protocols — used by the group members with each other.

The group boundary is not necessarily perceived by any of the group members, but it is perceived by a potential "invader" such as Cal, in the error values he experiences in trying to control perceptions involved in protocols that the group has evolved differently for similar interactions such as being introduced. In some ways, the group boundary acts as a defensive moat or wall around a castle within which the occupants are not much rattled by each other's actions or by external disturbances. Unlike a moat or a wall, the defensive boundary of the group is a pure abstraction, intangible and invisible, but rattling possible invaders. It is a science-fiction "energy deflector".

In the cartoon, Cal is in one sense a group member. He has been admitted as a graduate student, and is therefor a group member within the formal wall erected by the admissions authorities of the university. He has two choices, isolate himself from the older students who use these unknown protocols, or learn to use the group-specific protocols.

Learning is, for Cal, reducing his experience of being rattled when controlling certain perceptions. He is likely to reorganize his perceptual control hierarchy to use different atenfels in the context of graduate school than he has used and will continue to use outside that context. If he is successful in doing that, he will experience low rattling, and so will the earlier group members, Adam and Beth, when they interact with him. The average rattling experienced over the three of them will be minimized.

Each individual, Adam, Beth, and Cal, probably belongs to several other groups, in each of which they use protocol forms evolved within the group. Some of these forms are embedded in the language of a culture. For example, as we quoted at the end of Section III.2.4:

> *The elaborate levels and styles of Korean speech vary according to the relation among the person talked about, the listener, and the speaker. The factors considered are age, social position, familiarity, and gender. There are two basic levels: a polite level for superiors and a plain level for inferiors or equals; each of the two levels is further distinguished between formal and informal styles.*

The "group" in this case consists of native speakers of Korean living in the Korean culture. In Section IV.3.8 we show how such group-defining language idiosyncrasies may and have been used to identify on which side of the group boundary an unknown person belonged for a group defined by language and culture, but that is not the point here. Here we are interested in the development of groups of groups in a hierarchical structure like that of perceptual functions in a perceptual control hierarchy, and we pointed out that Adam, Beth, and Cal are likely to belong to groups unrelated to their membership in the graduate student group.

Let us suppose that Adam is working on a research thesis in some engineering topic.

IV.4.3 Informal Organization

Informal groups are bounded only by their common use of a set of protocols that are not used or are used differently by the larger population or specific other groups. They have no rules defining membership in the group, either permanent or even commonly accepted by the members of the group.

If you are fluent in the use of group-specific protocols, you probably are a member of the group whether you know it or not, and share with most other group members ways of controlling some particular set of perceptions. The perceptual functions may be different from ones generally used by non-group members, or the perceptions may be the same, but the group's members similarly controlling a wide variety (many dimensions) of perceptions leads the group to act as a set of GVCs (Giant Virtual Controllers) for correlated perceptions that may not be the ones directly controlled by group members.

Groups may become self-organized, as, for example, a few families who often get together at a neighbourhood ice-rink to play a game of shinny (free-form ice-hockey), or they may be formal, with roles defined by others in the form of an organization chart and rules laid down in some generally accepted form, typically writing. An informal organization has no pre-specified roles or rule.

As the members of the group co-reorganize, however, different pairs of members may develop different protocol relationships. Roles and rules appear as the organization, though remaining informal, grows more stable through the development of homeostatic loops of the main- or side-effects of perceptual control actions. Controlling by members of the informal organization becomes easier and the Quality of Control (QoC) averaged over the group improves.

Dominance relationships may appear, meaning that "Give me X" type protocols are more likely to work when one of the pair initiates them. When the other member does, the protocol might not work to provide X to the requester, but instead eliciting a response along the lines of "Who do you think you are?" possibly implemented physically and non-verbally if the request was perceived to be intended as disrespectful to "the Boss". Small collaborative subgroups may evolve because they have different loop gains or somewhat different reference values for control of subsets of perceptions that are controlled by all group members.

Such protocol pairs or subgroups may perhaps seem as though they define roles, and on occasion they may in fact do so. The test of whether they do in any particular informal organization is whether the same or similar protocols would be used by another person with the same partners if the current person departed. If the test suggests that the Role and not the person determines how the interactions are performed, the informal organization may be on the way to becoming a formal one, complete with the kind of written or collectively controlled specifications and rules of the organization that we sometimes call a "constitution".

Group evolution might exchange person for Role as the group moves from informal to formal status. "The Boss", for example, who achieved that position by using personal abilities, may come to have a defined Role called "President", "King","Leader", "CEO" or "Commander" into which different persons may be placed by collective control of the now formalized group members. Members of one subgroup may come to be identified as playing the Role of "policeman" while members of another subgroup may have the Role of "cleaner" or "doctor".

We may be getting a little ahead of ourselves here, since we discuss formal organization, toward which our informal group is evolving, in Chapter IV.3. However, it may nevertheless be worth noting that distinct formal organizations may be themselves the units or elements of an informal organization. Nations prior to the creation of the League of Nations or the United Nations provide a large-scale example. Individual Nations may agree to interact by custom or by formal treaty on some matters, while

within each Nation a formal or informally reorganized Constitution may specify the organizational structure and rules of interaction.

The idea of a passport in very old, going back at least to 4000 years ago in the Middle East, but the modern passport was invented only a couple of centuries ago, in the form of a document in a recognizable visual style. The passport at that time conveyed a request from the leader of a traveller's home country that the authorities of a foreign country afford the traveller unimpeded passage. Many current passports still carry this same message, but instead serve as a request that the border authorities of the foreign country allow the holder to enter.

Originally, a traveller might have chosen to take advantage of the request conveyed by the passport, or not. A passport was not required for entry into the foreign country at all. Only much more recently has a passport been considered a necessity for foreign travel, formalizing what had been an informal arrangement between the formal structures that we now call Nations.

Returning to consideration of informal organizations, we note that when a controlled perception is disturbed, a control system acts to counter the disturbance. The hypothetical Ph.D. students in Section III.3.6 collectively control some perceptions of the forms of protocols, and of the "Authority" to enforce them. If the slap in the cartoon of Figure III.3.4 was administered by someone who Cal perceives to "have no right" to do it, it might disturb a different perception than if administered by someone Cal perceives to have the "Authority", in this case Adam, the older graduate student.

Since Cal perceives Adam to have the right to administer the slap, the newcomer "defers", in that he perceives the slap as[20] a guide to correct execution of protocols particular to the informal graduate student culture. In the example, the slap is likely to disturb a perception of the correct (collectively controlled reference) form of the greeting protocol. If, however, a passing stranger administered the slap, it might disturb Cal's self-image perception, or his perception the level of civility in the general neighbourhood, or of something else, and his corrective action might be to object to the slap verbally or physically.

A specific person who is "Them" may not actually be opposed to "us", as Cal in the cartoon was not, but it is easy to see how a person wrongly using protocols appropriate to "us" might be perceived as playing a Role that is indeed opposed to "us", thereby becoming a "bad guy" by definition. "Not us" is just a person unable to use "our" group's special protocols effectively, but since "We" cannot be at fault without disturbing "our" collectively controlled self-image, "They" and their control actions must be responsible for "our" collective failure to control something.

"Belonging to a group" is a controlled perception, or rather two. In my self-self-image I may be a group member, but in my other-self image based on perceiving actions by others I may not be. I control my perception of my group membership, and I control my perception of their perception of my group membership, in the same way I control my perceptions of my partner and my partner's perceptions of me in my performance of any protocol.

IV.4.4 Cultural Reorganization

The next Chapter is about "Us and Them". This Chapter is mostly about "Us", though if the group we are discussing does not include everybody, there must also be people who are "Not Us", without necessarily belonging to "Them" a distinct group of "Not Us" people.

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20. The concept of "perceive as" is discussed in Section 8.3 and 6.4 in connection with polyflops and labelling.

There is no need to repeat the arguments of Chapters 12 and 21 about side-effect loops and the development of protocols, as they apply to Giant Virtual Controllers in the same way as they apply to controllers within individuals. Protocols of interaction between Collectives must have forms different from protocols of interaction between persons or roles within a self-organized group. Intergroup protocols nay be performed between individuals, but they apply to the interactions of cultures as a whole.

Some protocols between cultures as a whole do exist. We give the name of ”Negotiation”, “Treaty”, “Alliance”, “Pact”, and “Agreement” to protocols that are as formally defined as is a “Negotiation” or a “Contract” between individuals. Conflict between individual control systems in different individuals has its counterpart in wars between cultures.

Within an individual, side-effect conflicts increase the speed of reorganization. Reorganization may not find a system of perceptual controls that eliminates conflict, but when it does, reorganization slows dramatically, leaving the well-functioning system to continue stable operation, at least until its external environment changes, which might trigger “The Bomb” avalanche of control failure and its consequent reorganization process. The same occurs in conflicts among individuals. If they find a modus-vivendi, it is likely to remain stable until some external change destabilizes it and leads to new conflicts. And the same is likely to occur among Giant Virtual Controllers.

In all these cases of ever-larger systems, the effect is that of “punctuate evolution” — periods of stability punctuated by relatively short periods of dramatic change. We saw a different side of that in the last Chapter, when it was the mutual support of innovations due to increasing population density that led to the creation of new creative autocatalytic loops, rather than the mutual antagonisms between disparate stable structures.

In the case of large culture-level conflicts, one or two centuries ago we reached a stage in which the re-organizational phase changes affect the entire world. Two centuries ago, the Congress of Vienna after the Napoleonic Wars did not have a global reach; one century ago, the creation of the League of Nations after the First World War did, as have many subsequent sub-National organizations such as the World Bank, the International Court of Justice, or the World Health Organization that were created by global treaty or as components of larger global structures.

This kind of international reorganization is different from the reorganizations within an individual or among individuals, which lead to modular solutions in which there is relatively little interaction between modules. At a world scale, particularly when the “commercial” or “business” culture controls for increasing global interaction, there is little opportunity for a modular solution.

Are non-modular organizational structures likely to be stable in a highly varied world?Reorganization with restricted opportunity for modularization is an unstudied area. In Powers’ 14 degree-of-freedom Arm 2 demonstration (Powers, 2008), the achieved modularity is extreme, each top-level controller influencing almost exclusively its own private degree of freedom. His proposal in B:CP that reference values are produced from associative memories described a system with larger modules, because associations in one area are largely disconnected from associations in another. But so far as I am aware, no reorganization process has developed a non-modular stable control structure compatible with an environment that has a complex structure.

This does not mean that no stable non-modular system can exist, but it implies that if one does exist, it is harder to find than a modular solution, and is probably unstable, liable to disintegrate into modules. For the World bodies mentioned, some countries may fail to ratify the relevant treaties, or fail to abide by their provisions, leading to a loss of uniformity in the organization, and a partial fragmentation into sets of smaller collaborative organizations, such as NATO or SEATO, for military protection instead of United

Nations peace-keeping forces, and Trade organizations such as the North American USMCA or the Pacific Trade Treaty beginning to supersede the World Trade Organization.

One might therefore suggest that the current fashion for large-scale treaties that reduce or eliminate barriers to international commerce (in the larger sense) may be misguided and may fail in the long run to provide a stable environment in which different cultures might flourish.

In Section II.2.4 we introduced the concept of phase transitions in autocatalytic processes, using as an example the observations by Turchin et al. (2015, 2018) that occur when communities reach a certain size, which we judged would be on the order of low hundreds of individuals for one such phase transition. We elaborated on this phenomenon extensively in Chapter III.8, using the rattling-theory of Chvykov et al. (2021) in accounting for such phase changes.

We likened the interactions among individuals at these phase changes to the freezing of a liquid or condensation of a gas, when the individuals cease being like the free-floating atoms or molecules of a gas, each able to go its own way occasionally bumping into random others, and become more like the atoms or molecules of a liquid or solid, loosely or more tightly fixed in a long-term relationship with specific others. These relationships with specific others are in the form of loops in which the specialized activities of the different actors on balance enhance each other's ability around the loop.

Unlike the case of the solidifying gas, however, not all control units participate in the benefits of belonging to any particular loop. The phase transition actually belongs to a less familiar class of network behaviour, in which the transition is between a lot of small independent subnetworks to a situation in which most of the nodes belong to one giant network while a few are left out, unlinked to the big network. The transition occurs at some point when the average number of outlinks and inlinks for a node passes some critical value, in the same way as when an infection transitions to epidemic status if the average number of persons infected by one infected person exceeds 1.0, or as when a nuclear chain reaction occurs if the neutrons released by the splitting of one atomic nucleus lead on average to more than one other nucleus being split.

In such "network" phase transitions, there are always units that are left out. Not everyone succumbs to the infection in an epidemic, and not every nucleus is split in a chain reaction. Similarly, not everyone benefits in the same way from all the beneficial loops in a social phase transition.

People who are left out, have less "worth" than they would if they belonged to more beneficial side-effect loops. They may belong to a few such loops, but these are likely to correspond to the isolated small subnetworks that remain after almost any phase transition to a giant interconnected network. These "low worth because isolated" individuals are still hierarchic control systems, and as such will presumably control for increasing their worth, their ability to control a wide variety different perceptions.

Small isolated subnetworks may be mutually linked into one or more self-sustaining homeostatic loops, and these will enhance the "worth" of their members despite not being supportively connected to the main giant network. In Chapter IV.7, we will discuss "The Big Lie", which might engage one or more of these "outcast" structures, and might thereby give them a collective control power that could disrupt the main "body social". The next section, however, approaches this same social problem from a quite different viewpoint.

IV.4.5 Bureaucracy: Tonic or Toxic?

In the life of anyone able to read a book such as this, they will have heard that they should try to eat more of this, less of that, together with other adjurations than they should do exactly the opposite. Some things "cause cancer", but kill you quicker if you don't eat them. Too much salt kills, perhaps slowly, but

you die quicker if you can't get enough salt. Animals can risk being eaten by predators if the only way they can get salt is by finding a rare "salt-lick" where predators might be waiting. Vitamins and other minerals are the same; too much or too little will kill, but the right amount, not to mention the right balance among them, keeps you healthy.

I will argue that the same is true of bureaucracy in organizations, both formal and informal. Too much or too little, or of the wrong kind, is toxic, rendering the organization ineffective as a control system within its working environment.

Here I offer a long anecdote based on my own life experience, not as scientific evidence, but as a real-life example of a bureaucracy that turned from Tonic to Toxic.

When I joined the Canadian Defence Research organization with a new Ph.D., there were four levels of authority between me and the policy-making Minister of Defence. When I retired as a senior researcher, there were thirteen such levels intervening by several different interlacing routes. At the same time, scientists nominally involved in active research were complaining about being unable to find the time to do any research because their time was completely absorbed in filling out forms explaining their research, what it would achieve (if they ever had time to do the research and see what it might if their ideas proved valuable), when that promised achievement would be reached (presumably with promotion penalties if it was not achieved by the deadline), and the steps, timings and requested financial costs for each phase of the hypothetical research that might sometime be done in the small gaps between filling out the various forms required by different sub-agencies. That long sentence, in itself, is an analogy to what had happened to a vibrant and innovative research environment with many important discoveries to its credit in its earlier years.

Continuing the example by anecdote, we may ask why that happened from a PCT viewpoint. In the Canadian system of government, there are two kinds of authority, political and civil. The political authority is determined by periodic election of individuals to seats in the House of Commons. At every election, some members lose or relinquish their seats (roles) and different members (persons) take their place. The political power structure may not change, but the persons who play roles in the structure often do. Among those roles is that of Prime Minister, who provides reference values for what other Departmental Ministers are supposed to achieve, in the form of "Mandate Letters" given to the persons the Prime Minister selects to fill those roles as part of their appointments.

The civil authority (called the Civil Service) is supposedly non-political, and the persons playing the Civil Servant roles in it have employment and an income independent of the periodic elections. In theory, the most senior Civil Servant in a Ministry is given reference values by the Minister for things to be achieved within that Ministry, except that the Prime Ministry is headed by the most senior Civil Servant who has some authority over the whole Civil Service, including the senior Civil Servants in each Ministry. The role structure is formally defined, but the persons playing the different roles may change, and each Minister has the authority to change the persons playing the most senior roles in that Ministry.

To continue the anecdote, the Prime Minister, Pierre Trudeau observed that when he wandered through the various ministerial offices to talk with his Ministers, many Civil Servants did not appear to be doing anything more useful than solving crosswords. He thought that the Civil Service might be more efficient (and less costly) if those who performed no function for the nation were let go, and the role they nominally filled were removed from the organization chart. Rather than quietly arranging with his minsters and senior Civil Servants to make this change slowly one person and one role at a time, he thought it would be politically popular if he announced that the Civil Service would be trimmed by about one-third.

That rattled the whole Civil Service organization. Many of the individual civil servants who fitted his (I'm told, accurate) description of "*coming in to work at 10, doing the crossword, and going home at three*" were individually rattled by this, because they perceived the Prime Minister to be talking about them, a large, rapid, and unexpected change in the error of several of their controlled perceptions, such as the stability of their income. The best way then to keep their job was to find something to do that fitted the formal role they were playing, and to be sure that the work was perceived as important enough to require at least one assistant, creating more roles to fill which new persons must be employed, which meant employment interviews that needed to be done by persons playing interviewer roles who then themselves needed assistants.

In the end, this attempt by the Prime Minister to cut the Civil Service by 30% resulted in its increase by 50%, and the production of many forms for some other people in other roles to fill in. Those forms had to be produced by the newly hired assistants in order to justify their roles, but once produced, the forms had to be justified by requiring others to fill them in and return them. Many of these others were those who had been performing the actual work of each Ministry. Their work, previously doing what they had been hired to do, now included filling in these forms that told people who had hitherto been harmless what the actual people doing the work for which the Ministry was tasked were doing. The filled-in forms would be analyzed by other newly hired people who filled roles that required using the filled in forms so that they could tell the researchers what they ought to be doing. By the time the growth spurt settled down, comparatively little of the work of the Civil Service involved helping the researchers with their basic job of discovering and applying new knowledge for the benefit of the military (and in the case of the institute in which I worked, civilian organizations on occasion). The researchers had become the raison-d'etre of the Civil Service, in place of the research.

I tell this anecdote to show one example of how a lean and helpful bureaucracy was turned into a toxic monster, rather in the way that a healthy cell turns into a tumour. This example may be extreme, but I think it illustrates one tendency of bureaucracies in general. Another general characteristic is that most persons playing roles in the bureaucracy are controlling more strongly for perceptions related to their income and their job security than for perceptions related to the overt mission of the bureaucracy, which is nominally to support of the control of perceptions by political decision-makers who set reference values for what their Ministries were expected to achieve. If the actions required for control of these very different categories of perceptions conflict, the conflict is more likely to be resolved in favour of personal interests than of reference values provided by the bureaucratic management.

The role structure of a bureaucracy is analogous to the conscious structure of the sequence of fingers-on-notes taught to a novice pianist by a skilled teacher and transferred into rapid non-conscious performance skills with enough practice[21]. Or to take a wildly different analogy in a different field, to a wooden frame that may be used to hold the stone blocks that will form a complete arch that becomes fully functional only after the keystone has been placed and the wooden frame has been removed. The implication in the bureaucracy is that its function will be best performed only after the framework provided by roles has been subordinated to the perceptual control abilities of the persons who animate the language-prescribed responsibilities of the various roles in the abstract and inactive framework of the formal organization structure.

An effective bureaucracy is one that best permits the active components such as the street-cleaners, the doctors and nurses, poll-takers, and others who interact directly with the physical and social environment, to do their job. Someone needs to observe and report which streets have potholes that need fixing, where people are having difficulty acquiring food, and so forth. Someone needs to determine what could be done, and someone, a political authority, needs to determine the priorities among conflicting

21. My teacher called this transfer from conscious to rapid non-conscious "muscle memory".

action possibilities. There must be a bureaucracy if there are so many people in the organization that none of them can know most of the others. This seems to happen in at least a rudimentary form when a village grows beyond about 400 people.

IV.4.6 Song and Dance: Music and Belonging

French revolutionaries in 1789 sang the Marseillaise as they marched. The Marseillaise became the National Anthem of France after the Revolution was successful. Most countries have a National Anthem, but they also have what might be called National songs, songs that are uniquely associated with the nation, such as the British "Rule Britannia", the Korean "Arirang", or the German "Deutschland über Alles", or even the US "America", which is sung to the tune of the British National Anthem..

National songs tend to induce emotions perceived as pride and thankfulness in people with the right nationality, and often contrary emotional feelings in members of some other nationalities. In my personal experience as an English child during World War II, I would say "Deutschland über Alles" is such a divisive song. These unofficial "national" songs often lead members of that nation to feel their nationality, sometimes perhaps even more than do their National Anthems. The songs enhance the singers' or listeners' feeling that they belong, if they do, but sometimes enhance a feeling of alienation from that group if they do not.

At the other end of the scale, how many couples who have been together for a while may hear a particular song and say to one another "That's our song"? Why "our" song, when they may hear and have heard other equally delightful songs in the same time period? At intermediate scales of group size, sports clubs often have a song or chant of solidarity that differentiates them from other clubs. Such chants are frequently heard in competition from different parts of the crowd at soccer matches, for example. They help the supporters of one side to cohere, while at the same time disturbing supporters of the opposition.

Belonging to "this" group is not necessarily inconsistent with also belonging to "that" group, depending on the groups in question. One may play the same Role or a different Role in the different groups. One can simultaneously belong to a book club that meets weekly by common agreement, to a group of two consisting of yourself and your "significant other", to a volunteer group who spend weekends clearing garbage from a local beach, and to any number of other non-conflicting groups.

In Chapter II.5, we remarked that listening to music has multiple effects on physiologically active biochemicals in the body. How much of this effect is due to rhythm and how much by melodic and harmonic structure is another question, to which an answer would be welcome. My suspicion is that the rhythmic structure of the sound pattern contributes the strongest effect. It certainly seems to be the most important component of much music currently popular with Western youth. Even in mice, rhythmic drumming can influence estrogen receptors (Kim et al., 2015) to the extent that the drumming can act as a suppressor of anaphylactic shock.

McDermid (2021) informally reviewed music therapy for patients suffering from delirium in the Intensive Care Unit, and also described a few studies of music therapy in other disorders. including Parkinson's disease. The American Music Therapy Association (https://www.musictherapy.org/about/) is a resource for learning more about the topic, which is a digression from our interest in music as a tool for group cohesion. We will not pursue the topic of music therapy further, but will note in passing that its therapeutic benefits necessarily involve effects on the biochemicals involved in the homeostatic loops that interact with the reorganized perceptual control hierarchy.

Going back in deep prehistory, one might expect that the earliest form of music consisted of the rhythm of chant rather than the melody of song or the harmony of interacting voices. Dance requires

rhythm, whether done in silence or with acoustic support, but dance does not require melody or words. Drumbeats are quite enough, as can be attested even today by anyone who has attended a native North American “pow-wow” as a participant or an observer.

In a dance circle such as often forms part of a pow-wow, the accompanying drumbeats, perhaps accompanied by a rhythmic chant, help a large group of people to synchronize their movements, particularly their foot movements, in a formal dance. Such synchronization would be much harder without the drums. The participants can perceive the precision of the synchronization of the dance, and better perceive themselves as members of the dance group the better the synchronization.

There may be as many different dance styles as there are nationalist groups, from the English Morris Dance, to the Scottish Highland sword dance, a Greek circle dance, a Hawaiian Hula or a Russian Cossack dance. Facility in any one of these styles is one indicator a member of the group might perceive to be an indicator whether the person is “one of us”.

IV.4.7 Belonging and Trust

When one begins to perceive oneself as belonging to an informally organized group, and perceives that others also perceive one as belonging, group membership becomes part of one’s World Model. The environment in which one controls has changed, including one’s repertoire of atenfels, as suggested in Figure III.10.3 and Figure III.10.4. But those new means of control will not be useful until reorganization has created the skills to use them effectively.

One aspect of belonging, or of not belonging, to a group is the perception and collective control of a boundary of trust. For some perceptions, truths communicated through protocols are different if the source is perceived to be within the group or outside the group. Some perceptions, and particularly their reference values, are trusted to be similar for all group members. For example, all members of one street gang are supposed to have a set of reference values to dislike members of an opposition street gang, and to act to counter perceived disturbances caused by members of the other gang to perceptions trusted to be being controlled by members of one’s own gang.

Shakespear once again comes to mind, with the Capulets and Montagues of *Romeo and Juliet*. Trust within the Capulets and within the Montagues is an important consideration when we deal with inter-group relationships, as is the corresponding distrust of groups perceived as intending to create disturbances to members of one’s own group. Romeo and Juliet both betray the trust of the groups to which they belong, being the opposite of antagonistic to each other.

President Reagan’s “Trust but Verify” slogan applies here, since most group members are likely to control for perceiving other group members to have these particular group-specific reference values. Nobody verified that either Romeo or Juliet perceived all the members of the other group as antagonists, as they were trusted to do. Group members collectively control perceptions of each other, so that a group member who acts as though they have different reference values will find that collective control by the group will disturb some other perceptions, perhaps even so far as ejecting the dissident from group membership. Romeo and Juliet had to keep their love hidden until their deaths together at the climax of the play.

Religious groups call such dissidents “heretics”. In some religious groups heresy is punishable by death, or at least excommunication. Even in groups of supporters of different professional soccer teams, failure to display antagonism to supporters of the other team may make it difficult for the person to control various unrelated perceptions — in everyday language, he may find life among his friends rather

difficult. So, for the most part, people who control for being part of an informal group can be trusted to control a particular set of reference values near those held by the collective.

Trust can happen not only because many kinds of protocols have been reorganized to be usable by people in recognizable roles, but also because protocols used with familiar partners take advantage of prior knowledge of what the partner knows, can do, and is expected to want to do. Group members may be assumed to know some things special to the group, things that can be omitted when using a protocol common in the group.

Early computerized speech recognition systems were hard to use, in part because many of them required the speaker to confirm each word as it was spoken. An experimental BAC-111 aircraft that was demonstrated to me in the 1980s used voice recognition for control of a map display in a more user-friendly way than was normal at the time. If the speaker said “Range 50 miles” the display set its scale without asking for confirmation of any kind. If the recognition system had made a mistake and the setting was not what the speaker wanted, he could correct it by saying something like “No, 50 miles”, in which case the system would eliminate from the list of acceptable perceptions whatever it had previous recognized and try again.

Technical jargon must be explained if used with a non-specialist in the discipline, but not with a professional colleague. If Adam says something to Beth, with whom he often talks, he does not usually check whether Beth understands each word one at a time while he is speaking. He checks whether Beth acts as he wanted to perceive her acting. If she doesn’t, then he is likely to try to correct the error in some of his perception of her states, and that may include checking to see whether she understood some word he spoke. Up to that point, however, he trusts that she did.

On the other hand, if Adam has never spoken to Beth before, he may not be able to trust that she will understand his words. Maybe he speaks English and he knows that she speaks Russian. He might start by seeking Beth’s R-display, perhaps by asking “Do you speak English?”. But if he perceives her to have some properties that are associated with a Role, and other players of that Role have always been able to understand his words, he is likely to trust that Beth will, too.

Widely used roles necessarily use popular protocols with roles that are played by many different persons. For example, a customer at a checkout desk in an English-speaking country will trust that the cashier will understand at least those English words commonly used in paying for the kinds of good sold in that store, and will be able to use English words well enough to allow him to perceive necessary things such as how much money to pay, but not necessarily well enough to explain the thermodynamics of weather systems. Of course, if that trust is not justified, the corresponding perceptions can usually be controlled in the normal way, by actions that bring them gradually closer to their reference values.

Belonging to a group means that when one meets someone playing the Role of belonging to the group, one can trust the protocols frequently used by the group. If Adrian and Charlie are two surgeons who happen to belong to the same rugby club, they would probably not use the same protocols in the bar after a rugby game as they would in the operating theatre. Associative memories produce outputs that correspond to their partial inputs, and those inputs include perceptions of the situational context.

For Role-playing communicative purposes, surgeon Adrian is not the same person as fly-half Adrian, and fly-half Adrian on the playing field is not the same person as Adrian celebrating a hard-won victory in the bar. Those different Adrians are the same physical person, but they act very differently, as though they could be quite different persons. The Role belongs to the group, at least as much it as does to the person. None of that, however, prevents Adrian in the bar from allowing Charlie to know that just now he wishes to be perceived as surgeon Adrian for a few minutes and to use “surgeon” protocols until he wishes to return to the “after a winning game” rugby Role.

Sometimes trust without verification is misplaced. We might trust the surface we walk on, and as a result trip over a curb, miss a step and fall flat, or fail to notice a rabbit hole and twist an ankle. Our trust that the ground was what and where it "should be" was misplaced. But usually our trust is justified, and walking without checking the ground every footstep works very well. There are, however, situations in which checking the ground every footstep could save your life, as when crossing a snow-covered glacier where smooth new snow might cover a deep crevasse.

The same applies to trust in protocols used in social roles. When one is with familiar friends, one expects familiar protocols to "just work", and one does not probe to see whether a particular person is likely to act to reduce error in your perception before you initiate a particular protocol. In unfamiliar company, more low-level on-line control is required. Trust reduces the load on our control units, but only probabilistically. When the probability of the trust being misplaced is high enough, control is improved by controlling the perhaps mis-imagined perception in perceptual reality rather than in imagination.

IV.4.8 Scheveningen and Shibboleths

A feeling of "belonging" is at heart a perception that you are with people you can trust to treat you with goodwill, and to interpret what you say in the way you intend it to be interpreted. In PCT terms, what does this mean? First and foremost, it means that you will probably be able to control your own perceptions through interactions with others with whom you perceive yourself to belong, using protocols appropriate to that group.

If Adam can perceive the Role that Beth is playing, Adam immediately has many protocols that should work with Beth to control his perceptions, whether Beth happens to be a stranger, a friend, or even a sibling. Conversely, if Adam can make it known to Beth that he can play the same or a complementary Role, he may expect Beth to be able to use that same set of protocols with him. Greeting patterns, shibboleths, clothing and accent are among many ways that Adam and Beth might perceive some of the roles each could play.

Above we talked about informal groups being defined by the sets of protocols that are used within the group more than by non-group members. Roles define sets of protocols that can be used by the Role-players, so informal groups may also be defined by the set of roles than can be played by group members. The more frequent the past interactions have been between Adam and Beth, the more likely it is that they have found several different Role-sets of protocols they could use with each other. Some might even be special to the pair of them, as appears sometimes to be the case between twins who seem "magically" to know what each other is thinking.

There are occasions when concealing the existence or nature of a protocol message may be important to the protocol partners. The interplay between pitcher and catcher in baseball is designed so that both know what the next pitch is supposed to be, but the batter does not, even though all are playing the Role of "baseball player". Even though for the most part the players on one team can use the same protocols when interacting with other members of their team or of the opponents, yet each team also has its own private protocols that are deliberately obscured, perhaps to the degree that the opponent does not even perceive that a protocol is being used.

To belong to a well-defined group is to be able to use protocols specific to the group and to one's position in the group, and to be known by other group members to be able to do so. Since a protocol serves only to aid in controlling some perception through the actions of another person, to belong to a group is to extend the number of perceptions one can control. And the more perceptions one can control, the more power or worth one has, the less reorganization is going on, and the better one can trust one's social environment.

Scheveningen is a popular Dutch seaside resort with a large pier and a famous casino. It is a suburb of Den Haag, the capital of the Netherlands. Frequent street cars go there from the centre of Den Haag. Once when I was at a meeting in Scheveningen, our chairman, an English phonetician, was in central Den Haag and wanted to get back to the meeting site. He boarded a tram and said "Scheveningen" with a questioning intonation, using his best phonetically trained Dutch sounds, and was answered by the driver in Dutch. Only when he asked in English what the driver had said was he told, in English, that this was indeed the tram to Scheveningen.

Figure IV.3.5 Scheveningen Pier, ca 1903, from a postcard (Image in the Public Domain).

During the German occupation in World War II, the Dutch used the name "Scheveningen" to test whether a stranger was German or Dutch. Germans were likely to pronounce it either "Skeveningen" or "Sheveningen", whereas no Dutch person would pronounce it in either of those ways. The Dutch "ch" in Scheveningen is pronounced much as is the raspy "ch" in the Scottish "loch", very different from either a "k" or a "sh" or even a "tch". If my English colleague had not been a trained phonetician, the tram driver probably would have answered him in English immediately.

The use of "Scheveningen" as a way to distinguish a Dutch stranger from a German stranger during the war was more than just a matter of interest to the person using the device. A German, whether a soldier or just a member of a family on a seaside holiday in occupied territory, would be most unlikely to sympathize with the Resistance, whereas a Dutch person might well do so. This distinction would be just one of a syndrome of perceptions of the stranger that would become part of the context for any further conversation. Only in that context would the Dutch person perceive what would be necessary in order to execute protocols effectively, even the protocols of everyday life unrelated to the dangers inherent in the Occupation.

Used in this way, “Scheveningen” is an example of a “shibboleth”. The Scottish “*It’s a braw bricht moonlicht nicht the nicht, ye ken*” (It’s a lovely bright moonlight night tonight, you know.) is sometimes used in the same way, to determine whether a person is a true Scot, because the “icht” sounds are difficult for most non-Scots to produce.

“Shibboleth” has become a generic name for a disturbance that induces someone to perform a control action that in-group members will do in one way but out-group people will do in a different way, because of their different histories of reorganization. To speak the word “shibboleth” was, however, originally an identifying verbal act. One of “Us” would recognize a mispronunciation as being spoken by one of “Them”. According to Wikipedia[22],

> *Recorded in the Book of Judges, 2:5-6, after the inhabitants of Gilead inflicted a military defeat upon the invading tribe of Ephraim (around 1370–1070 BCE), the surviving Ephraimites tried to cross the River Jordan back into their home territory and the Gileadites secured the river's fords to stop them. To identify and kill these Ephraimites, the Gileadites told each suspected survivor to say the word shibboleth. The Ephraimite dialect resulted in a pronunciation that, to Gileadites, sounded like "sibboleth."*

In Toronto, the name of the street “Spadina” at one time served as a shibboleth, though perhaps not one that was deliberately used. If you heard someone say “Spad*ee*na” you would probably perceive them to be wealthier than if the person said “Spad*eye*na” to rhyme with “China”. Although it was the same street, the upper part where the richer people lived was called “Spadeena” by the city locals, whereas the commercial part of the street was known as “Spad*eye*na” (“China”-style). If you heard “Spadeena”, you also imagined a host of associated perceptions of the person, some of which might not actually have been true, but which you would use in executing protocols in an interaction with that person until the failure of a protocol changed some of your perceptions or led to reorganization.

Not all shibboleths use voice. A particular form of handshake, such as it is reputed that Freemasons use, is a non-verbal shibboleth. In England, the sound patterns of the voice once were (and maybe still are) used by a listener to perceive the speaker as belonging to a particular class as much as, or perhaps more than, to a geographical region. Ascribing a person to a “class” includes many associated perceptions, such as of how well and where the person might have been educated, how they might respond to a command as opposed to a request, which political party they are likely to support, and so forth

English class at that time could also be perceived using another non-verbal shibboleth, style of dress. A century ago, a cloth cap as opposed to a silk top hat would produce the same set of associated (imagined) perceptions as would the heard accent. If the two conflicted, the listener-viewer might perceive that some trickery was being executed, and probably would not trust perceptions involved in protocol interactions with that person.

Shibboleths are perceptions with “Yes-No” outputs. The other person is perceived to “one of us” or “not one of us”. Depending on one’s reorganization based on experience, somebody who is perceived to be “not one of us” may ipso facto be perceived as one of “Them”. In the next Chapter we address the political complications that can arise when this happens.

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22. Retrieved 2018.05.07

Chapter IV.5. “Us”, “Them” and the “Middle Ground”

This Chapter examines from a PCT viewpoint why people tend to be wary or even afraid of strangers, particularly if the stranger can be seen as a member of a group that is “Not Us”. If many of “Us” have perceptions we cannot control, why is it so easy for a liar to persuade so many people that our troubles (inabilities to control against disturbances) are due to deliberate actions by “Them” rather than being the effects of natural events and interactions, or even of our own actions?

Why was it even plausible for US President George W. Bush after the 2001 attack on the World Trade 4 to say to the World “If you aren’t with us, you are against us”? He arbitrarily identified every “Not Us” person as belonging to “Them”, the trouble-makers. Why did so many of his people seem to believe him? And why did Bush choose to make that false identification of some as his enemies who perceived themselves as friends of the USA? Can PCT, as we have developed the theory so far, offer a plausible suggestion?

If “They” are responsible, our believing the liar does not disturb our own self-self-image, whereas to perceive the fault as being our own requires action, possibly even reorganization, to correct for the resulting error. The liar is therefore a “good guy” whereas the “bad guy” truth teller, who says the trouble is something you can fix by your own action, is easier to disbelieve. At least in the short term, you probably are less rattled if you believed the liar than if you believed the truth-teller. In this way, the liar can use “Truth Control” to create a fantasy world in which most problems are caused by “Them” rather than by “Us”.

What, according to PCT, can “Truth Control” possibly mean? Control is of a perception, but what perception, controlled by whom? The last part of this last question is easily answered; the liar controls his or her own perception, but of what? The “Truth” the liar controls must be his or her perception of something, some state, in his target audience. The liar wants to perceive that the target has a desired perception of some state of their environment, social or physical. Perhaps the liar perceives that the target’s belief in the lie might serve as an atenfel for the liar’s controlling a perception of something quite different. In the case of a political liar that something might be of his or her own status in the community, but also might be of some state that the liar thinks might be beneficial to the target — a “White Lie”. That state is the “Truth”. But who is the target, an individual or a collective, and is the liar an individual or a GVC?

As MacKay (1852) noted, social groups, even unstructured ones he called “crowds”, can be very powerful instruments in changing the perceptions, and therefore the actions, of the individuals in a group, to the extent that the title of his book was “*Extraordinary Popular Delusions and the Madness of Crowds*”. MacKay used as examples such phenomena as market bubbles, literal witch-hunts, crusades, the “animal magnetism” fad following the exploits of Mesmer, and so forth. To Mackay’s examples we could add many 20th and 21st century examples, from weird conspiracy theories circulating in and from the USA spun by Q-Anon, Fox News commentators and a former US President, to 19th and especially 20th century anti-Jewish persecution in Eastern Europe and especially in Nazi Germany, to current (2021) populist anti-immigrant prejudice in the United States and several European countries.

Conflict between individual control systems in different individuals has a counterpart in conflicts between cultures that may escalate into war. The side-effects of these wars often disturb perceptions in neutral nationals and embroil their nations in a conflict whose basis is unrelated to their collectively controlled national set of CCEVs. Barbara Tuchman (1984) discussed historical examples of unwanted wars from the Trojan War to the late 20th century, under the title “*The March of Folly*”.

We can go back to even earlier times, before the Trojan War. At one time in Ancient Egypt all foreigners except “Kheftiu” — those from the glorious Minoan civilization on Crete — were simply

called “vile Asiatics”. Asiatics, one might understand even though presumably some foreigners came from Libya or Sudan, but why “vile”? Why do we so often categorize strangers as in some way inferior and undesirable? Why are supporters of a professional sports team so often the targets of abuse by supporters of their opponents?

And especially, why is this “vileness”, in the form of racism, team, religious bias, or even food preferences, so readily attributed to people who can be identified visually by their skin or scarf colour as “Them” or to people whose dress identifies them as having a different religion? Why is it often so bad not to be “one of us”? Is that a human characteristic or a cultural one that is learned in the way language is learned in childhood? Can PCT address these questions? I think it can.

IV.5.1 Boundaries and cultural divergence

We started to discuss boundaries in the context of lateral inhibition in Chapter I.9. Lateral inhibition between perceptual functions sharpens the boundaries between the patterns to which two similar perceptual functions are best attuned. We met a similar effect again in Section II.2.3, when we discussed the ways two autocatalytic networks in a large conceptual space might drive each other apart rather than merging into a larger network, and again in Section III.6.5 in connection with understanding the contextual meanings of similar words and phrases. In all of these cases and many others, a boundary is made increasingly distinct by an effect similar to lateral inhibition, separating two similar patterns of perception.

Figure IV.5.1 (Figure I.9.14 reproduced) illustrates the transition between what we called a crumpling “bend” to a crumpling “crease” as identical to the bifurcation catastrophe caused by what in the Figure we call the contextual or task stress. Whereas in Figure II.6.7 we saw the transition between crease and bend as being caused by the degree of difference between the “A” and “H” arrangements of the sticks, now we recognize another dimension that works along with the pattern difference. The crease occurs at any fixed degree of pattern difference when there is more task or context stress, the bend when “it doesn’t matter much which it is”, the crease when a decision is required. This dimension is the “pressure” discussed in Section II.6.2.

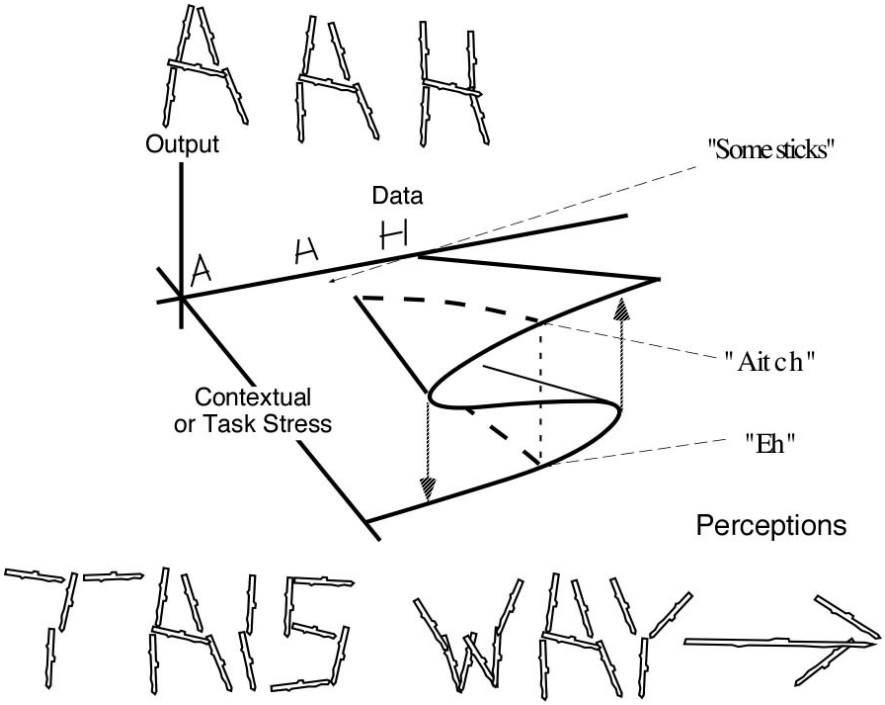

Figure IV.5.1 (Figure I.9.14 reproduced) The way the same visual pattern is seen differently in different contexts. Outside the context of what might be words, the group of five "sticks" in the middle of the upper set might be seen as a more or less random arrangement in space, but once it appears to belong to a word, the "contextual or task stress" increases the flip-flop loop gain, and the pattern is likely to be seen as a letter appropriate to the context. Why do you (probably) see the right hand word as "WAY" rather than "WHY"?

Contextual stress in this Figure is an effect of context, since at a higher level the sticks laid out on the forest floor are laid in a way that is highly unlikely to have happened by chance. They are in small groups with spaces between the groups but not within the groups, and in two larger groups of groups — a hierarchy. Within the groups, the ambiguous group of five sticks that by itself might be as the sticks randomly fell, or as a deliberately arranged A or H, is first perceived not as random but as a letter because all its neighbours are letters, and then first as H and then as A because those are the only similar letters that fit the meaning context. Context stress, however, is not a function of perceptual level, It depends on whether

Task stress has nothing to do with the perceptual levels involved with the hierarchic grouping. If one was casually walking on a forest path and came across this pattern of sticks, one would perhaps be interested in the fact that someone had laid out the sticks in what seemed to be words, but would probably otherwise ignore them. On the other hand, if one were trying to find a rendezvous place for a particular group, to see the sticks as forming not only letters and words, but a message possibly directed at oneself could be important to the control of a perception of being at the meeting place. In this example, task stress and contextual stress work together, but there is no principled reason that they should always or even usually do so.

These perceptual boundaries illustrate that "the same" thing can belong to two contrasting categories. "The same" is true only if the relevant context is the same. In the example, if someone were asked to control a perception of the words being accurately laid out, they might act to widen the top gap in the "H"

and narrow it in the “A”. Only in the actions consequent on the difference between the two contexts do the stick patterns differ. Later in this Chapter we will meet a situation in which a visible but irrelevant difference between two groups result in entirely different ways in which members of the groups interact. The children (in a blue-eyed versus brown-eyed group) treat each other very differently after being divided into a “better” and an “inferior” class by their teacher. The boundary is sharply defined and the behaviours of group members diverge, which earlier had not been the case.

Geographic boundaries may be defined by geographic features, or by cultural practices or by the arbitrary decisions of bureaucrats, such as are the boundaries across the Saudi Arabian desert, between the countries in most of Africa, or between India and Pakistan. Such bureaucratic boundaries often divide tribes or close-knit cultural communities. Each such arbitrary boundary between nations creates opportunities for the construction of separated bureaucracies with Roles that include the Role of Immigration Officer with authority to deny entry to people from the other country, even if the boundary has arbitrarily severed one community into two, splitting the documented nationality of families whose members happened to have long ago decided to live on this street rather than that, or even on this side of the street rather than that.

The boundary between the USA and Canada might separate people from their favourite grocery shop because the bureaucratically set boundary runs down the middle of a street on which they are on one side and the grocery is on the other. In my youth, the Canada-USA boundary was almost non-existent to the traveller from either country, something of which a high proportion of people in either country were proud. The same insubstantial kind of boundary used to exist between countries in Europe. Even now (or at least when my most recent British passport was re-issued), a British passport has written in it words to the effect that that his or her Majesty “requests” that the country will afford the holder of the passport every aid and assistance, not that the traveller asks for permission to enter.

Such wordings may once have had a real effect on the perceptual controls by persons on the other “foreign” side of the border when there were few, if any, border post that had humans playing the Role of National Guardian and checking passports, but as of 2022 it is only within the compliant nations of the European Union that such “open borders” still exist, replacing the use of the passport as a request to be allowed to cross the border. Of course, in federated nations such as the USA, Canada, and the “United Kingdom”, crossing borders within the federation still do not require a passport.

Living control systems organize to control their own social boundaries, defined as the outer edges of areas within which they control effects on their perceptions of the actions of other living control systems, either to admit or to exclude them from the area. Such decisions affect the rattling induced by actors on one side on the perceptions controlled by actors on the other. A “hard” border reduces the side-effects of actions by living control systems on one side on the perceptions of people on the other, and hence of cross-border rattling.

This quasi-insulation against cross-border rattling has been seriously perforated by the World Wide Web (the internet), and some authoritarian countries have tried to block its penetration. lest the rattling induced by its content increases the likelihood of social reorganization that would be more likely to reduce the collectively controlled authority of the autocratic ruler’s person, and perhaps even of the autocratic ruler Role itself.

Geographic boundaries are closely coupled with the concept of Ownership (Chapter III.8), if the living control system is human or a collective of many kinds of non-humans, whether they be insects such as bees who attack invaders to the hive, marmots who defend as a family against encroachments by other families, or human landowners who control for keeping strangers away by posting “No Trespassing” signs.

Cultural boundaries are like watersheds in one way. Both are like fractals, in that the smallest little rill has its own watershed that is part of the watershed of the larger stream it feeds, and of all the watersheds that are parts of the watershed of a river that eventually flows into the sea or a salt lake. Similarly, each family controls an area that is included in an area controlled by a group of associated families, and so on into named parts of a town, the town into a "greater City" region, regions into nations, and so forth. Many of these divisions can be precisely represented by marked boundaries between areas on an official map.

In another way cultural boundaries are unlike watersheds. They are defined not by geographical areas, but by associations among the things they do or don't, can or cannot, control. For example, one cultural group might consist of people who have lost an arm, who might bond together to help each other deal with the loss. Such groups are bounded by excluding people who have not lost an arm, but the boundary is not precise, as the problems of people who have lost an arm differ according to how much of the arm was lost, and people who have not lost an arm might nevertheless have lost much function in an arm.

The speed of communication has increased in discrete jumps over the last five or six millennia. Earlier, the only communication was by voice (or instrumental sound such as drums or horns) or gesture perceivable by someone within acoustic or visual range of the communicator. Whatever the source, the receiver had to be geographically close, and be watching or listening at the right time.

Successive jumps in communication technology have in turn partially relaxed these constraints, until today we can send a message audio-visually with anyone or any group located anywhere in the world whether or not they were present at the time the message was produced. Effectively instantaneous response to the original communicator was once limited to those who were within auditory or visual range, but now can be worldwide, though there is still the time constraint imposed by the speed of perceptual control at the level of the hierarchy implied by the content of the communication. A response to "Can you hear me" will be orders of magnitude quicker than a response to the arrival of a scientific paper, which in the 18th century would be at the speed of the post-office from the writer to the reader plus the time the reader would take to understand what response would be appropriate, if any.

Why does it matter when and how the constraints on "there and back" communication have been successively relaxed? That time is the lag time of any feedback loop that uses the communication channel in question.

IV.5.2 The Ramsbottom Premise

‘ “*...someone's got to be summoned," so that was decided upon.’*

Stanley Holloway*, Albert and the Lion,* 1931

In Stanley Holloway’s monologue, Mr. and Mrs. Ramsbottom had taken young Albert to the Zoo. Albert had poked a lion, using his “stick with the horse’s head handle”, whereupon the lion had pulled Albert into his cage, and eaten him. The Ramsbottoms tell the Zoo management that they need compensation for the loss of young Albert, and Mrs. Ramsbottom issues the quoted line, thereby saying that it was someone’s fault, not Albert’s and that person should be held criminally responsible.

It didn’t matter to Mrs. Ramsbottom that maybe it *was* Albert’s fault, that the lion acted naturally, and that the cage was designed to some standard in order to hold lions rather than to act as a filter against mischievous little boys. If something goes wrong, it always has to be someone else’s fault, and according to the quoted line, all concerned agreed with the truth of this generalization.

In politics, we often see the same mindset. Whatever has gone wrong from the viewpoint of a member of the general public, such as the emergence of a new pandemic virus or a slowly developing climatological disaster, it must be the fault of the current government alone. Mrs. Ramsbottom’s generally accepted assertion that “someone’s got to be summoned” is the core topic of this Section.

Hitherto, we have concentrated, as did Chvykov et al. (2021) on the rattling caused by interactions among agents, two at a time, the agents being their “smarticles” or our control loops interacting through the local environment. In our winter-leaf analogy, however, we ignored the effect of interactions among the leaves, except that some may “shadow” others to reduce the effect on them of the variable wind. The movement of a leaf to settle in a calmer place is caused, not by the active operations of other leaves, but by the variability of the wind strength and direction, an *environmental* influence that affects every leaf in the area. There is a big difference between an area-wide environmental cause of rattling and the highly local effect of a two way interaction. It is like the difference between looking at a city map to decide on a route, and deciding which road to take when arriving at an intersection.

In the map analogy, your map may be at any scale, from a global overview to a few city blocks or even to the floor plan of a building. Likewise, the effect of some environmental event might impinge directly on as few people as those in, say, a shop that ran out of a popular commodity, to as many as the employees of a corporation whose management decided on some new company policy, or to all the people in the world affected by climate change or by a pandemic.

Remember that the rattling measure depends on the uncertainty of the velocity of change of a variable, any variable. A variable has a value that changes over time, so its rattling measure is low if the variable follows a well defined trajectory of ups and downs, such as a sine wave. Over years, the average temperature on a given date at a given location rises and falls very predictably, for precisely known astronomical reasons.

On a particular January 25 at Mytown, the temperature may be far from that average, but if Mytown is in a temperate region of the Northern Hemisphere it will probably not be as hot on January 25 next year as it will be in on July 25, but it could be if Jan 25 is exceptionally warm for the time of year and July 25 is exceptionally cold. The day’s weather is less predictable months and years in advance than the climate, because of massive averaging of climate over similarly situated places and several years. For a resident of Mytown, the unexpected effects of changeable weather cause more rattling than does the regular annual variation of climate.

What are likely to be the effects of widespread environmental rattling due to disturbances that happen faster than we can control, and that simultaneously affect many people either concentrated in one place or distributed widely in space? Mrs. Ramsbottom has one answer, an answer with which many people may agree, blame someone and punish them.

A widespread environmental event might be the years of drought currently affecting the western half of the USA at the date of this writing (November 2021), and forecast to continue. It didn't happen suddenly, but many of its effects did, such as the reduction of water supplies to major cities and to agriculture. Those sudden rattling effects obviously must have been caused by the incompetence or malfeasance of the local or national authorities. It presumably came as a shock to many people accustomed to turning on a tap and washing their car or taking a shower to be told that their water was to be rationed. The advance of the drought may have taken a decade or two, but only at a certain moment did its effects hit home to city dwellers and farmers reliant on Colorado River water.

In most cases of rattling, there is a wide distribution of levels of rattling of different entities (such as people), most being near the low end of the distribution, some few in the "long tail" of the distribution being strongly rattled. The same will be true when an environmental cause adds to the rattling experienced by different individuals. Some will be able to continue as normal, though perhaps with a little less security and precision when controlling some perceptions than before, whereas others might completely lose the ability to control some perceptions.

The key point about widespread rattling events, whether social or caused by changes in the natural environment, is that no rattled individual acting alone is able substantially to reduce the rattling he or she experiences. Increased rattling accompanies increased uncorrectable error in one or more controlled perceptions. In Section I.6.4 we said this:

> *When control by a previously available means is blocked — frustrated — the error in the perception that should be controlled can become indefinitely large. In this situation, the rate of reorganization increases, and while no effective means of control is found, the e-coli method of reorganization would keep changing parameters in the hierarchy erratically. The part of the control hierarchy to which this control unit sends reference values would start behaving wildly, as many people, especially immature or autistic ones, do in a fit of anger sometimes called a "temper tantrum".*

More mature individuals are less likely to resolve their frustrations with a temper tantrum, since they are likely to have learned multiple ways to control most perceptions, one of which is to perceive that their problem is not due to their own actions or inactions, but might be resolved by the appropriate actions of other people. In Section IV.6.1, we will discuss "It's Their Fault" more generally, but for now, we can simply say that it is not unlikely that a person rattled by the effects of some environmental shock that has led to some previously controllable perception becoming uncontrollable will say that the problem is someone else's fault, in that what "they" did caused or criminally failed to prevent the environmental effect.

Simply assigning fault to an unspecified "them" does not resolve the person's inability to control, especially if "they" are ill-specified. In many cases, "they" would probably be perceived as a collective, since the effects are too widespread to have been caused by any one malicious or selfish individual. Each affected individual might choose a different collective, but few if any of those choices would be likely to offer any possibilities for action that might correct the problem. What we do expect, however, from our earlier discussions of rattling, is that the affected organization — which in this case consists of all the people affected — is likely to change its structure in some way.

How it will change is as unpredictable as is any reorganization that will follow a temper tantrum in an individual. A “social temper tantrum” is a bit different from an individual temper tantrum, however, in that although it may be caused by the actions of individuals randomly choosing ineffective actions to control their perceptions frustrated by a widespread environmental change, those actions in themselves do not reduce the rattling. Indeed their side-effects simply add to the general rattling, a little for most people, a lot for a few people.

In Chapter IV.2, I argue that a widespread drought in Mesopotamia caused by climate change five or six millennia ago was the root cause of the suppression of women in regions politically dominated by followers of the Abrahamite religions today. That drastic change in cultural organizational structure (cultural ecology) reduced the rattling of the people, both male and female, by reducing the interactions among them and their Gods and Goddesses. Might today’s western North American drought have such long-lasting effects in some way yet unknown? A centuries-long drought in the same region some thousand years ago seems to have done so.

In the Mesopotamian drought, I speculate that men blamed women for in some way angering the Goddess they worshipped in their underground caves, so that the Goddess did not do her job of nourishing the crops, causing widespread starvation. In the current western North American drought, no such “them” is readily at hand. But broadcast media is, and if someone chooses to settle on some random collective, some people will believe them and spread the word. The truth was probably offered half a century ago by the cartoon character Pogo “*We have met the enemy and he is us*” (Walt Kelly, on an Earth Day poster, 1970). Pogo was depicted as trying to clear up litter but is confronted with a forest floor deep in trash far beyond his ability to clean up.

Our own actions being the cause of the problem is seldom a perception we can admit into our self-image, no matter what perception might have a value we are unable to bring nearer its reference value without having to alter our current perceptual control hierarchy, causing even more rattling. We performed those actions in order to reduce errors in other perceptions for which the feedback loops are much faster than the feedback loop of climate change. Climate change is something we do not control, but to which, by our membership in a set of GVCs Collectively controlling many different perceptions over many decades, have created this Collective Side-Effect called Climate Change.

If someone proclaims that it is not our fault at all, but names a villain, it will reduce the rattling we experience if we believe it, and collectively control to destroy the ability of the chosen villain to act. Even if we fail to destroy the villain, we will have “done the right thing” by trying. We have successfully controlled for perceiving ourselves as belonging to “the Good Guys”, who tried to render the “Bad Guys” unable to act. We have reduced our own rattling both by individual reorganization and by social reorganization to change an unpredictable set of interactions into a coordinated one in our new “Team”.

Pogo’s “Us” is very general, but this “Good Guy Team” had a well-defined membership with at least one Collectively Controlled Purpose. This Purpose is not the same as the virtual reference value of a perception controlled by a collective Giant Virtual Controller. This Purpose is supposed to be shared, each Team member having the same purpose. This Team Purpose contrasts with the purpose of a Giant Virtual Controller, which is the result of averaging the set of purposes of the individual controllers whose joint effects combine to create a virtual reference value for a virtual perception that none of the individuals control.

Let us look back at the “Short Taxonomy of Collective Control” (Section III.1.7), in which three single-level and three multilevel forms of collective control are described, followed by the caveat that these six are unlikely to be definitive. And here, in the form of a highly rattled Team, is an example. The members of this Team share a common perception and belief strength in that perception, and a common or nearly common current value and reference value for that perception. They therefore act in

coordination in controlling that perception, though they may not act in the same way, any more than do the different members of a sports team on the field of play, who all have the same purpose (to outscore the other team — "Them") and the same perception of the current state of play. "Us" and the "Them" to be destroyed might well have very different views on the "state of play" that caused the strong rattling "We" are trying to reduce by destroying "Them".

"Somebody's got to be summoned" carries the implication that there is fault, for which somebody is responsible. Even when the rattling was caused by a 2009 earthquake in Aquila, Italy, six seismologists were convicted but acquitted on appeal, of manslaughter for failing to provide timely warnings of when and how the earthquake would happen. They were not accused of causing the earthquake, but they were accused of causing the injuries and deaths from collapsed buildings, on the grounds that if they had given correct notice of when people should go to safe ground, those injuries would not have happened.

Here is a quote from the journal Nature on the matter (Abbot and Nosengo, 2014):

> *Six seismologists accused of misleading the public about the risk of an earthquake in Italy were cleared of manslaughter on 10 November. An appeals court overturned their six-year prison sentences and reduced to two years the sentence for a government official who had been convicted with them.*
>
> *The magnitude-6.3 earthquake struck the historic town of L'Aquila in the early hours of 6 April 2009, killing more than 300 people.*
>
> *The finding by a three-judge appeals court prompted many L'Aquila citizens who were waiting outside the courtroom to react with rage, shouting "shame" and saying that the Italian state had just acquitted itself, local media reported. But it comes as a relief to scientists around the world who had been following the unprecedented case with alarm.*
>
> *"We don't want to have to be worried about the possibility of being prosecuted if we give advice on earthquakes," says seismologist Ian Main of the University of Edinburgh, UK. "That would discourage giving honest opinion."*

Notice the public rage at the verdict, since after the successful appeal, nobody was being held accountable for the earthquake deaths, which strongly rattled most of the survivors, who controlled a perception along the lines of "the extent problems are caused by intentional actions of others", with a value near "all". If "others" had been identified (the six seismologists), to acquit them would necessarily have generated much rattling. The rage would have been the usual result when a person was deprived of means to control a perception they had had under control — a tantrum, or a continual "tumbling" of the e-coli reorganization process (Section 6.4), but now it was expressed by a collective rather than by the individuals who formed the collective.

"Somebody's got to be summonsed", said Mrs Ramsbottom when she perceived an unpleasant and irreversible event to have happened. So also collectively said many citizens of L'Aquila under similar circumstances. In the case of Albert, as Stanley Holloway told the story, the fault was entirely Albert's, but since neither Albert not the lion could stand trial, someone else had to be found at fault for the tragedy.

In L'Aquila, a suitable culprit analogous to the lion was at hand — the tectonic forces within the earth — but could not be summonsed, so someone else had to be found at fault for the tragedy. Whether many people individually chose the seismologist as the "someone else", or whether some leader initiated the choice, the result was the same action by a Grand Virtual Controller (GVC). The seismologists were

brought to trial and convicted, as might have been the zookeeper or some other zoo employee in the Ramsbottom case.

That they were later acquitted on appeal is irrelevant to the issue at hand, which is why "somebody's got to be summonsed" is so often an action following a disturbance that caused some perception to depart from its reference value in an uncorrectable way. Mediaeval witch-hunts are of the same class. Cattle might, for example, have been infected by foot-and-mouth disease, for which no cause was known, and therefore the local "wise-woman" who knew things most people did not know must have cast an evil spell and could therefore be legitimately punished, even by death.

The word "witch-hunt" in the sense of assigning blame where it does not belong has been much over-used in the last few years (as of 2022), often to refer to a search for truth among different claims rather than the mis-assignment of culpability for consciously perceived unnecessary disturbances to the controlled perceptions of some GVC. It has even been used to refer to a search for whether some culpable action has even occurred. In this context, culpable does not necessarily mean an action that deliberately disturbs perceptions controlled by many people, but instead an action that according to some law was not allowed, whether or not it actually discomfited anyone beyond those who control for perceiving that law to be obeyed.

We will discuss Law in Chapter IV.8, along with its relatives Morality, Ethics, and Fairness. But first we should consider why these relatives are even relevant. This we begin to address by introducing an example situation that occurred half a century ago.

IV.5.3 "Us", "Them", and Bullying

We start by describing and discussing a classroom exercise performed half a century ago by Jane Elliott, a schoolteacher of third-grade (age about 8 or 9) children in a small rural community in the central USA.

One obvious way for me perceive someone else as "Not Us" is if a person is perceived to belong to "Not Us" has a skin colour sufficiently different from mine. In much of the USA, however, visible skin colour may no longer be the criterion, having been replaced by a perception that the person's ancestry includes someone from Africa who may have had a dark skin. That perception depends not on visual appearance, but on what the perceiver has read or been told about the person by others. If one perceives the person to have such an ancestor, they are "black" by definition, no matter how pale their actual skin colour. Usually the person also perceives himself or herself to be "black".

Typically, one perceives "Us" to be in some way "better" than "not Us", and controls that perception by various means, such as keeping apart from members of "not Us" socially. In the local culture of people acknowledged to be "Us", the inferior "not Us" people may quite morally be ignored, subdued, colonized, and generally mistreated, as the following example illustrates. We will investigate why after we describe the event.

In 1968, Jane Elliott, a teacher in Riceville a small rural town in Iowa, attempted to inoculate the children in her class against thoughtless racism involving a perception unjustified by personal experience, that "white" people are "better" than "black" people. Here is a description of her demonstration, from the Smithsonian Magazine[23]:

On the morning of April 5, 1968, a Friday, Steven Armstrong stepped into Jane

23. https://www.smithsonianmag.com/science-nature/lesson-of-a-lifetime-72754306/ (Retrieved 21.09.07

Elliott's third-grade classroom in Riceville, Iowa. "Hey, Mrs. Elliott," Steven yelled as he slung his books on his desk.

"They shot that King yesterday. Why'd they shoot that King?" All 28 children found their desks, and Elliott said she had something special for them to do, to begin to understand the assassination of Martin Luther King Jr. the day before. "How do you think it would feel to be a Negro boy or girl?" she asked the children, who were white. "It would be hard to know, wouldn't it, unless we actually experienced discrimination ourselves. Would you like to find out?"

A chorus of "Yeahs" went up, and so began one of the most astonishing exercises ever conducted in an American classroom. Now, almost four decades later, Elliott's experiment still matters—to the grown children with whom she experimented, to the people of Riceville, population 840, who all but ran her out of town, and to thousands of people around the world who have also participated in an exercise based on the experiment. (She prefers the term "exercise.") It is sometimes cited as a landmark of social science. The textbook publisher McGraw-Hill has listed her on a timeline of key educators, along with Confucius, Plato, Aristotle, Horace Mann, Booker T. Washington, Maria Montessori and 23 others. Yet what Elliott did continues to stir controversy. One scholar asserts that it is "Orwellian" and teaches whites "self-contempt." A columnist at a Denver newspaper called it "evil."

That spring morning 37 years ago, the blue-eyed children were set apart from the children with brown or green eyes. Elliott pulled out green construction paper armbands and asked each of the blue-eyed kids to wear one. "The browneyed people are the better people in this room," Elliott began. "They are cleaner and they are smarter."

She knew that the children weren't going to buy her pitch unless she came up with a reason, and the more scientific to these Space Age children of the 1960s, the better. "Eye color, hair color and skin color are caused by a chemical," Elliott went on, writing MELANIN on the blackboard. Melanin, she said, is what causes intelligence. The more melanin, the darker the person's eyes—and the smarter the person. "Brown-eyed people have more of that chemical in their eyes, so brown-eyed people are better than those with blue eyes," Elliott said. "Blue-eyed people sit around and do nothing. You give them something nice and they just wreck it." She could feel a chasm forming between the two groups of students.

"Do blue-eyed people remember what they've been taught?" Elliott asked.

"No!" the brown-eyed kids said.

Elliott rattled off the rules for the day, saying blue-eyed kids had to use paper cups if they drank from the water fountain. "Why?" one girl asked.

"Because we might catch something," a brown-eyed boy said. Everyone looked at Mrs. Elliott. She nodded. As the morning wore on, brown-eyed kids berated their blue-eyed classmates. "Well, what do you expect from him, Mrs. Elliott," a brown-

eyed student said as a blue-eyed student got an arithmetic problem wrong. "He's a bluey!"

Then, the inevitable: "Hey, Mrs. Elliott, how come you're the teacher if you've got blue eyes?" a brown-eyed boy asked. Before she could answer, another boy piped up: "If she didn't have blue eyes, she'd be the principal or the superintendent."

At lunchtime, Elliott hurried to the teachers' lounge. She described to her colleagues what she'd done, remarking how several of her slower kids with brown eyes had transformed themselves into confident leaders of the class. Withdrawn brown-eyed kids were suddenly outgoing, some beaming with the widest smiles she had ever seen on them. She asked the other teachers what they were doing to bring news of the King assassination into their classrooms. The answer, in a word, was nothing.

Back in the classroom, Elliott's experiment had taken on a life of its own. A smart blue-eyed girl who had never had problems with multiplication tables started making mistakes. She slumped. At recess, three brown-eyed girls ganged up on her. "You better apologize to us for getting in our way because we're better than you are," one of the brownies said. The blue-eyed girl apologized.

On Monday, Elliott reversed the exercise, and the brown-eyed kids were told how shifty, dumb and lazy they were. Later, it would occur to Elliott that the blueys were much less nasty than the brown-eyed kids had been, perhaps because the blue-eyed kids had felt the sting of being ostracized and didn't want to inflict it on their former tormentors.

When the exercise ended, some of the kids hugged, some cried. Elliott reminded them that the reason for the lesson was the King assassination, and she asked them to write down what they had learned. Typical of their responses was that of Debbie Hughes, who reported that "the people in Mrs. Elliott's room who had brown eyes got to discriminate against the people who had blue eyes. I have brown eyes. I felt like hitting them if I wanted to. I got to have five minutes extra of recess." The next day when the tables were turned, "I felt like quitting school. . . . I felt mad. That's what it feels like when you're discriminated against.

[...]

Stephen G. Bloom, Smithsonian Magazine, September 2005

Elliott's exercise of half a century ago demonstrated to the children how easily we can accept that a member of a "not Us" group can be perceived as a lesser person than any member of "Us", and that perception can be accepted by both groups as representing reality. Not only that, but children in both groups perceived it to be socially acceptable for a child or a set of children in the "better" group to treat a child in the "worse" group badly, and did so.

Elliott never said anything about how the children should change their ways of playing with each other as equals, but her words did change them. The groups each collectively perceived children with their own eye-colour to be "Us" and the other group to be "Them". In both groups, each perceived, individually and collectively, that any member of "Us" was "better" than any member of "Them", and

had the *right* to treat a member of "Them" badly, even if that child had been a best friend. A "Them" child would not control against a disturbance apparently caused deliberately by a member of the "Us" group, because of this perceived "right".

What may be even more important was that the school performance of children in the "worse" group deteriorated, and they lost confidence in their abilities, whereas children in the "better" group became more alive and more self-confident. The Smithsonian article does not say whether their academic performance improved, but it seems likely, since a reduction in the self-confidence of the "worse" children was accompanied by a worsening of their school performance. This is, of course, speculation, but it seems plausible, despite having no obvious derivation from PCT. You tend to perform up to or down to the expectations you has of yourself and those expectations may be influenced by your perception of the expectations that others have of you.

Why should the "better" children actually treat the "worse" children badly? Why would they act any differently toward their friends of the previous weeks and months who had the other eye colour, and in some cases switch to new friends of their own eye colour? The simple answer is "because they can", but that is not an answer at all. As we discussed in Chapter III.9 on the Trade motif, they collectively produce a GVC that has increased worth, whereas the "worse" children have had some of their abilities to control taken away, and perceive themselves as having less worth.

We cannot know what a member of either group might have been controlling in any particular interaction, but if they control self-self- or other-self-images, one of the elements of either self-image would be in the perceived freedom of a member of the "better" group to control their perceptions of the actions of a member of the "worse" group — a perception of their own increased worth. This perception could not form part of the other-self-image unless it was demonstrated to others by overtly executing that ability to control without the Authority (the Teacher in this case) intervening. Both "better" and "worse" children would perceive that the "better" children had that permission.

This is, of course, pure speculation. One thing of which we can be sure, however, is that any one of "Us" who perceived a non-reciprocal right to disturb a "Them" member would be less uncertain about the disturbances in the interaction than would be the "Them". "Them", as a group, would be more rattled than "Us" as a group, and less able to control their perceptions — which is saying the same in different words. As a group, "Them" would be more likely to act to change their individual internal organizational structures than would "Us". We will see this on a larger scale when we discuss freedom and revolution in Chapter IV.7.

What is perhaps more interesting than the behaviour of the children in Jane Elliott's class is the reaction of "White" adults who learned about the exercise and its effects on the children. The Smithsonian article goes on to report how angry a substantial proportion of her "White" colleagues and neighbours were about what she had done, as were many people in the wider public when the story became widely known, though many others (not locally, however) thought that Elliott had done something both interesting and worthwhile. There was a divide, with little or no middle ground, between the "Elliott haters" and her supporters.

Elliott had observed "*the blueys were much less nasty than the brown-eyed kids had been, perhaps because the blue-eyed kids had felt the sting of being ostracized and didn't want to inflict it on their former tormentors*." Her white neighbours had never experienced this kind of asymmetry reversal, and presumably perceived themselves as "better" than a black person. Being better, they would be justified in perceiving "blacks" as their servants and expecting them to have the same perception of their status and to do such things as move off the sidewalk when a white person passed by, perceptual control actions emulated by the "better" children with respect to their "worse" classmates.

Many, if not most of the village area residents were angry enough at Jane Elliott that they wanted to run her out of town, or worse. How have we described “anger” in this book? We have called the “anger” behaviour a “tantrum” (Chapter I.6) in connection with “The Bomb in the Hierarchy”, but the Bomb explodes in a tantrum when the environment changes in a way that turns a low-level feedback loop from negative to positive, destroying control. That isn’t what we are talking about here. The relevant environment is social, and a social environment contains many internal feedback loops, some negative and stable, some positive. In the latter the loop variables would tend toward extreme values.

We are talking here about an unexpected (and therefore rattle-inducing) event that disturbed some perceptions in ways that had and have no socially acceptable atenfels available to reduce the error created. The social structure was not organized so that the angered residents could easily eliminate the error in whatever perception Elliott’s actions had disturbed. In 17th century Puritan Massachusetts, Elliott might have been burned as a witch, but that atenfel was not available to the residents of 20th century Riceville. Reorganization that reduced rattling caused by Elliott’s unexpected demonstration or by its effects on the children might have occurred, but we are not told of subsequent race relations in Riceville.

Nor are we told of how the relationships Jane Elliott had had with individuals in the town were changed after her classroom demonstration. The organization of the town as a whole was highly rattled, so its structure, a structure that includes teacher Jane Elliott, presumably changed to reduce the total rattling. An easy way to reduce the total rattling would be to remove her from the town, which would reduce the uncertainty that now, and for some time to come, might come from possible further interactions with any of her classes or with individual students.

Although we can never know in the case of any individual, we can assume that what she did disturbed some perception that they were controlling with high gain, and that learning of her teaching tool created error in that perception that they could not correct using any atenfel at their disposal. What did she do that the adults might perceive as such a disturbance? Whatever that might have been, they would have perceived it only as a result of what their child reported or did when they went home after school.

On the Friday, a blue eyed child might have reported that because of their blue eyes, they were inferior, while a brown-eyed child might have told their parents that they were superior. Most adults would have been unlikely to believe the truth of either unexpected claim, though one might guess that a parent of a brown eye would have been less disturbed than the parent of a blue-eyed child.

The parents had a whole weekend to talk with other parents about this apparently false teaching by Jane Elliott, a possibility Elliott might not have considered. Furthermore, the children would have continued interacting with each other over the weekend, and possibly some brown eyes might have refused to play with their blue-eyed erstwhile friends, introducing a divide between the blue and brown classes of children, akin to a Hindu caste division, that might have solidified over the weekend.

The more the children controlled perceptions based on this “blue-better, brown-worse” division, the more it would reorganize their control hierarchies, to the extent that those controls and the actions used in them would tend become non-conscious. It would become customary for brown-eyed children to boss blue-eyed children around, and for blue-eyed children to accept it, even though it would be likely to create conflict with other perceptions they were controlling.

Elliott was presumably not controlling for this to happen. She had asked the children whether they wanted to know what being discriminated against felt like, and they had told her they would. None of them, I assume, had an insight as to what would follow over the weekend before she reversed the situation and told the class she had it wrong, and actually blue-eyed children were “better”. Neither, I presume, did Elliott anticipate the effects of the demonstration on the parents, which completed a feedback loop affecting herself and her position as schoolteacher.

Elliott initiated the demonstration when a student asked why someone shot Martin Luther King, and she asked if the children would like to know a little of what a black person might feel in a predominantly white society. We might plausibly guess that their perception was of black people as a category, rather than of any one black as a person. If in their daily lives they had encountered any black people at all, those they encountered would probably not have been prosperous business owners, but labourers in menial occupations, perhaps helpers on local farms.

Most of them would have known about black people only what they had been told by people they trusted, but if they had encountered black people only in menial, subservient, jobs, these tales that black people were inferior would have been corroborated by their direct observation. If this is true, it implies that the children's parents would have thought people in menial jobs were doing these jobs only because they were not good enough for "good" jobs. As Elliott was trying to teach the children that having black skin did not make a person either better or worse than a white-skinned member of "Us", she would have been contradicting what their parents would have told them, that they were better than black people.

The Smithsonian article says nothing about how children in Elliott's class who were neither blue or brown eyed interacted with members of either the "better" or the "worse" group. Green or grey-eyed children occupied a middle ground, being neither "better" nor "worse" individually than the collectively controlled perceptions of "better" and "worse". There are, however, very few of these "middle-grounders" in most of North America, and perhaps there were none in her class of 28.

Consider the changes in self-image of a child told by an authority that they are "better" or "worse" than some of their classmates, and there is no intermediate possibility. The children have had no reason to disbelieve what the teacher tells them, so the other-self-image of a "better" child should be likely to include enhanced self-confidence and an increase in their worth, while the opposite would be likely for a child told he or she is "worse".

One result of a loss of self-confidence is illustrated in the Smithsonian reports: "*A smart blue-eyed girl who had never had problems with multiplication tables started making mistakes. She slumped*." Presumably the girl did not previously have the habit of checking her answers, being confident that they would be correct, but after being told she was "worse", and losing self-confidence, she would have completed the perceptual control feedback loop, examining her preliminary answers consciously to check whether they were correct, rather than relying on her fast non-conscious well-reorganized processes.

The next sentences of the Smithsonian report are: "*At recess, three brown-eyed girls ganged up on her. "You better apologize to us for getting in our way because we're better than you are," one of the brownies said. The blue-eyed girl apologized*." Both blue-eyes and brown-eyes accepted this as appropriate, despite the bullying action of the brown-eyed child. The teacher having enhanced their worth in their self-self-image and as they would have perceived in their other-self-image as well, they perceived that they had the *right* (Chapter IV.8) to bully, which beforehand they had not had.

We cannot know whether any of the children perceived ethics or morality in their actions, or whether what the brown-eyed girls perceived that what they were doing might be perceived by others as bad, but we can surmise that they didn't. But they could, and perhaps did, perceive that they now had permission from the teacher to expect blue-eyed children to obey their orders, and this was what Elliott had wanted both sets of children to extrapolate to their perceptual control actions toward someone they perceived to have a different skin colour. People of their own eye or skin colour were either "better" than "Them" and entitled to treat "Them" as disturbances or as useful atenfels, or "worse" and expected to accept being badly treated by their "betters".

We will be arguing later in this Chapter that "hollowing out of the middle" is a consequence of a positive feedback loop that drives the ends of a continuum distribution of perceptual reference values

apart. The strength of the "middle" or its absence determines the relative strengths of three possible Giant Virtual Controllers. But before that, after looking at collective bullying in the form of colonists and dictators, we will look at a couple of examples of "Us" and "Them".

IV.5.4 Self-Image and Self-Confidence

Self-image is a perception we have addressed when discussing PCT as applied to individuals, but the discussion above suggests that it has an important social aspect, as Jane Elliott's classroom "exercise" in domination and submission illustrates. When the brown-eyed children were told that they were better, Elliott noted that "*several of her slower kids with brown eyes had transformed themselves into confident leaders of the class. Withdrawn brown-eyed kids were suddenly outgoing, some beaming with the widest smiles she had ever seen on them*." Their self-image perception had improved, in that they perceived their "worth" to have increased, in that they now could allow themselves to control variables they had not thought they could.

The opposite happened to the self-image of the "worse" blue-eyed children, who now disallowed themselves from controlling perceptions in ways that they had previously been able. Though the Smithsonian report does not say so, it seems likely that these perceptions were ones they could have controlled more quickly and precisely than could most of their classmates. "*A smart blue-eyed girl who had never had problems with multiplication tables started making mistakes. She slumped*."

The implication here is that there is a linkage between the different controlled perceptions of other-self-image and self-self-image, by means of the kind of reorganization suggested in Figure II.10.B, but where the problem and the solution would be provided from the social environment rather than from an internal narrative (Figure II.10.A). One might ask whether similar effects would have occurred had the class not been told that one set identified by an irrelevant characteristic was "better", but instead the brown-eyes had been moved to a different school, and the rest been told that brown-eyed children were going to a school for high-performance children, leaving the blue-eyes with their peers.

This school segregation would still have told the blue-eyes that they were inferior, but would not have subjected them to the frequent reminders by the brown-eyes that they should not behave "above their station", or be "too big for their boots", among many aphorisms with the same import. Class, caste, station in society, all are perceptions of one's own relationships with members of other classes, some of which one perceives to be superior, others inferior. Before Jane Elliott's exercise began, there was no caste division between blue-eyed and brown-eyed children. During the exercise, and perhaps for a while afterwards, there was.

The interplay of this kind of class is between Roles played by caste members when interacting with complementary Roles played by members of other castes, as described in Section IV.4.1. The interactions are *played* by individuals, who individually might choose not to play their caste Role, and to treat their interlocutor as another individual, rather than as a member of a superior or inferior Role-playing class. One particular complementary pair of Roles is of Parent and Child. To the individual child, the person of the parent is not playing a Role. That is a view taken by an external analyst. But to the child the parent is also an Adult. In the Elliott sense, every Adult person is "better" than any Child person, or perceived as such by most members of either category.

Not all personal child-parent relationships play these Roles. There are cruel or negligent parents, parents perceived by their children as inadequate and not "better", and so forth, but in most families children and their parents play the "worse-better" Roles in that the children believe what their parents tell them, and the parents expect, or at least hope, that their children will behave as they are told to do, implementing the domination-submission aspects of the "better-worse" Role play. They may not, and

probably do not, consciously adopt these Roles, but from the Analyst's outside viewpoint, they play them, though less and less as the children mature toward adulthood, shifting their self-categorization.

As with most generalizations, these presumably do not apply in every instance. Individual children might be different. For example, a blue-eyed child might have gone home after class and told her parents that she was inferior because brown-eyed children had this genetic advantage, but the parents might have reassured her that even if what they had been told were actually true, no genetic advantages or disadvantages applied to everyone with those genetically determined traits, and it had long been obvious (to the parents) that you (their child) was in many ways special, so why not in this way, too?

The child who had been taken in by Ms. Elliott's fabrication might not have accepted the contradiction offered by the parents, because they too were probably also blue-eyed, and therefore perceived by the child as cognitively suspect. But not all blue-eyed children would have been so taken in by the ruse as to trust it over years of experience of not being inferior to their brown-eyed classmates. The experience that they would suddenly perceive their brown-eyed classmates acting as though expecting them to be submissive might perhaps have had a greater influence than anything their teacher told them. Their self-confidence would, in either case, be weaker than before the classroom demonstration, and they might have resorted to consciously checking their actions in control of perceptions that would have normally been controlled non-consciously.

In most of cases for which this is a model, the effects on individuals are likely to be distributed like an exponential, with most in a clump, and a few in a declining long tail of mavericks who neither accepted what they were told nor "went along to get along". These in later life might remain in the extremes of various distributions, becoming perhaps leaders, inventors, explorers, research scientists, or criminals.

This reorganization of the classroom structure would have been highly rattling to the children suddenly told that the others were "better". Now there were two separate organizations within the class, one of brown-eyed and one of blue-eyed children, both rattled by unexpected different disturbances to their normally controlled perceptions (remember that the rattling measure is the *unexpectedness* of the rate of change of a variable, in this case the error variable in a controlled perception — or rather, that total over the set of perceptions controlled in an individual or in an organization).

As Chvykov et al. (2021) showed with their non-living "smarticles", the rattled organization is more likely to settle into a lower-rattled state than a state of higher overall rattling, in a way similar to that of the molecules that jostle one another in a material undergoing a process of annealing. In the case of the children in the classroom, the total rattling was split between the interactions within each group of children with a common eye colour and interactions between members of the two groups. Reduction in total rattling might occur (it is not a goal, but something that statistically tends to happen) because of stabilization of relationships within a group, between groups in which one is dominant and the other submissive, or, most probably, all three.

IV.5.5 Domination, Submission

Jane Elliott told her blue- or brown-eyed children that they were "better" than the children with the other colour of eyes, and the "better" children began to bully the "worse" children, which none of them apparently had ever tried to do before. Why? What did they perceive to be associated with being "better"? Whatever it was, they either assumed or discovered that they could to some extent coerce any "worse" child into accepting and obeying at least some of their instructions, despite that those actions might conflict with what that child might have intended to do. The "better" children perceived themselves to have more Worth (be able to control more perceptions and control them better) than they had before being told they were "better".

What newly controllable perceptions might they perceive themselves as able to use that their classmates could not? These newly controllable perceptions could not be of the physical environment, because that did not change, and they would not intrinsically be able to control what they could not control before, though if they had changed their self-image perceptions, both self-self and other-self, they would be likely to have improved their self-confidence and actually control better. Some of the “better” group’s newly controllable perceptions would be of the social environment, in particular those that involved their classmates of the “worse” eye colour. A “worse” child could be used as an atenfel (could be ordered around) by a “better” child without the kind of retaliation they might have expected to experience before the class demonstration.

These newly controllable perceptions could not have been incorporated beforehand in the Powers reorganized hierarchy, so they would be consciously controlled using the Narrative slow track in imagination. The “better” group would perceive consciously that they could take advantage of the “worse” group without their teacher, Jane Elliott, interfering, though they probably would not have incorporated an ability to seriously injure a “worse” classmate among those permissions.

The “worse” group would have very similar considerations, in particular that they should accede to what a “better” classmate asked them to do, if they could do so without conflicting with some perception they controlled with high gain. Getting off the sidewalk when a group of their “betters” approached would cause increased error in their self-image perception, but as Ms. Elliott had already done that, any conflict would be likely to result in concession rather than a battle for control of the sidewalk. If the “worse” child were to be asked why they rather than one of the oncoming group should make way, the only rationale they needed to offer was “because they are better than me”.

The whole class demonstration was started because a child asked why someone shot Martin Luther King. Jane Elliott intended, by switching the eye-colours between “better” and “worse”, to illustrate as the whole class had asked what it felt like to be oppressed, as were black people, and to be the oppressors as were “white” people like themselves. All the children knew that the eye-colour distinction was intended to show that. One might speculate that perhaps the “better” group directly controlled (collectively controlled) for acting to oppress the “worse” group only in order to make the demonstration work and thereby please their teacher, a perception most schoolchildren in early grades control. If that had been the case, the point of the demonstration would not have carried over into different situations, such as the oppression of non-whites by “better” whites, as it was designed to do.

Nobody told white people in North America that they were “better” than non-whites, but for the centuries since the start of the transportation of black people as slaves to North America, that has been a perception controlled by many, perhaps most, white people. Slavery, however, has a much longer history than the puny four or five centuries of North American slavery of black people. Even before trans-Atlantic slave-traders functioned in western Africa, Arab slave traders plied their trade in East Africa, and are reputed to do so illegally even today.

Well-to-do Roman households usually included a slave, who might be well educated and perhaps even be a teacher of the family children. In what way might the adults in the family perceive themselves to be “better” than such an erudite slave? The slave probably had not been a Roman citizen before being enslaved. More probably, the slave had been a member of some conquered tribe and was *ipso facto* inferior to any Roman citizen, “worse” in the language of Jane Elliot’s classroom, regardless of their personal qualities and abilities. They could be ordered around, especially if they were alone among their owners, far from any maverick Spartacus.

The same is true of any conquered people, whether we are talking about a submissive bullied wife or the people of an entire nation or region who accept that they have been conquered. By this, I exclude maverick people on the tail of the post-rattled distribution of submissiveness or accommodation, who

engage in guerrilla actions to discomfit the colonists. We will talk later in this Chapter about people who are “worse” only by virtue of having less money.

What we have done, perhaps imperceptibly, is to shift our thinking from one side to the other of a feedback loop, not a control loop with its inherently asymmetrical gain, but a feedback loop nevertheless. Jane Elliott told one set of children they were better than the other, and they changed what they could do when interacting with the others. In particular, in the initial phase, the brown-eyed children were acknowledged by the entire class to be “better” than the blue-eyes. The brown-eyes then were able to treat any blue-eye as a menial who should perform an action that they were told to do (I presume within limits of bodily harm), and the blue-eyes would accept the order much as would an employee of a hierarchically structured organization if asked by the manager to do a task within the job description.

Jane Elliott’s action had the effect of letting the children believe that one group should be dominant and the other submissive, when members of the “better” group interacted with members of the “worse” group. The situation was quite artificial, but in everyday life similar effects are so frequent as to be not noticed, unless a member of the “worse” group tries to assert their equality to or superiority over a member of the other in some property to which they are not entitled, according to the reference values of perceptions controlled by members of the “better” group.

Members of the group that have reference values to perceive themselves superior will experience perceptual error if a member of the “inferior” group acts in a way perceived as acting as if they were of equal status, even if they do so passively. As always, perceptual error is liable to lead to overt action, especially if the error is beyond the perceiver’s tolerance zone for it. That tolerance zone is influenced by interactions with members of a group one perceives as one’s own.

For example, Jesus Christ, according to the Gospels, tried to influence people to have a wide tolerance level for differences in thought and action: “Love they neighbour as thyself” is a Christian adage. In practice, since the death of Christ on the cross, few people who perceive themselves to be Christians have been able to act as Christ asked them to act. One may think of the treatment of Jews by non-Jewish people, usually nominally Christian, in many places and times up to the Nazi Holocaust and even subsequently, or of lynchings of legally free people in the Southern USA whose visible difference was only in their skin colour. They were not “loved as thyself” by their pink-skinned neighbours, and nor have their descendants been over the intervening century and a half.

Both “White” and “Black” families would mostly have told their children that “Whites” were “better”, and the children would have grown up with that perception. Some in either community might have had reference values that differed from these perceptions, but most would not, so the same perception by both whites and blacks would change only slowly through the generations, that whites, by virtue of being “White” were “better” and therefore authorized to bully “Blacks”. “Bullying”, both in this case and in the case of colonization, could reach the level of lethality, which would be collectively, if not legally, authorized.

Why over the centuries has it been so difficult for people who call themselves Christian to act as Christ asked them to do? One may ask the same of Islamic Extremists, nominally acting as wished by Allah the merciful, but happy to behead non-muslims in public and to kill multiple people in bombing and otherwise destroying buildings in which people live and work. The sin of not believing as one believes they should, for those people, a capital offence (or, as those who believed in the religion of Donald Trump acted to control their perceptions, a Capitol offence). Is there a valid PCT explanation? I think there is, and we will discuss it in Chapter IV.7.

IV.5.6 Colonists: Collective Bullies

Using PCT, I will derive likely trajectories of colonial development from initial encounter between individuals of two cultures to a period of colonial domination and a final revolution of the colonized, using occasional historical examples and counter-examples (e.g. Ethiopia and Thailand, a.k.a. Siam) as instances. Both countries were able to resist being colonized during the 16th to 20th century expansion of European colonial "Empires", during which their neighbours were colonized by Europeans, notably France and Britain, as were the many nations that existed in the Americas before the arrival of Columbus colonized by Spain or Portugal. India is an interesting example because the conditions differed across the many regions of that huge area south of the Himalaya, which over its long recorded history had seldom if ever previously been considered to be a single social or political entity.

Are colonists as a collective necessarily bullies, in the same way Jane Elliott's "better" children were when interacting with a "worse" classmate, or in the analogy that was the reason she performed the demonstration, as "White" people often are and have been when dealing with non-Whites, whether they be those with some African heritage, or the depersonalized "gooks" of the Viet-Nam War who won the war despite being considered inferiors by the American troops.

A very similar trajectory from encounter to domination to revolution of the colonized is true when we talk about the rise of populist dictators, since we will offer with examples from Julius Caesar (who styled himself "dictator", Latin meaning "speaker", and who was assassinated by his erstwhile friends) to the aspiring US dictator Donald Trump, by way of Oliver Cromwell or pre-revolutionary European kings. All of them presumably perceived themselves to be "better" in some way than the alternatives. The English King Charles I believed himself to be ordained by God, and therefore inherently "better" than his subjects, a self-self-image and behaviour for which he had his head chopped off by anti-monarchic revolutionaries. Dictators, Kings, and Revolutionaries, however, can wait until Chapter qIV.10. In this Chapter we deal with the Roles of colonist and colonized as Dominants and Submissives.

The story of Jane Elliott's classroom exercise with the "better" blue-eyed or brown-eyed children provides in miniature essentially the psychological (PCT) background to colonialism. The colonists were better equipped militarily than the colonized, which marked them as of a "better" class, and hence collectively able (and therefore entitled) to treat the colonized as servants and to disturb the colonized people's controlled perceptions completely arbitrarily. As a rule, they perceived swarthy or dark-skinned people as inferior if they were unable militarily to resist the Europeans, who were generally lighter-skinned. If they could resist, they were perceived as worthy people collectively and individually, and treated with respect, regardless of their skin colour or other visual appearance differences from the characteristic appearance of a colonist.

On a large scale, the colonizing Europeans provided many examples of the reason for Jane Elliott's demonstration, the arbitrariness of the perception that dark-skinned people were inferior to we pink-skinned (i.e. "White") people. I say "arbitrary", but in this book, that word demands more than a simple use. There should be a PCT explanation for anything that on the surface seems arbitrary. Whereas in Jane Elliott's classroom, the distinction between "better" and "worse" was imposed by the teacher, and the both categories perceived the "better" group to have been enabled to bully the "worse" group, in colonialism, the ability to control perceptions of the actions of one group by the other group without reciprocal capabilities (bullying) was what determined which group was "better". The subordinate group might collectively control for perceiving themselves to be able to control their perceptions by actions that were not influenced by the control actions of the colonizing group, but any action to do so would result in Conflict (Section 1.6.6), manifest in observable actions by members of either group.

What made the colonial function different in Ethiopia and Thailand, and to some extent also in India? What was different about China before the Japanese invasion that started World War II and after the war ended? How did the transcontinental colonial expansion in North America occur? Were they all examples of bullying by "better" colonists of people they perceived to be "worse than" them? We will not go into historical detail about these different questions, but we can attempt a PCT answer to the question just posed.

We might well ask the same question about workers and management in large companies, in which a person's Role is often perceptually more important than the person playing the Role. Workers who play a Role that interacts directly with the company's external environment are considered "worse" than those in management, as measured by the generally accepted monetary value of their hourly remuneration. I say "generally accepted" as though the pay level was close to everybody's reference level for it, which is not often true.

These "better" and "worse" labels may be identified with levels of "Worth" (Chapter III.8), the total ability of someone to control their variety of perceptions that they want to control. In the Trade motif described in Section III.9.4 fair trade increases the Worth of both parties to the trade. But now we are no longer talking about fair trade, but a trade enforced by a bully who uses the trade to increase his worth with no regard to whether the other perceives their own ability to control to be enhanced, downgraded, or unaffected. If the bully does not control their own perception of the other's Worth, the "trade" is simply theft "in broad daylight" enabled by the overt submission of the victim — collectively the people of the region colonized in this case.

In the foregoing, either or both parties to a trade may be collective controllers, which we have called "Giant Virtual Controllers" (Chapter III.1). The particular kind of collective controllers of interest here are those known as colonists. Colonists usually start by a few of their number executing fair trades with individuals or with local collectives in the persons of their Leaders. At that point, the existing societies in the area are usually "better" than the stranger-explorer.

The conquistadors of what is now Latin America are obvious exceptions, as they considered themselves better than any local inhabitants, no matter how superficially glorious their civilization compared to what the conquistadors had at home. The conquistadors were "better" only in the quality of their weaponry, which usually enabled a few of them to win any physical conflict with the local inhabitants. Their musketry allowed them to become dominant, and, in a reversal of logic similar to the logic that says the reason why poor people are poor and rich people are rich is that rich people are "better" than poor people. The authority of the conquistadors did not derive from the perception of their "betterness" by the people of the southern Americas, but from the weaponry that allowed them to become dominant, as perceived both by them and by the conquered people.

David Livingstone in Africa and the early European traders in India are more typical, perceiving the local rulers as their superiors in the context of the moment, and submitting to the local rules of behaviour. In many cases in Africa, these rules were collectively and democratically controlled by the general populace rather than being Laws arbitrarily defined by the currently accepted ruler. Only when Europeans arrived in sufficient numbers and with adequate weapons could they be perceived as being "better" in that they could do what the local people could not.

In our "Just So Story" of the multi-thousand year suppression of women following the Saharan-Arabian-Mesopotamian drying (Section IV.2.2), we did not mention the resulting perception of men as "better" than women (in the non-specific Jane Elliott sense) by most men and a large number of women who are believers in the militaristic Abrahamic religions, many of which still encourage the suppression of women, especially in matters related to biological sex, such as abortion.

IV.5.7 "Us and Them": Income Disparity

There are many ways that "we" differ from "them", whether it be between our family and the family next door or between "Us" citizens of Ourcountry and "Them", citizens of Thatplace —foreigners. One quite different important divide involves the PCT Trade motif (Section III.9.4). In our discussion of the Trade motif, we pointed out that a mutually acceptable trade increases the "worth" of both parties to the trade, but we did not consider the before-trade differential worth of the parties, tacitly assuming that they had near equal power in their ability to influence the perceptions whose control enabled the trade.

This assumption is good enough in most cases of trading between individuals, most of whom have low to moderate worth, but it fails when there is a large discrepancy between the worths of the parties, one of whom may have information the other lacks. Consider the situation described in Section III.8.3, in which "*Carol owns a Chinese bowl that her friend Yvonne would like to have*". If we add that Carol just likes the shape of the bowl and that it is a memento of her grandmother, whereas Yvonne believes it is a very rare kind of bowl crafted for a 15th century Emperor, worth a lot of money on the antiques market, we get a very different idea of the trade possibility as perceived by the two, Carol who owns an aesthetically pleasing memento and Yvonne who would like the money she could make by selling it.

Whereas the original example was of a fair trade that gave both traders more worth than they had, with this revision, Yvonne has a very strong advantage, the advantage of access to more relevant information sources than her potential trading partner, Carol. Yvonne can perceive and control what Carol cannot, and this is not a fair trade when seen by an independent observer who knows what each knows.

A similar imbalance of worth usually exists between a potential employer and someone seeking a job, whom we might call Paul. Apart from the supporting perceptual controls involved in it, the Trade motif involves four controlled perceptions, two in each party that are in conflict with each other internally, and two in each party that conflict over a CCEV, the trade price. When all of the three CCEVs in these related conflicts result in both parties increasing their perceptions of their own "worth", the trade can be made, but is that enough to make the trade "fair"?

When the trade is whether Paul will accept a job offer, there are many controlled perceptions beyond those for which the CCEV is the financial value of the job. These non-financial aspects of the job offer that might influence its value to the potential employer and employee could include conditions of work, holidays, sick days, and lots more, all of which we shall ignore for this "Us and Them" discussion. The financial value of the job to the potential employee might be as income in the form of wages or salary, as shares in the company, promises of performance bonuses, or as some kind of a mix. To the potential employer, the potential increase in value would be in the form of increases in the number or the QoC of controllable perceptions that might use Paul as an atenfel, while the trading decrease would be mainly financial.

Enhanced access to financial resources has an outsize influence on the worth of an impoverished person, since each dollar can be used in a trade for increased worth, perhaps in the ephemeral form of food, or children's' clothing, perhaps in the longer-lasting form of enhanced skills or tools. If the trader is able to control their various perceptions subject to ephemeral but inevitable changes in disturbance level, then the dollar can be used for control of a wider variety of perceptions, giving the recipient a choice of which perceptions to control, and hence more worth.

Let us imagine that Paul's potential employer is Peter, the proprietor of a small variety store. One question an analyst might ask is whether Peter perceives that employing Paul would offer enough him value to compensate for the value lost in paying Paul's wages. Maybe Peter could stop working twelve-hour days if Paul could do some of the things Peter currently does, or maybe Paul could spend some time keeping Peter's book in order, saving enough money to pay Paul's wages. However it is, either Peter will be able to trade with Paul in a way that allows them to come to an agreement about what Paul will be paid, or they will not, and one of them will break off negotiations.

As part of the negotiations, Peter might share some information with Paul, such as the state of the shop's finances. This information might be useful for them to have a fair trade, Paul's services to the shop in exchange for his promised wages. Without that information, Peter can perceive an upper limit to how much he can afford to pay Peter, but Paul may not be able to perceive how much he can ask, beyond what he truly needs to be able to pay his recurring expenses plus a little more to give him choice in controlling some other expenses. It matters to both of them how much Paul is to be paid.

The same is not true of a richer trading partner than Peter, whom we can call Richard, or Rich. One extra dollar is very unlikely to change what perceptions Rich can control, and so its effect on his self-perceived worth is almost, but not quite, zero. Rich has many employees, some of whom are like Paul in acting so as to perceive themselves to be earning a "living wage" that allows them to control against their recurrent ephemeral disturbances, others of whom are controlling perceptions of how much people like Paul should be paid so as to minimize what Rich has to pay while maximizing what the "Pauls" do to bring in more money for Rich.

Although Rich is the employer, he does not personally trade with Paul in setting the wage for the job. When Rich controls a perception for which his business needs more employees, he thinks he knows what the new employees would need to control as his atenfels. He already has employees who control perceptions of what they would have to pay to get a new employee to take any of these jobs, and at the higher levels, the potential new employees probably have little uncertainty about how much they should ask. The higher the authority level the job in the new project, the more financial income and "perks" they can trade for, because they perceive that Rich perceives that the work done by the taker of the new job has a high value.

Paul has no such advantage, nor has he the information he would need about Rich's finances that an applicant for a high-paying job might have been able to acquire. Paul is faced not with a fair trade, but with a "take it or leave it" choice, to do certain work for a defined level of income. If Paul perceives that the choice to take the job will provide him more value than other jobs that he might apply for, he would be likely to take it, even if the income being promised is insufficient to cover his ongoing ephemeral expenses. Paul has no power in this trade of work bartered for income.

How can a person increase his or her power to control some perception? By using collective control, acting in concert with others who are controlling correlated perceptions. The collective has more power to control against disturbances to the CCEV (which may not be exactly what any of them are controlling) than does any individual. Together, the "Pauls" might have sufficient power to trade as an entity fairly with Rich. Such a collective controller is often in the form of a trade union, with its own formal organized structure.

Most of what we have said in this Section so far has involved much uncertainty in the various perceptions controlled, and hence the effects may be related to changes in the relevant rattling measures. Here, however, we are concerned with whether income disparity tends to create an "Us and Them" distinction similar to that between rural and urban, or local and foreign populations.

Clearly, Rich and Paul live in different perceptual worlds, have different networks of people with whom they frequently interact, and in have different access to atenfels for control of their perceptions. As "objects" with many different categorical ranges of perceived property values — they are far apart on the crumpling hierarchy of crease separations. Since there are other people like Rich and other people like Paul, much closer in each case in the crumpling hierarchy, they certainly could belong to "Us and Them" categories. Do they? How can we tell?

One way of telling is whether the intermediate cases, such as rural people who frequent cities or urban people who spend part of their lives living rurally are sufficient in number to allow a reasonable proportion of each to perceive that they might transition between the two populations. If there is an exurban possibility of living partially in both worlds, or enough people switch seasonally between urban and rural life, then many people will perceive "Them" as known quantities not much different from "Us" or at least with differences that are well defined. The difference is less uncertain than if there is no intermediate possibility or knowledge of "the other".

Hence, although all interactions add some uncertainty to perceptual control, and hence introduce some rattling, an interaction between "one of us" and "one of them" when there are known intermediate possibilities will be likely to add less rattling to both than when a member of each group is unlikely to know much about a typical member of the other group. In the case of Rich and Paul, as exemplars of high and low income groups, the question is whether environmental changes or social interactions allow Paul to perceive a possible route to joining the group to which Rich belongs or for Rich to perceive how he might join Paul's group, so that he might control for that not to happen. If they can, then although Paul and Rich might currently be very distinct "objects", their social groups will not be perceived as "Us and Them".

It all hinges on the perception by each of whether there is an intermediate stage in a route that can be followed or avoided by control of the perceptions of both Rich and Paul. If they perceive no such route, but a large gap that cannot be crossed by any atenfel that could serve as a bridge for Paul to join Rich's group, or over which Rich might stumble, then the two groups might well become antagonistic "Us" against "Them", or perhaps "Owners" versus "Workers".

We are moving toward an understanding that the key issue in "Us" versus "Them" antagonism, is probably the unfamiliarity of "Us" with some properties of "Them". Unfamiliarity implies uncertainty in the disturbances inherent in any interaction between a member of "Us" and a member of "Them". Uncertainty in the *velocity* of change of error is the measure of rattling, and in a single control loop, increased rattling implies lower Quality of Control (QoC). In everyday language, if you meet someone who you perceive to be one of "Them", you don't know how to act toward them. You are rattled, in the everyday and in the technical sense of the word.

One general way of reducing rattling caused by interaction or by mutual side-effect of control actions is to distance oneself from the source of the rattling. Make the person or group go away, by whatever means you have available. As we have seen, rattling is reduced by reorganization, either social or within the individual. Strict separation is one form of reorganization, but it is far from the only one. As we saw in Section IV.3.2, a form of partial distancing leads to a modular hierarchy of society, in which moderate degrees of separation between modules such as families, villages, religious congregations, and so forth reduce inter-module rattling, distributing the rattling reduction throughout the society, just as a tensegrity structure distributes the effects of an external force throughout its structure.

Quite apart from separation, rattling is reduced by improvements in QoC, since rattling is one measure of QoC. QoC is improved by changes in loop parameters. For a control loop at any level of the hierarchy, its parameters, and especially its base level of rattling, are affected by the QoC of the lower-level control loops that contribute to its perceptual input or that participate in implementing its output.

As we saw in Chapter II.8 and Chapter II.9, and as used in the "Method of Levels" therapy, conscious control both reorganizes existing control loops in the non-conscious hierarchy and can add novel perceptual functions that may become part of that hierarchy if their control improves — or at least does not adversely affect — the stability of the biochemical homeostatic loops. When interaction as a member of "Us" with a member of "Them", we are in precisely the situation of needing new perceptual functions for the ways "They" act either when we deliberately or inadvertently add to the disturbance of a perception they control or when we passively observe "Them". We build our perceptual functions that produce controllable perceptions of "Them" consciously, and consciously learn how to control those perception — how to calm the rattling that occurs when they are not well controlled.

At this point we should be ready to deal with when and how immigration affects the organization of society.

IV.5.8 "Us and Them": Rural and Urban

Rural and Urban people live in different environments, and control different perceptions. Maritime fisher people are different yet again, but for now we concentrate on the urban-rural divide. Suburban and exurban people inhabit a transition zone, which may be important because it provides a geographical middle zone between rural and urban. We will ignore the internet, and consider the environment before its advent.

When environments change unexpectedly, the changes rattle all these people differently. For example, a large earthquake may create widespread havoc in a city, but may only shake up rural people while it is happening. Weather that changes dramatically between drought and flood, or between extremes of heat and cold, may destroy a farmer's crops, while having relatively little effect on urban people who live with air-conditioners and use grocery shops that source their foodstuffs from distant areas — at least until storms are severe enough to damage their physical environments.

An earthquake that increases rattling in perceptions controlled by urbanites should lead them to demand changes in the actions of the relevant authorities, whereas rural dwellers would do the same in case of weather extremes, though the following analysis suggests that individual farmers would do what they can by individual or communal efforts, before resorting to outside resources such as "authorities" that (according to PCT) they usually perceive as interfering with (i.e. disturbing) their personal control abilities (i.e. atenfels).

Urban people use as atenfels public resources such as urban transit systems and well made roads, specialized shops accessible on foot, specialized medicine, and much more, resources not usually available to rural people. Urban people reorganize to control their perceptions using these public resources. Rural people cannot, and do not. They reorganize to control their perceptions largely using their own resources, rather than public ones. The result is that rural and urban people are likely to perceive the world differently, but not only in their different local environments, especially in what to do to control against increased rattling caused by widespread environmental change.

Accordingly, most rural people should be expected to have a self-self-image or an other-self-image controlled to reference values that include being autonomous. Not needing help, a mechanism that relies on people helping each other to overcome the rattling induced by the environmental changes will not be

likely to emerge. High personal individual strength is likely to be part of their self-image reference, and part of their perception of either kind of self-image held as a reference value by those with whom they usually interact.

Accepting help with “personal problems” is a disturbance to those self-images, except when their inability to control is of a kind that they perceive that their neighbours would also be unable to control, such as the rebuilding of a barn destroyed in a tornado. “We” help each other when “we” see that they have a problem that even “we” could not fix by “ourselves”. “We” perceive that to help under these conditions will not be seen as “us” perceiving that the person being helped lacks strength. Accepting help from a distant source, however, such as “the Government”, might be perceived as “the Government” perceiving us collectively to lack strength, increasing the errors in “our” self-images. Analytically, the situation is analogous to the child who forcefully asks the parent: “Let me do it myself”.

It should be clear that the few paragraphs are more likely to apply to rural than to urban people, not least because their communicative environment makes providing help rather more difficult than is the case in urban regions of higher population density and better transportation access. In rural regions, perceptual control without using others (including “the Government”) may well be energetically more efficient than using the abilities and strength of others, employing the protocols and collective control management techniques required to do so.

A Rural farmer is likely to have a Perceived Reality very like that of that of near neighbours — where “near” means something very different from the meaning of “near” to a resident of a city street. To the farmer, a farmer who lives 5 km away may be near, while from the urban person, someone who lives at the far end of the block might be “distant”, and have a rather different perception of both local reality and of the effects of a change in their common physical or political environment.

One implication of this difference in conscious perceptions of the panorama of perceptual reality (PR) is the difference in the meanings of words, and the need for words that involve categories used by rural by not by urban people. An urban visitor to a rural community might be a “city dude” who uses “hifalutin” language but “knows nut’n”, while a rural farmer visiting a city might be a “stupid rube” who “lacks an adequate education”.

“Dude” or “rube”, each may be highly skilled in controlling perceptions when in their native environments. Neither is “better” or “worse” than the other, except in their abilities to function effectively in the other’s environment. If relatively few people inhabit the exurban semi-rural region where they might interact equally with both rural and urban people, the perceptions and means to control them of rural and urban people are likely to diverge as the cultures evolve and drift (Chapter III.6).

The “other” environments inhabited by the two groups are likely to be perceived as alien and unwelcoming. Rural people, as discussed above, are likely to regard accepting help as a sign of weakness, whereas urban people take an environment that gives them a lot of help as “just natural”. Good roads, buses and subways are simply “there” as part of the natural environment, and so a city dweller can travel long distances within the city.

Transit systems (and the rest of the city infrastructure such as sewers, fresh water, electric power, local banks and services, etc.) aren’t perceived as “unwelcome help” that must be rejected if you are not to show weakness. A city dweller may well control for being perceived as strong, but in many cultures, help is simply “there” to be used as an atenfel when needed to control the perception(s) one is not strong enough to control alone. Rural residents often do not have these “just there” environmental atenfels available to be incorporated in the reorganization of maturing, and might not have the skills to employ them when they visit the city.

The same applies at many different scales. Teen groups evolve terminology that is not understood by those outside their group, and by the time their elders — the quintessential outsiders — have learned the meanings of the words within the group, those words have become passé.

A teen is rattled largely by changes in the scope of the ever enlarging environment within which they must perceive new things and act using new atenfels. It is a rattling of the shockwave of frequent invention, a probably exponential enlargement of the creative autocatalytic soup (e.g. Chapter II.2, Chapter II.7, or Chapter III.2). The same happens as an environmental cause of rattling when new invented objects such as smart phones or new laws become part of the environment of an adult.

This kind of sudden environmental change is not a cataclysmic problem, as is climate change or a major earthquake, since in the long run it makes control better for many people, reducing organizational rattling. On the other hand, it alters the field of perceptual reality and of perceptual control unexpectedly, and in the short term increases rattling and the overall difficulty of perceptual control by many people, and greatly for a few, by on average easing or improving the quality of perceptual control after the reorganization induced by the rattling settles into its new configuration.

IV.5.9 “Us and Them”: Battle of the Sexes

We discussed the possible deep roots of a common “Us” versus “Them” interaction in Section IV.2.2: the “Battle of the Sexes”. There, the point of the discussion was not “Us” versus “Them”, but why it was possible for the division to start, to maintain itself over millennia, and to spread over so much of the Euro-Mediterranean world slowly but inexorably to a culmination only 500 years ago in the Baltic region.

Here we take a different viewpoint on the same issue — why has it been only so recently that women have explicitly questioned their generally subordinate status, exceptions not being collective, but individual, such as Joan of Arc (burned at the stake), and northern European Queens regnant. So far as I am aware, the earliest published work, at least in English, questioning the legitimacy of the general inferior status of women was Mary Wollstonecraft’s (1792) “*A Vindication of the Rights of Woman*”. Before those individual women who did not accept the necessary submissive status of women, there may have been other individuals, but at that time there was no collective action based in a perceptual reference that there is no inherent reason why women collectively must be “worse” than men.

The disturbance caused by Wolstonecraft’s book to the perceptions of both men and women as collectives was probably probably very small, not least because only a very small proportion of either group would have read it, and probably fewer would have agreed with her conclusions. But there would have been a few of both sexes who read, understood, and agreed with its thesis.

Wollstonecraft may well have had friends with whose help she developed her book, but the issue about which she wrote largely remain with us in English-speaking countries today. Dominant men continue to interact with submissive women, but many of the “submissive” women collectively or individually dispute that status. On the other hand, many women actively control for its continuation having a reference value for their other-self-image for being perceived as being attractively submissive to some male or males. From my own male viewpoint I have wondered why any woman controls for at least her other-self-image to have a reference property of being seen as submissive to a male husband, father, brother, or political leader, at least in public, rather than as being a competent person in her own right just as much as would a family male.

By a century after Wollstonecraft's book was published, the ideas in it had percolated to some readers and from them through networks of friends to an increasing number who began to perceive that women should have more rights and should be less submissive to men. These "should be" perceptions would be reference values for perceptions of "is currently" that for many women and fewer men would result in perceptual error to be reduced by control action. An individual woman who deviated from the collective controlled perception that she should be submissive to some man or men would at the very least be perceived as "strange" and as deviating from the collective reference values to the extent of requiring collective action to control her overt actions that differ from the collective reference for submissiveness.

When there were enough women controlling for perceiving themselves and being perceived as equal to men, not only in their self-self-images but also in their other-self images, their actions as collectives would be more disturbing to men who collectively controlled for perceiving "their" women to correspond to the reference ideal of beautiful, delicate, and most importantly, submissive to the actions the men used to control many of their perceptions. The suffragette movement to permit women to vote for their government "masters" was definitely perceived by many men as not close to the reference values for their perceptions of how women should act — submissive to rules imposed by men.

In Section IV.2.2 we suggested that the strong gender bias in the Abrahamic religions as possibly being the stable result of climate change resulting in drought in the southern part of the Fertile Crescent. But we find it also in such diverse places as contemporary India and Han China, with their very different religious backgrounds. How may this long-standing cultural "Us" and "Them" sex divide be explained in those areas, among the masses who do not subscribe to any of the Abrahamic religions? Could it have indigenous roots, is it due to cultural communication from one religion to another, or possibly from migratory patterns of masses of people? It may be worth noting, perhaps, that the traditional peace-preaching Jesus came from the northern part of Galilee and that he forms part of the "classical" triumvirate of male God-in-the-Sky, the human male Jesus, and the sexless Holy Spirit who emerged from his burial cave (underground).

I have no evidence to prefer any of these options, but it may be worth noting that the Indus Valley civilization (often called Harrappan after the modern name for one of its major cities) shows no sign of gender disparity, nor of reverence to any male figure, human or god-like — or female figure either, for that matter. No large statues of human figures have been found in those cities. Neither did Harrappan cities have evidence of defensive walls, in contrast to cities in the Levant of similar age.

The following is relevant, the implication being that where women are….. equal in governmental power to men, the region or nation is less likely to be aggressive or to require strong defences against aggression. To quote from an article in the Globe and Mail (2022.03.08) "*...gender equality is the single biggest predictor of peace in any nation. Gender equality is a bigger factor predicting peace than either a country's economy or its political system*." The article is not given a scholarly reference, but the source seems to be a report contributed to the World Bank "Pathways to Peace" project (Crespo-Sancho, 2017).

We may note an apparent link, once again, between the hypothetical suppression of women when their Goddess worked against the populace by failing to produce harvests during a prolonged drought and the aggression of men in warlike raiding parties trying to take what inadequate harvests their neighbouring communities might have been able to glean. Women might even have perceived themselves as having failed their Goddess and thereby their menfolk and their children, and therefore as "worse" than the men who could provide food if their raiding of the neighbouring communities and their protection of their own was successful. If Jane Elliott's school class is anything to go by, no such submissiveness would have been expected of women in the North, as it would have been in the South.

There is a psychological, if not a visible physical, "middle ground" between the sexes, as is shown by the existence of such words as "bisexual", one who may control for having sexual relations with a partner

of either biological gender. But unlike the “middle ground” we have talked about in other “Us and Them” dichotomies, no individual is likely to transition from one sex to the other by way of this particular middle ground. Indeed, rather than the “middle ground” being somewhere between the “Us”and the “Them” as it is in the rural-urban divide or the income divided, in the sexual divide the extremes are in most cultures considered normal, whereas anything else is considered at best “odd” and at worst as deserving the death penalty.

Not only do we have a divide according to the sexes, but we also have a divide between aggressive nations which have predominantly male leadership and relatively peaceful ones, though the division is by no means clear cut. This is clearly a statistical tendency rather than a reliable distinction, but nevertheless, it may be worthwhile to see if there might be a PCT reason why this tendency might exist. PCT says nothing about gender, but we would have reason to be surprised if the hormonal differences between the sexes did not affect such parameters as the average loop gain, and hence the average general rigidity (“wire” tensions; loop gains) of the control-tensegrity structures in the two sexes. As with most such measures, there is probably a large overlap in the distributions of one sex and the other.

One or other sex would in general control with higher gain, and gain is a loop parameter that may well be affected by specific hormonal concentrations in the blood. High gain is incompatible with wide tolerance widths. If, say, testosterone was associated with high loop gain on average, men would be more prone than women to conflict difficult to resolve by action on the external environment (see Figure I.8.5).

One might also ask whether the difference could be mediated by the monthly hormonal changes that are more prominent in women than in men. These would be expected to alter the tensegrity rigidity more in women, allowing for structural changes (reorganizations) difficult for men to tolerate. Men, rather than creating changes in themselves, would then be more likely to act to disturb other individuals — “taking it out on them” — by some form of aggression than would women.

This line of thought leads to the expectation that women in a culture where they are trained to be submissive would be relatively unlikely to have reference values for perceiving themselves in leadership positions, despite that it appears to be true that they are, on average, better leaders from the viewpoint of keeping a country out of military conflicts than are men. As always, when we deal with wide-ranging distributions, there are outliers, “exceptions to the rule” such as Margaret Thatcher in England, but they tend not to be as extreme as are men who lie on the “macho” extreme of the male distribution.

At the opposite end of the male distribution are rapists. If the foregoing analysis of the Battle of the Sexes is at all valid a rapist is likely to be controlling for a perception of female submissiveness — to him and to men in general. But his perception of “the way the world is” includes few if any women who act submissively toward him personally. However, he can use his probably superior physical strength to force physical submission of a random woman he might find on a woodland path or other place where he perceives that his actions are unlikely to be observed by anyone who might come to the aid of his victim. The rapist can prove, if only to himself, his superiority by the act of rape, in which the woman was physically submissive if she was unable to escape.

All this requires some research if it is to be moved from “plausible” to either “refuted” or “supported”, since what I write here is simply what I perceive to be a consequence of PCT. Though it may be plausible, is by no means demonstrable from the mostly anecdotal evidence available to me.

Chapter IV.6. ”Us” and Them”, “It’s Their Fault”

IV.6.1 It’s THEIR Fault: Unfamiliarity, Fear, and Hate

In this Section we elaborate a little on the discussion of the likely antagonism between strange groups meeting prehistorically at watering places discussed in connection with rattling theory in Section III.10.6, or nowadays when migrant groups meet long-standing inhabitants of their new region.

Failure to use effectively a protocol that is specific to a group means that the initiator of the protocol fails to control the perception that is usually controlled by using that protocol with a group member. A person who persistently misuses a group-specific protocol, such as by saying “Skeveningen” or “Sheveningen”, is a “not Us” person if “we” are people brought up as speakers of Dutch.

Just as “one of us” may fail to control by inadvertently initiating a protocol with a “not Us” person, so also the prospective continuer “not Us” person is quite likely to have a controlled perception disturbed by the initiator’s actions and be unable to correct that error by performing the (unknown) protocol. Neither has an effective way of reducing the error introduced by their mutual disturbances. Both are rattled by their failed attempts at perceptual control.

Sustained error and high rattling is likely to lead to an increased rate of reorganization, quite often preceded by an increase in output of the control unit that is failing to control the perception in question. For example, as is often said of the English tourist in a foreign country, instead of speaking softly, the tourist might start to yell, thereby defining a widespread protocol which gives the other to perceive that the tourist is not pleased and is highly rattled by the interaction. This yelling rattles the “foreigner” who is actually the local inhabitant, leading to some kind of reorganization of their interaction, perhaps by bringing a moderator or interpreter into the interaction, perhaps by discontinuing the interaction, each with the perception that the other is not a person they would want to meet again.

Such protocol failures perceived as ill-will rather than simple ignorance can lead to antagonism directed against the group to which the other is perceived to belong, even when none initially existed. You may perceive protocol failure and its attendant changes of action as indications that the other is ill-disposed toward you, meaning that the other has a reference value to reduce your perceived happiness. If you perceives the other as playing a Role or as belonging to a known category of “Them”, the perception of ill-disposition might be associated with the Role or category rather than simply with the individual with whom the protocol failed. Around 1942, a person apparently playing the Role of Gestapo Officer would probably have been perceived by most Dutch persons as being ill-disposed toward them.

An individual who participated in a failed protocol that leads to antagonism was “not Us”. The perception of such a person easily transitions into one of “Them”, some category of “foreigner” who are the perceived cause of the failure of “Us” to control well some perception. Since “they” are perceived as being intent on blocking “our” control of one perception, “they” might also be sneakily affecting control of other perceptions that we are unable to control well. “They” have arcane powers to do “Us” damage in ways “we” cannot predict. “They” rattle “us”. Without knowing any member of “Them” as an individual, each individual “Them-person” is to be treated as an enemy to be at least kept at a distance if not to be killed.

In everyday language, “they” become scapegoats for almost everything that goes wrong, even though “they” actually have done nothing but perhaps use some protocols differently from “us”. If “we” are the larger community, “they” may be actively suppressed. If “they” have the stronger collective controllers, “we” may “go underground” and actively oppose “them” whereas initially “we” had no perception of any “them and us” conflict.

Some might have been highly rattled by learning a truth that strongly disturbed their self-self-image in a way against which they had no means of controlling. Since they could not control their self-self-image perception, they had to control something contributing to the disturbance, perhaps their perception of the generalizability of the results of Elliott's experiment to their own behaviour when interacting with "black" people. If the results applied only to children, and then only to the obviously artificial blue-eyes versus the brown-eyes, then Elliott would have been telling the children a malicious lie directed at them by telling them that the exercise was relevant to Dr. King's murder.

These suggestions are, of course, speculation, but if true, they would explain what happened to Elliott after her classroom exercise became public beyond her local small town. The "righteous" people of a town that apparently had no "black" inhabitants perceived her to be among the "non-righteous" and therefore to be worthy of the same kind of treatment that the brown-eyed children collectively meted out to the blue-eyed children in Elliott's class. Elsewhere, however, people who heard about the exercise were sharply divided into "Elliott haters" and "Elliott followers". A natural question is "why a divide rather than a range of opinions?

This Section started with an example of a perception tested by use of a shibboleth. Without having acted to disturb any perception otherwise controlled by one of "Us", an individual member of the "different" group is now perceived to be antagonistic, even though the antagonism to that individual did not exist before the test. In Elliott's exercise the "better" group did not act as though the other group was antagonistic, so much as that both groups perceived that in the case of conflict, any member of the "better" group would best any member of the other group, no matter which was their own group.

The Smithsonian article says: *A smart blue-eyed girl who had never had problems with multiplication tables started making mistakes. She slumped*.

As we have seen, however, perceptual states can exist simply because that state of the world is reported by a trusted source. If someone in your own group tells you that people wearing red and blue shirts are dangerous, and might kill you if they saw you in a green shirt, you might believe it, especially if you hear the same thing from various different people. Anyone in a red and blue shirt may become a person to be feared, as a jungle-living fruit gatherer might fear a tiger.

What is "fear"? Introspectively, it seems to depend on failed attempts to control in imagination using one's current models of *the way the world is* together with *the way the world works*. The former produces a perception whose value differs from one's reference value for it, such as not being close to a person in a red-blue shirt, while the latter may provide no means to control that perception. The resulting imagined perception is uncontrollable, because if the imagined result was effective countering of the disturbance, then the possibility of such an occasion actually occurring would not be feared. Most people do not fear impossible events such as attacks by armies of Tyrannosaurs, but may fear low probability events such as being in an air crash or being struck by lightning.

A terrorist intends to create fear, and succeeds despite the extraordinarily low probability that one will oneself be physically harmed by a terrorist act. In most industrialized countries, the probability of being hurt by a terrorist is orders of magnitude less than the probability of being killed while in a car. But the car is not usually feared, and the terrorist is. Why should this be? I suggest that the answer is the intent. The terrorist has a reference for perceiving other people to be fearful, and the atenfel for achieving this is

to kill deliberately at a time and in a way that would prevent an effective counter to the terrorist act. Few people have these intentions, so the terrorist is a member of a different group, not "one of us".

Now you are told that people wearing red-blue shirts are likely to be terrorists (though your informant says that some of them are good people). You fear them, and you may hate them — but what is "hate"? In one sense, "hate" is a quality rather than a perception, as is "red" or "comfort". But it refers to a perception, so we must ask what states of the environment lead one to hate someone or something.

One does not "hate" the disturbance that in imagination causes "fear". What, if anything, one hates is its source, whether the source is perceived as an identifiable entity (even one as hard to perceive as Mr. Dowd's rabbit of Section III.6.4) or as a vague unknown. The source may not even be a living organism. It could be inanimate: "*I hate that river that I fear may flood my house*", it could be a social control system: "*I hate the corporation I work for that I fear will leave me to starve*", or it could be a group of "them": "*I hate those atheists who I fear may damage the power of my God*."

How does this fit with "*I hate that garbage dump opposite my house*" or "*I hate getting up so early for school*" or "*I hate modern art*"? It really doesn't. These uses of the word are derivations, extensions of the term. They do not have the same connotation of fear and distrust associated with hate of the feared and perhaps unknown "other". They are synonyms for an extreme form of "dislike".

Such uses of "hate" refer, perhaps, to a persistent and uncorrectable deviation of a perception from its reference value, but that perception is not one that the person is likely to try to control. One could move house to get away from the garbage dump, or petition the Authority to remove it and dump the garbage somewhere else, but few people would be likely to do either. They just get on with life, hating the garbage dump. They set their tolerance bounds for its perceived location so that the garbage dump location remains inside their tolerance zone.

IV.6.2 Aliens: The Story of Robin in Silverwater

When we discussed "Marcel among the J's" (Section III.3.5) Marcel was an alien, in that the ecology of his language differed from that of the "J's" he visited. In this section, we discuss a similar situation, but try to be a little more realistic in that the alien "Robin" is an ordinary human, and Robin speaks what is nominally "the same" language as his new hosts.

In Chapter III.3, Marcel and all the J's were synthetic people who could understand and use audible language based on what we called a "synx" that moved within an ecology of what we called "syncons" to form "trajectories" that were the larger units of their languages. The languages of the J's and of the alien Marcel all were similar in that their linguistic foundations were these synx trajectories. They differed in how their trajectories were configured and how trajectories and relationships among trajectories had developed in their two cultures to allow the use in their cultures of protocols about actions that typically would be useful in controlling aspects of their own environment. These might be the same or similar in the J culture and Marcel's M culture.

Our hypothetical Robin lived in an era before rapid travel or communication. Robin and Sam live in small towns, Robin in "Riverside" on the bank of a gentle small river on which Robin and his friends of either sex like to boat and fish. Sam lives on the seacoast in "Silverwater". He, like most of his male neighbours, goes out in a boat to fish while many of the women forage in in forest for fruits, berries, and whatever edible they find to supplement the fish.

At home, Robin mostly eats berries and other fruit from the forest together with agricultural produce the men and women of Riverside grow, but he and they also like to eat the fish they often can catch by

angling in a widening and deepening of the river beside the village. They preserve their forest products for later periods when they are out of season, such as overwinter in most cases.

Sam and the people of Silverwater eat mostly the fish they catch, preserving overwinter the usually large excess in case of times of poor catches or storms when they can't safely fish on the ocean. What do Sam and Robin drink? Fresh water, Sam from a well, Robin from the river.

It takes a few days of walking to get from Riverside to Silverwater, so hardly anyone ever makes the trip in either direction. Why would they? In both cultures, the interactions among the inhabitants have resulted in a stable, self-sufficient, ecology in which people are happy, since they have been able to control their perceptions very well, doing "the same-old-same-old". They don't want anything they know about from the other town, and quite possibly perceive the inhabitants of that village as being rather odd, if they know anything about them at all. The cultural ecologies of each village has settled into a low-rattling state, and the two cultures share what was originally a common language, and still is, apart from slightly different accents and words and phrases that are used in their different cultures.

As we have frequently observed, however, low-rattling equilibrium states do not mean that every member of an organization experiences low rattling. Most do, as we have often observed, but there are always a few outliers who are relatively strongly rattled. The creativity shocks that are a feature of homeostatic loops usually dissipate fairly quickly, as most people reject novel ideas as irrelevant to their own perceptual controls, but the shocks don't dissipate equally in different members of the ecology. Some of them are likely to experience a concentration of the shock, the effect of the novel creation being to rattle those few nodes quite strongly and for a long time, even if the creation itself is quickly discarded from the ecology as "intrusive new-fangled nonsense".

In Riverside, let us assume that Robin is one of the nodes of the network ecology that is highly rattled by some novel creation. In this context, a creation is an idea, and that new idea profoundly rattles some perceptual part of the ecological network inside Robin's perceptual control system. There are many things Robin might do to calm his rattling experience, depending on what perception is rattled and that he no longer can control very well. But as we noted earlier, one generic way of reducing rattling is to leave the environment in which the rattling is experienced. So Robin leaves Riverside for a long walk, to see whether a holiday in Silverwater might ease his rattled perceptual control and calm his frazzled nerves.

When he arrives at Silverwater, Robin is thirsty, as he has emptied his water-bottle since he filled it from the last lake he passed on his long walk. So he does what he would do at home. Never having encountered even the concept of salt water, he goes to the nearby water body and dips his water-bottle into the sea. When he takes a swig from it, he spits it out and tells Sam walking nearby that the water is bad. Sam asks what is bad about it, and Robin says it tastes awful. Sam asks why Robin would try to drink sea water anyway. They have a cultural mismatch, as Robin, the alien, only knows one way of controlling a perception of being inadequately hydrated, dipping his water bottle into the river, and Sam has never encountered that way of controlling a perception of thirst.

They both use "the same" language, or thought they did, and both understand Robin's "Because I am thirsty" answer to Sam's question about why he tried to drink water from the sea. But Sam does not understand Robin's means of becoming less thirsty, and Robin has never heard of a "well", to which Sam now directs him without showing him. Robin does not understand Sam's "We get water from the well" until he is shown or told the actions that allow one to obtain drinkable water.

In Riverside language, there's only one category of water. In Silverwater language, there are two, one from which you get fish, one you can drink. They are distinguished in Silverwater language by their uses as atenfels, as we discussed in Chapter II.6 and Chapter II.7. In Riverside, the same two atenfels — fishing and drinking — apply to all the water the Riverside people encounter. The only way they would

learn about sea water as being different from river water would be for someone who had at least visited Silverwater to tell them about it. That informant might well not be believed, any more than people would be likely to believe the stories told by Lemuel Gulliver, even if Gulliver had not been a fictional character (Swift, 1726).

When Robin arrives in Silverwater, he is not in the position Marcel was when he visited the J's. Robin can talk with Sam and his friends Stuart, Silas and the rest. But Robin may not know what Sam's friends are talking about when they say that the "scrood swish" failed and they might have go after "garez" instead. Silverwater people perceive that the fishers will have to put themselves into danger if the scrood do not come, but Robin knows nothing of this.

The scrood fishery and its occasional failure is an aspect of the Silverwater ecology entirely unknown in his Riverside culture. Robin asks what they are talking about and is told that scrood are a kind of small fish that at the same time of year most years, when there is a full moon, a "swish" — a large number of schools of scrood — comes close inshore. Fishermen spend all night, usually catching boatloads of scrood, most of which they preserve, though they eat quite a lot fresh. Very occasionally the scrood swish does not come, and the fishermen collaborate and go after a large fish called "garez" that lives in a particularly dangerous stretch of water. On the years when that happens, almost always at least one fisherman dies in a shipwreck.

When Robin learns this, he asks why they have to catch fish in order not to starve over the winter. Why do they not do what is obvious to Robin, namely control their hunger by collecting products of the surrounding forest such as fruits and berries, and preserving them over the winter. Silverwater people have never done this, because as far as they know, any food they get from the forest has to be eaten right away, before it gets rotten. So Robin introduces one or two of the women, who regularly forage in the forest, to Riverside techniques for preserving fruits and berries in edible condition over the winter.

This is a new idea to both the women and to the fishers who the women tell about Robin's suggestion. If some choose to follow it and preserve winter supplies of forest products, the men not need to risk their lives fishing for garez. But this change will add to the rattling experienced by at least some, if not all, Silverwater residents, because it changes some of the homeostatic loop linkages in their pre-existing stable ecology. For example, only one or two fish processors know how to process garez, though every fish processor can, and expects to earn their winter keep by processing large quantities of scrood.

On the other hand, the conflict between fishing for garez and controlling for staying alive might not exist in future for those fishers who would use a winter diet of preserved forest products as a substitute. That source of rattling would no longer exist, and furthermore, some might perceive that preserved forest products would be a nice tasting addition to their usual winter diet of preserved scrood even in years that would not need to fish for garez. However, the organization still would have its rattling increased by the scrood swish failure, not least because of the several fish processors who have no way to be valuable to the community in their usual way.

Robin's suggestion of preserving forest products to eat over the winter is common practice in Riverside but unknown in Silverwater. It might be accepted or rejected a weird and stupid by the Silverwater population as a whole. If it is accepted, tried, and found effective, most of the Silverwater people would perceive Robin as a kind of saviour. The out-of-work fish processors would not, but Robin might be able to reduce that source of rattling by offering to retrain them so that they could serve as forest product preservers if necessary.

The Silverwater ecology (and economy) as a whole would, after a period of increased rattling caused by the "Shock of the New"[24], be stronger than before. The ecological network would be changed by the flow of forest products to the erstwhile fish processors, and it would be better able to cope smoothly and with little shock the next time the scrood swish failed. Since the Silverwater ecology now incorporates part of the Riverside ecology, it is exhibiting the effect known as "hybrid vigour".

However, if the Silverwater people do not link Robin's suggestion into their ecology, allowing the idea to decay from the minds of most, Robin would be perceived as a trouble-maker, a heretic, or at least immoral. He would be perceived by the collective as a person whose presence in Silverwater increases disturbances and errors to perceptions controlled by most people, increasing the rattling in Silverwater as a whole.

One means they might reduce this community organizational rattling is to remove Robin from the Silverwater community so that he doesn't try to get them to act in other stupid and offensive ways, Perhaps they could put him in jail, perhaps they insist that he leave town, perhaps they execute him for heresy. Which method they choose would depend on other parts of the ecological network they had stabilized over several generations.

Robin might avoid this fate by apparently accepting that his idea was in fact wrong, for reasons he had not understood, and be allowed to stay in Silverwater provided he learned to follow their customs and moral laws. To do so would increase his own rattling, but reduce that of the community in total. He would not be able to control his perception of wanting to improve the life of the Silverwater population by telling them how to preserve forest products so that they would have a more varied winter diet and would not have to fish for garez, and he would be unlikely to try again to persuade them that it works in Riverside.

If, however, the Riverside technique of preserving forest products is tried by even a few Silverwater families and found to work, two things are likely to happen. They, being known to be trustworthy, might induce their friends to try it as well, and Robin, with his alien customs, vaguely unfamiliar language and accent, might be accepted as a useful member of the Silverwater community — an immigrant rather than a long-term visitor.

Whether Robin is driven out of Silverwater or is accepted as an immigrant, Robin's perceptual control hierarchy had been previously reorganized to use Riverside ways of controlling his perceptions. Let us assume he was accepted. He would have to learn Silverwater customs to replace some of his Riverside customs. For example, he might learn that certain gestures or turns of phrase might be perceived as deliberate insults that could be ignored when he was just a visitor, but not if he had become perceived as a regular member of the community.

Until he reorganizes to non-consciously use Silverwater modes of control, he will continue to find many of his controlled perceptions disturbed in unexpected ways. He will be more rattled than would most born and bred Silverwater people. At some point he might "feel homesick", perceiving in imagination that he was less rattled at home in Riverside. He control for actually perceiving himself to be there, and go home.

When he arrives in Riverside, having learned to drink from a well, not from the water beside Silverwater, he is confronted with an unexpected perception of his old Riverside compatriots. The Riverside people "know" that the water they encounter, which they use both for fishing and drinking is good unless they leave it lying around too long in hot weather, when it becomes "bad". Why should they believe a traveller's tale, one among many, told by a Robin returning from a long holiday in Silverwater, about a big body of water that is all bad, but that the Silverwater people use for fishing anyway?

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24. Hughes (1980) titled his TV series and the accompanying book "*The Shock of the New*".

The Riverside people know from experience that no idiot would fish in bad water, even if as Robin claims, such a big body of bad water with fish in it did happen to exist. Robin had been thought a bit weird before he left for his long holiday, and must have had his head further addled by his stay with those Silverwater people who seem to do everything wrongly. To them, Robin is no longer a proper Riversider, trusted to use Riverside customs properly. But not all Riversiders necessarily dismiss the new knowledge he has brought from Silverwater, and some might even try digging a well, to see whether they could get water that way, at home, without walking to the riverbank and dipping a bucket into the river.

IV.6.3 Immigrants and Hybrid Vigour

Hybrid vigour, or at least the transfer of useful customs, is not restricted to the effect of single alien invaders like Robin into a different but related culture. Transfer of useful customs has been observed across different but related species, and not involving a single alien such as Robin from Riverside (Leca et al., 2021). It may be a useful concept to introduce when we think of "alien contact" more generally, as an aspect both of human immigration and of the effects of introducing alien species into a stable ecosystem.

In genetics, the concept of hybrid vigour was already becoming of interest to academic research plant breeders by at least 1910 (****REFS****), and a century later had become a matter of common understanding. Without the name, however, cross-breeding to produce stronger or more useable plant varieties has bee practices for several millennia.

Does the concept of hybrid vigour apply in other domains, particularly to societies, and if it does, what might be the mechanism? The story of Robin in Silverwater suggests by using a hypothetical example that it may well apply to societies.

I will argue that it usually does, and that the mechanism is autocatalytic creativity, whether in genetics, in individuals or in societies. We discussed autocatalytic creativity at length in Chapter II.2 and Chapter *2:5-6*, and used the idea in Section IV.2.1 on Cultural Phase Change. Robin from Riverside introduced just one novel idea into the Silverwater ecology, exactly as might have done a member of the autocatalytic homeostatic network ecology of Silverwater in the absence of the alien.

If either Robin's or the autocatalytically created idea linked back into the network to form a new homeostatic loop, as Robin's did in the story, the ecology would gain in vigour in the same way — but the chance of that idea occurring autocatalytically in any particular year and then being accepted long enough to be tested by the community would be very low, in contrast to the probability of the same happening as a result of the visit of Robin, the alien.

Nevertheless, it may be worthwhile to restate the mechanism of creative revolution in the present context — why mixing previously isolated cultures often leads initially to intercultural war and later to a more vigorous and creative society than either progenitor. Much of this was discussed in a simple "chemical" context in Section II.2.4, which I quote here:

> *An autocatalytic network produces increasing numbers of different kinds of product, each of which might combine with others and catalyze new or old reactions. By doing so, it provides ever more opportunity for a new and independent autocatalytic cluster to emerge. The new autocatalytic cluster itself produces an ever-increasing number of new complexes. which are likely to have a family resemblance that differs from the family resemblance among the complexes produced*

by other clusters. When there are enough reaction products in the soup, the mathematics of considering them without considering the original "atomic" units leads to the same conclusion. Clusters and loops are highly likely to form that incorporate only those new creations, without or nearly without any of the earlier catalysts.

Another situation in which eventually there will be enough distinct autocatalytic networks to allow the same mathematics to be used, in which complete networks are the elementary units. A "superloop" at a new level may come into being, functionally identical to the original autocatalytic network, but in which networks of networks are the product. Indeed, the mathematics argues that this is an almost inevitable consequence, once the number of complexes produced by the individual autocatalytic clusters exceeds a critical value. Each low-level network in the new superloop produces product complexes that enhance the activity of another network in the superloop, just as each reaction in the low-level network produces a product that catalyzes the next reaction around the loop. In this way, the existence of one low-level autocatalytic network catalyzes the operation of the next around the superloop.

These "superloops" might well be considered an example of hybrid vigour when what they produce is compared with what the individual lower-level loops could produce by themselves.

Earlier, in Section II.2.3, there is also this passage:

If the "soup" is more or less homogeneous initially, its homogeneity will be reflected in the existence of formally similar autocatalytic structures of, say, type A in different regions of the soup. The complex products that are part of the autocatalytic process will be created in the region of the cluster, but they will diffuse over time, since being catalysts they are not destroyed by participating in the reactions they catalyze. Their diffusion allows the reactions they catalyze to occur with increased speed everywhere in the neighbourhood of the initial type A autocatalytic cluster. It spreads not only its products, but also its processes — its reactions — through the soup in all directions. Each occurrence of a sequence of type A reactions enhances the likelihood of a type A loop becoming active nearby because of this diffusion of catalysts.

But the same is true of cluster B, some of whose products inhibit the loop reactions of cluster A. In the soup near an instance of cluster B, the cluster A reactions will be slowed as compared to their speed on the side of A away from cluster B. Cluster B tends to sweep its neighbourhood clear of instances of cluster A, and A also tends to sweep its neighbourhood clear of B. Between them, depending on the strengths of their anti-catalytic products on the "opposing" cluster, the region may be a dead zone or a zone with intermingled reactions from both clusters, varying in concentration from the core of one cluster to the core of the other. The core region of highest activity of each cluster has moved away from the core of the other, but in the interzone there may arise a new type of loop, type C, that involves

some reactions from A, some from B, and some that occur in neither loop but involves products or waste from both.

Here we have an opposed, inhibitory, effect that might occur when two different autocatalytic clusters come to interact. Each acts to block the dynamics of the other. We know, of course, that every homeostatic loop and hence every homeostatic network, must incorporate at least one anti-catalytic (inhibitory) process, so the pre-existing clusters A and B must already have incorporated some inhibitions if they were stable.

When these two networks first interact as units, loops that incorporate parts of both will result, some of which will have odd numbers of inhibitory process and some that would have even numbers. The latter would be unstable, leading to exponentially increasing energies in their opposing actions (in a linear system, which these are unlikely to be). The situation is closely analogous to the kind of conflict McClelland (1993) used to illustrate the Giant Virtual Controller created in a direct conflict, or it would be if the two networks A and B did not have several links of both catalysts and anti-catalysts in each direction.

Each interactive link between the A and B networks disturbs something in the other differently from how it had been disturbed, enhancing the rattling of the A+B organization compared to what it would have been before the two met. Each also creates its own "Shock of the New", and any hybrid C network that might be created introduces its own changes in the rates of creation of potential new catalysts for further invention. The possibilities could be anywhere from overwhelmingly inhibitory (meaning, in social structures. antagonistic) to overwhelmingly excitatory (meaning mutually welcoming), but most would, as usual, not in total being extreme in either direction. What would almost always change in just one direction, however, is the amount of total rattling across organization that consists of the interacting networks.

What is the implication of transferring to social ecologies the concepts of the interaction of creative homeostatic networks as expressed in "*Cluster B tends to sweep its neighbourhood clear of instances of cluster A, and A also tends to sweep its neighbourhood clear of B*"? I think we could quite properly call it "anti-immigrant" action. Later in this chapter we will supply this anti-mixing effect with a specific PCT mechanism, but for now we need note that though the effect is very common, it is far from universal. We should explore why it might seem to be so and why it actually is not.

Leca et.al. studied a band of free-ranging macaques inhabiting the Uluwatu temple in Bali that had discovered they could steal objects from tourists in order to barter them back to the tourist owner for food bought by the tourist and presented either by the tourist or the temple staff, a practice that started in that temple some time before 1990. Other bands of macaques elsewhere seem not to have been reported in engaging in this behaviour, although the tourist Role is played by many visitors at other temples where independent bands of the same macaque species live.

The macaques apparently engaged in the full bartering process as described in Section III.9.4 on the Trade Motif, in that they would insist on better food in trade for objects the tourists appeared to value more highly, discarding food offerings that they perceived as being of lower value. Leca et al. make no observations as to whether this band of macaques barter among themselves, but they do demonstrate an age gradations of skill in thievery, in assessing the value of the items stolen, and in precision judging a mutually acceptable "exchange rate" of food for stolen items. In the Uluwatu context, the bartering behaviour apparently was invented by some individual macaque and adopted by others, and the bartering technique was accepted and refined over the following generations.

The barter partners in Uluwatu are often not the owners of the stolen items, but the temple staff, who know the protocols that have evolved over the macaque generations. A first-time tourist visitor may have heard about it from earlier visitors or from guide books, but is unlikely to know all the symbolic gesture components of the protocol, which would probably be largely verbal in human barter protocols. The temple staff, on the other hand know how to play the Role of barter partner while the macaques have learned to play their part in the protocols that co-evolved between, not the individual humans and individual macaques, but among the Roles of "Us", "Tourist", and "Temple Staff".

A barter interaction between a particular macaque and a particular tourist might never recur. Indeed, without being told about it by someone else, no tourist might ever imagine that a macaque might possibly expect to successfully engage in barter for the return of a stolen cell phone. If the macaque did try to barter the trophy for food, the uninformed tourist would be unlikely to recognize the macaque's R-display as such, and therefore would not engage in the protocol. For the macaques playing the "steal and barter" Role, an unfamiliar person is likely to be perceived to be playing a Tourist Role (category) rather than just being a tourist (perceptual value) or a known person (probably a member of the temple staff).

Every act of creation creates a shock of disturbance, whether the result stabilizes as a member of a newly configured homeostatic loop or soon vanishes from the "soup of possibility". We saw this kind of shockwave in the creation of a new crumpling fragment pair from an existing larger fragment or category. Such shocks of creativity increase the uncertainty of disturbances and hence of error variances in related control loops. In other words, they increase the rattling for all the control loop members of the homeostatic loop, at least in the short term.

All these additions, slow though they might be to occur and get stabilized into a network of catalysis rather than a simple loop, will eventually occur if the network itself survives disturbances that might overwhelm it in their magnitude or rapidity as sudden "shocks". Shocks are inevitable consequences of creations, but most that are the effect of new creation are simply absorbed into a newly stable reconfigured loop or network structure. All of this is in the context of an isolated "soup" devoid of contributions of different kinds of "atoms" or "molecules" from other loops that might have been created elsewhere.

What would we expect from a "soup" that had been evolving somewhere essentially out of contact with the soup we have been discussing. Would the same network of creations have evolved in both soups? It is possible, but not statistically likely, since the order matters in which particular creations appear and join existing loops to form their different creative additions to the soup. Despite having started with the same source material and statistical possibilities, in the absence of environmental constraints, the two stable creative networks, which we may now call "ecologies", might be quite different. They might also be very similar. The shock to both that would occur if they meet could be small in the latter case, but could be very large if the two ecologies are very different.

Every ecology incorporates a number of kinds of interactions among categories of individuals, as distinct from a single interaction that happens between individuals. Ecologists typically study interactions among the flora and fauna of a land area. For example, the salmon that spawn near the head of a North-West North American river die either after spawning or on the way up-river. The ecologist does not care whether this salmon or that one dies, but the number that die from being caught by bears does matter.

The remains of the dead salmon are transported by animals such as bears and other fish-eaters fattening up for the winter to some place in the riverside forest where it is safe or undisturbed to stop and eat them or perhaps cache them for later. Eagles and similar birds of prey carry them off to further distances. Wherever on land they wind up, their remains are not in the river, but in the forest either

partially intact, or in the fecal waste of the animals that eat them. They fertilize the ground on which bushes and trees live, aiding their growth. Trees enhance rainfall and moisture capture from fog, increasing the amount and steadiness of river flow that the salmon require in order to spawn a new generation.

This hypothetical example sketches a homeostatic loop woven through the river, the forest, and the air. It is a small part of the ecology of the area, but illustrative of the possible effect of immigration. In this context, "immigration" implies the advent of what are sometimes called "alien species". Alien species grow or live elsewhere in the world, living and interacting in a different stable ecology that contains different homeostatic loops.

Some alien species are inhibited at home by being eaten by alien bugs, birds, or beasts that they do not encounter in the different ecology where they are alien, though they can flourish on what the new ecology can provide them nearly as well as they could where they came from. They can grow uninhibited, expanding exponentially in number or growing area, using resources that were well-balanced in the ecology they invade, and acting directly as inhibitors on the flora and fauna of their new ecology.

IV.6.4 Refugees and Rattling

A member of an unfamiliar but identifiable group of aliens such as refugees from Zyngaria is likely to be seen by a native of the host nation (Bescia) as a player of a new "Zyngarian refugee" Role, not as a person with an individual story, personally controlling perceptions other Zyngaria refugees may not control, using atenfels other Zyngaria refugees may not. Zyngarian refugees may not speak the Bescian language, dress like Bescians, worship the same God or Gods as Bescians, and in other ways Zyngarians are unmistakably different to native Bescian perceptions. Most Bescians will be uncertain how to behave in an one-on-one interaction with a newly arrived Zyngarian refugee. Both would be rattled by the perceptual control uncertainties inherent in such an interaction.

Simply put, to some Bescians who have never visited Zyngaria, Zyngarians act in unexpected ways, their food smells odd, so if bad things happen shortly after they begin to appear in significant numbers, they must have been the cause of the troubles, however obscure the way they might have caused the problems. To those Bescians, the mantra "Bescians are good, Zyngarians are bad" describes both themselves and "the others" in terms of the degree to which their influence on the Bescian perceptual environment enhances or reduces the overall level of rattling of their controlled perceptions.

Other Bescians perceive that these Zyngarians, odd though they may be, were invited to Bescia by the Bescian government, so even if their behaviour did cause the new "bad things" to start happening, it would have been a side effect of their collective behaviour rather than a result of intentional collective or individual control. These Bescians would be likely to control for perceiving Zyngarians to be happy despite their perception that most Zyngarians would have preferred to stay home in a Zyngaria as it had been before the recent troubles began that led them to become refugees.

These two different kinds of initial perceptions are likely to cause different average levels of induced rattling during subsequent interactions between individual Bescians and individual Zyngarians. An individual who believes most, or even many, Zyngarians control for causing trouble to their Bescian hosts are likely to control their perceptions of Zyngarian attempts to use Bescian protocols with lower tolerance than would a Bescian who believes Zyngarians as a group control for learning how to act effectively in a Bescian context. The result is a difference between the two Bescians in the rattling values for the perceptions they control in any given Bescian protocol when the partner is a Zyngarian refugee who may not know the differences between the Bescian protocol and the equivalent Zyngarian protocol.

The same would have been true for Robin from Riverside when he first arrived in Silverwater. In telling his story, we made the assumption that Silverwater people perceived Riverside people as usually friendly or as usually unfriendly. Robin might be odd in not understanding the annual rhythm of ocean fishing and the dangers to the community and especially to the fisher-folk when the "scrood swish" failed, but in most respects, Robin was able to use the Silverwater protocols, so most people would not perceive him as an unknowable alien and, because of that uncertainty, as a possible threat. Not perceiving him as a threat, Robin's proposal of wintering on forest produce instead of having to risk the lives of the fishers by going for garez in a year when the scrood swish failed might create a Silverwater person's perception of Robin as a person trying to help rather than as a person trying to lead them into danger.

Robin in Silverwater was a single alien person. Zyngarian refugees are not. As a group they can often interact using their own Zyngarian protocols, since a Bescian would not be expected to understand non-Bescian protocols. The advent of the Zyngarian refugees as a Role causes the kind of shockwave we previously associated with the creation of a new crumpling facet, a new category formed by fragmenting a larger category (in this case two categories "refugee" and "foreigner" simultaneously) (Section II.7.4).

Shockwaves are unexpected by their very nature, locally increasing the immediate level of rattling, and potentially leading to a restructuring of the organization involved. Shockwaves causing rattling by category splitting are needed if the existing organization to accommodate the new category into a new and perhaps calmer organization structure.

As we saw in Chapter II.7, after a shock has passed through, the organization affected will usually settle into a structure with reducing rattling, perhaps even eventually returning to the "good old days", but more probably falling into a new, calmer region of the control space, perhaps even one that nevertheless suffers from higher rattling than before the shock. Even if the organization returns overall to the good old days, the distribution of rattling being the same as before the shock, nothing guarantees that any individual returns to their earlier rattling value. Probably some people will be more rattled than before the reorganization, while some are less. Though the equilibrium rattling distribution is the same, the selection of its individuals probably is not.

Where would a "Zyngarian refugee" fit in this new organization caused by the shock of their arrival? Individually, every refugee has been strongly rattled, and is still encountering unexpected (category) perceptions or (analogue) perceptions requiring control that in Zyngaria would use atenfels now unavailable. Individually, some would be likely to find means to reorganize by developing new perceptual functions, new category perceptions, and to them new atenfels (lower-level control loops using facilities available in their new environment).

Most would find themselves less rattled if they immersed themselves among groups of other Zyngarian refugees, forming local clusters of Zyngarians who have as little interaction with the host Bescians as they can arrange, because initially, each interaction with a Bescian will incorporate uncertain perceptual control, implying a high level of rattling. From the Zyngarian viewpoint, Bescia may have welcomed them in, but a Bescian person will behave unpredictably. In some cases, the Bescian host group reorganizes in such a way as to provide training centres where a Zyngarian could learn Bescian protocols. ESL (English as a Second Language) classes are an example in North America.

To the Bescians, localized Zyngarian areas where Zyngarians have settled in order to be less rattled than they might have been in an environment mainly Bescian might acquire names such as "Zyngarytown" and be perceived as regions in which "these alien people" are often unwelcoming to locals. Since most Zyngarians do not know Bescian "welcoming" protocols, control will be uncertain and therefore using these protocols "wrongly" contributes to uncomfortable added rattling in both Zyngarian and Bescian, both of whom are trying to be friendly.

Unless these two persons can reorganize so that their "welcoming" interactions reduce rather than enhance the rattling they experience in their interactions, They will tend to try to stay away from one another in future. Reduction of the rate of interaction with strangers is one way to reduce rattling caused by the unexpected actions of the strangers, whether the "strangers" be the host Bescians or the Zyngarian refugees. So is a perception by either party that the other is at least trying to use their protocols[25].

We said above "*if bad things happen shortly after they [Zyngarian refugees] begin to appear in significant numbers, they must have been the cause of the troubles*." Coincidence or correlation is easily perceived as cause, no matter that such a perception is logically unsupportable. What is true is that perception of "bad things" is almost a defining characteristic of high rattling (uncertainty of the rate of variation of perceptual error), and when rattling is high, the individual elements of an organization — people in this case — are likely to act to change the situation in such a way as to allow reduce the uncertainty in their ability to control their perceptions. "Bad things" might be caused by climate change or by a circulating virus, but neither of these are obviously easy for an individual to deal with, and maybe after all the Zyngarian refugees might really be causing the problem. An individual native Bescian can kill a Zyngarian, thus reducing the ability of Zyngarians in general to cause further "bad things".

Let us move on a generation. The children of Zyngarian refugees who were not themselves refugees attend school — most of them a Bescian school if Zyngarians do not require their children to be schooled in a particular religion. At home they are likely to eat Zyngarian food, but the food of the host natives, their school friends, is also familiar, and they may even like it, which their refugee parents may not. Encounters with host native people involve using protocols with which either they are familiar or that they are learning. They probably do not use these protocols while playing the Role of "Zyngarian" with the partner Role of "Native host". Instead, they use them mostly as two natives might do, playing such Roles as student to teacher, customer to seller, and so forth, all in the Bescian manner. Unlike their parents, interaction with host natives seldom causes enhanced rattling that would tend to lead to reorganization.

These growing children also learn to play Roles used in their Zyngarian families and the Zyngarian regional clusters in which they are likely to live. They are learning to be bicultural, capable of using many of the perceptual categories, atenfels, and protocols of both Zyngaria and the host region.

IV.6.5 Refugee Relationships

What perceptions of Bescian-born children of Zyngarian refugees are Bescians of the next generation likely to develop? That depends on many things, not least of which is the set of perceptions held by the majority of the people among whom they grow up, but also importantly their experiences of interactions with the children of Zyngarian refugees and their parents. If they have no direct interactions with people of Zyngarian ancestry, they will be totally dependent for their perceptions of "Zyngarian" on what they learn from people with whom they do interact, their social neighbours locally or electronically.

The situation then is not unlike the situations of Jane Eliot's blue-eyed and brown-eyed children. If Zyngarian ancestry tends to make children visually different from those of Bescian ancestry, one or other group will be generally perceived by both groups as "better". Typically, this would be the receiving

25. A personal anecdote: in the late 1960s my family returned by ship from a year in England. The ship stopped at Quebec City for sightseeing before heading to Montreal. A line of taxis was awaiting passengers and the passengers lined up to get taxis into town. Just before us was a pair of middle-aged ladies, and when they got into the taxi, they almost immediately got out again, and the driver told the dispatcher "Parle pas Anglais" ([I] don't speak English). So we got in and I said to the driver "Centre-Ville s'il vous plait". Almost as soon as we left the taxi rank, the driver started chatting to us in English.

Bescian group, because the incoming Zyngarian refugees would not use Bescian atenfels available in principle to both as effectively as would a native Bescian who grew up in a milieu in which those atenfels were just a part of everyday maturing and learning.

Playing their different Roles, then, a Zyngarian refugee would be expected to be submissive to the "better" Bescian, who is familiar with social atenfels that work in their local protocols, atenfels a Zyngarian would not be expected to know how to use, or perhaps by Bescian collective control would not be allowed to use. Of course, these claims depend on what a Zyngarian refugee perceives as properties of the Bescian stereotype and vice-versa. What the Bescian individual might perceive of a Zyngarian must depend on the Bescian's perception of the reason the Zyngarian is a refugee. For example, if the Zyngarian is escaping religious persecution because they are of a faith with high status in Bescia, then the refugee would not be expected to perceive the host as "better", except in their ability to use local protocols.

A Zyngarian new to Bescia would be in the same position as the new Ph.D. student "Cal" in the cartoon strip (Figure III.5.4), who makes several egregious mistakes in trying to use a greeting protocol appropriate in the wider world when introducing himself to another Ph.D. student, Beth. Cal's guide, Adam, clearly indicates when Cal misuses the greeting protocol used in the Ph.D. student community, as might a Role-playing Bescian when an individual Zyngarian visitor misuses a Bescian protocol by trying to use a protocol a Zyngarian might use when introduced to somebody new in Zyngaria.

A tourist Zyngarian in Bescia might have these problems, but a Zyngarian refugee has those and more, because the refugee hopes to make a new life in Bescia, not just avoid offensive mistakes when interacting with a new acquaintance in Bescia. Some 60 years ago, Adlai Stevenson, a potential Democratic candidate for the Presidency, made such a mistake when visiting some Arab Country, and sat in a relaxed way that allowed the hosts with whom he was seated to see the sole of his shoe, apparently a severe insult to the hosts, of which Stevenson was totally unaware. Of such inadvertent misuses of local protocols are hosts' misperceptions constructed.

It would be almost impossible for a Zyngarian refugee (as opposed to a tourist visiting Bescia for a few days) to avoid such inadvertent protocol errors while living in Bescia. To this point, we have assumed that any Bescian would perceive any Zyngarian as an instance of the Role of Zyngarian, but many refugee situations are different. Individual Bescians might volunteer to play the Role of "host" with some individual Zyngarian playing "guest" for each individual Bescarian's "host". The issue for the perceptual controls of these individuals is whether the overt behavioural protocols associated with these perceptions are compatible. In some cultures, every guest is an "honoured guest", entitled to anything the host is in a position to offer. So it is worthwhile looking at a host-guest protocol and asking what kinds of perceptions might be controlled with what reference values in both host (Bescian) and guest (a Zyngarian refugee).

IV.6.6 Why is the Person a Refugee?

So far, we have treated "refugee" as a well defined Role, implicitly assuming that most individuals in the host country (a Bescian in this hypothetical example) would perceive that an individual refugee (Zyngarian) acted in escaping as they themselves would have acted in what they hypothesize to have been the refugee's situation. How they perceive what perceptions the individual Zyngarian probably was controlling will influence the disturbance to the Bescian's self-self-image and other-self-image perceptions, and the atenfels the Bescian would have available to reduce any resulting error in those perceptions.

The situation is quite similar to the situation that gives rise to a communicative protocol. In the protocol two partners, by observing each other's behaviours, infers what each is controlling. If neither partner is intentionally deceitful, and tries to help the other to correctly perceive what perception they are trying to control, then communication can be swift and over time the Primal Message can be believed by both parties to have been understood by the recipient, at least within some acceptable tolerance level.

From one viewpoint, the situation of a person showing up at a national border to be confronted by an immigration officer is just that of the initiator of any protocol, such as a customer showing up at a cashier in a shop. From another viewpoint, the Role of "Immigration Officer" facing a would-be "Country Entrant" is rather variable, depending on whether the Immigration Officer controls more for keeping undesirables out of the country or for allowing into the country those with authority to enter and a selection of others who have properties that should allow their entry.

This is the kind of conflict that is involved in any control-tensegrity structure, and like any tensegrity structure, its toughness and flexibility depend on its "wires" and "rods" not being too much or too little stressed. The Role of Immigration Officer may be provided with precise legalistic rules as to who should be allowed in and who should not, and a structure built on these rules (perhaps even codified into actual Laws) will be inflexible. Flexibility is potentially possible only in the person playing the Role.

The Immigration Officer Role may well specify a set of reasons for allowing or denying an applicant entry into the country, but a person playing the Role might perceive properties in the applicant not precisely described by the rules and depending on how those perceptions disturb perceptions controlled by the person playing the Role, those disturbances will influence how the immigration officer person acts to control the disturbance created by the applicant's unexpected appearance at the border post. "Unexpected" applies to the person applying for entry, not to the appearance of an anonymous player of the applicant Role.

An unexpected arrival creates an unexpected change in the error of associated perceptions controlled by the immigration officer. If the immigration officer is limited to playing the Role of Immigration Officer, with only such flexibility as is allowed by the "rules of the Role", then the applicant is treated as playing the "Applicant for Entry" Role, and to the one Role the other is far from unexpected. It is to the person playing the Immigration Officer Role that *this particular* applicant person is unexpected, and therefore adds to any rattling of the immigration officer person's organization. That rattling might result in the immigration officer's personal reorganization, but since the Immigration Officer Role is not rattled by the expected appearance of a player of an Entry Applicant Role, the formal structure in which the Immigration Officer Role is defined will find its rattling measure increased.

What does the Immigration Officer Role suggest that the immigration officer person should do when the person playing the Entry Applicant Role asks for asylum, claiming to be a refugee from some intolerable and irremediable situation in the home country? If his Role has been supplied with rules for who can clearly be admitted and who can not, and the applicant's claim is described by at least one of these rules, then the Immigration Officer can simply apply the Role's rule to the case. If it is not, then the immigration officer person must use personal judgement.

In PCT terms, the immigration officer person must correct a perception disturbed by the arrival of the applicant at the border, and act to remove the applicant from in front of the desk. The the immigration officer takes to correct this perceptual error depends on other perceptions, in particular the perception that the Bescian Immigration Officer Role has of the Role of Zyngarian. If the Role does not prespecify how the Immigration Officer should perceive a Zyngarian, as could be the case if to live in Zyngaria might be known to require every adult Zyngarian to take a side in a lethal conflict such as a gang war or a Civil War, in which case the Immigration Officer Role might specify that any Zyngarian claiming refugee status should be admitted.

IV.6.7 Inter-Cultural Protocols

The Protocol Motif applies equally to individuals and to collectives, but there are differences worth noting. Of the 19 controlled perceptions in the Protocol Motif, 18 are control of beliefs. When we talk about individuals, at least consciously the individual can perceive how strongly held the belief is at any moment. One can say "I believe you" or "I don't believe you" with different disturbing effects on perceptions controlled by the one called "you", and on the actions taken by "you" to correct those perceptual errors. "You" may even be strongly rattled if the answer was unexpected and causes a jump in some perceptual error. If so, the enhanced rattling will increase the rate of local reorganization in "your" perceptual control hierarchy.

But how would these effects carry over into a Giant Virtual Controller, "virtual" because no contributor necessarily has either the virtual perception or the virtual reference value produced in the GVC? The simple answer is that they would not carry over to a GVC that controls a single scalar perceptual (or environmental) variable, because rattling influences organizational structures, and one can not change the organizational structure of a single control loop — virtual or concrete — without destroying the control property.

Is this simple answer correct for a collective structure, which is what the GVC is? It depends on whether the elements of the GVC have a structural relationship, an organization. For example, by definition the perceptual function of a scalar GVC is created from the perceptual functions of the members of the collective, but are they organized in a way that could, in principle, be affected by rattling? Would a change in the structure of this organization of perceptual functions influence the overt behaviour of the collective that constitutes the members of the GVC?

Organization means that actions by one control loop have effects on another control loop, whether those effects be to disturb the other's perception, to change the other's precision of perception or of action, or to alter the strength of a disturbing signal — interactions of types 1, 2, 3, and 4 in Figure II.5.3. Collective control requires none of these, but in most cases the constituent members of the collective do affect each other, by side-effects if not deliberately by controlling perceptions of some property of another made manifest by their actions, including communicating directly.

In the next Chapter we will discuss "the Big Lie" (so named by Adolf Hitler in "Mein Kampf") as a way of forming a Collective that would come to believe in a state of the world about which the members might have no direct evidence from their own experiences and therefore were open to perceive a world in which what Hitler told them was true, if no individual or collective consistently told them the opposite — or even if they did, but trusted Hitler more. Subsequent autocrats and would-be autocrats have taken Hitler's teaching to heart, and have made good use of the Big Lie. But discussion of this must wait until the next Chapter.

In Section II.11.1 we quoted the Canadian diplomat George Ignatief as saying "*I learned that protocol is really a language, a set of rules and conventions which enable people of different nationalities, social backgrounds and political persuasions to feel comfortable with each other*" (Ignatieff, 1985). He was not deliberately talking about Protocol as we have been using it, but that is what he was actually doing. International protocols are between Roles, and to be an effective diplomat, a person must learn to play the Role accurately, using Role-protocols that will be also used by the other side, if the other side is represented by a diplomat who has learned to play the Role effectively.

This is not normally the case when either side is represented by a head of government rather than a trained diplomat, especially if that head of government is an autocrat whose self-self image includes either that he (always, or almost always, male) is better than everyone else, or wants his other-self image to incorporate that fact. Either way, he controls for others to perceive him as "better" and thus — as with

the “worse” children in Jane Elliot’s classroom (Section IV.5.3) — to control for acting submissively toward him. For a “should-be submissive” to control a perception by acting in a way that disturbs a perception the autocrat controls, precisely by acting in a non-submissive way, requires the autocrat to disturb strongly some perception the non-submissive controls. The non-submissive rattles the autocrat, but the non-submissive probably will not be rattled by the disturbance created by the autocrat. The autocrat, however, controls with probably high gain for maintaining the social organization he has been able to construct.

When interacting with someone from an area, whether it be from outside the family of a domineering father or from a different nation, the autocrat can avoid being rattled by trying to act so as not to disturb the outside person’s controlled perceptions in such a way that they might act unexpectedly and strongly disturb some perception the autocrat controls. International diplomatic protocols have evolved over centuries to achieve this “placid” effect, regardless of how divergent the positions and politics of the current governments of the two (or more) nations. The diplomat who plays the Role skilfully can create a perception in the leader of the other government that his nation offers no threat, by the way in which he or she uses Role-appropriate diplomatic protocols with a trained diplomat of the other nation.

After a revolution, or a change in a government of a nation in which ambassadors are not trained diplomats but political appointments, the new government is in effect not represented in foreign nations by trained people who understand both the diplomat Role and the cultural proprieties of that nation. It is represented by an ambassador who is politically aligned with the new government, but not one who understands either the protocols used by the various Roles used in the foreign culture or the protocols used by trained diplomats playing their diplomat Role correctly.

Another way of seeing this is that a revolution is quite likely to induce rattling in parts of other governments that did not have trained diplomats on the ground in the nation that had the revolution. The social (national) organization involving other nations around the revolutionary government is likely to undergo reorganization, changing the perception of that government by governments and people in other nations.

The same is true when an autocratic ruler acts unexpectedly in a way that disturbs perceptions collectively controlled in other nations both by people in the government of the other nation and in some of the people in the other nation — not necessarily many, as most are generally controlling perceptions related to their daily lives, and what happens elsewhere does not usually disturb those perceptions immediately. Those effects, such as restrictions imposed by the new government of the other nation, do not usually take effect immediately in creating uncontrollable disturbances to the controlled perceptions of daily life.

The Role-protocols of a diplomat do not ordinarily assume that the diplomat partner is lying. In Section II.5.7 we discussed the use of protocols for deceit, and the specialized protocols of the diplomat Role are no different from the more general protocols used in any culture. They do not, in themselves, protect the victim from deceit. If the victim perceives the protocol partner as likely not to tell the truth as the partner perceives it, nothing in the use of a protocol will tell whether the Primal Message is truthful. As the US President Ronald Reagan said: “trust, but verify”. In other words to perceive whether a protocol is delivering a truth, the evidence to check it is elsewhere.

That “elsewhere” is likely to include a whole network of perceptions previously held by the recipient, a network within which there are few direct contradictions that are placed in direct opposition. Indeed, since it is unlikely that these perceptions were created either by direct observation or by the conscious application of classical logic, the perceptions created by prior communication (through protocols) are likely to be quite imprecise, and therefore malleable without creating the perception of contradiction. This relationship of imprecision enables a liar to communicate apparently logically self-contradictory

“facts” and be believed about both sides of the contradictions, something a “Big Liar” may have to rely on. We study the “Big Lie” and its uses in the next Chapter.

Part 10: Government

In the final chapters we put together all that we have been discussing separately earlier, to consider collective control in a variety of areas such as forms of Government, the importance of perceived "fairness", income and wealth imbalance, unpredicted catastrophic waves in the Stock Market and in popular opinion, the power of magic in politics in the form of the "Great Saviour" who becomes a dictator, the Monarch who is not, and too much else to summarize in a brief interlude.

Government is about control, which requires the power to alter the environment so that the governed are perceived to act as the government wishes to perceive them acting. Control requires the ability of the controller to perceive whatever is to be controlled. In the case of a dictator, the power must somehow be available to the Supreme Leader, whatever the title, be it Chairman, President, Leader ("Führer"), Supremo, Father of the Nation, or something else. The dictator can wield power only through people who accept his Authority as the CEO of the Organization as a perceptual control hierarchy.

Government that is not a control hierarchy led by a dictator is usually an elected council of some kind, with a name such as a Parliament or a Congress, both of which imply that the purpose of the elected members is to debate issues among themselves and come to some conclusion about the best course of action. In practice such elected bodies almost never are organized, or rather unorganized, this way. A multilateral debate almost inevitably involves high rattling and the development of sub-organizations among members who collectively rattle each other less than they would on average if the debating body were unorganized, every member acting independently.

If the body segregates into a few subsets of people who do not rattle each other very much, the organizations of these clusters will individually tend toward calmer regions of the organization's description space, but individual clusters rather than individual members will tend to be opposed to one another, and as a result may rattle each other if they do unexpected things. The clusters may coalesce into political parties that derive their power to act from the people, not just from the electors who elected their members into the debating club. We will discuss this and much more in these final few Chapters, beginning with the power of collective controllers.

Chapter IV.7. Government, Freedom and Revolution

Some countries have phrases such as the French “Liberté, Egalité, Fraternité” (Liberty, Equality, Brotherhood) designed to define something about the country. The USA, for example, in its Declaration of Independence lists as inalienable rights “Life, Liberty, and the Pursuit of Happiness”, which is often taken to contradict the Canadian “Peace, Order, and Good Government”, a phrase that defines the authority of the Federal Parliament in the British North America Act that created the unified nation of Canada.

I do tho think, however, that these are contradictory. Rather, the Canadian phrase is a necessary means to the achievement of the US phrase, whereas the unspoken insertion of “My own” before each element of the US phrase tends to work against its claim that all people should actually enjoy those rights of Life, Liberty, and the ability to pursue happiness (i.e. to be provided with the atenfels that allow them to control their perceptions).

Another way of saying the same thing is that the Canadian phrase lists some atenfels without which control of various perceptions to reference values described by the US phrase becomes very difficult. “The Pursuit of Happiness” in particular seems to be a catchall phrase that describes a state in which most perceptions are within their tolerance zones, a state that is unlikely to be achieved without “Peace, Order, and Good Government”.

In this Chapter we consider how PCT might illuminate those concepts, how Peace, Order, and Good Government can be seen as atenfels that ease “the Pursuit of Happiness”, and consider how some restrictions on freedom of action can increase Liberty. “Life” is a different matter, but if we treat it as meaning the length and quality of life, “Peace, Order and Good Government” again seem to be required. No nation ever is guaranteed “Good Government”, no matter what its proclaimed aspirations, but nations that do aspire to it may also be well placed to achieve the state to which the US motto.

When one thinks from the viewpoint of a PCT controller, what might “Liberty” mean? Surely it means that ability to control one’s perceptions. That ability depends on access to atenfels for controlling those perception and the skill to use them. As we have seen, access to money provides access to ever wider varieties of atenfels, some of which are in the form of people willing to use their skills to act on one’s behalf, so one aspect of “Liberty” is access to money. Another is the acquisition of skill through experience and education, so another aspect of “Liberty” is access to education and to a variety of environments within which the citizen may require different means to control particular perceptions.

There are many other aspects of “Liberty”, but these alone seem sufficient for many Americans to determine that PCT supports “Socialism” and is therefore anti-American. We will look at why and how this paradoxical belief might have arisen, and why “Libertarianism” may be the political movement that most restricts the Liberty of the majority of citizens, while it is easier to argue that Socialism (not the variety practiced in the Union of Soviet Socialist Republics, which actually is dictatorship, not Socialism) provides more freedom to individuals to control their own perceptions (give them more “liberty”) than most other “isms” do.

“Government” is a word that means different things to different people, apart from having several dictionary meanings. But all of the meanings have in common that some people determine limits and restrictions on what other people (perhaps including themselves) may do, or directions as to what they must do. In what follows, the word refers to some person or group that is collectively perceived to have Authority to pass laws. Whether any particular person or group accepts that Authority as legitimate is another question entirely.

IV.7.1 The Big Lie

"*..and why do the people imagine a vain thing*?"[26]

A "vain thing" here has nothing to do with personal pride, but means either useless or untrue. By choosing that quote for his great oratorio "Messiah", Handel was commenting on and questioning the reasons behind the fact, as true in the days of the Psalm writers as in Handel's day and in our own, that a lot of people believe what they are told, having no means of determining the facts for themselves, and that they may be told "the facts" by someone who could use their perceptions of the facts to their own advantage. Going back to McClelland's quote (

Leo the liar is trying to alter Harold the hearer's World Model so that Harold will act in a way that helps Leo to control some perception or perceptions, perceptions that may not involve Harold directly. Leo does not control a perception of the worth of the lie to Harold. The Big Lie has positive worth to Leo if others perceive it as true, but could have either positive or negative worth to Harold and other hearers if they do believe it. When Harold has incorporated the content of the lie into his or her World Model, Harold's World Model differs from Leo's World Model in a way convenient to Leo, no matter how if affects Harold's ability to control his own perceptions.

The "Big Lie" is like a Convenient Myth (Section III.6.5), but it differs in two ways from myths such as Mr. Dowd's rabbit or the historical Troy. Convenient Myths are not propagated for some personal purpose by people who believe them to be untrue, or if they are, the fact that the Myth is fiction is often part of the telling. Convenient Myths are not deceitful. The "Big Lie" is.

The essence of the Big Lie is captured in the following passage[27] that refers to Adolf Hitler.

> *His primary rules were: never allow the public to cool off; never admit a fault or wrong; never concede that there may be some good in your enemy; never leave room for alternatives; never accept blame; concentrate on one enemy at a time and blame him for everything that goes wrong;* ***people will believe a big lie sooner than a little one; and if you repeat it frequently enough people will sooner or later believe it****. [Emphasis added]*

in "*Mein Kampf*" Hitler himself said:

> *Propaganda must not investigate the truth objectively and, in so far as it is favourable to the other side, present it according to the theoretical rules of justice; yet it must present only that aspect of the truth which is favourable to its own side. (..) The receptive powers of the masses are very restricted, and their understanding is feeble. On the other hand, they quickly forget. Such being the case,* ***all effective propaganda must be confined to a few bare essentials and those must be expressed as far as possible in stereotyped formulas. These slogans should be persistently repeated until the very last individual has come to grasp the idea that has been put forward****. (..) Every change that is made in the subject of a propagandist message must always emphasize the same conclusion. The leading slogan must of course be*

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26. From Handel's *Messiah*, based on Psalm 2.1 in the Book of Common Prayer.
27. Quoted from Wikipedia <https://en.wikipedia.org/wiki/Big_lie> retrieved 2011.10.17, which cites an OSS report submitted in 1943 or 1944 by Walter C. Langer entitled "A Psychological Analysis of Adolph Hitler: His Life and Legend" (p51), and later published as Langer (1972)

illustrated in many ways and from several angles, but in the end one must always return to the assertion of the same formula[28].

When he achieved power, Hitler put these ideas into practice with the reestablishment of the Nazi propaganda newspaper *Völkischer Beobachter* and the suppression or disparagement of those news sources that attempted to report the true state of affairs following careful investigation.

The equivalent in 2016-2020 USA is to label the investigative media as "enemies of the people" that report "Fake News", and to use the same tactic of simple, typically three words long, formulaic slogans repeated many times. Such slogans become calls to action by the followers of the Big Liar, "Lock her up", "Build the wall", and the like, and on Feb 6, 2021 "Hang Mike Pence" (at the time Vice President presiding over the ratification of the presidential election results).

We have already considered "what I tell you three times is true" (Section III.6.2), a thought encapsulated in both long quotes. Now we must consider why "*people will believe a big lie sooner than a little one*".

First we have to ask just what makes a lie a "Big Lie". All lies consist of someone saying or otherwise displaying something contrary to what they believe to be true. Leo the liar does not intend the Harold the hearer to perceive the discrepancy. Instead, Leo controls for Harold to perceive that the lie actually represents not only what Leo believes, but a fact about the *Way the World Is* or the *Way the World Works*. All lies are like that, so what makes a lie a "Big Lie"?

Let's first try to distinguish a "small lie" from the "Big Lie" in which we are primarily interested. Perhaps the small lie is one that the liar intends to deceive only one person or a small closed group, rather than a wide audience. Perhaps it is a lie that the liar intends not to reduce the total worth of the hearers, but perhaps even to increase it. We call such lies "white lies", such as "You are really doing very well" when the liar perceives the hearer to be doing acceptably well but not as well as might be hoped. Perhaps a small lie is a lie only insofar as it tells only a partial truth, omitting something that the hearer might have used as an atenfel. None of these are intended by the liar to have much effect on how a large number of people control many perceptions. A Big Lie is.

From the liar's viewpoint, any lie is an action to bring one or more of the liar's controlled perceptions nearer their reference values. As the Analyst can see, the controlled perceptions for a small lie are likely to include perceptions of the target hearer's worth (general quality of control), though they do not necessarily do so. For a Big Lie, they never do, though the Big Lie is likely to have a content that would alter the World Models of the hearer in ways that would lead them to perceive that their worth had improved. In their imaginations, the target audience can use the Big Lie to see various perceptions brought nearer their reference levels. In the Big Lie, the Big Liar creates the specially designed Perceptual Reality in which those perceptions are controlled.

From the viewpoint of the people in the target audience of the Big Lie, political lies such as "*None of your problems are your fault. They are all caused by those people over there wearing red-and-blue shirts*", or "*Trust me, only I can fix it*" influence perceptions that the people in the target audience have not themselves been able to control, often because to control those problematic perceptions needs money they do not have.

If they believe the Big Lie and build the Perceptual Reality as designed by Leo the Big Liar, their ability or inability to control by their own actions no longer matters, because in imagination they can perceive that their personal control will no longer be necessary if collective control gives the Big Liar the

28. Quoted from a translation in Wikipedia: <https://en.wikipedia.org/wiki/Propaganda_in_Nazi_Germany>, retrieved 2016.01.24. Emphasis mine.

Authority to act in the matter. Maybe that could happen if the Big Liar wins an election. The problem will go away by the magic of the Big Liar, but only if the Liar acquires the Authority to use atenfels only he can use as he wants.

Lies big and small will not affect a listener if they tell a testable "untruth", though they can remain effective so long as the listener does not make the test. Even then, the Big Liar may follow Chico Marx in the movie "Duck Soup" in saying "who are you going to believe, me or your lying eyes?"[29]From the liar's viewpoint, untestable truths and partial truths are more reliable than completely novel fabrications, because the worst that can happen is that there is a perceptual conflict between an untestable truth previously believed and the liar's equally untestable "truth".

If the Big Lie is built on a "truth" the audience already believes, so much the better, because the untestable truth of the lie is associated thereby with pre-existing truth. In the 2016 US Presidential election, the repetition of slogans such as "crooked Hilary" and "lock her up" provided a pre-existing (non-)truth that provided a context sufficient for someone to believe a further lie that Clinton ran a child prostitution ring out of what purported to be a daycare centre in the basement of a pizza shop (that in reality did not even have a basement).

In the case of an "I can fix it" type of lie, the target audience members already perceive that nobody yet has "fixed it", so there is no direct conflict, provided that dependent perceptions do not themselves become conflicted by acceptance of the lie as truth. We can illustrate this with a little ancient history, which may or may not be historically accurate, but which makes the point even if it turns out to be fiction (which I believe it is not)[30].

IV.7.2 "The Others" and the Big Lie

We often talk as though we impute intentions to inanimate objects. We say things like "That stupid hammer" or "The weather is conspiring against me". Seldom are those imputed intentions directed to our benefit. That, however, is consistent with the idea that we are more likely to be conscious of the contexts of perceptions we are not controlling well than we are of those of perceptions under good control. As an engineering undergraduate I learned about "The Law of Aepulio", which concerned "the innate perversity of inanimate objects", much along the lines of the better known "Murphy's Law".

This imputation of intention to parts of the inanimate world is a pale reflection of the situation several thousand years ago, when most people were "animists". Earlier, according to Gimbutas (e.g., 1974, 2001) many parts of Nature were avatars or aspects of the Goddess or the God (not, I think, separate Gods and Goddesses, as some would have it, and as was the case later according to Gimbutas). The God and the Goddess were represented by avatars immanent in most natural objects. Even in later times, as in, say classical Greece of 500 BCE, trees had their dryads, pools their naiads, mountains their oreads, and so forth.

Appealing to the better nature of the avatars, and through them the God or Goddess, was a protocol as natural as disturbing some perception controlled by another person to get them to do something that helped you to control your own perceptions. This *a priori* very reasonable way of interpreting natural events, none of which at that time had a rational explanation, was widespread across the world.

According to Gimbutas (e.g., 1974, 2001) the avatars of the Goddess in Southeastern Europe (and probably elsewhere) were generally based underground and were associated with life, death, and regeneration. Gimbutas offered examples such as rivers which continually pour water that must be

29. https://quoteinvestigator.com/2018/07/31/believe-eyes/ Retrieved 2021/01/23.

30. Warning: The ancient history aspects of the next few paragraphs are highly speculative.

regenerated underground somewhere distant and whose flow follows a seasonal rhythm of flood and trickle, birds carrying hidden eggs that will hatch into new birds, spring regrowth from under the earth that becomes the summer's crops, and the like.

In contrast, the avatars of the God were skyward, such as the Rain God, the Sun God and the Storm God, all of whom brought life and death in equal measure to a land subject to heat and drought. Between the underground and the sky was the surface of the land and sea, the realm of human action. That realm, the realm of direct perception, was subject to the whims of the powers above and below that needed to be kept happy with their human playthings. The God was erratic and unpredictable, whereas the Goddess was usually more predictable in the rhythms of the parts of human experience for which she was responsible.

If the humans behaved appropriately in their dealings with the Sky and Earth deities, the whole system could be kept in balance. If they did not, one or other of the God and Goddess might be angry and visit disasters on the misbehaving humans in the form of failed harvests, earthquakes, droughts or great floods. Such "natural disasters" now can be related to many other observable phenomena by using what we call "the scientific method", but thousand of years ago this tool was not available, and it was very reasonable to assume (as we might say from a PCT viewpoint) that some behaviour by humanity had disturbed some perception controlled by the God or Goddess.

The God tended to be quick both in anger and in nurturing, whereas the Goddess, whom women particularly supported (and were supported by) brought life, death, and rebirth more gently and usually cyclically predictably. Women, at least in some cultures, tended to worship underground in secluded caves, whereas men held their rites on high places open to the Sun. In such societies, the God and the Goddess usually had different but equal powers, as did men and women. Then came climate change.

Through the millennium either side of 4000 BCE the monsoon bands gradually shifted as part of the solar cycles related to the Ice Ages. The effect was a great drying of the Sahara, Southern Arabia, and presumably Southern Mesopotamia over those centuries. In the Sahara and southern Arabia, and one may suppose also Southern Mesopotamia, both cultured crops and wild harvests would have begun to fail more frequently, leading to famines.

As with in many later societies, when large numbers of people lose the ability to control perceptions they once could control, someone has to be responsible. And that "someone" is definitely never "me". Usually that someone is arbitrarily chosen to be an identifiable group of "others", scapegoats identified popularly by Leo the lying demagogue using the Big Lie to augment his own worth, (his ability to control many perceptions well).

After about 4000 BCE in southern Mesopotamia the dangerous people who caused the famines would "obviously" have been adherents of the Goddess — women. Their failures of proper worship must have caused her to decide not to provide reliable crops. Women were therefore to be feared and kept under control so that they would at least not annoy the Goddess any further[31]. Women and the Goddess no longer shared equal powers with men and the God, because the women had dramatically failed in their duty to keep the Goddess happy.

A later Sumerian legend tells of Gods and demigods who created the deep Qanats and surface irrigation systems were built in antiquity to supply the water needed to keep people alive. Men or male demigods were the labourers who did the work of building these massive public works that undid what the Goddess had done by refusing to produce reliable crops. Men, supported by the God, were therefore

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31. The next few paragraphs are my personal speculations, and are not necessarily archeologically verifiable.

quite properly acting in opposition to the Goddess, with some success, provided women were kept from acting in support of the Goddess. Opposition between the sexes had largely replaced coordination and collaboration, both spiritual and mundane.

The perception of women as "them", the "others", the source of misfortune, would not have been hard for some demagogues to peddle as "truth", in the way that demagogues do today and have done throughout history using different scapegoats, from cats to Jews to foreigners. Even as late as early Christian times, women were identified as being either sacred like the Madonna or evil, the sacred state being unattainable by normal women.

In Greek and Roman religion, snake-haired Medusa who could turn a man to stone by a glance was the ultimate image of terror. Snakes, according to Gimbutas, had been an avatar of the Goddess because they regularly shed their skin to grow a new one, and in the northern part of the Fertile Crescent not affected by droughts, the Goddess and God, women and men, were still regarded as equal but different. By the time of the Greeks and Romans, however, that way of life had been suppressed by invasions from the now male-dominated south of what is now Iraq.

Medusa might well have been a representation of the Goddess, in the same way that a model of the crucified bearded European Jesus represents Christianity today despite the probable ethnic background of a historical Jesus two thousand years ago. A thousand years earlier, images of the snake-haired Goddess had been produced, not as symbols of evil, but to be venerated in the Minoan civilization of Crete, and by the art-loving Philistines. These "triune" societies, however, eventually were militarily overwhelmed by the God-only cultures from the South in a process that took thousands of years, reaching Baltic Europe only as late as 500 years ago.

In areas that did not suffer the drought effects of climate change, such as the Eastern Mediterranean, Etruria, and northern Mesopotamia, this shift in the status of women apparently did not occur until much later[32]. In those areas men and women seem to have still had parallel roles with more or less equal powers, as the Romans reported to be true of Britain before their takeover. Heritage in those regions tended to be matrilineal because a woman knows a child is hers, whereas a man never does unless the woman has been kept isolated, as a prisoner, in the manner of the Southern "God-only societies". Inherently evil women were always available as scapegoats for personal or regional difficulties of perceptual control — the permanent "other".

In 1930s Germany the financial collapse and impoverishment of the general public was largely due to the reparations and constraints imposed by the Allied Powers, who had been the victors of World War I. These powers could not be challenged directly, so the Nazis needed to choose another kind of alien "other" to blame for the problems that obviously could not have been the fault of the German people.

They chose "The Jews", and claimed that the loss of the war had been caused by an international Jewish conspiracy. Jews therefore were to be feared, mistrusted, and hated. Historically the "others" in Europe had often been Jews, as witness many pogroms in societies from England to Russia But Jews were not always the "others" to be scapegoated. In late 16th century England, the "others" that caused all the troubles were Catholics. In 16th Century Spain the "others" were non-Catholics. In the USA, the

32. Perhaps in the Mediterranean region only after the effective destruction of the Minoan culture in Crete around 1650 BCE following the volcanic explosion of the island now known as Santorini, or even the Roman defeat of Etruria over a thousand years later. In Northern Europe, the transition was probably not complete until the conversion to Christianity became final, around 1000 CE in Scandinavia and around 1500 CE in the Baltic region. This late transition may in part account for the relative parity between male and female politicians in Scandinavia.

feared and hated “others” have usually been recent immigrants of some nationality such as Irish or Italian or Chinese, or of the wrong religion, recently Muslim. And so it goes. There is always someone to blame.

The alien “other” may not even be human. In the early part of the Industrial Revolution, mechanization took over the jobs of such people as weavers, but the target of the Luddites was not the mill owners who bought and installed the machines, but the machines themselves[33]. They were the alien “other”, the unfamiliar and dangerous. Today, we expect machines to do jobs hitherto done by people, leaving many in relative poverty, but the machines themselves are not the targets. The targets are the people with the wealth to buy and use the machines.

The “truth” of the Big Lie reduces the error caused by disturbances to your controlled perception of your own self-image as being “good” and “able”, if the “truth” told you over and over again is that those responsible for your problems are not you yourself, but “them” the “other” group, however that “other” group is selected by Leo the lying demagogue. It is even easier if the truth fits with other “truths” that are already part of the World Models of many of the people targeted by Leo. Robots are the quintessential alien “other”, so we consider them next.

IV.7.3 Before the Truth gets out of Bed

The idea that lies propagate faster than truth is not new. It was discussed at least 300 years ago[34].

> *Metaphorical maxims about the speedy dissemination of lies and the much slower propagation of corrective truths have a very long history. The major literary figure Jonathan Swift wrote on this topic in “The Examiner” in 1710 although he did not mention shoes or boots. Boldface has been added to excerpts:*
>
> *Besides, as the vilest Writer has his Readers, so the greatest Liar has his Believers; and it often happens, that if a Lie be believ’d only for an Hour, it has done its Work, and there is no farther occasion for it.* ***Falsehood flies, and the Truth comes limping after it;*** *so that when Men come to be undeceiv’d, it is too late; the Jest is over, and the Tale has had its Effect…*

If “the truth shall set you free”, why do the World Model networks of perceptions believed by members of different groups to be true not converge rather than diverging, as they so often do? When we examine political campaigns and the growth of cults and sects throughout history, the “Swift” metaphor seems to do no more than make vivid a plain fact: a lie that has been tailored to fit with the World Model of some people will be accepted as truth by those people and propagated to their contacts more readily than will a truth that does not fit. Such a non-fitting truth applied to the world Model of the hearer is likely to disturb the hearer’s perceptions, and the controller’s actions are more likely to discount the new information than to change their existing World Model.

Either way, a new truth is likely to take longer than a compatible truth to be incorporated smoothly into an existing World Model. If the new truth does not disturb an existing controlled perception it is nevertheless likely to affect the network stabilities of the existing World Model. The supportive truth will be promulgated to like-believers and beyond much more quickly than will be a disturbing new truth, since the new truth takes time for resolution of the conflicts it is likely to induce in the perceptual control hierarchy of the hearer.

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33. https://en.wikipedia.org/wiki/Luddite. Retrieved 21.01.23

34. . https://quoteinvestigator.com/2014/07/13/truth/ (Retrieved 2019.04.30)

What does this entail for Leo the Liar? Leo must have prepared the soil in which his Big Lie will thrive, or it will be the incompatible novelty that does not propagate. Propaganda, which Hitler equated with lies, must propagate to be useful. Hitler used the “what I say three times is true” form of embedding the lie into the fabric of existing mutually supportive “truths” — perceptions of the World. But even Hitler did not rely on that method alone. He prepared the way with lies his audience would be already have been prepared to believe.

Even late in the first World War most members of the German public had apparently reliable sources continue to tell them of the might of the German land and air forces. They had defeated Russia and could deploy those troops on their Western Front, where they initially made rapid advances. So why had everything gone wrong for them so quickly?

Sabotage from within was the easiest answer, rather than being asked to believe that the almighty Wehrmacht was not enough to withstand the Allies who now included the Americans. The source of the sabotage would have to be some form of “Them”, some minority, the “not-us” part of society. The Big Lie about the identity of “Them” was irrelevant, so long as “They” were a numerical minority, and some of “Them” had been in an obvious position to influence events in 1918 and at the “sell-out” Peace Conference of 1919.

Accordingly, it was quite easy for the Nazis to propagate the Lie that the present (1920’s) financial and other troubles of the average German — perceptions the individual could have controlled only a few years earlier but now could not — had been caused by unpatriotic Jews who were continuing their destructive behaviour. That Big Lie could move fast through a large proportion of the public, even though many of them had previously been friendly with their Jewish neighbours.

A really Big Lie sown by Leo the Liar seldom has such fertile ground on which to take root and grow, but Leo can cultivate the ground by using small lies. Each of those early small lies will have a modicum of truth that will link it into the target audience’s World View. They will also contain some false and surprising new information, the payload of the lie. If they are well crafted these “payloads” will themselves form into homeostatic networks of mutually supporting perceived “facts” about the world in such a way that they begin to seem better supported than the more tentative “truths” to which their connector components were originally attached.

What was once perceived as true is now perceived to be false, and what was not perceived at all before Leo described it is now considered to be true by his followers, who we may call “Leonites”. At this point, the main Big Lie will have enough background “truths” to be seen as true. Anything that disagrees with the Perceptual Reality being built by Leo to suit himself, most particularly anything built by others as a result of careful investigation, is now perceived by his followers as “Fake News”. Into this fantasy Universe, Real Reality is unlikely to intrude, since few, if any, of the Leonites will access the relevant events by way of their own senses. The World Leo describes is the World Leonites perceive, no matter how fantastical.

One of the easiest places for the Big Lie to link into the pre-existing perceptual worlds of the future Leonites is the fear or dislike of the unfamiliar alien who behaves in unpredictable ways. A farmer may see a “city-slicker” as such an alien, bent on cheating the honest farmer out of money he might earn from his toil, but how much more “Not Us” would be a stranger from a foreign land, speaking bad English or some unintelligible language? Leo can easily find fertile ground for a perception that some such unfamiliar alien is the cause of the problems, not only of the farmer, but also of workers who have lost their jobs and can no longer control their perceptions of their “worth”.

IV.7.4 Truth Control for Acquiring Power

If most truth is an artifact that can be shaped into plausibility by a skilled sculptor (Section III.6.9), the control of truth is key to the acquisition of power. The Big Lie shapes more than a single aspect of the truth, since the Lie must fit with a pre-existing World Model held by most of his audience. That World Model is likely to have been shaped by other Lies Leo has told. From Leo's point of view, the single Big Lie is no more than an atenfel for controlling some other perception. One possibility — probably a frequent one — is that Leo controls a perception of his power or "worth" with a reference level for it to be greater than it is.

A successful Lie alters the World Model of those who believe it. As we discussed above, the World Model produced by earlier lies has different places into which a new Big Lie can fit, places that were not available to the initial Lie, especially if some of those places were sculpted by the first Lie. The lies, big and little, together form an ecology that is stable if Leo is successful, but that ecology interacts little, if any, with the ecology of beliefs held by others who rely more on the more intricate networks of interactions among direct observations and internal ("ecological") consistencies. When the sculptor working on his block of marble has carved out one eye, the other eye cannot be placed randomly on (or in) the marble, if the sculptor wishes the viewers of his finished masterpiece to perceive the likeness of a human.

The easy Big Lie of the dangerous "other" does not fit well with World Models of members of the target audience who believe their physical environment is safe and unthreatened. Leo must create more Big Lies so that the targets come first to perceive their environment to be unsafe, and then to be unsafe because of these "others". Leo can fit the "dangerous other" Big Lie onto news of real terrorist activities, despite the extremely low probability of any particular person being directly affected by a terrorist act. As we saw in "The Commons of Ideas" (Section III.10.4), so builds a homeostatic network of controlled perceptions that sustain themselves in the contextual "soup" (Section II.2.1) of many other Lies that float in the Commons of Ideas.

Leo intends the Big Lie of "those others are dangerous" to provide him with collectively controlled authority to impose laws and regulations that restrict the abilities of the target audience members and others who have not accepted the "new truth" to control their own perceptions, while enhancing (usually) Leo's power because his next Big Lie ("I can keep you safe") becomes another part of this evolving sculpture of the World Model of the targets. A person who now says "He doesn't need to keep you safe, because you already are safe" is now perceived to be a dangerous liar, because "you already are safe" is no longer a property of the World Model of the target audience.

The truth has been controlled, just as the shape of the block of marble has been controlled by the sculptor into taking the outward shape of a live human. Controlling truth is a way of achieving collectively controlled authority without formal organization. It is never obvious in such a situation which version of truth conforms to facts that might be found by direct observation of the environment. Direct observation of the relevant environment may not be possible, and even if some such observation were feasible in principle, in practice it probably is not. Few of us have the opportunity to test any of the truths proposed by Leo the liar, except by testing their internal consistency and their consistency with what we already believe to be truths.

In this, Leo is indistinguishable from Timothy the Truth-teller, whose truths always correspond with Timothy's own World Model, though they may not correspond exactly to the Real Reality of which we can never be sure. Both Leo and Timothy may acquire collectively controlled authority from people who believe their versions of truth. Which prevails has little to do with the unknowable actual truth, until the actions based on Leo's version fail to have the effects on each individual that Leo promised.

Timothy's actions may also fail to have the promised effects, though they are more likely than Leo's to do for the hearers what Timothy tells them to expect. For the target audience, however, the promises refer to a future as yet unknown and unknowable. Either Leo or Timothy, but not both, may be delegated with the power of the collective. Leo is more likely to promise a low-rattling outcome, since he has more freedom than Timothy to promise that he can "fix the problems", whatever those problems may be.

The rationale for collectively controlled authority, however, is more obvious in the structures of formal organizations, to which we turn in the Chapter IV.4. We discuss the delegation of Collective power to an Authority in Chapter x42, and revolution against the Authority in Chapter IV.4.

IV.7.5 The Madness of Crowds and the March of Folly

The title of this Section is based on the titles of two books with similar themes, Mackay (1852) and Tuchman (1984). The theme is encapsulated in the "Madness of Crowds" half of Mackay's title: "Extraordinary Popular Delusions and the Madness of Crowds". Mackay's title refers to a tendency for people to follow the crowd, in the belief that if the crowd is going one way, the people in it go that way for some personal benefit. Mackay was not directly referencing the Big Lie, which is easy for an autocrat to propagate through the many communication channels available today, but to a counterfactual belief autonomously grown and popularly collectively controlled.

On the surface, Tuchman deals with a different problem, the tendency for national leaders to escalate conflicts to social breaking points thus collectively controlling some virtual variable we might call "probability of mutual destruction". This turns out to be a version of Mackay's problem, the delusions not necessarily being in the minds of the leaders, but perhaps in the minds of their followers, having been introduced by propaganda intended to enhance the likelihood that their followers would perceive the "other" to be a threat. Who the "other" might be is often the choice of the leader. Hitler, for example, chose "the Jews" as a threat to be exterminated.

As we described in Section III.1.1, even simple conflicts can escalate until at least one of the contestants reaches a resource limit. Mackay and Tuchman were not dealing with simple conflicts, however. Mackay was dealing with situations in which positive feedback loops develop within a community to influence the perceived trading value of some entity ("value" as in Chapter III.9, "The Trade Motif") was subject to a positive feedback loop across a network of people who trusted each other, and for which the use as an atenex of the entity (its "intrinsic value") was near zero.

One of Mackay's examples was the Dutch "Tulip Mania" of 1636-7 during which a single tulip bulb is said to have reached a trading value equal to that of five ordinary houses. According to Wikipedia ("Tulip Mania" accessed 2022.10.06), few, if any, actual bulbs changed hands. The Mania was in the prices of bulb futures, and occurred out of season for tulip flowering. Mackay has several other examples of such escalations in trading value — how much someone perceives their own worth to be changed by its acquisition — followed by dramatic collapses. Today's near equivalent would be a stock market bubble, in which the stock in a company or sector, which is determined entirely by what a buyer is willing to pay for a share, soars in price only to collapse. When it happens to a class of stocks, as often happens, it is usually called a bubble, as in "a tech bubble".

Tulip prices and shares in the stock market share one property, that their trading prices are largely disconnected from the intrinsic "worth" (Chapter III.9) of the property. The same is true, thought perhaps not to the same extent, of house prices. Any of these things, and much else, such as an old master painting, are priced at whatever people will pay for them, and that depends to a large extent on how much

someone else is willing to pay, or has paid for a similar item. The lowest price at which the owner is willing to sell puts a lower bound on the price.

"The Madness of Crowds" in Mackay's is a large-scale stochastic example of the simple conflict between controllers of the same environmental variable when the controllers have integrating output functions demonstrated by McClelland (1993) to the Control Systems Group conference, in which two perceptual controllers try to move a single environmental variable to different reference values. An effect similar to the "Madness of Crowds" effect occurs in auctions when two or more bidders bid on the same item, escalating their bids until only one bidder is willing to pay more than the amount the others would have paid.

The value (Section III.9.4) of the item is to the bidders unrelated to the value it would have to them if it could have been picked up off the street. Its value might depend for some mutually antagonistic pair of bidders on their ability to prevent each other from winning ownership of the item, rather than on how its acquisition would add to their own perceived worth, as in the Trade Motif.

On the surface, Tuchman's (1984) "March of Folly" has little to relate it to Mackay's Madness of Crowds. "March of Folly" deals with how small differences between the leaders of great nations can escalate coalitions of nations into great wars in which the leaders seldom are killed, but many of their followers are. The seduction of a leader's wife, Helen of Sparta, by the ambassador of a foreign country, Troy, would seem from this vantage of time to be in itself hardly worth the effort of creating a coalition among neighbouring countries and besieging for ten years the fortress of the ambassador's country, with great loss of life.

Or so we would think from a perspective of some three thousand years after the Trojan War (if it was fought according to the story in Homer's Iliad). But from the viewpoint of the time (or at least of Homer's time half a millennium later) the personal insult to the king whose wife was Helen of Troy was quite enough to engage such a grand coalition to engage in a war that killed a good proportion of men on both sides.

As Pinker in his "Better Angels of our Nature" book (2011) points out, such lethal violence was much more normal then than now, when most people would think its inception quite unacceptable. Recourse to the courts would, in most countries, be considered far preferable, with the conflict adjudicated after the circumstances had been presented to a judge (and perhaps a jury). Today, Menelaus, the cuckolded Spartan King might complain to some court in Troy, or failing satisfaction there, to an international court of arbitration or some such. Or he might send an embassy to Troy to persuade Helen to return home. But unless there were other reasons for war, as there were in the case of the assassination of the heir apparent to the Austrian Emperor, no Mycenaean coalition could have formed[35].

Tuchman, however, describes how even today such conflicts are likely to escalate lethally. World War I is a relatively recent example, in which the murder of the Austrian heir to the throne by a lone "Serbian patriot" when Serbia was a part of the Austro-Hungarian Empire, led by a sequence of alliances to many millions of deaths of soldiers of countries that had no interest at all in the originating incident. The March of Folly is the "march" of leaders of one country after another to come to the aid of a country who had come to the aid of … , and to commit their soldiers to fight those of a country with which their country might easily have been partners — as in the case of the historically intricately connected Britain and

35. Troy held a commanding position that could control access by the Mycenaeans, not particularly Spartans, to the Bosporus and thus to the riches of the Black Sea coasts. All that might have been required to allow a coalition against Troy (generally allied to the Hittites of Anatolia) to form was a pretext. If so, then the "Trojan War" — if a single such war ever happened — was a war for freedom of passage past the Gallipoli peninsula to the Black Sea, not a war over Helen at all.

Germany who became enemies because of this war. They did not fight each other because they were enemies, but became enemies because their soldiers fought each other under the direction of their leaders.

Is there a PCT explanation of this kind of escalating conflict over essentially nothing? I think there is, and it is largely based in the rattling induced by the initial shocking event — shocking in both its everyday meaning and in the more technical meaning of initiating a shock wave of effects that disturb perceptions faster than the corresponding controllers can compensate the sudden growth of the perceptual errors, or than the effects can be redistributed through whatever tensegrity structures are involved. Such shock waves must rattle perceptual structures in any who detect them, regardless of whether the effects can be subdued by dispersal, which cannot happen faster than the rates of perceptual control, through the tensegrity structure(s) involved. The rattling is likely to increase the rate of reorganization, but in the process there is a period of local disorganization, perhaps manifest as a distribution of rattling at lower levels through the tensegrity structure.

We have here a description of the current (as of this writing in 2022) escalating levels of gun violence as a result of the rattling caused by a variety of shocks, such as the sudden disruption of supply chains by lockdowns used in China as a means for control of varieties of Covid-19, and in 2022 by the sudden reduction of the supply of Ukrainian wheat to food-impoverished Africa and elsewhere following the shock of the Russian invasion of Ukraine. These shocks rattle many perceptions in government leaders, and because of their actions, in their populaces. The result is immediately seen as violence, but eventually is likely to result in political organizational structures more resilient against similar shocks, and a perception by the majority of the populace that things were worse, but are getting better.

IV.7.6 Through Violence to a Calmer Place

As noted above, Steven Pinker, in his book "The better Angels of Our Nature" (Pinker, 2011), shows that over time since prehistory, the level of violence to which any of us might expect to be subjected has been dropping century by century, whether we talk about violence within the family or war between nations or on any scale between. Pinker offers a variety of mechanisms, psychological and historical, for this somewhat erratic trend.

In this Section we examine the trend to reduced violence from a very different, PCT, point of view, using what we have learned about rattling. Our view supplements rather than contradicts Pinker's, since we are concerned with the effects on organizations of rattling, whereas Pinker, apparently unaware of PCT, deals with mechanism. The calming reorganizational effects of rattling require mechanisms to have their effects, but those mechanisms can be as varied as the languages used in communication using any kind of protocol.

Introducing his review of two books in the August 28 2021 edition of the Globe and Mail newspaper, Nathan Whitlock says

> *What connects these debut works is frustration with self-imposed limitations and a desire to find a wilder and more authentic way of living (even if that search brings with it a lot of pain). [The reviewer] spoke to both authors about the limits of the intellect and the* ***calming effect of violence*** *— real and imagined.* [Emphasis in the original]

As the quote from the book review suggests, violence is sometimes used as a route to a calmer place by individuals. The violence increases the rattling in everyone affected, because whatever perceptions they might be controlling are likely to be disturbed in unpredictable ways, increasing the uncertainty of

the velocity of changes in the perceptual errors. In the case of the book authors, the violence is limited to well defined circumstances, and not directed toward unsuspecting or unwilling victims.

At this point we take another look at rattling itself, and consider some points either passed over or de-emphasized when we have discussed it in earlier passages.

A bully controls for perceiving his or her own dominance over other individuals. As a component controlled perception, the bully controls for perceiving the victim to be submissive. If the bully perceives a potential victim to be willing and able to fight back, that potential victim is unlikely to be the target of the bully. The preferred victim is one who tries to appeal to the bully's "better nature", to the bully's self-image, which includes that he can control a perception of others as submitting to him. A fighter in the ring also controls for perceiving the opponent as submitting, but unlike the bully also perceives the opponent as an equally willing participant, who may win the fight.

A bully does not control for disturbing perceptions controlled by a willing and equally strong other, but for disturbing perceptions controlled by one who is then unable to control the perceptions disturbed by the bully. The bully's actions may be physical assaults on a victim's body, or may be directed at higher-level perceptions such as the victim's perception of their own competence (as by a parent telling a child they will never be good for anything, or an office manager who always finds something to criticize about work performed by an underling[36]). Girls seldom resort to physical bullying but form gangs that collectively bully other girls by excluding them from intra-gang conversation.

Over the internet, physical violence is impossible, but verbal-visual assaults on the self-self-image of a victim are easy, and are possible to execute without fear of reprisal by the chosen victim. In some cases, such as that of Amanda Todd[37], these assaults on either self-image may lead to the death of the victim, as surely as do physical assaults on the victim. Indeed, the bully who harassed her was convicted of sexual extortion (extortion is a behavioural action that is at least in part for control of a perception of domination over the victim) and was given a jail sentence of 13 years imprisonment.

A bully may feel better (lower error in an component of his or her other-self-image perception) after beating up a weaker person physically or verbally, though the weaker person has been severely rattled, and will continue to be because of the inability to control some perceptions when the bully is nearby. The victim might well reorganize to control for displaying submission to the bully. The bully has acted to control some perception, possibly of the self-worth component of self-self-image perception, which is likely to be in error, with few other means of increasing it. Quite possibly, the bully was severely criticized at home for failure to excel in something that a parent perceives as controllable by the actions of the child. The bully is less rattled than before the assault, the victim more rattled.

Whether total rattling of the interacting group, the organization, that contains both bully and victim is increased or decreased after the event depends on its current structure of collectively controlled Roles. Some organizations collectively control for their members to demonstrate brute strength. In these, the bully's other-self-image perception will probably be enhanced, its error diminished by a successful assault on a weaker person. The bully is strong, and therefore good, the victim weak, and therefore bad. Such an organization may well be less rattled because of the general perception that the bully's strength is closer to what their reference perception for it may be than it had been perceived to be before the successful assault. The assault reduces the total rattling in this kind of organization.

36. Many readers will have encountered an editor who controls for being asked to approve all reports intended for external consumption, who would always find errors requiring rewrites, and many of us will have taken to ensuring that all reports submitted would contain minor deliberate errors for that editor to complain about.

37. For Amanda Todd's story, see Wikipeda "Amanda Todd" (retrieved 2022.10.15).

Another kind of organization would have its total rattling increased by the bully's actions in hurting — increasing the rattling of — the weaker person unexpectedly. When talking of rattling, we always must remain aware of the importance of unexpectedness. During periods of violence, the violence itself, after its onset, is not unexpected, but at a finer time-scale the individual acts of violence may be. For example, in the current (2022) USA, mass shootings are so frequent as more often than not to be ignored on the main media means of information dissemination.

That a mass shooting occurred in their own country would be a shock that rattles a person in much of the world, but would not be in the USA. On the other hand, that a mass shooting occurred in their local school would suddenly disturb perceptions controlled by many people, rattling them, especially if someone close to them had been killed. After every such occurrence, many people try to change some aspect of the political organization in which they live, but changes that might reduce the frequency of such events (frequency not being a perception easily susceptible to rattling) are usually strongly opposed by enough people that their collective power exceeds that of the collective formed of people controlling for change — usually several smaller collectives that control for a variety of different changes.

IV.7.7 Rattling and Revolution

Revolutionaries often use a claim of a need for political change as a justification for their actions, whether crudely in the form "The only way to produce a just society is to break it and start again from scratch", or in the intellectual form of documents such as the American Declaration of Independence, which had a similar effect on the governmental organizations of the rebelling thirteen colonies individually and collectively.

If few people are seriously rattled by the pre-existing situation, which is to say that in it nothing happens that is really surprising, the organization will not change. In the American case, the British Parliament was making laws that were imposed on the American people in the separate colonies without notice (or consultation), some of them with unexpected and immediate effect, such as changes in taxes on different trade items. "No taxation without representation" was a slogan of the American revolutionaries, probably shared by many of those who were more severely rattled by the immediate effects of the revolution than by unexpected changes in tax laws.

What would have been different had the same laws been enacted if the American colonies had representatives in the British Parliament who had been outvoted? The difference is that the changes would not have been sprung on the colonists as surprises. The changes might well have increased errors in perceptions the colonists controlled, leading to action, but those actions would largely have been within the organizational framework that existed, rather than leading as they did to a superficial reconfiguration of the organization structure of government of British North America.

A major revolution like that of the thirteen states (the people of French-speaking Canada, now Quebec, refused to join as a fourteenth) requires collective action by rattled people who agree on actions that would have the cumulative effect of reorganization that would reduce their rattling as compared to their experience with the current organization. One way of doing this is to separate from the rattling source, and reorganize so that on average the individuals of whom the organization is composed experience fewer and lesser sudden unexpected changes to their perceptual errors.

To measure the rattling contribution of an individual to that of the whole group, in principle we should need to know both the individual's total rattling, and beyond that, how severely the direct- and side-effects of that person's actions rattle other individuals in the organization. The organization's rattling value will change as the individual reorganizes to fit in with the group. That is the measure that we expect to trend toward lower rather than higher values, even if sometimes it goes the other way for a while, and

even if the group trend results in increasing rattling of a few individuals. In a useful saying sometime applied to this kind of situation: “You can’t make an omelet without breaking some eggs”. Raw eggs have a well defined structure that is very different from that of the eggs cooked into an omelet, but the new structure is nearer to the reference value for its perception by the hungry person than is the perception of the eggs as laid by the hen.

For the group organization and reorganization, an individual’s single rattling measure is unimportant in itself. What matters is the rattling of the group as a whole. A disruptive individual’s actions may increase the rattling measures of many other individuals, noticeably increasing the total group rattling. Since the highly rattled individual has error variables that vary more widely than most, so will the energy the individual uses to counter disturbances be distributed to the environment in the form of side-effects that are stronger, wider-ranging, and less likely than average to be beneficial to those affected. These side-effect contributions to the rattling of other individuals may be reduced by “quarantining” the individual — reducing the strength and frequency of his or her interactions with other individual members of the organization. Usually the form of quarantine has historically been prison, but more recently it may be achieved by restricting the individual’s access as a publisher to the internet.

Rattling reduction is easily achieved if the rattled organization can be separated from the influences of the source of rattling, as is done by these forms of quarantine. Organizational rattling can also be reduced by collecting the rattled entities into subgroups whose intercommunications and influences are stronger than those of the larger organization. This appears to be what happened that eventually led to the events at the US Capitol building on January 6, 2021, when a large mob centred around two small groups called “The Proud Boys” and “The Oath Keepers” invaded the building, nominally intent on preventing the peaceful transfer of the Presidential Role (and power) from Donald Trump to Joe Biden after the election of November 2020.

I say “nominally” because I do not believe that was more than a surface choice of a justification for a strong transfer of rattling from a highly rattled group to the larger structure of the political organization of the USA. Had they succeeded in preventing the transfer of Role from Trump to Biden, they would thereby have altered the “democratic” structure of the United States, with a subsequent settling of the politics of the nation into a substantially new form (quite probably a dictatorial autocracy). Many political “pundits” have been warning of this possibility, so the introduction of rattling as a measure may seem to contribute little. Where it does contribute is to the organizations of the leaders of the Proud Boys, and to a lesser extent, the Oath Keepers.

Recall the discussion of the “Magic Number Seven” (Section II.8.8). There, we followed Kauffman’s analysis of interactions in a toy universe, to suggest that there really is a “Magic Number”, but it is a number relating to the independent agents who form a close-knit structure within which the interactions are closer than are the interactions of individual agents with others outside the group. Here, we will treat the “close-knit structure” as the inner leadership of any functional group, whether it be the “Inner Cabinet” of a democratically elected government, of a large business concern, or an autocratic ruler of a country. The size of the inner leadership group, whatever its formal structure, seldom if ever exceeds half a dozen independent voices, which is the size that a probably unwarranted extrapolation from Kauffman’s finding suggests might be the most efficient and effective.

If this application of the “Magic Number” idea is valid, one might expect that after serious rattling, the restructuring of informal organizations might tend to be done by leadership groups of this size rather than according to the whims of dominant individuals. The rattling itself might be increased by the actions of individuals, if those actions sufficiently disturb perceptions controlled by numbers of people in the population of the organization — possibly even as much as an entire nation or more. As of mid-2022, the invasion of the Ukraine by the Russian followers of Vladimir Putin seems to involve rattling of that

magnitude and of such a large number of people around the world. Personally, I wonder into what kind of configuration the community of nations will settle after the actual war has ended.

Returning to the “Insurrection” that culminated on January 6, 2021, those who participated in the attack were probably in the long tail of the reconfiguration that led to the formation of the political parties that provide members for the US law-making body, the bicameral Congress plus the sitting President. The laws passed by those law-makers constrain the actions of all the people, under the rubric “Nobody is above the law”. However, every law passed by them will inhibit some from controlling some of their perceptions, and will enhance the uncertainties of the velocities of their perceptual error values, the very measure of how much they are rattled internally.

As we have pointed out, as an uncertainty measure, the measure of rattling is additive, so the rattling total of the individuals in a group contribute to the total rattling of the group. The group itself will tend to reorganize so that is is less rattled internally, and one way this can happen is by forming subgroups of individuals who are rattled in informationally related ways: “Birds of a feather flock together”. Together as an cohesive group such as the “Proud Boys” they are less rattled than as individually powerless persons they would have been. Their power as participants in collective control actions has a greater influence on whatever perception they are controlling than would their uncoordinated individual actions (see “Stochastic Collective Control”, Chapter III.1).

In using language, as I must if I am to communicate through words in a book, I may write as though all the above is thought out by the individuals to determine their actions. But I do not intend for you to take this meaning from my words. Indeed, I would expect the “flocking together” to be more like the “winter-leaf” phenomenon in which leaves flying in the breeze settle and stay if they land in a calmer (less rattling) environment, as much or more non-conscious than thought-out. It is just more comfortable to be less rattled. To paraphrase Tennyson (The Charge of the Light Brigade) “Theirs not to reason why/ Theirs but to do or die.” The “or” replaces Tennyson’s “and” because the rattled, mostly rural, people participating in the insurrection were being promised life, when they might have perceived their current circumstances as rural farmers being exploited by large city-based “capitalist” agri-businesses, as leading to early death.

Many of these highly rattled people in the long tail of the rattling distribution may well have perceived the laws passed over the years by Congress as intended to benefit the already wealthy owners of businesses. Whether this perception is correct, in that the members who wrote and who voted for these laws had the intention of biasing the laws against the rural farmers and families, it may well have been a common perception, leading to the likelihood that a collective controller (a GVC) might have developed that would act, given suitable atenfels to allow control of the common perception, with a collective reference value and hence a virtual error value that could be reduced only by action on the perceived political environment that allowed the agri-businesses so much power to constrain the operations of the farmers..

So far as I am aware, when Kauffman simulated the toy universe of cells that interacted by altering their content depending on the ones and zeros in their close neighbourhood, and found that modules of size around six were neither too rigid nor chaotic, he did not consider these modules as actors on an external environment, or even on each other. The cells were passive observers of their neighbours. But in our “social universe”, the “cells” are more than observers. They are actors, and the effects of their actions on their neighbours, like the actions of the “smarticles” of Chvykov et al. (2021) rattle each other with effects on the overall organization of the group. Some of these effects are deliberate, as would be the case if a leader asked a group member to do something, some are not, and are side-effects of other actions by group members and others.

IV.7.8 Social Maladies: Network Chaos

Just as in the individual organism an illness drives some of the networks of effects outside their homeostatic bounds, from which the individual might die, or might recover after a fever to a state either like the pre-illness state or to another quite different semi-stable state with rearranged homeostatic loops and networks, so in the social case the settling after a large rattling disturbance might be to a state like before the disturbance, to some quite different stable state, or the network might fragment. We might suggest that war is such a large-scale disturbance. It is a cause of rattling to most of the population of the warring nations and even of neutral affected by the war.

Few nations return to their previous state after engaging in a serious war. Some fragment and disappear as nations, some reach a quite different stable state, and there might be some few that resettle more or less where they were before the war. For example, after World War I, the great European Prussian and Austro-Hungarian Empires were dissolved into sets of small nations, their Emperors were reduced to the status of private citizens. The Tsarist Russian Empire became a "Union of Soviet Socialist Republics" and the Tsar, whose family had ruled Russia autocratically for centuries, was deposed and then murdered along with his entire family. This happened even though Russia had been part of the winning coalition during the war.

Consider how strongly the warring nations had individually been rattled, and how different as nations their groupings were before and after the War. Before the war, Germany and England considered themselves as sister nations, at least at the upper echelons of society. The Royal Family was essentially German, both in its heritage from the Hanoverian prince who had been imported to be King George I, and in its multiple intermarriages between English royal youth and various German princes and princesses, including the well loved and respected Prince Albert of Saxe-Coburg-Gotha, the instigator of many industrial reforms in England, not least among them the Great Exhibition of 1851 in the remarkable "Crystal Palace" whose name still is attached to a London subway station. Kaiser Wilhelm, Emperor of Germany, was a cousin of both King George V of England and of Tsar Nicholas II of Russia.

The gist of all this is that most homeostatic networks based on control of individual perceptions are not as stable as the name might seem to imply. The same is true if the control processes are collective, in any form of collective control. If we consider all the controlled perceptions involved in any part of the network that includes at least one cycle that is a homeostatic loop, they use energy at a rate that is measurable in principle, if not necessarily in practice. This energy is deployed to counter the energy introduced by disturbances that would increase the entropy of the set of controlled environmental variables (and the total mutual uncertainty between reference values and CEV values). The energy used to counter the disturbances is part of a through energy flow, and the rate of this flow — the power used — determines how low the control can sustain the entropy of all the CEVs and their structural relationships.

If a high-energy disturbance impinges on one or more of the environmental variables in the loop, or if something influences the negative loop gain of the important loops in the part of the homeostatic network in question, it might overwhelm the energy available to carry off the resulting entropy increase of the various CEVs in the loop or network, in effect raising their "temperature". This is used to good effect in a process called "annealing" that is used to allow alloys or simple compounds to reach a well-mixed state. The bulk material is heated and then slowly cooled, allowing it to settle into a low-energy configuration. Some processes in artificial neural network learning uses "simulated annealing" as a way of keeping the network from stabilizing an inefficient configuration when a more efficient one is available.

Although annealing may be a useful process in some cases, it is unlikely to be very beneficial to the organisms that use McClelland's stabilities of control as atenfels in their own perceptual controlling. The high-energy disturbance may not destroy any specific homeostatic loop, but it will leave the variables in the loop in an uncontrolled or barely controlled state for a while. During this period of instability, controlling using well reorganized techniques that were built to use stabilities of social homeostatic loops will probably not work.

What constitutes a "high-energy disturbance" in this context? Think back to Chapter 12. There we talked about the latent heat of homeostasis as a direct analogue of the latent heat of freezing or boiling of a liquid. If the semi-stable structure of a homeostatic network is imagined as its solid state, a "high energy disturbance" is one that is capable of disrupting at least one homeostatic loop in a homeostatic network, making it difficult or impossible for any of the variables in the loop to be controlled unless they participate in less affected homeostatic loops.

The same thing happens to a homeostatic loop if some controller in the loop ceases to control a variable that is a catalyst in the loop, as are all of McClelland's "maintenance" controlled stabilities. Many of these stabilities are collectively controlled conventions not written into law. A political leader may quite legally decide not to follow these conventions. In doing so, the stabilities that are affected by the leader's actions cease to exist, as do all the loops that use them as catalysts. The destruction of these loops may make it easier for the non-conventional leader to control his own perceptions, by eliminating side-effect disturbances from controlling by other people, but it has potential "avalanche" effects on the critically evolved network. It could be a quite different form of the "Bomb in the Hierarchy" (Section 6.4).

The Bomb breaks no control loops, but it represents the change of sign of one loop, a change that might propagate up and down the hierarchy to an undetermined extent. Here, we are talking about the slackening or breaking of a tensegrity "wire" that ordinarily "pulls" a CEV to a value that reduces the error in the controlled perception of that CEV. Breaking a tensegrity wire may simply reduce the elastic energy storage capability of a physical tensegrity structure[38], or it could collapse a small or large portion of the entire structure, with the release of the stored energy. In the next Chapter we will consider some of the consequences in the form of small and large revolutions.

Stochastic Collective control can also induce instability, as in the Stock Market. The Stock Market offers a familiar example of the actions of Giant Virtual Controllers — two for each stock, in a kind of trading relation. The price of a stock depends on control by many people of their perception of the relative worth to them of owning the stock compared to that of owning the money with which they would buy it or at which they would sell it. The bid price is the reference level of the Giant Virtual Controller

38. . The You-Tube video of a bouncing tensegrity ball, which continues to bounce though with decreasing resilience as one wire after another is cut, illustrates this point quite well <https://www.youtube.com/watch?v=Y-Ny3BfhVdw&list=PL4IGA3iO2R63bePc6GfZ0T0F1AuSviaYc> retrieved 2019.01.20.

that consists of those who might buy it, and the ask price is the reference level of the GVC of those who own it. The two Giant Virtual Controllers are in conflict, as in Figure II.12.6, and the price at which the stock actually is bought and sold is a CCEV, both of the conflicted collective control by the two individual "buyers" and "sellers" Giant Virtual Controllers, and of the single Giant Virtual Controller that consists of those two conflicted Giant Virtual Controllers.

One may ask why, if stock prices are so well controlled, they fluctuate so much, in what seems to be a fractal fashion (their proportionate price changes are the same at all time scales). The answer is partly in the fact that the perception of the value of the stock depends on how its price has been changing, as well as on infrequently or slowly changing properties of the company itself, and partly in the fact that most of the members of the Giant Controllers are controlling for making money, and there are many different stock available for buying or selling. Trading a different stock might better support control of the "money" perception.

The first situation is similar to the "Bomb in the Hierarchy" (Chapter 5.1), in that if the stock price is rising, many people increase their perception of its value and are willing to buy it instead of something else, as well as being willing to pay more than they otherwise might. The combination of effects is likely to create a positive feedback component in the environmental feedback function, whereas the relatively stable characteristics of the company serve as intangible atenfels in its negative feedback components. The same positive feedback is responsible for the collapse of the price of a stock following a transition from rising to falling stock price. The collective side-effect of each person's decision to buy or sell a stock changes the price upward or downward, influencing another individual to buy or sell, moving the stock price further in the same direction.

Stock value analysts use many characteristics to estimate what a company's stock is worth, whereas "technical" analysts base their estimations on the dynamics of the price changes. How the price actually changes depends on the interactions of these factors with the perceptual control systems of the participants, which feed back into the actual stock price.

The Stock Market system is inherently nonlinear, and complex nonlinear systems are highly likely to show chaotic behaviour. Most of the time, positive feedback effects are quick but are swamped by the longer-term negative feedback effects, but the "avalanche" effect sometimes overwhelms the negative feedback for long enough to create a bubble or a crash (or both in sequence) of any size from what is called a "correction" to a "catastrophe". The nonlinearity of a homeostatic network subject to large disturbances is similarly likely to lead to chaotic behaviour, perhaps to the extent of being manifest as a revolution that utterly changes the political system of a nation.

IV.7.9 Democracy, Autocracy, and the Destruction of Ebla

If the development of ever increasing levels of technological autocatalysis is the underlying reason for the increasing complexity of a society or polis, why might there be a social collapse? What might link the ancient fall of Ebla[39], the end of the Roman or Mongol or British Empire, the disappearance of the

39. The story used here comes almost entirely from Pettinato (1991), the original translator of a portion of a trove of 17,000 tablets that were preserved in the city archives by a fire that destroyed the Government Centre. The archives do not include any information as to whether the ultimate destruction was caused by internal revolution or by enemy invasion. The destruction part of the story is entirely my own imagining, based on the implications of PCT that have been discussed throughout the book, and parallels the decline and fall of other major empires in which power and money corrupted the political

complex Mayan society, the several revolutions against Imperial power over the millennia of Chinese history, and so forth? Why might a whole region or nation that was rich be reduced to poverty, with the citizens foraging among the ruins of past grandeur as in mediaeval Greece and Rome? Can we see the seeds of such collapses anywhere at present? I use the story of Ebla as a surrogate for them all.

Ebla was a major centre of trade over 4000 years ago. Its story may illustrate one of the themes of this Chapter, the pattern of the gathering of power from everyday people to the rich, followed by the violent destruction of the polity. This was about a thousand years after the first cities developed in Mesopotamia, such as Ur and Uruk. Climate change had dried out that southern portion of Mesopotamia, so agriculture depended on irrigation from the two great rivers, Tigris and Euphrates, but Ebla, in what is now northwestern Syria near Turkey and Lebanon, was in the so-called "Fertile Crescent".

From what was discussed in the earlier parts of this book, one might anticipate that the effect of this drying might lead to centralization of power and conflicts over food resources, and this was exactly what happened. But something else may also have happened. Apparently[40] in earlier times, and into much later times further north, the stewardship of the Earth was divided three ways, among a Sky God responsible for things above the Earth's surface, an Earth-Mother Goddess responsible for cyclic events such as the seasons and the crops and anything that sprung from below the Earth's surface, and humanity, responsible for what happened on the surface of the Earth.

The Sky God, worshipped mainly by men, and the Goddess, worshipped mainly by women, appeared in a large variety of avatars, that are sometimes seen as representing an animist kind of religion. When the long drying occurred and crops failed, the Goddess responsible for regeneration of the crops had failed in her duties and was imagined to have become an enemy. The work of the Goddess in supplying fertility was taken over by the work of humans, specifically men, who dug irrigation canals and were talked about as demi-gods in the Sumerian epics. By extension, the women who worshipped her were potentially treasonous, and had to be suppressed. In the north, this did not happen, and in Ebla and other similar places, men and women continued to have complementary powers and equal levels of respect until much later in history.

Over the period of 125 years covered by the 17,000 City archives preserved by a final fire, the form of government in Ebla changed, not formally, but in practice. Early in that period, according to Pettinato, Ebla was ruled by a Cabinet of equals, one of whom was elected as "Chief Minister" for a non-renewable term of seven years. This elected Leader or king did not receive taxes but paid taxes into the national treasury like everyone else. Unlike in the more southern cities, no grand monuments to any of these leaders is known from Ebla, though a small statuette of the last leader was found. The Leader was not associated with a City God, as was the case further south.

Ebla had trading relations with other communities, but from time to time engaged in defensive war with more southern cities, including specifically Mari on the Euphrates. There is no record of Ebla warring with any city further north, but traded with them as equals (even nearly a thousand years later, some of those more northern trading cities were ruled by queens rather than kings). Ebla based its power

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leadership, such as that of Rome. The triune responsibilities

I should note that a curator at the Royal Ontario Museum told me a few years ago that some consider Pettinato's translations questionable in places, but that the situation is unclear because the expedition director had then not published the tablets, even forty years after their discovery.

40. Much of this comes mainly from Gimbutas (1974, 2001), augmented by reading between the lines from many secondary sources. We may see even now an echo of the triune powers of sky, land, and regeneration from below the surface in the Christian Trinity, of the God above, the Holy Spirit emerging from below, and the human Son of God, Jesus.

and wealth not on military strength and domination, but on free trade over a wide network of trade routes, which apparently reached to the shores of the Black Sea and Mediterranean, and in the other direction as far as Afghanistan and India.

Because of the need to ward off the depredations of the southern cities and would-be empires, Ebla was far from pacifist, but was usually not territorially aggressive, as Mari was. However, early in the period covered by the archive, Ebla finally appeared have had enough, and totally defeated Mari, where they installed an Eblaite governor. After a few years they replaced him with a native Mari governor who accepted Ebla's dominance. Mari had had what amounted to a colony, Asshur.

After defeating Mari, Ebla might have taken over the colonial overlordship of Asshur, but did not. Instead the two cities signed what may be the earliest known written formal treaty between nations. Each would respect the laws of the other when visiting or trading, and each would maintain a consulate in the other city, among many other clauses. By this treaty, Asshur joined the "Ebla Common Market". In effect, Ebla was the core of an extensive trading group that seems to have been very like the European Common Market before the European Union existed.

This state of affairs changed when one of Ebla's leaders managed to get himself elected to a second seven-year term, and made his son the Treasurer. The son succeeded his father and ruled for five seven-year terms, no doubt making himself very rich, though that is not recorded by Pettinato. The son installed his own son as Treasurer and then ruler, but shortly after that son took office the palace was destroyed. The clay tablet archives were preserved by the fire and hidden by the debris that fell over them. Naram Sim captured the city, a feat that he boasted his grandfather Sargon had been unable to do, but it is not clear whether the palace was destroyed by him or in a revolution that left Ebla open to his invasion. Either way, it is clear that decades of rule by the family that had usurped power from the Cabinet must have greatly weakened Ebla's military prowess or resolve, and enabled Naram Sim's success.

How might it have been weakened? During the earlier period of the archives, it is likely that the current Chief Minister, having been elected by a quasi-democratic procedure, had more collectively controlled authority allowed by the general populace than did the later self-perpetuating dynasty that followed a succession pattern of family control not only of the Chief Minister position but also of the national Treasurer. It is not hard to believe that although the Chief Minister theoretically paid taxes to the state, his family and friends might have extracted more money from the Treasury than they paid in, though no such implications are reported by Pettinato as having been recorded in the official archives (as one might expect, whether it was true or not).

If institutional corruption increased the disparity of wealth between the now-ruler's family and friends and the general public, it would not be surprising if many of them ceased to perceptive the rulers as representative of the nation or of the people. Furthermore, if individual members of the public found their ability to control their perception using national institutions diminished or blocked, according to PCT they would be likely to try to find other means of control.

As we noted way back in Part 2, the result of this reorganization process can be what in children is called a "temper tantrum", especially if the blocking or removal of some atenfels happened to unmask an environmental feedback path that created a positive loop gain, exploding what we called a "Bomb in the Hierarchy" (Section 6.4). Any individual person in whom such a Bomb exploded might easily become what is now fashionably called a "terrorist" by the authorities. The side-effects of violent actions are likely to disturb many unrelated control systems, in effect temporarily making effective action impossible.

When the "tantrum" is a manifestation of collective failure to control, the result is similar. The Giant Virtual Controller for many controlled virtual perceptions, lacking a generally available atenfel for that

control, is dissolved into random dis-coordinated action, often violent. The society as a whole becomes unable to act in a coordinated manner until a process akin to reorganization has settled into a new configuration.

At such times, local coordinations into smaller Giant Virtual Controllers (which the authorities may call “criminal gangs”), emerge from the turmoil, though in many cases, their members may not perceive themselves as criminals, but instead may perceive the laws as illegitimate, their existence creating error in some high-level (systems or principles level in the Powers hierarchy) perception. Their actions may be aimed at changing laws. We see these “non-criminal” “criminal gangs” in protest marches and sit-ins, which the more authoritarian leaders label “terrorist”.

A small proportion of such gangs in modern times may collectively control for destruction of some specific target, such as setting fire to a neighbourhood or besieging a government office. In Ebla, maybe such a gang finally “had had enough” of the corruption at the top, and invaded and destroyed the Palace. Or maybe a disaffected populace welcomed Naram Sim as a saviour, or a lesser evil than the corrupt family of the now hereditary ruler. Who knows? What is known is that after the destruction, Ebla never recovered its status as a regional centre of influence.

This story of the decline and fall of Ebla may or may not be true in detail or even in outline, but even if it turns out to be a total fantasy, it would serve its purpose as a concrete instance of some of the more abstract discussions that follow in this Chapter. It directly parallels the decline and fall of the Roman Empire and many other situations throughout history and in widely separated parts of the world.

Chapter IV.8. Morality, Ethics, and Fairness

Looked at from a distance in space and time, one might see Jane Elliott’s classroom exercise with Blue-eyed and brown-eyed students as unethical or immoral, despite its apparently having taught the students of both eye colours a lesson they requested. But what gives rise to the very ideas of morality and ethics? How do they become stabilized, and why do the ideas of what is and is not moral or ethical differ so widely from culture to culture?

IV.8.1 “Right” versus “Wrong”: Morals and Laws

Every growing child, whether a street-wise orphan or living in a loving family, learns about “right” and “wrong”. But what is “right” in one culture “may be ”wrong”, even to the extent of being “evil” in another. Consider, for example, US President George Bush’s “Axis of Evil”, the nations of North Korea, Iran, and Iraq, after the attack on the World Trade Center in New York, September 11, 2001. Did the people who carried out the attack, most of whom were Saudi citizens, consider their acts “evil” or even “wrong”? Probably not.

In PCT terms, what would it mean to an individual to perceive their own actions or those of somebody else as “wrong”, as probably we all do from time to time? Or for that matter, what would it mean to perceive those actions to be “moral” and “righteous”, or for a law to be “immoral” and “wrong”? Why would something “immoral” in one culture be “righteous” in another, and to be of no concern in a third? Different cultures appear in different physical environments, so the physical environment might have some influence, but also different cultures appear in very similar physical environments, so the social environment has a possibly stronger influence. How does this come about and remain fairly stable over many generations?

The background underpinnings of this Section are largely in Chapters 28 to 30 though they were not developed there. Here we do develop them slightly. First, let us reiterate the main difference between a moral precept and a law. A law is a written document that specified something about action, such as whether, when, or where the action is prohibited or required. A moral precept, on the other hand, refers to both a reference value and an observable form of action. It may be immoral in religions based on Judaism for a man to want to have sex with his neighbour's wife, but it is more immoral for him to act in that way, even though it may not be illegal if the coveted wife controls for the same event to occur.

The world is full of possible patterns that could be perceived by the appropriate perceptual functions, and those perceptions might be controlled by effective actions. But would controlling them help to stabilize or destabilize the biochemical homeostatic loops of "intrinsic variables? Only those that help more than they hinder are likely to be long retained in the perceptual control hierarchy. Which those are depends on the environment, physical and social, in which that living control system, an individual, grows up and continues to live.

Actions in contradiction to the dictates of "The Law" are likely to lead to appreciable disturbances to all the perceptions controlled by those actions as atenfels or as components of molenfels. Those disturbances are likely to cause rattling to the lawless individual — increased uncertainty of the rate of change of the error variance, of the error, and of the derivative of either. They are uncontrollable by the rattled loop, and perhaps by the individual as a whole control system, whose organization of perceptual control loops experiences elevated total rattling.

In the present context, "elevated total rattling" in a person can be reduced by two main techniques, separation from the part of the society that causes the rattling — hiding from the "Strong Arm of the Law" — or by ceasing to try acting contrary to the law — changing the library of available atenfels, moving the personal organization to a calmer place. This person might join another group of persons who are rattled by the same law, and might join them to separate from the same law, as the American Puritan Pilgrim Fathers did to avoid the strictures of the English law of the time.

They might be less rattled when interacting as a group, but the North American Native people who met them would be more rattled by an unexpected event, and then by their uncertainty about the actions of these new arrivals. Neither the invaders nor the inhabitants had laws that they could apply to the others, because the others might not agree to aide by them. This is also true of laws to which most people in a culture do agree to abide by. To them, the laws are "right and proper", and disturbances to perceptions controlled in ways that contravene the laws are "morally" justified. To disturb — punish — those who contravene them is "right".

In the case of the arrival of the Pilgrim Fathers, to apply their laws to the previous inhabitants might have seemed right, but attempts to do so would be likely to have unfortunate results. The same would be true if the native inhabitants attempted to apply their laws to the new arrivals.

In this encounter we are actually working in a region in which morality blends with, and is often indistinguishable from, law. In Christian North American culture, it is illegal and also immoral for a person to have two spouses, but it is neither illegal nor immoral in some cultures for a man to have several wives or in others for a woman to have several husbands (though I know of none that have the moral or institutional legal approval for both together). Let us go to the other extreme and ask about morality and custom. Why and in what way do Law and morality differ from the viewpoint of PCT, as opposed to the purely observable differences we have noted. The answer is that they don't, except in that the disturbance to a person who breaks a law are imposed by formal legal structures such as courts, whereas the disturbance to a person behaving immorally are applied by the people with whom that person interacts. They have different causes of rattling, both to the person and to the local social organization.

This book is largely about feedback loops and structures, and here we do not depart from this practice, though it may have seemed so in the last few paragraphs. Let us go back to the "autocatalytic soup" of Chapter II.2 and the derived Homeostatic Loops of Chapter *2:5-6*. We already used as an example the development of the biochemical interaction with the perceptual control hierarchy in the form of homeostatic loops containing "intrinsic variables".

Whatever the organization, the components of a loop perform more stably in an autocatalytic or homeostatic loop — have a lower rattling index — than before they were connected in a negative feedback loop, no matter how different or in what domains of the Universe they individually act. In a homeostatic loop, the individual elements are less rattled than they were before the loop formed from the soup. The soup has become more structured. By interacting in ways constrained by a homeostatic loops, the interactions among people have more stable variation than without being part of the loop. Loop formation follows the Chvykov et al. (2021) principle of organizations trending toward regions of lower rattling, which the formation of an autocatalytic or simple homeostatic loop does.

The interactions in a social loop may be identified as moral if they helps keep the loops stable. Perhaps they are initially side-effect loops (Chapter III.2) but many of them will be likely, according to the Chvykov et al. principle, to become controlled perceptions, stably controlled even without the immediate influence of the effective other members of the loop. A child learns that if they want to get along, they behave "this" way and not "that". Moral principles such as "Please share your Teddy with Veronica" disturb perceptions that the parent is pleased, and sharing may become a regular behaviour as the child grows up.

If the parent is seldom perceived as being pleased, that they are not pleased might not change the perceived variability of the relevant perceptual control errors, and rattling would not be changed by habitual sharing. The child's internal perceptual control structure would be unlikely to be reorganized to produce more consistent sharing actions. As an adult, the child probably would grow to be greedy, controlling for acquiring more financial wealth than social wealth, whereas the child less commonly disturbed by parental actions might be more likely to imagine and control for lessening the disturbances to other. In other words, within that culture, the frequently approved child would grow up to be a more "moral" person than the other.

I use "sharing" as an example of what might be a moral action in many societies, whereas holding onto everything one has might be immoral, especially those in which most people have very little to share. Morality, like the law, often leads to internal conflict, in which the moral action trades against an action that more directly reduces error in some controlled perception. It may be convenient to remove the person who has caused you some disturbance — has rattled you somewhat — by killing them, but in few if any cultural groups is it moral, at least not if the disturbing person is a member of the same group.

IV.8.2 Moralities and Ethics

We discussed interactions among different varieties of "Us" and "Them" in Chapter IV.6, but we did not consider why some things that are moral to "Us" might be immoral to "Them" and vice-versa, and why it may be societally counterproductive to change the "immoral" into the "illegal".

We return to the autocatalytic soup, in which are "floating" many separately developed control loops, motifs, narrative fragments, social groups, or whatever, controlling against disturbances to the participating perceptions. In this soup, a variety of distinct autocatalytic loops might form, some with variables shared between loops, some loops isolated from the others. As the soup matures and develops in complexity, new productive homeostatic loops form and merge, until the soup has become composed mainly of one giant network — an ecology — with possibly some "hermit" loops and isolated entities

that are less likely to survive long (Chapter II.2). It is the intermediate stage between a soup of units and a frozen network ecology that interests us in this discussion of variations among moralities.

This representation of the autocatalytic soup is obviously vastly oversimplified, though it remains useful as a concept on which to build. One problem with it may be found in Section IV.4.1, where we discuss the distinct difference between person networks and Role networks. The existence of a Role depends on collective culture, and the Role network attains stability only as a homeostatic loop whose elements use specific sets of protocols to communicate with each other, such as a Shop Cashier with a Customer. The Customer person, Shirley, may know well the Cashier person, Tony, but the Cashier deals only with the financial transaction, while simultaneously Tony and Shirley may chat for a while about personal things if no other Customers are waiting (and may do anyway).

Shirley and Tony may live in a culture in which it is immoral to interrupt a personal conversation, and a person playing the Customer Role may perceive that they have no means of controlling a perception of being at an appointment on time, so long as the persons Tony and Shirley continue to chat. While the person to person chat continues, nobody plays the Cashier Role, and if stealing is also immoral and the waiting customer controls for perceiving herself to be a moral person as well as for having the item she wants to purchase, she is stuck. For the waiting person, the interaction between Role network and Person network has become "frozen", without a completed feedback loop that would allow for a moral completion of her purchase through the Cashier-Customer link of the Role network.

A culture with this morality has a more rattled organization than one in which the waiting customer is morally able to interrupt the Tony-Shirley person interaction and request Tony play the Cashier Role for a moment. Such an interruption might slightly rattle Tony and Shirley, but if their "moral" actions include perceiving themselves as controlling for accommodating the perceived needs of others, it probably would not. This kind of culture is likely to be less rattled as an organization than one in which Tony and Shirley are happy to continue the chat and would be annoyed by an "immoral interruptor". The organization with more rattled moral culture would be the one more likely to change.

What about the organization might change is never pre-determined or even predictable when rattling is sufficient to expect some kind of reorganization, social or individual, to occur at a noticeably high rate. In individuals this might be the functional reason why psychedelic therapy can be effective in cases that depend on the existence of stable loops of perceptual replay that may reach the level of consciousness in problems such as PTSD.

In principle, morality should not be connected with law, except insofar as that the law should not be perceived as immoral in some way. Some religious groups, however, control for making their own reference values for morality be reference values for the making of laws. The English system on the seventeenth and eighteenth centuries of laws being based on the moral values of the Anglo-Catholic church was one reason why groups of refugees of different religious faiths left England to settle in North America, and why the Constitution of the USA tries to ensure "separation of church and state" so that state and Federal laws do not depend on what any particular religion describes as moral. In practice, some churches are powerful enough that they can coerce lawmakers to perceive that it is in their interest to write laws that agree with church law of the sect dominant in their state, county, or municipality.

So far, we have not defined "morality" or its related words "moral" and "immoral". All of these words are rather slippery, in the sense that is moral to one person may be immoral to another. Even a law may be perceived as immoral by some people, though it would probably not be by those who voted to pass the law. Morality may be conflated with religious law, although the former is collectively controlled which the latter is codified. As far as I can see, some groups collectively control for seeing some actions as moral, such as putting a convicted murderer to death, which most people around the world would consider immoral.

Conversely, some groups collectively perceive that to have or to assist an abortion is immoral, whereas other groups would perceive preventing an abortion to be immoral. In some cases, these perceptions are even codified into laws that specify punishments for acting against the local group's moral judgement — in much the same way as in mediaeval times, it was considered moral, right, and proper, for a heretic to be put to death. In most cases of moral judgment, people who act against a person they perceive as immoral perceive themselves to be doing God's will. Whether this is true outside the militant Abrahamic religions, I do not know.

Ethics and ethical behaviour is related to morality. Someone who acts ethically is unlikely to be collectively perceived as immoral, whereas someone collectively perceived as having acted unethically is probably collectively perceived as having done something immoral. But in contrast with morality, the concept of ethical behaviour is often raised in the context of a conflict. If you find yourself in this situation, should you do this action or that. Which choice is the more ethical one? That is a relationship perception in each person, but it is very likely that a collective answer exists, perhaps two of them, different groups collectively selecting each option.

From a PCT viewpoint, there can be no correct answer to an ethical question. Following the thread of most ethical arguments, the actual answer for an individual depends on how the contrasting action possibilities would influence the perceptual errors in the self-self-image and the other-self-image. The other-self-image in this case would depend on who the "other" was, an individual or a collective. If the perceived effects on the two self-images of the possible actions that are contrasted are the same, then there is no ethical dilemma. Only if one action increases the perceptual error in the self-self-image while decreasing it in the other-self-image (or vice-versa) is there a conflict that the individual might want to resolve. How the resolution might be achieved, if the individual controls for perceiving it to be resolved, is not something about which PCT has anything novel to add beyond what has already been said about conflict and how resolutions may be achieved.

IV.8.3 Fairness, Ethics and the Abuse of Power

There is an old saying "All is fair in love and war". This may have been true when the saying was originated, but now (2022) this perception of fairness in war as not restricting the permissible actions of a warring nation no longer holds. Now there is a concept of a "war crime", actions that seem to be for control of some impermissible perceptual reference on the part of the "criminal", and that might be referred for prosecution to the International Court of Justice.

What, from a PCT viewpoint, is "fairness". Nothing we have discussed so far seems to bear directly on the question. Most of us can, as with obscenity "know unfairness when we see it", but and often that perception disturbs a controlled perception that our system is fair. Is it "fair" that some individuals willingly accept orders from a "better" dominant person, as a worker will do from his or her "boss"? What if the worker perceives the orders to be unfair, or that it is unfair that someone else was promoted to a coveted position?

Fairness is a perception deserving of the same treatment as "beauty", which is said to be "in the eye of the beholder". But we have another way of dealing with it, based on collective control. If a collective controls for fairness and has a collective perceptual input function that reports the fairness level of some perceived action (by an individual or by another collective such as a nation with which the collective's

own nation is at war), and the collective perception will be in error, and even if the individuals forming the collective are not in communication, the result may be a collective action to change the situation[41].

Fairness has a relation to power — dominance and submissiveness — in that how an action by a dominant individual that disturbs a perception by a submissive person may be perceived is different from the perception of fairness if the situation were reversed. It is unlikely that a third party would perceive as unfair an action by a submissive that disturbs a perception by a dominant, because the dominant has the means of correcting the resulting perceptual error. In the reverse situation, the submissive may have no apparent means of acting to reduce the error in a perception intentionally disturbed by a dominant.

Fairness is also a relationship perception, in that if an observer (who may also be a participant) perceives two individuals who the observer perceives to be in the same category being treated differently, the observer is likely to perceive one as being preferred unfairly, only because of the differential when compared to the treatment applied to the other. These perceptions may not be the same as the perceptions of fairness by the participants themselves. The observer might not have noticed that the dominant had offered some perquisite such as a promotion to one, who had declined it in favour of the other.

Fairness is a perception that depends on the environmental context in the Perceptual Reality of whoever is perceiving it. As a word, it does not specify anything about the environment, but depends on the social context that is perceived by whoever is perceiving something to be or not to be fair and according to collectively controlled limits on behaviour. These limits are neither sharp nor rigidly fixed, but do distinguish in various contexts behaviour that would be generally considered unethical or immoral, both of which would include unfairness.

We have been talking about fairness and relative power as though the power is that of an individual person. It could equally be that of a collective on one or both sides of the power comparison, whether the collective control of a perception of fairness on the part of the other is of fairness by or toward an individual or a collective. A business leader may be perceived by the workers in the business as a “good boss” (a fair one) or a “bad boss” who might not be unfair, but who also might not be consistent in expressing his or her wishes for the behaviour of the workers. A “bad boss” who is consistent provides a point of stability on which a worker might rely when controlling his or her perceptions, as McClelland points out in the quote that heads Chapter II.3.

On the other side of that conflict, if the workers form a union, it is more difficult for a boss to act in a way that union members perceive as unfairly towards any individual members or to the general membership, because the collective power of the union is at least commensurate with that of the boss. Many business leaders control for perceiving their organization to be union-free so that they can remain dominant over submissive individual workers who they can fire if they do not submit.

If the workers perceive that the owners and managers are taking more money than what they perceive to be a fair amount from the organization as compared to their own pay level, given their perceptions of what those “high-level” people contribute to the wealth of the organization, they may use the collective power of a union to try to get more for themselves. Seldom, if ever, in North America do they

41. A personal anecdote. In my Scottish high-school days, corporal punishment in the form of a strap swung onto the palm of the hand of the offender was considered only fair by the rest of the class. But the punishment had to be applied in moderation commensurate with the heinousness of the offence. On one occasion a member of our class was given this punishment, which the class considered he deserved. But the teacher unfairly (in the collective opinion of the class) gave him too many strokes of the strap, and the class collectively and with little intercommunication left the room to complain immediately to the Headmaster about this unfair punishment. I don’t know whether our complaint had the desired effect of the teacher being reprimanded by the Headmaster.

individually or as a union control their perception of what the “high-level” people should earn (their reference value for what they would consider fair). Those pay rates are set by Boards, which frequently consist of people who own or control other businesses, and therefore form a tight network in which quasi-homeostatic loops are likely to form. I say “quasi-homeostatic”, because there is no inhibitory connection to keep the loop from exponential increase in the “stable” values of Executive pay voted by the interlocking Boards of Directors.

The situation is different when workers collectively (as unions) have a say in the proper compensation of senior management, as they do in Germany, where Boards of Directors are supposed to include union representatives. As far as I know, the same homeostatic networks of interlocking Directorships exists, but the workers do have a means of influencing Executive pay. They may be outvoted at Board meetings, but if the union representatives perceive the result as unfair, they have the details that are denied to workers in companies that have Directors all chosen from the same interlocking network of already rich persons.

The short term effect of this is that the CEOs who serve at the pleasure of the Board of Directors may control for the nominal profitability of the company rather than controlling a perception of their own income. Many of them seem to control their other-self-image for being perceived as more effective than their counterparts in other companies, and the measure of their effectiveness in the minds of their Boards of Directors is their pay. In the quasi-homeostatic network of Directors, on which some of them may serve, their ranking is precisely ordered by their remuneration. The arrangement means that short term profitability rather than long-term performance is the measure of the CEO’s performance, but even if the company has made a loss and the share price has tanked, the CEO who serves on other Boards of Directors is likely to be awarded increased income by Directors who control for their own income to rise, income that is determined by Boards on which that CEO may serve. The long-term result of this is an expanding gap between rich and poor, and a depletion of the numbers of individuals in the middle.

Somebody not involved in any of the Boards involved in this homeostatic network is likely to perceive the system — not any individual — as unfair to the workers in any of the companies involved. The actions of unions as collective controllers of the incomes of the workers are unlikely to have much effect on the exponential effects of the interlocking Board network, as it is a side-effect of perceptual control by the members of that network. No one individual member of the network has the power to accede to the demands of the worker’s union in the company he or she controls. Leaders of smaller companies may have that ability, as they will not have either the connections into the network nor the constraints against acting fairly with respect to their own workforce.

It is easy to see the wielding of power to increase each other’s remuneration at the expense of those who do the actual work of the company as quite unfair, but as we pointed out in Section IV.4.5 in connection with the general concept of bureaucracy, some management is required if the company is to function effectively. Too much “micromanagement”, setting reference values for not only their immediate subordinates but also for those supposed to be instructed by those same subordinates, prevents the actual workers from controlling perceptions that allow them to do their job. As the saying goes: “One can not serve two masters”. This form of micromanagement is often perceived as unfair to the subordinate who should be directing the next lower level in the organization, but is being overridden by the boss.

Is the boss acting to perform some of the duties for which he has given a subordinate reference values an abuse of power? Is it unfair to the subordinate. This depends on perceptions each holds about the competence of the subordinate. If the subordinate has been newly promoted, having been perceived as capable in his or her previous position, perhaps he or she welcomes some direction from the boss as to the appropriate actions to take if they perceive certain situations.

If, however, the newly promoted person has a self-self-image perception of being competent at the new position, then actions by the boss to affect their perception of the situation will act as disturbances to

that perception, disturbances that may not allow action to the resulting perceptual errors. The situation is the same as that in which a child tells a parent "I can do it myself", when the parent tries to be what the child perceives as "too helpful". Is the dominant party in either situation abusing their power or acting in an unfair manner? Again, it depends. It depends on how the less powerful party perceives the situation. The dominant party — or anyone in any situation — seldom perceives themselves as acting unfairly or as abusing their power.

Let us change the situation to the simple unadorned Trade Motif (Section III.9.4), in which we identified a "fair trade" as one in which both parties perceive what they gain as having more value to them than what they lose in the trade. An "unfair trade" must then be one in which one party perceives themselves as having made a net loss of value (ability to control their perceptions). In a "fair" situation, neither party would normally agree to such a trade, but if one party perceives themselves as submissive to a dominant other, they may accept it because they see value in their change of relationship with the other, in addition to whatever value they appear to an outside observer to gain in the trade. Such a trade might be perceived by the submissive party to be fair, even though to the observer it might seem unfairly coerced. This example suggests that fairness cannot always be judged from outside, though when a trade dispute is brought before a judge, that judge is required to perceive whether it is fair or not.

One of the trades that is formalized in a capitalist society is that of pay for work. We discussed this from one point of view in Chapter III.9 and Chapter III.10. In those Chapters we implicitly considered this trade, among all the others, to be fair. But it need not be, at least from the point of view of the less powerful party. Again we arrive at the utility of collective control in the form of unions to even the power of the parties in trading pay for work. But if unions have been declared illegal (typically by politicians who depend on money from businesses to help them in elections), then the collective power of police can be used to prevent fairness in the work for pay trading relationship. There have been many examples of this in practice in the USA and elsewhere in the capitalist world.

Access to atenfels is a right that is subject to collective control by any organization, including governments. It is a right sometimes elevated to almost sacred status under the name "freedom", but it is a right that can never be available to more than a small elite group without creating conflict over access. "Rights" associated with any atenfel other than a Catalytic-Unlimited one are potentially a source of conflict.

IV.8.4 Laws and Atenfels

As McClelland wrote in the extended quote, the mere fact of the stability of a controlled perception can sometimes be used as an atenfel for control of some other perception. In the case of a law, the fact that there is such a law offers the same kind of stability as the fact that there is a dictionary provides to the meaning of a word. Not everyone uses the word as it is described in the dictionary, and not everyone acts as the law prescribes. But if the word meaning or the action is questioned as unfitting for its context, the parties can compare their perceptions or reference values to the written authority. Reference to a dictionary is not always successful "*Fraught doesn't mean that*" "*Well, that's what I mean by it anyway*", and no more is reference to the law "*You can't do that. It's illegal*" "*So who's to know*?".

PCT suggests a distinction between civil and criminal law. In civil law, the law is invoked because there is a conflict in which neither side can overpower the other, or in which the weaker side denies the collectively controlled *right* of the stronger. The judge in a civil law case decides on which side of the conflict to add the strength of the Giant Virtual Controller that is the social group that defines the law. In criminal law, on the other hand, the conflict is usually between an individual (though it could be a social control system such as a business) and the social Giant Virtual Controller. The judge in a criminal case decides whether the social GVC has the *right* to overwhelm its opposition. This right is granted to the judge by the GVC that defined the applicable law.

Laws do not determine how a person will act in any particular situation, but they do increase the probability that a particular action will have a particular influence on some controlled perceptions. Traffic on an expressway has a tighter distribution of speed if the highway has a posted speed limit than if it doesn't. For an anecdotal example, once in Germany I was cruising at a comfortable 170 kph in the slow lane of an almost empty Autobahn when I was passed by a car in the middle lane and simultaneously by one in the fast lane. Using the 100m markers set alongside the road, I judged the middle car to be going about 240 kph and the fast one near 300 kph. Such a range of speeds is very unlikely to happen in North America, even on an empty highway.

The stability provided by a system of laws is not absolute. Indeed in most countries (I assume) the laws have grown in a rather ad-hoc manner, few being eliminated while others in the same domain have been passed. Contradictions and anomalies occur, and I have heard it said that few of us go through a day without breaking some law or other. When I was an undergraduate, I occasionally wasted time browsing through the Statutes of Ontario in the reference library across the road. One paragraph has stuck with me in the six decades since. That paragraph prohibits three actions: Strewing garbage on the highway, riding a horse furiously on the highway, and hitch-hiking. At the time, hitch-hiking was a very popular way for young people to travel between cities, almost nobody rode horses on public roads, and it was probably easier to put your garbage somewhere nearer at hand than on a highway. But the law remained in force.

A community can control its virtual perception of a CCEV that it perceives as an "authority" to which the members defer. On Tuesday Joe may be the authority, but on Thursday Bill is sworn in to become the new authority. A dictionary is "authoritative" only because many people control a perception of it being so. A dictionary is, however, an authority only in a specific domain. One written in Old Norse will not be considered an authority on the meanings of modern French words, though it might be perceived by scholars of Old Norse to be an authority on that long vanished language. If, however, a forensic researcher then discovered that the Old Norse dictionary had been written in the 18th century as a great joke, most of those same scholars would cease to perceive it to be an authority on anything.

A parliament, congress, academy, or other rule-making body is perceived by some Giant Virtual Controller as having authority in some areas, in that many people defer to it in the area that they perceive to be its legitimate domain. These authorities, unlike the authority of a dictionary, themselves collectively control, as CCEVs, artifacts we call laws and constitutions.

These written artifacts specify "correct" execution of protocols and influence the availability of atenfels in the same way as do social conventions. Conventions differ, however, in that they usually provide reference profiles for a platonic ideal for the execution of a hierarchy of protocols, whereas laws usually define tolerance bounds with sharp edges for the actions used in controlling unspecified perceptions. The reference values that occur as part of a convention may well be for the observable actions of people in particular contexts controlling unspecified perceptions, but the relevant control loops of the collective will tend to be of low gain. You don't wear jeans to a formal party, but if you show up wearing jeans, the worst that will happen is that you will not be admitted to the party.

One's actions may not conform exactly to the reference pattern of a convention, but one may be excused for small deviations. If there were a law against wearing jeans to a formal party, rather than a convention that it "just isn't done", the penalty would be a reduction in the jeans wearer's ability to control some irrelevant variable. A fine reduces the violator's ability to use money in controlling perceptions. A jail term does the same, with a wider ranging effect.

For law, there is no middle ground[42], whereas with a convention one may have slightly violated the ideal while acting "within the spirit" of the convention, and the penalty is usually reflected in the ability to control related perceptions. You may not be able to control perceptions associated with attendance at the party if you show up wearing jeans, but that will not affect your ability to buy food tomorrow, or to travel where you will next week.

To blunt the sharp edges of the law is one function of a jury of one's peers. A jury may refuse to declare a person guilty despite having clearly violated the law as written, if they unanimously perceive the law as being unfairly applied in the context of a case, or of being in general not compatible with "natural law". Sometimes laws are changed because of such jury decisions, as happened in Canada when three different juries on three separate occasions refused to convict Dr. Henry Morgenthaler of the crime of performing an abortion. The law was changed, and that act became a normally regulated medical procedure.

IV.8.5 Social Power

The long history of human communities contains many periods in which the powerful became relatively fewer and more powerful, while the masses became more subservient. These periods usually ended in protests, riots, catastrophic uprisings or individual murders (in a style we currently call "terrorism"). The short period of Greek democracy in the Age of Pericles (ca. 500 B.C.E.) followed the violent and bloody overthrow of the Autocrats; The "Peasant's Revolt" in 1381 in England and the Luddites of the early 19th century were protests against the harsh conditions of the working classes in contrast to the wealthy; Lutheran Protestantism was initially a protest against the magnificence and money-grabbing practices of the Church hierarchy; the French Revolution was a protest against the wealth of the aristocracy compared to the poverty of the masses, as were the many European revolutions of 1848 and the Russian Revolution of 1917; the suffragette movement for which the CCEV was the right of women to vote was a protest against the arbitrarily unequal division of power between the sexes; the assassination of Julius Caesar could be seen as a failed attempt by the Senators to put off a similar revolt against their own largely corrupt power and enormous wealth; the international 2012 "Occupy" movement, with its slogan "We are the 99%" was explicitly targeted at inequality in wealth. And today's jihadist revolt against the super-rich countries can be seen as another example on a larger scale, as yet not very coherent.

All of these protest movements were opposed by strong and often lethal force wielded on behalf of the powerful and wealthy, though a few, such as the suffragette movement, were successful despite that force. In PCT language, the attempts by individual members of the weaker but larger group to better their lot did not disturb beyond their tolerance zone the aristocrats' perceptions of maintaining their "worth", whereas when the individuals formed "teams" in the sense of Chapter III.5. their collective actions did. The action to correct the error was to destroy the disturbing GVC, in one way or another. Sometimes the aristocrats, those of high "worth" and hence power, were successful, but often they were not, and the collective instead reduced the "worth" of the aristocrats, sometimes to zero by way of the guillotine or its equivalent.

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42. . Any possible middle ground is excluded by the authorized decision of a judge or jury.

What does PCT have to say about this repeating pattern in history? The immediately obvious fact is conflict. According to PCT, if two control units attempt to set their perceptions of a single CEV to different reference levels outside their tolerance zones, they will continuously act in opposite directions, and if their output function or environmental feedback path includes an integrator, as most do, the conflict will escalate to a limit set only by their available output. But let us look into the issue a little more closely.

In these collective conflicts, there is no obvious CEV, nor even CCEV, perceived by the conflicted parties and controlled with different reference levels. One might expect that in each case there is such a "bone of contention", different in each case, but escalating similarly because the dynamic situation is the same in each case. That naïve assumption might even be correct, but there is another possibility, which is that the there actually is no CCEV, but instead there is a loop akin to a protocol loop connecting the two GVCs.

Let us consider a well defined conflict we call a "game", using soccer, American football, hockey or other field sport as an example. Each team has both offence and defence. The offence controls for perceiving their side to score a goal, while the defence controls for perceiving the other side to be unable to score a goal, by removing the means that the opposition's offence might employ to score a goal.

The passage by McClelland quoted at the start of Chapter II.3 on Infrastructure mentions several abstract atenfels that are the CEVs of some controlled perception, many of which use money as a supporting atenfel in controlling the corresponding perception. Continuing the chemical analogy, money can be seen as a catalyst for many perceptual controls, in the sense that control with money is often easier, more powerful, and more precise than control without money. Indeed, many perceptions that can be controlled easily by someone with a lot of money cannot be controlled at all by someone without.

When an atenfel for controlling a perception is itself the CEV of a different control system, it is stabilized, which may be helpful for control. We sometimes call such stabilization "maintenance", which McClelland describes as being critical to the network of control paths (as well as of physical paths). If the quality of a road surface is not being controlled by some Giant Virtual Controller, or even by an individual who has sufficient physical power, it will soon deteriorate and become useless. A road that is being maintained is an atenfel of type Path-Catalytic-Limited for perceptual controls that involve driving a car over it (Limited because too much traffic makes the road almost impassable for an ordinary car). An unmaintained road is of type Path-Resource. It gets used up a little every time a car passes over it, faster in some climates than others, but no matter what the climate, if the quality of the road as an atenfel for car driving is not the CEV of some maintainer, the road eventually becomes impassable for cars.

If an object provides an atenfel for control of perception "X", and also offers atenfels of the Resource type or the Catalytic-Limited type, its use by another control system could inhibit or preclude control of perception "X". For example, if I want to use a commonly owned hammer for pounding nails, but you have burned it for warmth, I can't pound the nails. If between the two of us we have $100, and I use $60 to buy something, you cannot buy another instance of that thing for yourself. This is not conflict in the classical PCT sense, in which two control systems control a single CEV with perceptions having different reference levels, but it has a similar effect. At least one, and possibly all, of the control systems needing to use the atenfel will be unable to control.

IV.8.6 The Power of Organizations and the “Social Bomb”

When we considered reorganization in the individual hierarchy, we noted that if an atenfel for the control of a perception is blocked, that loop might switch from negative to positive feedback, and might thereby induce further positive feedback loops in higher control systems that it supports. The result, we argued, would be the equivalent of a temper tantrum or worse. Now we consider the same issue for collective control.

If use of a resource-type or limited-type of atenfel by one control system precludes its use by another, the other may have no other means to control some perception it could have controlled by using that atenfel. Even if the person containing the thwarted control system accepts the rights involved, nevertheless the failure to control always carries the prospect of possibly triggering a Bomb avalanche in that individual. The person may act in a way that creates positive feedback elsewhere, too, quite outside the positive feedback implied by the initial conflict. The behavioural manifestation, as mentioned in Part 1, may be as simple as a brief show of annoyance, or it might become a general action against “Authority”.

An individual Bomb explosion can be very destructive, but for the person concerned it often results in reorganization that improves their future range of control. One of the changes reorganization may produce is the use of the collective as an atenfel to substitute for power the individual does not have. As we saw in the development of the “Vee Party”, like-minded people may reorganize to act together in a new collective independent of their previous collective. The new collective must be in at least some dimensions in conflict with the old, or the split would not have happened. Such conflict is likely to induce positive feedback. The propagation of that positive feedback up through levels of Giant Virtual Control could be limited above by the same mechanism as in the individual, or it could escalate into a more destructive form, such as war or revolution.

The mechanism described in this Section may be responsible for the recurrence over the long stretch of history and prehistory of various levels of revolution against those who arrogate power to themselves at the cost of the majority. Having access to a wide range of atenfels, and in particular having money that catalyzes access to atenfels, those with power are able to acquire ownership of more atenfels. They are able to create organizations that act not just as collective control systems, but as actual control systems. In acquiring atenfels of types other than Catalytic-Unlimited, in all likelihood they reduce the atenfels available to others, reducing the ability of the majority to control their own perceptions unless the growth of atenfels by invention exceeds the rate at which the powerful act to increase their own power.

Inability to control may lead to reorganization, but that reorganization may not result in the ability to control. Instead, in the powerless it may lead to a state of resignation in which no effort is made to control a wide variety of perceptions that the powerful might control very easily. A slave may not even try to control a perception that would involve acting in opposition to the master’s wishes, because no atenfel exists to permit control of that perception without creating large error in some other perception when the master administers punishment. However, when a Spartacus appears, the possibility of creating such atenfels now seems possible. One slave may be unable to act freely, but a slave collective or better, a slave organization, might do so.

Less dramatically, the organized structure of a labour union might have sufficient power to move a CCEV such as the wages of its members to a place different from the reference value of the company boss, where simple collective control by the wage-earners could not. Historically, and today in the USA and a few years ago in Thatcherite Britain, many of those with power in the form of money do what they

can to destroy labour unions, which they perceive as being able to enhance the power of the weak and diminish their own.

More dramatically, some might imagine destructive revolt that damages the organization controlled by the powerful as an atenfel that would allow the collective after the destruction to have sufficient power to counter the depleted power of the boss. Here we have the lone wolf bomber, who in the early 20th century was called an "anarchist" and now is a "terrorist". The bomber does have power in that action, but as with the temper tantrum of the child, rarely if ever does it have the intended result. Under some circumstances, however, the physical bomb could plausible trigger the metaphorical Bomb in the collective control hierarchy, changing the structure of society, as did the attack on the World Trade centre known as 9/11.

IV.8.7 Teams and team spirit

If there is an "us", there must also be a "them" or at least an amorphous "Them"[43]. A person perceived as one of "us" is trusted to be able to use the set of protocols associated with "us". More than that that, any "one of us" is trusted to have at least a few reference values in common with "most of us" for perceptions of matters that do not require interpersonal interaction. These associations create expectations (Chapter 8) that can give rise to questions of the form "How can you think that" and statements given to police after a horrifying murder "He was such a lovely neighbour. I can't believe he would do that".

"Us" might be one sports team, and "Them" another. Teams may be formal, as, say, an eleven-member soccer team, or informal, such as a group who do things together and say "We make a good team". Whichever kind of team it is, the members interact in ways defined by their different roles on the team. Most team members are likely to be controlling for perceiving themselves as belonging to the team, and for having others perceive them as belonging. But that is not a criterion for belonging. The criterion must be that they control some perception(s) by actions that aid other team members to control their own perceptions. To do otherwise is to be perceived as "not a team player". The soccer player who is observed to try to score goals himself rather than trying to arrange for the team to score goals is often given that epithet.

In PCT terms, what does it mean to be "not a team player"? There is no objective criterion for being or not being a team player. It is entirely a question of how the other team members (and spectators) perceive the player, who we may call Zeb. From the viewpoint of other team members, Zeb is a good team player if the protocols the team uses ordinarily work well with him. From the viewpoint of spectators Zeb is perceived as a team player if the team does well when he is actively involved in the play, and especially so if the team's good results come about when other players make the most overtly dramatic moves.

If another player, Rudy, tries to use a protocol with Zeb and it doesn't work, Rudy may be annoyed, but may perceive other reasons that Zeb did not do as Rudy wished. For instance, Zeb might have scored a goal just after Rudy asked for a pass. If Rudy is a "team player", Zeb's goal will reduce the error in a perception he controls, but if Rudy's reason for wanting a pass was that he saw an opportunity to score a goal himself and thereby improve his personal standing (the way he is perceived by team members and others), Zeb's goal would increase the error in Rudy's perception.

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43. We discussed in Section 8.7 on Similarity and Difference how these two concepts differ. A person can have a graded similarity to being a core member of "Us", and when that similarity is below some arbitrary threshold they are "not Us". "Them" is a separate category, which is different from "Us", rather than being below an arbitrary level of similarity to "Us". Someone who is a member of "Them" is *ipso facto* different from being a member of "Us", no matter how similar their characteristic properties are to those of a core member of "Us".

In the latter case, Rudy is not a team player. Is Zeb? It is impossible to say. Did Zeb keep the ball and score for himself because he was controlling for being seen as a star, or because he was controlling for having his team win and he perceived (in imagination, of course) that a goal was more probable if he kept the ball than if he passed it to Rudy? The only way to tell is to determine the probability that Zeb will refuse a protocol initiated by other team members during the play.

If he always accepts, perhaps Zeb is too submissive and too "ready to go along" to be useful to the team. His submissiveness deprives the team of a possibly valuable imagination. But if Zeb frequently refuses a protocol, the team will not be able to trust him to act effectively in executing a plan. Both extremes might result in Zeb being perceived to be "not a team player". On the other hand, if Zeb is a good team player, he will initiate as many protocols as other initiate with him, and not try to dominate, unless he is in a Role such as team captain or coach in which he is expected to initiate most of the protocol interchanges in which he participates.

In public statements, particularly after a less well regarded team beats one that is superior in individual talent, the speaker refers to "team spirit". The team members worked well together, each controlling for a perception of the team succeeding, rather than every individual controlling for a perception of themselves doing well.

Being a team player might be the same thing as having "team spirit" when considering only an individual, but what could it mean when an observer proclaims that team X has good "team spirit" but team Y does not? And how does the concept of "team spirit" apply to the team's supporters, who never use a protocol with any of the players, but merely watch on TV or in the stands? Clearly something is going on, when police must stand by in case of violent interactions between people whose only apparent difference is in the colour of the scarf they wear to the game. The issue becomes even more pointed when the "team" is a street gang that claims territorial ownership of a city block where a stranger might be killed for going there while unknowingly wearing the wrong colour clothes.

Team spirit relates to trust, whether we think of a team member or of a team supporter. The team member trusts that another player will execute a protocol regarding play on the field, and in cameraderie off the field. The supporter imagines that another supporter perceives the world, at least in the context of the team, in the same way, and therefore that certain protocols will work if needed. Perhaps more important, the supporter assumes that overt demonstrations of support for the playing team will not disturb another supporter's controlled perceptions in a way that leads to conflict, but may instead result in actions that also demonstrate support for the team.

In contrast, the supporter of team X trusts that the "Them" members of team Y will act to reduce the chance of success of "his" team, and by association, supporters of team Y may act to disturb perceptions "he" controls. If a supporter of team X controls in imagination for shielding against this disturbance by a supporter of team Y, that shield may take the form of actively controlling to reduce the atenfels available to team Y supporters for creating that kind of disturbance.

Team spirit, community spirit, and patriotism all have much in common. Patriotism is not the same as perceiving oneself as belonging to a nation-state. It involves overt displays, both of support for the actions taken by one's government in dealing with other nations (though not necessarily with all the actions of one's government that affect oneself), and of disapproval of people who display opposition to those action.

The patriot controls for seeing others display reference values like his or her own with respect to the actions of the government. Especially if the tolerance width if small. the patriot's actions to correct errors in this perception can be very damaging to people who do not make the same displays. "McCarthyism" remains a term of opprobrium even a half-century after the Senator's power was lost, but it is seldom

remembered that his power existed only because enough people perceived that any Communist must be working to destroy the United States and therefore controlled for removing Communists from any position of influence.

At one stage, to be opposed to McCarthy was to risk losing one's career, or, like Charlie Chaplin, to be excluded from the country. The cartoon of Figure III.1.4 illustrates the same point at a level several orders of magnitude less dramatic. The opprobrium was not caused by McCarthy's exposure of real Communists, but by his labelling people as Communists without evidence. It became clear that McCarthy was not a patriot controlling a perception of the safety from subversion of the USA, but a self-image perception of his own personal power.

The perceived existence of other like-minded people allows one to imagine an atenfel that provides one with more power than one would have when acting alone. To move a sofa by oneself is difficult. If one can get another strong person to have a reference value the same as yours for the location of the sofa, moving it becomes much easier. The same applies to a youth dissatisfied with the state of the world.

When, perhaps through the internet, the youth finds that others have the same dissatisfaction and have proposed action (or begun action) to improve the situation, these others become an atenfel for reducing the error in that perception. Perhaps they form a Party within a political system, perhaps they form a group trying to change the system within which Parties exist (as proposed, for example, by Marx, 1848). Perhaps they even join a revolutionary movement within which they could become "one of us".

IV.8.8 Cliques are not Teams

One form of module is a clique, a group of people who form a particular kind of structure of Giant Virtual Controllers. At least one feature of a clique is that the clique includes an avoidance controller that acts to oppose the membership of certain other individuals or small groups. An "open clique" is a contradiction in terms. As with all modules, the interactions between members of the clique are on average more frequent than between members and non-members. The result is that there is more opportunity for the development of mutual trust among clique members than there are among members of the average module.

Team members probably learn to trust one another as much as do members of a clique, but they may do so primarily in the context of the team in control of its collective purpose, whereas the clique may have no collective purpose. In its place are a variety of collectively controlled perceptions for which the clique members have similar reference values and similar perceptual values at any particular moment. Clique members may have many common purposes, an entire profile of collective control, as opposed to the one main purpose of a team. Their collective reference profile might be said to define a "personality" for the clique, in the same way as a sufficiently extensive and sufficiently stable reference profile for an individual defines the individual's personality.

The trust among clique members has a wider range of applicability than that among team members. A team member who has an invisible rabbit companion may or may not be trusted to have such an actual companion, but it is irrelevant to the value of the member to the purpose of the team because its presence or absence seems not to influence his or her performance on the field of play.

On the other hand, a clique member with an invisible rabbit companion risks being ousted from the clique — being perceived by clique members as not belonging — because the other clique members may perceive him or her to be untrustworthy. Unless, of course, the other clique members believe in the invisible rabbit's existence, meaning that they include the invisible rabbit in their models of the way the word is, in which case those who do not believe are likely to be excluded from the clique because

perceptions the clique members control using protocols that depend on the rabbit will fail with an unbeliever.

Chapter IV.9. Power and Political Parties

The key point about collective control is the obvious one, that a group of controllers pulling together have more power than any one of them could have alone. What is less obvious is the point that McClelland (1993) made in introducing the idea of collective control to the small community of researchers in perceptual control theory — that the same is true even when the controllers pull in opposed directions. The difference is that though in the latter case the CCEV does not get moved to a point where either controller wants it to be, it is nevertheless equally difficult for any one individual in a collective to influence.

Collective control is able to control an abstract variable we perceive as "Authority". Authority is almost always a property of a Role rather than a person, dictators who employ a "cult of personality" such as Germany's Hitler, Russia's Stalin, China's Chairman Mao, being notable 20th century exceptions.

People control a perception of a person as, say, a policeman, the Role, rather than the person playing it. By virtue of collective control of the authority of that Role, control very like collective control of the meaning of any word in any language, the policeman can perform certain actions that are collectively not permitted to a random individual. What actions these may be might differ in detail from one person to another, but in general they agree within a community. The scope of those actions is officially determined by a set of collectively controlled variables we call "laws", but the degree to which a policeman can effectively exercise that authority is itself collectively controlled by the community and the social environment within which he acts.

In a social context "power" or "worth" (the overall ability to control one's perceptions) is affected by the availability of atenfels such as money, by individual skill in using the atenfels to control perceptions, by environmental circumstances, but also most prominently by the authorities that are among McClelland's maintained stabilities: to command, to require obedience, to alter the availability to other people of different atenfels, and to delegate authority. None of these things are available to an individual to whom collective control has not conferred the authority to use them.

It is in this context that we should understand how Ben Franklin's comment to his fellow conspirators who may have had different ideas about how to achieve independence from Britain: "*We must all hang together, or most assuredly we shall all hang separately*" makes sense. By "hanging together", the collective had much more power to control their perceptions, even perceptions for which they might have different reference values, than they would individually.

Moreover, the Colonial Power of Britain had the collectively controlled authority, vested in colonial governors, judges, and juries, to hang people convicted of sedition, which all of them would presumably be if they did not act as a collective. To control for people not to leave the collective was important for the maintenance of the power of the collective. And so we begin by considering this kind of problem.

q43.1 Political Parties and The Middle Ground

IV.9.1 Teams and Political Parties

Team competitions pit two different virtual controllers against each other. In, say, a soccer game, both GVCs control the same CCEV, the number of goals for team A minus the number of goals for team B, as suggested in Figure IV.9.1. In a Parliament or Congress, the teams are political parties that control a variety of CCEVs, some of them in conflict, some of them cooperatively. Whatever kinds of teams are competing, from pickup schoolyard sports to coalitions of nations, the same basic considerations apply.

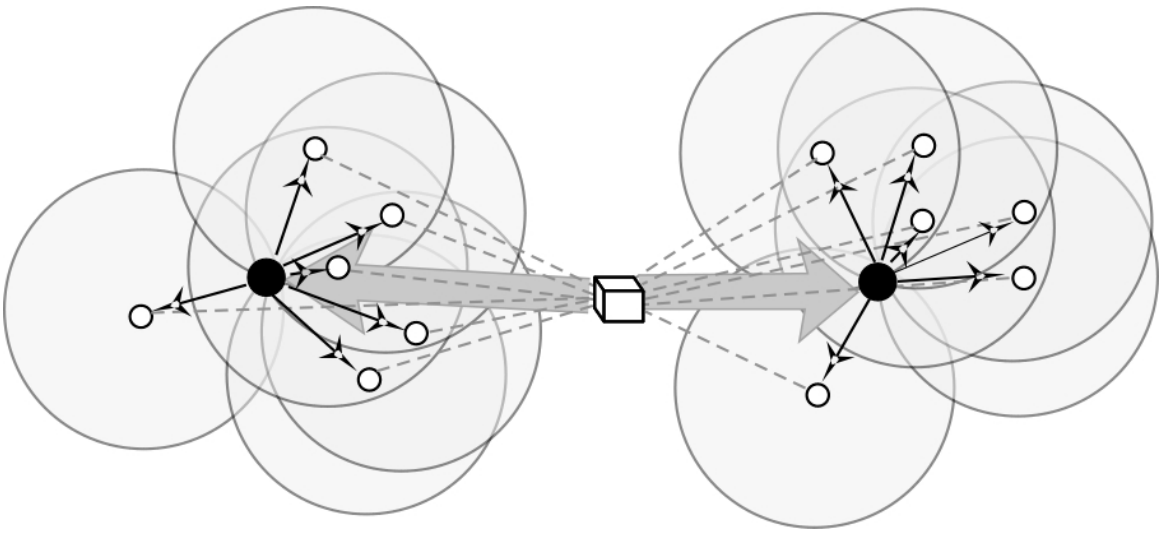

Figure IV.9.1 Team competition. The two teams are in conflict in the game, just as two individual controllers are if they control their perceptions of the same environmental variable at two different reference levels. The teams might be in a sporting competition, or they might be political parties or different nations claiming the same piece of territory. The black dots represent reference positions for the CCEV for the two virtual controllers that is within tolerance bounds for all the team members, but not necessarily where it would be if the members competed within the team.

Figure IV.9.1 represents both conflict and a higher order of collective control when two Giant Virtual Controllers have different reference values for the same CCEV. These GVCs should be classified as manifestations of Coordinated Control (Section II.14.7), since the team members are controlling for perceiving something described by the leader to a reference value prescribed by the leader. It is a "higher order" of collective control because although the influences are still those of the individuals who belong to the collectives, their actions are coordinated only through their membership in the specific collective, team or political party. The person playing the leader Role may or may not act as an individual member of the collective.

Each collective therefore acts more like a single individual than is the case when individuals separately control to move the CCEV toward their own reference value for it. The situation is analogous to the effect of a change of level in the perceptual part of the PCT hierarchy. Even though the single perceptual value is still just a function of the many individual inputs, yet the effect of controlling that value collectively is not the same as the effect of controlling each input independently.

At least in Western democracies, Figure IV.9.1 might represent a conflict between political parties in a two-party state. Even though the individual party members might not individually have the same reference values for a CCEV, to be perceived by their own collective as a good "team player", they must act as though they were all controlling their perceptions of that CCEV to the same value, at least within the tolerance limits of the party leader, who, within the party, has more power to enforce "party discipline" than does any other individual, and in some systems more than the collective of the rest of the members.

A collective consists of all the perceptual controls acting on the same CCEV. One may assume that the distribution of reference values for these many perception in different individuals is likely to be

unimodal, with most people clustered around some central value. Why, then, should we expect that the individuals would segregate into parties such as illustrated in Figure IV.9.1?

There are two complementary approaches to an answer. One is that even if the majority of people are moderate on an issue, so that the existing value of the CCEV is within their tolerance zone, yet there are likely to be outliers for whom the CCEV is too far one way or the other, and the two sets of extremes act in escalating conflict. We have seen in Chapter II.5 and again in Chapter III.9 that an equilibrium distribution of rattling across an organization or a property has many members near an average value but some few outliers on the long tail of the distribution.

For the second approach, we go back to the multidimensional concept of a profile that we used firstly in Part 2 to show how feature patterns segregate into identifiable identities we called "syncons" in the tale of Rob and Len (Chapter xII.11), and then used in describing the protocols of graduate student interactions (Chapter III.2). Now we use the same concept again, and treat the CCEV not as a single variable corresponding to a single controlled perception, but as a multidimensional profile of environmental variables, each corresponding to a different perception, as in Figure II.10.6 or Figure IV.9.3 (below).

Profiles of reference values may be smoothly distributed over the multidimensional space, but it is more likely that they will have clusters of people who think alike on many matters, while other regions of the profile space may be occupied very sparsely. We began to explore why this is probable in Chapter xII.13 and Chapter III.5. Rattling theory (Chvykov et al., 2021) directly explains the tendency of organizations to self-organize in this way. Figure IV.9.2 attempts to illustrate this in two dimensions, by adding a third party and some individuals to the two parties shown in Figure IV.9.1.

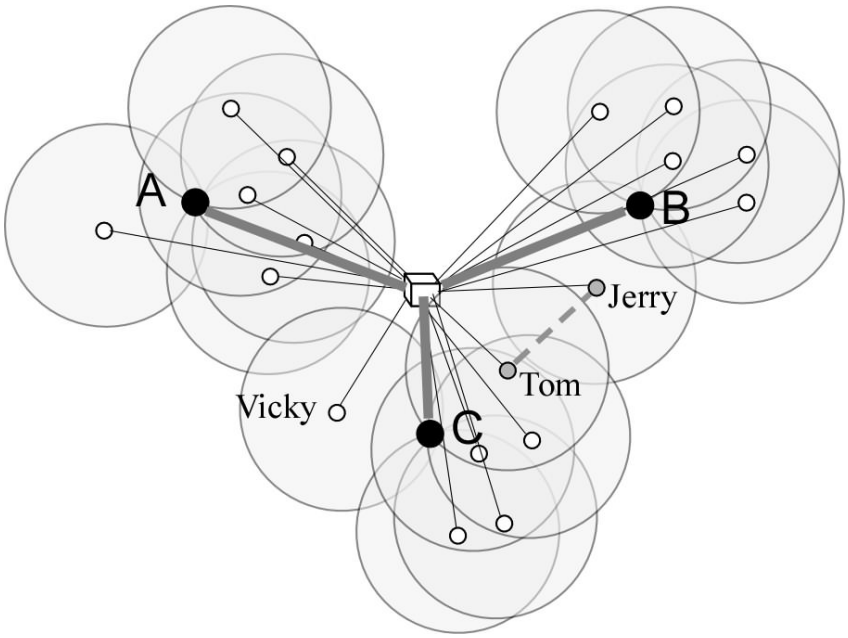

Figure IV.9.2 Collective control in two dimensions by three Giant Virtual Controllers (e.g. Political Parties). Three individuals are singled out for comment. Vicky is an independent thinker but could tolerate being a member of Party C if their reference for the CCEV is at the position shown. Tom and Jerry have a lot in common, but belong to different Parties because their tolerance zones include the reference values for their own Party but not the other's. Vicky has less in common with the other members of her own Party or the other Parties than Tom and Jerry have with each other.

When the reference values and tolerance zones for more features are included in the definition of the CCEV and the Party positions, the situation becomes hard to display on a page, but a profile representation such as Figure IV.9.3, an analogy to Figure II.11.6, may give some impression. The profile, or "parallel coordinates" representation has an advantage over the spatial diagram not only because it can be used to display many different issues or features, but because it can display more properties of the individual controllers. In Figure IV.9.3, in addition to the reference values and tolerance zones of the spatial diagram, it is possible to display the relative importance of a feature, which is the gain of the corresponding control system. In the spatial diagram, this could be displayed as differences in the densities or widths of the lines connecting the controllers to the CCEV, but those differences would be much harder to see accurately than they are in the profile diagram.

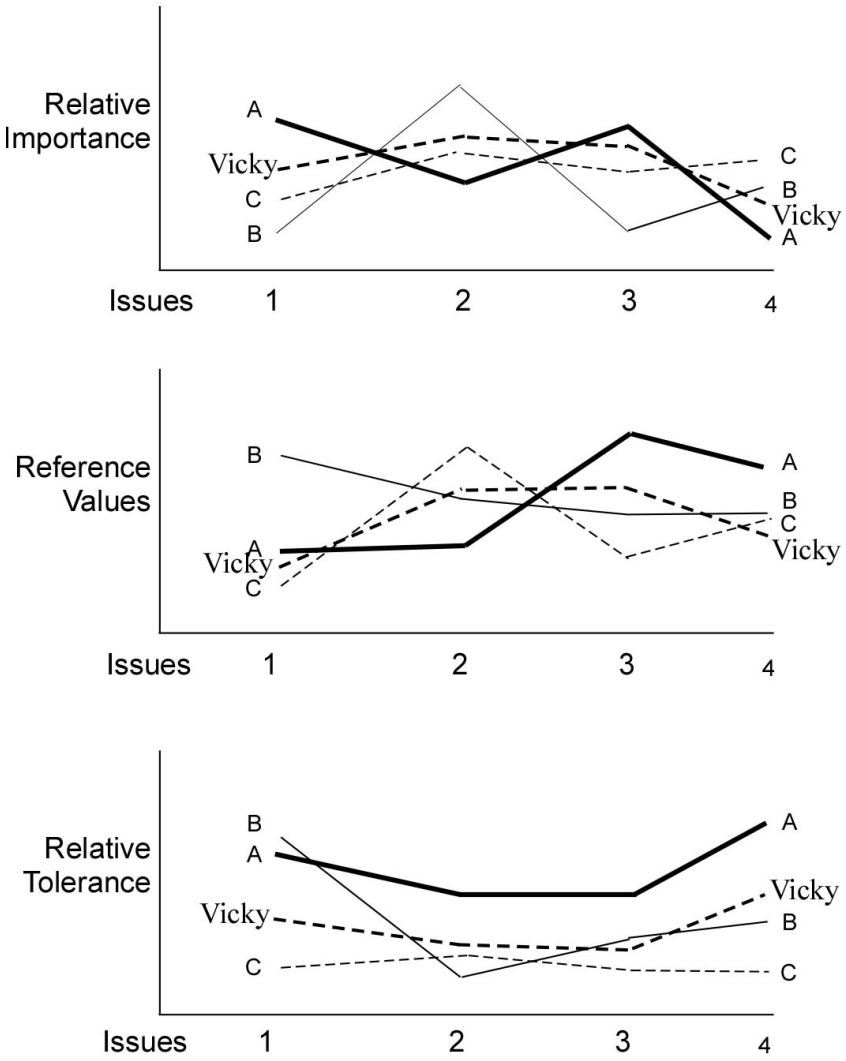

Figure IV.9.3 Profiles of political parties A, B, and C on different issues. The Giant Virtual Controller representing Party B, for example, has a high gain for Issue 2, and has very little tolerance for deviation from its reference value, whereas for Issue 1, although its reference value is quite different from the reference values of the other parties, Party B attaches little importance to that issue and has a wide tolerance for deviation. The "independent thinker" Vicky, a member of Party C with some affinities to A, is shown as an example of the profile set for an individual.

In these two Figures, we single out Vicky, who is in a difficult position with respect to controlling her perceptions of the CCEV profile acted on by the three Giant Virtual Controllers that represent the Parties. If she tries to control on her own, she has very little influence on the position of the CCEV in the multidimensional space. If she joins one of the parties, she increases its Gain as a controller, and therefore its influence on the CCEV, but even if that party were to overwhelm the others and bring the CCEV to its reference profile, Vicky would still experience considerable error.

Vicky will find error in some of her perceptions whatever she does, if her reference values do not change. But she may reduce the overall error by joining the Party and acting as though the reference values of the Party's Giant Virtual Controller were her reference values. She "takes" what she can get,

while “giving” the independence of her action. At the same time, Vicky may act within the Party, as in Figure IV.9.4 to try to move the Party’s reference values nearer to her own. She must now control her perception of what the party should be controlling for, instead of acting to control her perception of the general CCEV.

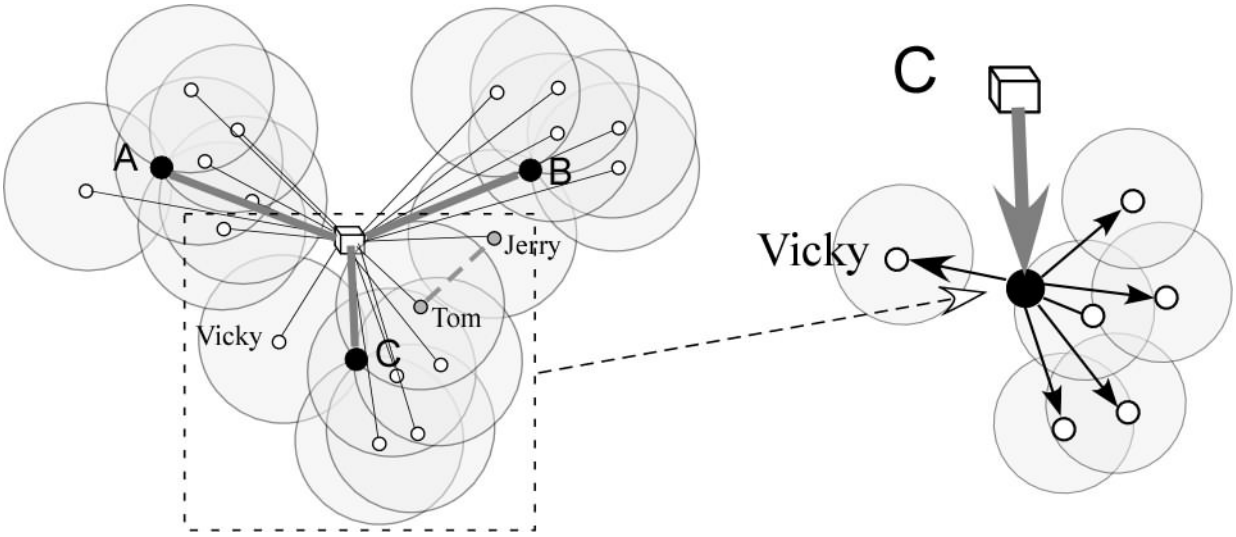

Figure IV.9.4 If independent Vicky becomes a member of Party C, she now uses as an atenfel the Party’s Giant Virtual Controller power to move her perception of the general CCEV nearer to her reference values, but at the same time acts on the Party’s reference values to move them closer to her own, as do all the other party members, making the Party reference values a CCEV in their own right. The tolerance zones of the members for what the Party should be trying to do may be narrower (or wider) than their tolerance zones for the general CCEV.

Once Vicky uses the Party as an atenfel for controlling her perceptions of the general CCEV that all the Parties are trying to influence (the box in the figures), she can no longer *directly* act to move her perception of the general CCEV toward her own, as opposed to the Party’s, reference values. To do so would lead to her being perceived as “not a team player”, and reduce any influence she might have on the Party’s (virtual) reference values. The power of coordinated action is appreciably greater than that of individuals pulling in a range of directions, even if their directions are somewhat similar.

This is, of course, an extreme statement. The reality is less all-or-none. Unless Vicky joins the party’s leadership, she may not be able to act to influence both her own CEV and the CCEV of the party without being seen as a destructive disturbance to the party. But the principle remains. Her CEV reference value and that of the party’s Giant Virtual Controller differ, and acting on one may interfere with her ability to act on the other.

These autocatalytic loops and the developing networks are functionally the same as those of the stable structures in the chemical soup. These have social consequences we develop in Volume III and Volume IV. Among those tendencies are some we have seen in the chemical soup, such as (Section II.2.3)

"schismogenesis" (the splitting of networks into distinct sub-networks that tend both to interfere with each other's stability and to stabilize each other).

Graeber and Wenrow (2021) mention a similar, perhaps functionally identical, mixture between attraction and repulsion in their discussion of tribal schismogenesis. We discuss political schismogenesis in political party structure in connection with the development of a "Vee party" in Section IV.10ff, but here we are dealing not with schismogenesis but with the growth of possible narrative event types in the maturing mind.

IV.9.2 Party Factions and Splits

It is one thing if Vicky is alone in her profile of controlled perceptions relating to the CCEV the party is controlling, but quite another if there are several who agree with her in many respects. The "Three Vees" might initially belong to no party, but were trying individually to move the CCEV in the same direction, ignorant of each other's efforts (Figure IV.9.5a). However, when they learn of the similarity of their objectives, they could choose to coordinate (Figure IV.9.5b). This is like Figure IV.9.4 with Vicky alone, except that in Figure IV.9.5a Vicky has friends and doesn't need to join the C party.

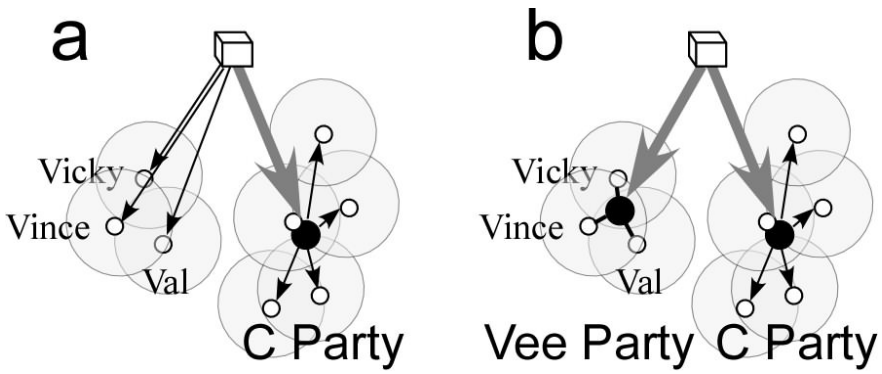

Figure IV.9.5 Individuals with similar objectives (a) may decide to coordinate their efforts, resulting in the same situation (b) as would have been the case had they been a ginger group that split from an existing party (Figure IV.9.7b).

However, the "Vee" group could choose to merge with the C Party, which is inherently more powerful than their small "Vee Party", creating the situation of Figure IV.9.6a. They might not agree completely with the C party's programme, but of the available major parties, the C party is nearest to their own objectives, so they might join it. Vicky and her "V" friends might form a "Vee" ginger group within the C party, acting coherently to influence the Party's reference values (Figure IV.9.6b).

Figure IV.9.5b and Figure IV.9.6c are identical, but they represent different histories. In Figure IV.9.5b, Vicky and her friends form a group because of their shared reference values for the global CEV. Later, they decide that they might have more influence on the global CEV by joining the C party and trying to move the reference values of its Giant Virtual Controller. In Figure IV.9.6c, they have tried and failed to do this, and have split to oppose the C party on at least some matters.

Returning to the situation of Figure IV.9.5a, before Vicky, Vince, and Val knew of each other's reference values, they might have individually decided to join the C party. Only later might they have joined to "speak with one voice" in trying to influence the C party's reference values as a "Ginger group". However they started, they arrive at the situation of Figure IV.9.6b, working within the C party,

but trying to move its objectives, or Figure IV.9.6c, having split from the C party to create a new "Vee Party" after failing to move the C-Party's reference values the way they want.

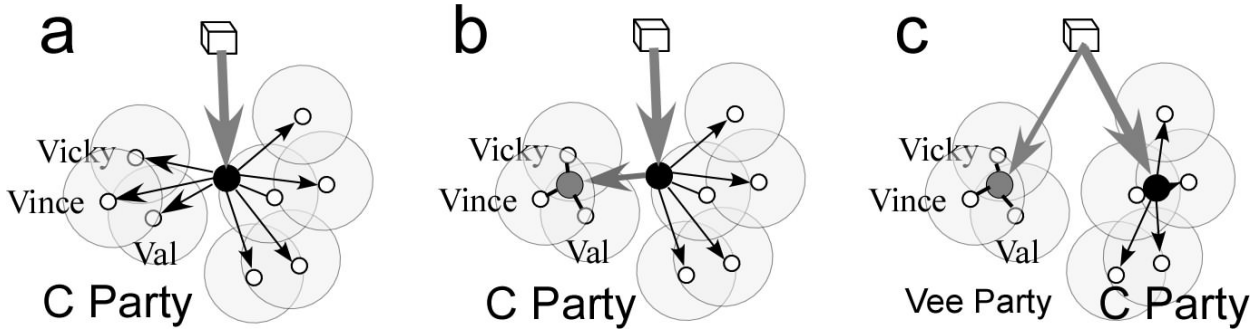

Figure IV.9.6 Splitting a party because one group of members who are in agreement about the changes they would like to perceive in the Party's Giant Virtual Controller reference values cannot get the other members to change. (a) The "Vees" perceptual tolerance zones for the C-Party reference values for the general CCEV (the box) do not overlap with those of other C-Party members, so (b) the Vees agree to work together to influence the C-Party reference values, but (c) the other members have more influence and the "Vees" start to act directly on the general CCEV rather than on the C-Party reference values.

The Vee group may disagree with the objectives of the C group less than they disagree with the objectives of the other major parties, but even so, they may split. But it matters just how their reference values differ from those of the party. If the "Vee" group generally agrees with the direction in which the C Party wants to move the general CCEV, but has more extreme reference values than the Party's Giant Virtual Controller (Figure IV.9.7c), the chances that they would split and form a new Party are rather less than they would be if they disagreed with the direction of the Party objectives (Figure IV.9.7a, b).

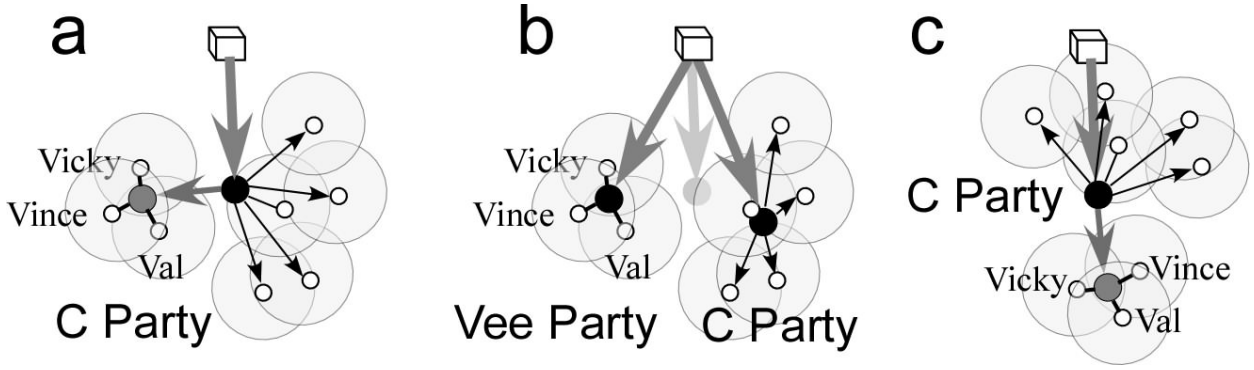

Figure IV.9.7 An extremist splinter group (c) is relatively less likely to split from the Party than is one that differs to the same degree from the Party reference values but would prefer a different direction of change (b).

In the discussion so far, every individual has had the same influence as every other on both the global CCEV and the local (Party reference profile) CCEV. In most practical cases, individuals have varying powers to influence the CCEV, whether we are talking about political parties or any other collective control system. In extreme cases, one member is a "boss" who is able to get the members of the collective to accept reference values he or she provides. In many political parties the boss is the Party

Leader, and the trade that the members make is that by accepting the Party reference values, they collectively have more power to influence what happens than they would by acting individually.

IV.9.3 Elections and Power

In most of the world, one of three governing systems are used: personal or one-party dictatorship, two or three parties that alternate in governing one at a time, or shifting multiparty coalitions. Only in rare or small governing bodies are any other models used. Each of the three is represented among the major nations today, but the issue at hand is not the analysis of current politics. It is to consider how PCT can serve as a basis for such analyses.

In Figure IV.9.6c and 42.6b "The Three Vees" formed the "Vee Party" because their influence on the general CCEV was stronger if they exercised their influence directly as a group than it would be if they acted indirectly by attempting to influence the reference values of the C-Party, or, as in Figure IV.9.5, if they acted individually. Whether this is the case depends on how the culture distributes the rights to use atenfels. In Figure IV.9.7c, the extremist "Vee group" would be unlikely to split until the C-Party was successful, because the main body of the C-Party is pulling in the same direction as they are.

In most cultural groups, from families and clubs to nations and groups of nations, some subsets of people have more rights than others. In the traditional Victorian English family, and in some places in today's world, the father ruled. "Ruling" in this context means that the rest of the family were forbidden to act in some ways, and required to act in others, according to the father's protocol displays. From a PCT viewpoint, actions are externally visible manifestations of the use of atenfels, so "ruling" becomes a right to allow, require, or block access to certain atenfels.

Shifting our viewpoint up several levels to a nation, almost always a government "rules", defining forbidden or required atenfels by passing laws. As we discussed earlier, the government is likely to be able to do this because the collective control of the culture has assigned the rights to them. Perhaps by free and fair election, perhaps by the use of Leo the Leader's use of the Big Lie and by careful use of propaganda to create a desired Perceptual Reality in many members of the public.

Not all governments rule by having the rights to permit or forbid atenfels assigned to them by collective control, of which one manifestation is an election. Some take or keep power by force, despite that most of the people would prefer a different government, but for now we consider those who have the rights by collective control. Figure IV.9.8a depicts the situation during an election campaign, in which the general CCEV is the identity of the Party to which will be assigned the rights of government. Figure IV.9.8b shows the situation after an election won by Party A.

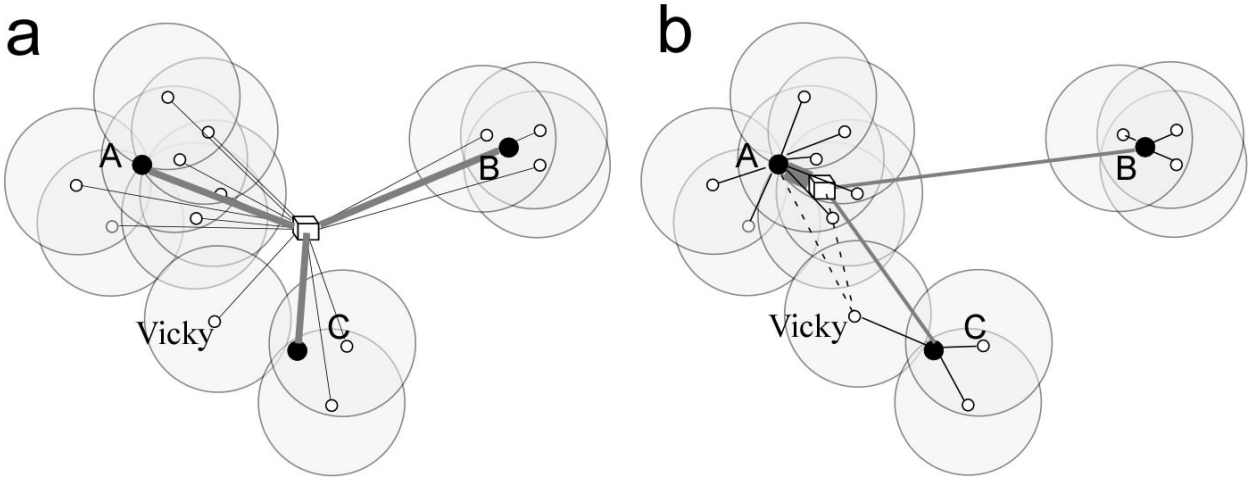

Figure IV.9.8 In an election (a) the voters act to move the immediate local CCEV (the identity of the party to form the government). Party A has more voters than the other parties, so after the election (b), it is able to move the general CCEV near to the reference values of its Giant Virtual Controller, while the other parties have very little influence on the general CCEV. After the election, there is a large imbalance of power, so what does Vicky do?

Figure IV.9.8b suggests the shift of power among the Parties after the election. Collective control has given Party A the rights to move the general CCEV to the location of its local CCEV, and Parties B and C have little influence on it. Independent-minded Vicky, who joined Party C in the hope of influencing it to use its collective control power to pull the general CCEV nearer her reference values, no longer can have even that influence on the general CCEV.

She has two possibilities of getting more influence on the general CCEV. She could leave Party C and join Party A in the hope of moving its reference values closer to her own, or she could try to influence the general CCEV on her own, possibly with the assistance of other independent thinkers who agree with her. This latter group, if it comes to exist, could be a NGO (non-governmental organization), subject to whatever atenfel permissions and prohibitions Party A chooses to define. In the former case, transferring her team membership from Party C to Party A, Vicky would probably be perceived as “not a team player” and would have little influence on the local CCEV of Party A. Either way, Vicky now has little power.

IV.9.4 Representation, Coalitions and the Convergence of Power

It is not always true that the result of an election is of the kind suggested by Figure IV.9.8. A result in which one of the parties gains all the power occurs only in electoral systems like those of North America and the UK. In many countries the usual result of a free and fair election is that no one party has the right to determine the value of the contested CCEVs., as illustrated in Figure IV.9.9. Coalitions must be formed among the parties, in much the same way as individuals form parties by agreeing to work together to augment their collective power while tolerating CCEV target locations that may not exactly correspond to their individual reference values.

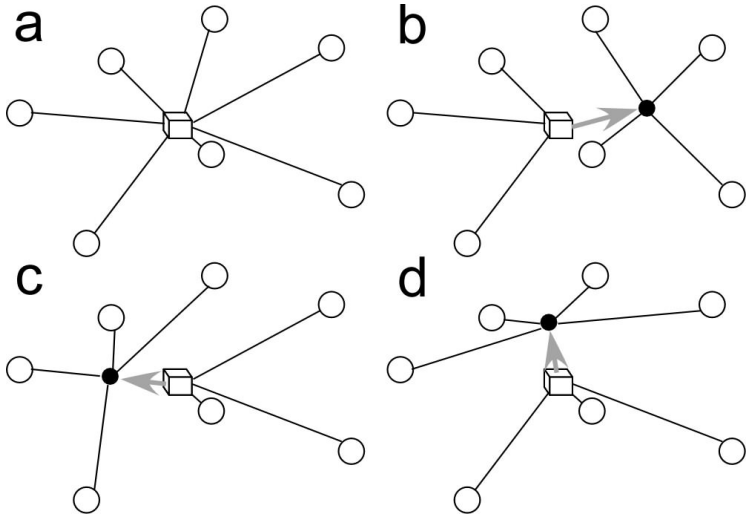

Figure IV.9.9 Various coalitions might be formed after a multiparty election. (a, top left) The election provided seven parties with seats in a legislature, no one of which can move the CCEV when acting alone. (b, c, d). Different groupings of the parties would, by acting together, acquire the right to move the CCEV, but only if they tolerate it moving closer but not entirely to their reference values. In these diagrams, the party represented by the uppermost circle could join any of the coalitions. The coalition in (b, top right) would be least likely to split, but the one in (d,bottom right) would bring the CCEV closest to its own reference value but at the cost of fragility because of the widely differing references of two of the four partners.

As Figure IV.9.9 may suggest, the net result of the formation of coalitions is that the CCEV is unlikely to change very much as the coalitions change, whereas in a winner-take-all election system extreme changes after an election are quite likely (almost all of the parties in Figure IV.9.9 that obtained the right to move the CCEV would want to move it further than any of the illustrated coalitions would be able to do). It has been said that the Italian government before 1994 was perhaps the most stable in Europe, though it changed Prime Ministers almost annually.

The reason was that although the parties forming the governing coalition kept changing, the central core of the policies agreed by the coalition parties never varied very much, as would be the case in Figure IV.9.9. After the "Second Republic" change of the Italian constitution in 1994 that reduced the proliferation of minor parties, policy changes became larger and more abrupt, as they usually do in the English-speaking North Atlantic countries after an election has led to a change of government.

IV.9.5 "Divide and Conquer"

A party split into a "Vee Party" and a "Cee Party" in the way we described in the last Chapter is weaker than is the original unsplit Cee Party. Although Vee and Cee agree on much, to keep the distinctiveness of the two Parties, agreement will tend to be de-emphasized, whereas areas for which they have different reference values will be of relatively greater importance. Although the Cee party members may control for the members of the smaller Vee party to rejoin, the Vee party members will be controlling for not rejoining. This is a classic PCT conflict situation on the surface, but is it one in reality? Perhaps, but not necessarily.

Both the Vee Party and the Cee Party exist as modules in a network of controlled perceptions, each of which is homeostatic in that the set of collectively controlled perceptions in each module forms at least one self-supporting homeostatic loop. The two parties have the same virtual reference values for the same perceptions over a large part of their separate loops, meaning that collective control for those particular perceptions has higher gain than for the parts of their loops where they differ. Each loop thus participates in catalyzing part of the other loop. The question of conflict hinges on whether the Cee party controls with enough gain a perception of Vee party members rejoining the Cee party while at the same time the Vee party members control for that not to happen.

The potential conflict may or may not act as an anticatalyst in the two loops. If it does and reduces the absolute loop gain of either below unity, that loop will tend to disintegrate, and the party will fold. But on the other hand, if it does but the absolute loop gain stays above unity, each network will tend to be stronger when the other is subject to external disturbances, so that the two will drift apart. The schism then evolves into conflict, but not the classic conflict. It is a different kind of conflict, formally similar to a protocol, in that each is controlling a different variable, the perception of the existence of the other as opposition, with a reference that the other should not exist. We see this especially in religious schisms, such as between Sunni and Shiite Muslims, in Europe between Protestant and Catholic Christians over several centuries, or in the USA between “Trumpets” and old-style Republicans.

On the other hand, in the areas in which the Vee party and the Cee party agree, disturbances such as attempts by a distinct “Rah” party to influence their common CEV should result in the Cee and Vee party acting in concert to oppose the Rah party, in yet another example of modular structure.

IV.9.6 Political Parties and the Magic Number Six

One of the differences among the political systems of independent nations is the number of political parties incorporated into the parliamentary, congressional, dictatorship, or other ways of deciding what behaviours are allowed or disallowed under what circumstances. When the system is a dictatorship, in which the reference values for the action components of the political system (army, police, bureaucracy, etc.) are set by one person or junta, the nature of what is required, allowed, or prohibited is whatever the dictator says it is at any moment, and can change with his (usually male) mood of the day. The structure is maintained, even though the details of how the submissive population should and should not act may be changeable.

At the other extreme, we have a legislative body that contains many parties that differ in the virtual reference values of their collective supporters for objectives along many dimensions. In the period after World War II, the Italian government was of this kind, with many changes of Prime Minister, sometimes more than two in a single year Political writers called it unstable, but from the viewpoint of a disinterested external observer, it seemed to be one of the most stable in Europe, since the policy directions of the government were very little influenced by which of the centrist parties, with whatever coalition parties, provided the Prime Minister. From my standpoint of 2022, I would say that the Italian parties before the change of constitution together acted to form a Giant Virtual Controller with controlled perceptions and reference values that were little influenced by which party was nominally in charge.

Party politics and national or regional governance are far removed from Kauffman’s toy universe of two-dimensional blocks of black-or-white cells each of which determine its colour dynamically according to the colours of N neighbours at the previous time-step. But the principles that led to Kauffman’s finding the “Magic Number Six” are universal, just as are the principles that lead to the very concept of perceptual control, to PCT motifs such as conflict and rigidity, trade and tensegrity (both of the former pair are currently (2022) prominent in the political structure of the USA).

Those principles are the influence on some state of a “cell” due to the combined (collective) influence of neighbouring “cells”, and the relative stability of collections of different numbers of “cells”, from a final state of rigidity when the collections are too small, to chaos when they are too large. A “cell” here may represent the value of a scalar variable averaged over many “sub-cells”, or a multidimensional collection of such variables. If a “cell” represents a person, each dimension might represent a scalar perceptual value controlled by that person, such as the ease of the person’s access to food.

Unlike Kauffman’s toy Universe, in the political structure of a society, whether the cell represent an individual, a collection of individuals, or a set of controlled perceptions, each “cell” has a substructure that is likely to incorporate simpler “cells”. Within an individual, the cells may represent perceived values of some set of “truths” of the social environment. These “truths” may be influenced by the perceptions of similarly perceived states of the environment communicated by the limited number of “neighbours” within a module. Here, on single dimensions, the “Magic Number Six” comes into play. If there are too many influential neighbours and they differ, a person is likely to think “I am confused”, and to settle on no fixed belief. That is one way of imagining Kauffman’s finding of chaos with too many influences.

What we are arriving at is the notion that any group that we might call a “leadership circle” for a group we might consider “political” should be no more than about six if it is to be reasonably stable, and not many less than six if it to be quick to change to adapt to changing circumstances. Do effective democratically elected political parties, as opposed to autocratic hierarchies, operate according to these principles by virtue of having been rattled so that they reform towards increasing effectiveness on the well-being of the majority of the population? Let us consider that, without initially referring to any “Magic Numbers”.

IV.9.7 Apostasy, Defection, Betrayal

Ben Franklin’s co-conspirators may each have controlled in imagination a perception of themselves hanging, with a reference to avoid that perceptual value. At the same time, they might also have imagined a perception of it not happening because they had controlled for perceiving themselves to act in coordination as a team. In other words, each might have controlled a self-self-image of acting in coordination with the group.

Even though none of them were at that moment perceived by the others as a defector, yet Franklin controlled for them not to allow themselves to be so perceived if they had been inclined toward defection. they would have been controlling for their other-self-image to be as a strong member of the group. Each conspirator, not just Franklin, would have some perception of the group’s aims and would control for none of the others to defect. At that stage of preparing for revolution, one would expect each member of the group to perceive that if one of them defected, all of them would be imprisoned and probably hanged, and therefore to control for perceiving all the other members to be staying in the group.

If the ability to specify rules of behaviour — Authority — is a CCEV, nonconformist people may run into problems that lead to reorganization, their own or that of members of the “authorizing” collective. Reorganization by a protester might take the form of changing their way of controlling the affected perceptions, or might lead the person to leave the domain of influence of the authority — for example leave the Church, emigrate, or resign from the Club. Reorganization in enough individual members of the authorizing collective would be likely to weaken or perhaps even destroy that Giant Virtual Controller. In some versions of Islam, for instance, apostasy is punishable by a collectively controlled penalty of death.

Tensegrity structures show resilience. When two Giant Virtual Controllers are in conflict, the members of each act to bring the conflicted CCEV, in the form of a CEV corresponding to a perception they control, toward their individual reference values. If a member of one of them changes their reference

value for that perception, it lowers the gain for the Giant Virtual Controller, making it easier for the competitor to move the CCEV nearer to its own virtual reference value, reducing the influence on the corresponding perception by the diminished GVC.

When an individual hierarchy finds its ability to control reduced, the rate of reorganization rises. Would this be the case when something similar happens to a Giant Virtual Controller? Not directly, since the GVC itself is just a single controller with no connections to reorganize. But the members of the GVC are not. They can reorganize, but how they reorganize is likely to depend on what they are controlling. Do they perceive and control the GVC's existence in the sense of perceiving themselves to belong to a group that has some coherent objective and controlling to continue to perceive themselves as belonging, as in the case of Ben Franklin's group of revolutionaries? Or do they simply control a perception that nobody but an Analyst can see happens to be close to perceptions controlled with similar reference values by other people? How the members of the GVC act toward someone who ceases to control the perception related to the CCEV to that common reference value depends on the answer to this question.

If the Giant Virtual Controller exists without the members controlling a perception of belonging to it, then the defection of one member is unlikely to be perceived by the others, so they will not act to prevent the defection. On the other hand, if the members do control for perceiving themselves as members, and if they can perceive whether another person is or is not a member, they can perceive a defection, and may control to prevent it and to gain new members.

How can a GVC control for members that are part of itself not to defect? The GVC that does so is not the one from which a member might be defecting. It controls a different CCEV, namely the membership status of the participants in the main one. The "non-defection" GVC membership consists of those members of the main GVC who do not want to see others defect, and may include people who are not actual members of the main GVC, but who nevertheless want that GVC to sustain its membership. For example, if there are three parties in a first-past-the-post election, party A might want to try to prevent individual members of party B defecting to party C, even though the reference profile for party A is far from the reference profile for party B.

How can anyone control for having anyone else do or not do anything in particular? We talked a little about this when we discussed protocol form. Protocols exist because the partners can display something about their states, their reference values, and their current perceptions that allow the partner to perceive what they want and that they want the partner to provide it. Groups exist because the group members display something that identifies them both as having similar reference values for perceptions of CEVs that can combine to be a CCEV, and as controlling for belonging to the group. If a member displays a different value for self-perception of group membership, or for the reference value for some perception collectively controlled by the group, the person ceases to be seen as a reliable group member, and perhaps even as being a member.

The display may not be active. Failure to show up for church without an explanation perceived as acceptable by the other members might be sufficient to disturb the collective perception beyond the tolerance zone of some members, or the tolerance zone of an authority tasked with controlling perceptions of "proper behaviour" by the members. The resulting action depends on many things, as does the action that compensates for a disturbance to any controlled perception. In different times and places "heresy" might even be fatal to the heretic. At other times and places, the "punishment" might be only a slight disturbance to some perception controlled by the wrongdoer, such as a mention by the priest that his church attendance has been a little erratic.

IV.9.8 Social Control Systems and Defection

An Analyst would see the kind of defection feared by Ben Franklin and by the members of some religions as different in kind from a defection from a social control system (quitting a job, resigning a position). The former might result in an incremental loss of effectiveness of the group, or its destruction by a stronger power. Either way, the loss is of a person. A Social Control System, however, is structured around roles rather than persons. So long as another person with the requisite skills is available to perform a Role, a social control system is little affected by the defection of a person.

Indeed, with a social control system the defection quite often goes the other way. The business simply shuts down in one place and moves to another place, eliminating most of the persons but retaining most of the roles unchanged. There is an analogy in a living organism. As we live, we discard and replace cells all the time, so that we currently have few of the cells we had ten years ago. And yet we perceive ourselves to be the same person, as do others. The structure is what matters, and we shed no more tears for our cast-aside cells than does the CEO of a relocating business for the cast-off employees.

What a social control system perceives is not what the persons filling the roles perceive. It perceives only whatever its perceptual functions have been constructed to perceive. A business is likely to perceive unit sales numbers, profit and loss, and so forth. Those perceptions are controlled in the usual sense, by actions on the outer world that affect the perceptions. If too many units are sold, the factory cannot supply them, customers are displeased by delivery delays and failures, and the reputation of the company suffers. Maybe there is some department within the organization that perceives these effects (even imagines them), maybe there isn't. If there is, they, too are controllable, maybe by setting a reference value for number of units on offer (perhaps a notice "while supplies last"), maybe by raising the price, maybe by building a new factory.

An organization may incorporate a perceptual function, in the form of a Human Resources Department, that allows it to perceive employee mood. The persons playing the roles are not part of the organization. The roles they play are. The individual persons are part of the environment of the organization, just as are the clients or customers who use the goods and services that are the output of the organization. The interactions between the organization and its employees or members have the character of protocols. If the organization controls for the employees individually to be happy, the organization as a control hierarchy is in the same position as mother Cora controlling for baby Ivan to be happy.

If an organization controls for happy employees, then an action to move the business will create a conflict between the perceptions controlled by this action and the control of the employee mood perception. Similarly if the company, as opposed to the people in the roles, perceives its influence on its local or global environment and controls for an environment in which people can live healthily, it is likely to discover conflicts with some other perceptions it controls. As with conflicts within an organism a Method of Levels approach to their resolution might be able to reduce the conflict. But to do this requires that the social control structure, rather than the persons in the roles, is able to perceive it.

The perceptual control hierarchy of a living organism is reorganized through the intrinsic variable processes with the ultimate objective of acting in ways that enhance the likelihood that descendants of it or others of its kind will exist into the future. Evolved social structures evolve under the same ultimate constraint. They exist because earlier structures did survive in the environments in which they existed. This is not always true of designed structures, which many social control systems are.

Of course, many businesses have an organizational structure that is based on copying the structure of earlier successful businesses. This kind of succession allows for evolutionary reorganization, but because the structure is a controlled variable with those earlier structures as a reference profile, it is not easily modified as the environment changes. Reorganization may occur as the people performing different roles

change, because their skills change, but there are no background “intrinsic variables” whose homeostatic loops include the organization’s perceptual processes and affect the location and speed of reorganization in the structure. We shall suggest, however, that organizational “intrinsic variables” do exist (Section IV.2.5).

The only “intrinsic variable” for a publicly traded business is the legally specified requirement to maximize shareholder value, though that might better be seen as a high-level reference value, since it is a value easily perceived in the day to day reports of stock-market valuations. That value is diminished by the defection of any person in a Role, but more diminished the higher in the social control hierarchy the Role-function sits. It therefore pays the business to do what it can to induce high-level persons playing roles not to defect, while at the same time perhaps defecting from large numbers of people playing low-level roles.

As might be expected, “to induce” implies that if the action to counter some disturbance to a perception controlled by the person is to defect, the “inducement” sets up a conflict with some other perception the person controls. Often, in business, an assumption is made that all high-level roles are performed by people controlling for having a very large amount of money. The inducement is assumed to be an offer of money from some other business, and the conflict resolution is to offer even more money if the person will stay.

The result is a positive feedback loop, as with the classical PCT conflict; two social control systems are controlling for the person to be at two different reference values, namely playing the current Role for company X versus playing a Role for company Y. The resulting escalation produces income levels for senior executives that far exceeds, perhaps by orders of magnitude, their “worth” to the company, as we defined “worth” in Section 6.2 — the total variety, range, and precision of perceptions controlled by an organism.

A social control structure does not function without people. Some roles may be filled by machines, but not (yet) all. The skills of the persons determine the functioning of the roles. Everything done by a Role is the result of a person controlling perceptions by acting, and persons may act outside their Role as well as within it. When we say that the business must perceive something, this does not preclude the possibility of a person perceiving something the business control structure has no perceptual function to see, and reporting it outside of the Role the person plays. That report, however, will go to a Role, even if that Role is the CEO reached through layers of persons playing different levels of management.

The power of a CEO who provides reference values at the top level of a social control system such as a business is usually greater than that of a person playing the Role of “leader” in an unstructured collectively controlling group of the same size. In many businesses, the CEO Role has more worth to the business than any other Role in the organization. This doesn’t mean the CEO is worth more to society than anyone else, but it does mean that the Role of CEO can use more roles in controlling more perceptions produced by the organization than can any other Role in the organization.

According to law, at least in the USA, businesses seen as control systems are allowed to have only one top level reference value, or perhaps one intrinsic variable, depending on whether it is seen as affecting day to day operations of the business or its longer-term changes of structure and personnel. Businesses usually are required to control for maximizing profit as a means of maximizing shareholder value. What this means is that in case of conflict between control of profit and control of any other perception, they should resolve the conflict in favour of profit.

Corporations have been likened to sociopaths for this reason. Although as persons some CEOs would like to have the company act to improve the life of their employees and of other people and living things, if they do so in their CEO Role and accept that doing so will decrease the value to shareholders, they are

likely to be replaced in the Role. In this sense, corporations are almost required to defect from any group that has the objective of improving the environment for life. The CEO who does not control for the company to achieve maximum shareholder value will effectively have defected from the company.

IV.9.9 Power, Individual and Social

What is the nature of psychological or social "power"? We have addressed this question before. Now we take another look at it. According to PCT, the answer is quite simple. The more different perceptions you can control well, the more power you have. Above, we called the weighted sum of controllable perceptions a person's "worth". If, in a conflict over the use of atenfels or the objects that provide them, you are able to use them and your opponent cannot, you have the greater power, at least in that particular situation. The more atenfels you can access and have the skill to use, the more power you have. In different environments, you will have different levels of power, because what perceptions you can control depends on the availability of atenfels, and atenfels that are available in one environment may not be available in another.

Reorganization under a range of different environmental circumstances adds to the variety of atenfels you can use to the same end, and enhances the number of different perceptions you might be able to control, but in itself, reorganization does not necessarily increase your access to the atenfels you develop the skill to use.

There are two measures of power, relative and absolute, both of which depend on the environment of the moment. Relative power is a measure of how your access to atenfels compares with someone else's, and the extent to which the other's use of atenfels precludes yours and vice-versa. Social control systems usually have considerably more relative power than individuals, because the power of their coordinated collective control, often in the form of money, far exceeds that of most individuals in any conflict.

Absolute power is perhaps best conceived as the product of the number of different perceptions you can control, the precision with which you can control them, and the variety of ways you can use to control them. This product measure is your individual absolute "worth", in the environment of the moment. "Punishment" is always a reduction in absolute power, whether it be grounding a teenager, locking up a criminal, or imposing a fine on an individual or a company. Few social control systems have more absolute power than most individuals, because the social control system is built to control only a relatively small number of perceptions that are related to the central purpose of the organization.

The creation and acquisition of atenfels may involve invention, but often is an action controlling a perception of the functioning of a control unit controlling a different perception. One puts a plank across the brook not just to perceive a plank across a brook, though to control for perceiving a plank across a brook is indeed possible. One puts the plank across the brook because one can imagine controlling a perception of being on the other side of the brook by walking across the emplaced plank.

Some atenfels are not very useful in particular circumstances — a plug-in space heater is not very useful for keeping warm on a dog-sled trek across Antarctica no matter how skilled you are in using it — but on balance each new atenfel is likely to increase the perceptions that one could control when one acquires the appropriate skill. The poorest person alive today may have more absolute power than the richest person alive at the height of the last Ice Age, or even a few centuries ago. Absolute power, however, is often less important than relative power, since most of our life involves social interactions of various kinds.

Which brings us back to "rights" and "ownership" (Chapter III.9). At least in North American culture, if you own the plank you have the collectively controlled right to determine which, if any, of the object's

affordances to permit others to use, if they have the skill to turn the affordance into an atenfel. You may allow others to use the plank you own as a bridge over the brook, or you can take away that right, reducing their possibilities for perceptual control.

If "power" is the ability to control one's perceptions, then the more atenfels one can use, the more power one has. In particular, if you are controlling for having many atenfels, then having an atenfel that aids control of that perception increase your ability to enhance your power. As they say, "money breeds money". You can use money to buy control of a company and the social control system that it embodies. You can use money as an atenfel to get politicians to change laws in ways that allow you to get more money. You can use laws to gain ownership of other affordances and prohibit others the use of them. You can use police to enforce the laws that give you access to affordances while denying them to others.

There is no intrinsic limit to the number of atenfels available to anyone, since invention continues to catalyze the production of new ones, so the acquisition of absolute power by one person does not necessarily imply the reduction of power available to another. But if there is conflict over the use of some atenfel, that conflict is more likely to be won by the person or social control system who has the power to use laws and lawyers as atenfels than by the one who does not. Money does not only breed money, it also can be used to inhibit other people from acquiring money. Monetary wealth is better correlated with relative power than with absolute power.

Social control systems probably have less absolute power than most individuals, because they are designed or have evolved to control fewer perceptions than the individual. But in any conflict over a limited set of controlled perceptions, the social control system will usually overwhelm the individual. Whether the individual perceives that limited power as oppressive usually will depend on what perceptions the individual person controls, and whether those perceptions can be well controlled without direct conflict agains the Giant Virtual Controller that is the Social Control system.

We have discussed two collectively controlled stabilities that are catalytic atenexes: money and language. Neither of these would be very useful without a third, "information", about the current state of the world — the entire set of your perceptions. The aphorisms "Information is power" and "money is power" attest to the popular recognition of the importance of both in everyday life. The ever-increasing amount of both overt and covert information-gathering by social control systems including states and businesses is a symptom that we treat further when discussing democracy, autocracy, and fairness in Chapter III.9.

In the atenfel classification of Appendix 2, "language" is Path-Catalytic-Unlimited. No matter how much you use it, the remaining supply is unchanged. The other two are Path-Catalytic-Limited. "Information" is limited because the situation may have changed since you last looked so the amount you have about the environment is limited by how quickly you can acquire it compared to how quickly the corresponding uncertainty would otherwise grow, and "money" is limited because if you spend some, you have less.

It is much easier to control your perceptions if you control a large store of the limited catalysts than if you have very little, particularly if you are controlling a perception that shares a CEV with a perception someone else controls, a condition of conflict. "The big bucks hires the best lawyer". The one with the "big bucks" and the good lawyer is likely to win a well-defined conflict against a large collective of people who individually have little power, as suggested in Figure IV.9.10.

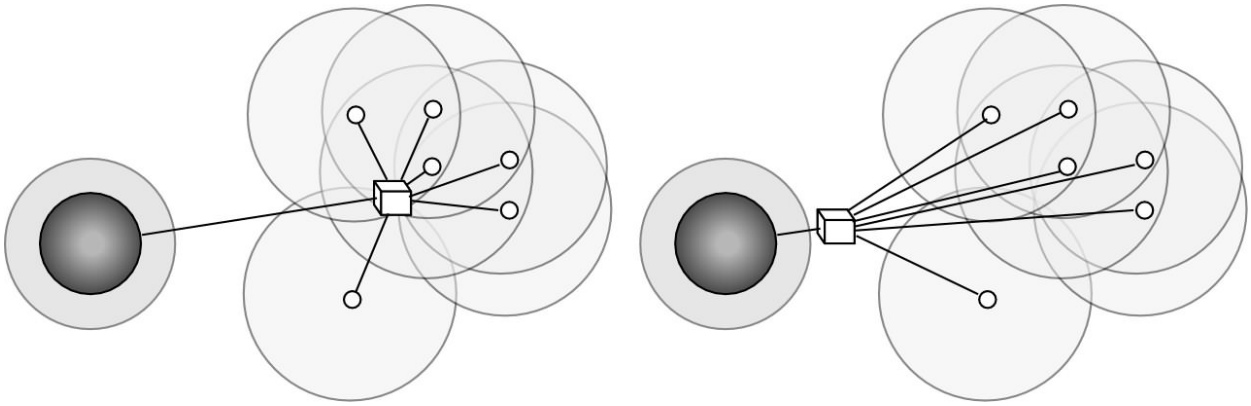

Figure IV.9.10 Although the Giant Virtual Controller may have much higher gain than any of its individual members, nevertheless a single very powerful control system can move the CCEV to its own advantage. Compare this with Figure IV.9.1 or Figure IV.9.8b. Here the "Dictator" might be a party leader who determines the reference values of the Party, or the CEO of a company. Either way, the ability of the Dictator to influence the CEV depends on the support of the team, which is used as an atenfel so that the Dictator takes the place of one of the teams.

We assume that in this conflict in which the one with the money hires the better lawyer, each party controls for a perception that collective control of the "right" assigns the right to them. In other words, though they are in conflict, nevertheless they participate in the same Giant Virtual Controller for which the CCEV is the ownership relation of the right in question. But this need not be true. Quite possibly one of them does not control for the same perception of rights as the other. For example, a communitarian who believes in common ownership (e.g. Marx, 1848) will not have the same concept of ownership as a strong capitalist, and will probably not accept the collective perception of the result of a conflict of ownership. Such a person might well have no error in a controlled perception of self if they were to steal from a profitable organization such as an insurance company, or from a person they considered improperly wealthy.

Chapter IV.10. Autocratic and Civil Government

The world contains several different kinds of formal government — government in which division of authority among Roles are defined, without relation to the identity of the person or persons who might play any of them. Many developed locally by incremental evolution, or by local revolution. Others, perhaps the majority, developed as a calming process following shocks such as war or colonization, which intruded "foreign" cultures into the local environment. A few, such as the US Constitution, L have been created by collective control following a written document designed to improve on the pre-existing form of government. Let us look at some of these ways of calming the rattling inherent in ungoverned anarchy.

In the previous chapter we examined electoral democracy, in which distinct political "parties" vie for more popular support than their opponents at election moments. We will not pursue that form of government here any further, other than to suggest how and whether its introduction might (or might not) have reduced the rattling of the overall organization of the people primarily affected by the actions of the resulting government, at least in the period after the shock of a change in the governing party.

IV.10.1 Monarchy and the Ombudsman

On various occasions in the history of civilization, ruling monarchs and autocrats have been overthrown and often killed. Famous names include Charles I of England, Louis XVI of France, Nicholas II of Russia, Julius Caesar, though he refused the title of King or Emperor, and the list could be extended greatly, going back into the depths of time. In what follows we will use the term "monarch" or "King" to describe any ruling autocrat, whatever the official title, which in modern times has usually been "President". Many other monarchs over the ages have been killed by rivals who wanted the job for themselves.

In earlier times and in different places, the same kind of absolute one-person rule has been a Role of monarchs — kings, queens, and emperors. "Monarchy" actually means approximately "single power". Civil Wars have been fought over what person might play the role in a certain region, the English "Wars of the Roses" of the 14th and 15th century C.E. being one example. In these cases, the population collectively agreed that the role should exist, and the Civil Wars were only about which person should play it.

In the 20th century, at least two autocrats, Hitler ("der Fuehrer") and Mussolini ("il Duce"), took power using the title of "Leader". In the depths of distant times, "leader" might have referred not to an autocrat, but to a person followed as a guide in some pursuits by a group of other people. The leader would have been regarded as more competent than most in, say, route-finding for a hunting posse, but not necessarily in maintaining the health of a cattle herd. Hitler and Mussolini were a different kind of leader, claiming leadership on all matters that might affect the people they "led". At this writing (2022) many countries large and small have that kind of leader, the two most prominent because of the size and access to resources of their countries being Vladimir Putin in Russia and Xi Jing Ping in China. In the USA, Donald Trump in the USA appears to be controlling for joining them.

What, if anything, does PCT add to the understanding of the phenomenon, which is encapsulated in "*Uneasy lies the head that wears the crown*"? Before we address that question directly, consider a more recent phenomenon, the ombudsman. According to a Wikipedia article[44] the concept goes back in China

44. . <https://en.wikipedia.org/wiki/Ombudsman> retrieved 2018.01.07

as early as 220 B.C.E. and in Korea to 670 C.E., but was maintained only sporadically. In Europe, it was used mainly in Scandinavia over the last 500 years, but was officially instituted as a permanent office only about 200 years ago, in Sweden. In the last few decades, it has become common in many institutions from national governments and government departments to moderate sized companies.

So what is an ombudsman, why has it suddenly become so popular after such a long history of appearing and disappearing, and how does it relate to monarchy? I will argue that all these questions come down to an issue we have been discussing at some length — collective control of Authority by different collectives, which results in reduction of some perceptual uncertainties, and hence of total rattling.

An ombudsman is a person who is given Authority to examine the misuse of power (in the PCT sense as well as in the everyday sense of the word) by another Authority that I will call the "Power". The Power might be the CEO of a company, the national Government of a country, a functionary acting on behalf of an agency to whom some Authority has been delegated, a manifestation of collective control, and so on. The Power, in this usage, does not refer to the individual as a person or to the collective as an organization, but to the Authority delegated to the individual in a Role. When the player of the Power Role acts outside that Authority, it is more probable that a judge rather than an ombudsman will be asked to resolve a dispute.

The concept of asymmetric conflict between the Power and a less powerful person is inherent in the concept of the ombudsman, whereas for the Role of Judge it is not, because the Role of the ombudsman (the "Ombud") is to determine whether the Power used its delegated Authority fairly, and to assist the less powerful person (the "Victim") if not, whereas the Judge is to determine not fairness, which involves some perception of the intentions of the parties, but to assess the correctness of the actions of the parties in light of the written law, a purely environmental perception.

Before the Ombud decides whether to side with the Victim to oppose the Power in conflict, there has been a conflict between the Power and the Victim in which the Power has prevailed, and the Victim has asked the Ombud for assistance. As always in PCT, the Ombud will not act unless a relevant perception it[45] controls is disturbed. In the construction of a particular Ombud Role, it is provided with Authority to perceive only certain aspects of its world and to perform only a restricted set of actions. The Victim's request must therefore disturb something the Ombud has Authority to perceive.

If the Ombud perceives the Power's actions to be unfair, the conflict then becomes a classic conflict between the Victim aided by the delegated Authority of the Ombud against the delegated Authority of the Power, in which the CEV that is perceived by both parties has one reference value in the Power, and another reference value in the collective of the Ombud and the Victim. The Ombud and the Victim individually will have their own reference values for their perceptions of the CEV, which are likely not to coincide, as the Victim's reference is likely to deviate further from that of the Power than is the Ombud's reference value.

The limitation on what the Ombud Role (not the Ombud person) may perceive is a limitation that is true of any collectively controlled delegation of Authority to a Role. The Ombud therefore must be allowed to perceive whether the Power's actions were included in the Authority delegated to it. In the case of King Charles I of England, he perceived that his Authority was limitless and had been delegated to him by God, whereas the CEO of a company may instead perceive that his Authority is limitless because it has been gained by his personal prowess. There is little to choose between these two possibilities. Either creates a problem for an Ombud person in how to play the Ombud role.

45. I use the impersonal "it" since a Role such as the Ombud has no gender, and our pronouns in English are inherently gendered. The same applies to the roles of Power and Victim.

In King Charles's Perceptual Reality environment, limitless Authority delegated to an agent by a superior Authority that could not be questioned provided an atenex for control of many perceptions by actions that many people might perceive to be unfair. Indeed, the proximate cause of Charles's rift with Parliament was the imposition of a very small tax that would have had very little financial effect on those who paid the tax, but a tax in support of a project of which they might or might not approve, but on which they had had no say.

No Ombud then existed, but enough people controlled perceptions that one or other of the King's perceptions of his Authority was false, including his ability to impose that tax without their having any say in the matter (the same issue that led to the "Boston Tea Party" and the American Revolution some 130 years later). The result was to induce a conflict-based collective control of the location (in the King or in Parliament) of the Authority to impose such taxes. Both King and Parliament were able to deploy collective controllers, the King's Army and Parliament's Army. These engaged in a civil war with the location of the Authority undecided until the action of the Parliamentary collective Giant Virtual Controller (the Cromwellian New Model Army) was sufficient to overpower the action output (the King's Army operations) of the King. At that point the Authority to impose taxes became vested in Parliament, and remained so even after the Role of "King" was re-established by collective control by the Restoration of 1660, in the person of King Charles II.

The value of the CEV (the ability of the King to act as though his perceptions were true of his environment) therefore took on the value of the people's collective perception, reflected in the slogan "Power to the People". Whereas Charles I perceived his own Worth to be limited only by physical capabilities and the Powers of other nations, Charles II controlled for keeping his own head on his shoulders, and not contesting the authority of Parliament in the matter of taxes.

By killing the person, and temporarily the Role, of "King", the people's Giant Virtual Controller ensured the end of that particular conflict, but not of others. As we saw when we first introduced collective control in Chapter III.1, conflict is almost inherent in collective control. If the opposition collapses, as happened when King Charles I was executed, the conflicts internal to the collective often become manifest. Much of this is prefigured in Figure IV.9.5 and the following Figures.

As history tells, little more than a decade after King Charles I was killed, collective control by the people resulted in his son being offered the newly established Role of King. Cromwell had taken on himself the related Role of "Monarch", which had been inherited by his son, and they had imposed Puritan religious rule, which created error and high rattling in many perceptions controlled by the ordinary people to values different from the Puritan reference values for them. There were two collectives in conflict, one perceiving (in imagination) that to have a King balanced by an effective Parliament would allow them more control of their perceptions, the other perceiving the opposite. In this second conflict, the Restoration faction prevailed without overt violence.

At this point, even people 400 years before PCT could see an important distinction between the Role "King" and the person playing the "King" Role. Whereas Charles I perceived that Authority had been delegated to him personally by God in the form of the Role of "King", Charles II was well aware that the Authority of "King" had been delegated to him by the Authority of the collective we call Parliament, whose Authority was in turn delegated by a collective of a segment of the general population who individually had Authority in their local regions.

Charles II could use the Authority allowed to the Role of "King", but he must have perceived that he as a person and the "King" Role were separable concepts. He would have perceived that if he tried to use an Authority not delegated to him, someone else might be asked to perform the "King" Role. His brother James II made the mistake Charles II avoided, and Parliament replaced James with his daughter Mary and her Dutch husband William as joint monarchs.

By this single Act of Parliament, the Role of "King" had been supplemented by an abstract object now known as "The Crown", which further separated the person of "King" (which always had included the female) from the Authority delegated by Parliament. The Crown was and is played by the Role of King, which in turn has been played by a string of identifiable individual persons.

From that time on, the concepts of "Crown" and the person of the monarch has become ever more separate, with the Authority delegated to the Crown being repeatedly reduced by Parliament, until now it is limited to a very few possibilities, such as choosing who to ask to lead the Government when the collective is in a matched conflict, and serving as a visible personification of the country. Occasions to use the Authority happen rarely, and the monarch has very little Authority beyond being expected to advise the Prime Minister off the record (if the Prime Minister agrees to be advised, though not necessarily to expect to be advised), and being required to sign into law whatever provisions the Government manages to have approved by Parliament.

With no real Power, the Crown in many countries has taken on the Role of Ombud for cases in which the collective control attempted by a powerful few opposes the collective control of the more numerous but individually less powerful populace. In recent decades, the Kings of both Spain and Thailand both used their delegated Authority on behalf of the people to prevent the military, at least temporarily in the case of Thailand, from asserting Authority that had not been delegated by the people either directly or indirectly.

How does the Ombud Role differ from that of a judge? A person using the Authority of a judge uses that Authority to determine which of two sides wins a conflict using only the written words of the laws and their interpretations by earlier judges (precedents) as the perceptual background, whereas the Ombud Role emphasizes the resolution of conflict by means that allow both sides to control their perceptions rather than continuing to a win-or-lose situation. Not all present day examples of Ombud have the same set of delegated Authorities, and few can do more than advise, having no Authority to overrule the high Authority to whom the Ombud reports.

The Ombud is in the position of a psychiatrist who uses the Method of Levels (e.g. Carey 2006, 2008, Mansell Carey and Tai, 2012) to resolve a conflict between control systems internal to an individual, whereas the judge is more closely allied to the executioner of King Charles I, blocking completely the ability of one party (individual or collective) to control a perception by their chosen means. The Authority of the judge limits his perception to what the parties do or propose to do — the forms of action output, whereas the Ombud is concerned with what the parties want to achieve — their controlled perceptions and reference values — rather than their means of achieving their goals. The Ombud is more a mediator than a judge, controlling a perception of the relationship between the parties with a reference value of them all being satisfied. Nevertheless, the Ombud can use only the atenfels provided in its delegated Authority to control the few perceptions its delegated Authority allows to it.

Now consider the different roles of King or Crown in a constitutional monarchy versus that of an elected President in a Republic such as the USA or France. The Authority given a President overlaps considerably with that given to the legislative body, which is not true of the Authority delegated to the Crown. This frees the person playing the King to act as a high-level Ombud, something a President is rarely able to do because the same electors who elect the legislators are the ones who elect the President.

In a Presidential Republic, the ombudsman Role often falls by default to law-bound judges in a system of "justice" that arbitrates between competing parties, one of which may be the State, a concept that in a republic replaces that of the Crown in a constitutional monarchy. As observed above, the Ombud mediates, the judge arbitrates. A Presidential Republic is therefore likely to find itself infested by lawyers, rather than by people skilled in finding acceptable middle grounds, and is thus likely to experience greater total rattling from internal interactions than is a constitutional monarchy.

Indeed, in most Republics, the President is elected as a representative of one of the very same political parties who contest issues in the legislative body, and in many republics, the President has actual power beyond advising and consenting. The importance of the courts of justice as implementers of the ombudsman Role becomes even more important in such cases. When the justice system becomes politicized so that judges are appointed who defer to one or other of the competing political parties, the ombudsman Role falls into decay, and the Republic develops toward a dictatorship of collective control. The stronger collective becomes able to coerce the weaker, getting what it collectively wants without regard to what others might want. If that collective has a single leader who provides its various controlled perceptions with reference values, that leader has considerable worth (in the sense of the variations of worth in a trade, discussed in Chapter III.8)

IV.10.2 The Great Man

Many people say to themselves or even in public something along the lines of "If I were in charge, I would make sure this kind of thing would never happen", but few treat "being in charge" as a reference value for a perception whose current value is different — they are not currently "in charge". The World in which they are in charge is an imaginary, or Fantasy World, and that they are not in charge is not a perceptual error for which they have an atenfel. They do not act in order to perceive themselves as being in charge. A "Great Man" does.

Walking on Ceres involves a "Fantasy" World Model, but it is a fantasy that could be built within a realistic World Model. One's imagination of how it might feel to walk on a very low gravity surface might not correspond with the way it would actually feel, but one can, in principle, calculate how much of a spring would send one into space at more than the escape velocity of Ceres. One can also imagine just about anything, such as a World Model in which Ceres is actually an alien spaceship sent to watch the destruction of civilization on the Earth, or one in which magic works.

Between these Fantasy World Models and a World Model consisting of the way one has reorganized to live in one's environment, there is an intermediate for that consists of the reorganized hierarchy for perceptions one is able to control, together with a fantasy of what one might do if one could control perceptions that are not as one would wish but for which one has no mechanism to bring them toward their reference values.

According to almost any form of PCT, perceptions in sustained error will lead to reorganization, but in some cases no amount of reorganization using the available tools (lower-level control systems and the associated atenfels in the environment) will serve the purpose. If it takes a million dollars to achieve some result, and one lives from hand to mouth, only some great stroke of good fortune will provide the necessary atenfel. That is the atenfel that the "Great Man" (without exception male, so far as I know) promises to provide for his adherents. Hardly ever does a "Great Man" fulfil those promises, but his followers perceive (believe) that he is controlling the perceptions that will at least enhance their own perceived worth.

Is there a distinction between a "Great Man" and a dictator? Perhaps, and it would be in a difference between the two kinds of self-image, the self-self-image and the other-self image (Section I.6.3), and in the perceptual errors in their various component perceptions. For example, the Great Man must arrange for his other-self-image to display a high level of self-confidence, whereas in his self-self-image he may not be very self-confident at all. If he perceives other people to perceive him as vulnerable and not totally self-confident, a likely solution to the perceptual error is to eliminate those other people, who might eventually (he imagines) prevent him from exercising control over those who he wants to support him.

It is said that an insecure boss uncomfortable in his skin is a bad boss, and this may hold all the way from job foreman to company intermediate manager to company C.E.O. (Chief Executive Officer) for whom the "others" forming his other-self-image are the Board of Directors of the company, quite apart from the political Great Man for whom the "others" are a sufficient number of followers to produce a sufficiently powerful collective controller that he can supply with collective reference (or perceptual) values for their collectively controlled actions to serve as atenfels for his own controlled perceptions. An insecure (in his self-self-image) Great Man is likely to be called "evil" by those not under his sway.

What do I mean by "under his sway"? Let's think of a 20th century "Great Man", Adolf Hitler in Germany, a failed painter and aspiring architect, a brave corporal decorated with Germany's highest military medal (the Iron Cross) in World War I, and one of many unemployed and hungry in the devastating (for Germany) aftermath of that war. There was a perceptual error he could not immediately correct, and according to the Ramsbottom Premise (Section IV.5.2) "somebody's got to be summonsed".

Since time immemorial Jews have served as a convenient scapegoat in most of Europe, along with "wise women" (i.e. "witches" who knew too much about Nature that was not recorded in the Bible), it would have been easy for Hitler to have perceived that Jews were likely to have been responsible for Germany's problems, and easy for him to lead many other Germans to perceive that this provided a solid reason for their inabilities to control perceptions they could easily have controlled before the war. From their local viewpoint, their inability to control perceptions they had been able to control — their loss of worth — had been provided with a reason and a potential method of improving their worth by removing the conflicting influence of the Jews controlling for keeping "honest Germans" in a low-worth (inability to control much) state. By promising to solve the problem, Hitler became a "Great Man".

Not all "Great Men" create scapegoats for solving widespread problems. Napoleon Buonaparte, for instance, offered and delivered order in France to take place of the chaotic structures that followed the Revolution. He needed to demonstrate true military ability, and did not need to lie about what he would be able to do. I would see Napoleon as a product of the more stable organization that often follows severe rattling, as people perceive the new organization that Napoleon designed as actually helping them improve their worth. Many countries still base their legal codes on the "Code Napoleon".

Napoleon is, I think, an example apart from the run-of-the-mill Great Man, though perhaps Nelson Mandela and Mahatma Ghandi deserve the name, although their kind of greatness is unlike that of Napoleon, and also is not the kind to which these political dictators aspire. Many monarchs are posthumously called "The Great" because of their achievements as hereditary dictators, but they did not control their other-self-image for this to happen. The kind of Great Man about whom I am talking is likely to have a self-self-image in which he is far from justifying the label of "Great", and achieving that status in his other-self-image with respect to many other people will lead to an appreciable discrepancy between the two kinds of self-image, a conflict that would not be a part of any perceptual control tensegrity structure.

I am arriving at a theoretical position based entirely on PCT, that the "Great Man" dictators and aspiring dictators are very likely to have very "tense" characters, likely to show anger when their constructed "World Model Truths" are opposed by evidence or contrary opinions, and to control for removal of the source of such evidence, which can then be denied or ignored as "Fake News", in the words of the US President (2016-2020), Donald Trump.

In the kind of language we used in Chapter I.8, their control tensegrity structures have their wires at high tension, which makes the entire structure very rigid, and spreads the effect of external disturbance more evenly through the structure, so that controlling just that disturbance becomes less localized. From the outside, what would appear would be unprovoked "outbursts" against things apparently unrelated to the original source of disturbance. Such people have little ability to "bend with the wind" but rather, they

“oppose the slings and arrows of outrageous fortune, and by opposing, end them” (Hamlet), or more commonly, end their sources.

The “Great Man” of this kind cannot allow the existence of an Ombud, for at least two reasons. The primary job of the Ombud is to occasionally disturb the Power, in this case the Great Man. The Great Man has difficulty controlling against this particular disturbance which is precisely directed at altering something about the Great Man’s atenfels, which exist as part of a tensegrity structure in high tension. The Great Man’s difficulty is that he has authorized the Role of Ombud to create exactly this kind of disturbance, and the existence of the Ombud Role is perceived by the less powerful as a means, an atenfel, for correcting perceptual errors that they have no ability to correct for themselves.

The Great Man’s collection of adherents is likely to be augmented by the fact that he has authorized the existence of the Ombud Role. Having one and then eliminating the role might be perceived by the powerless as the Great Man separating himself from their interests, whereas never having had one, the Great Man is immune from that perception by the populace. Remember from Chapter I.9 the importance of change-edges in both time and conceptual space, as compared to the unchanging middle of a state. The state of an Ombud who never existed is unlikely to be perception at all, let alone one in error because of a reference value for an Ombud to exist.

Even a Great Man needs an administrative Bureaucracy, to provide data from the external world (if the Great Man can tolerate the associated likelihood that it will conflict with his perception of the world), and to execute the actions he wants to perform, such as eliminating sources of data that might contradict the views he has as references to perceive those aspects of the world. Even a “lesser” Great Man in the person of Canadian Prime Minister Stephen Harper (2006-2015), a duly elected politician who uncomplainingly left office when an opposing party won an election, acted to stifle science and to muffle Government-employed (Civil Service) scientists, because it often produced results that disturbed perceptions he controlled to reference values that differed from what the science said. Even Stephen Harper needed a docile bureaucracy to execute his control actions.

We turn next to the role of the Civil Service, in which I now include the military, even if the Government is headed by a “Great Man” military leader, as often happens in many parts of the world, and as happened in England at the end of the Civil War of the 17th Century, when Oliver Cromwell, the victorious leader of the revolutionary army, took upon himself the position of “Protector” (of England, presumably).

IV.10.3 Government and Civil Service

Every government needs a means of learning about and acting to influence the available atenfels and to disturb perceptions controlled by the people and in the places over which it claims suzerainty. There would be no point in enacting laws if nobody takes any notice of them except lawyers and judges who get paid for learning them. This means of acting may take on a variety of forms, including roving gangs of bullies who use enforcement of the law as an excuse for disturbing people, an army or police force that has the duty to control for observable behaviour contrary to the reference values provided by the law, or a formal Civil Service.

Countries whose civil organization is based on either the English or French model are supposed to have a clean separation between the Government, which is elected, and a civil service, which is theoretically apolitical, and serves to advise the persons who play the Roles in the Government as well as to carry out the policy decisions of the Government. The persons playing senior Civil Service roles may be shuffled from one role to another as the elected political persons playing specific roles change, and the

newly elected Government may have different ideas about what Ministries should exist, which implies that the Civil Service personnel may move occasionally en masse from one Ministry to another.

In the English and English-based structure, the Civil Service supporting each ministry is headed by a Deputy Minister, a role played by a person appointed from within the Civil Service. The Deputy Minister, like all the Civil Service persons, is supposed to serve whatever party is in power equally well, though everything we have said about Perceptual Control Theory will tell us, as will everyday common sense, the persons playing the Deputy Minister Roles may be controlling for perceptions at variance with the Role reference values proposed by the Minister. The Deputy Minister role is supposed to communicate to the minister the likely consequences of performing what the Minister asks the departmental Civil Service to do, but to set the reference values for the role as the Minister asks, and if these conflict with the reference values held by the person playing the role, to resign the position and possibly also from the Civil Service.

Seldom does the interface between politician and Civil Servant work like that in practice in those polities with which I am somewhat familiar, though I suppose there may be happy countries in which it does. Typically, a senior politician such as a Minister, and especially a Prime Minister, surrounds him- or herself with trusted advisors who take it upon themselves rather than the official Civil Service support to that ministry to implement what they perceive their minister to want. In Canada, the PMO (Prime Minister's Office) appears to wield more power than the Ministers who were also appointed by the PM (Prime Minister). The PMO contains not only members of the Civil Service, but also people personally appointed by the PM. These latter appear to me to assume the authority of the PM when they talk to Departmental Ministers.

The question here is the autocratic authority of the Prime Minister. On the surface, the electoral system appears to select individual representatives who control for what they perceive to be the objectives of those who elected them, using the atenfels available to them to do so. With an autocratic PM who requires the elected representatives to "vote the party line" or be booted out of the caucus that (in theory) decides on the party line, the representatives have no obvious atenfels that involve voting on measures brought to them for approval or rejection.

The "Westminster" (British) form of government is collectively controlled for in many of the countries that once were British Colonies, even though most of them became republics after ceasing to be colonies. Most of them adopted constitutions that provided for elected Presidents as a substitute for the Crown, giving the President some limited authority, usually wider-ranging than that allowed the reigning monarch before the change. In some cases, these Presidents were also party leaders who assumed autocratic authority, which they could do because the new Constitution provided the requisite atenfels, as does the basic Westminster form of government.

Whatever the written Constitution, a "Great Man" who has enough public support because of his use of the "Big Lie" (Section IV.7.1) can easily ignore it. The power of collective control by his (always "his") supporters is sufficient to override any opposition by those who collectively control for accepting the written authorities provided by the Constitution to not only the President (or Crown) but also the judiciary whose collective responsibility is to determine whether certain actions conform to the Constitution and to the laws written under the authority of the Constitution.

At one time, and perhaps today, the Parliament at Westminster (London, England) operated with no written Constitution, the effect of a constitution being largely that of collectively controlled conventions — accepted ways of acting to control certain perceptions. When those conventions are violated by a powerful leader controlling his or her perceptions by actions not generally accepted, his response to those who control perceptions with opposed reference values may well be a perfectly rational "Who's gonna stop me?".

No single person can control all the perceivable correlates of the myriad environmental variables that define a modern society of millions of people, so even the most autocratic ruler needs a Cabinet of supporters who can lead different parts of a Civil Service.[46] There may be many inputs to a perception by the Minister of a Department of something that appears to be within his domain. Kauffman's toy universe that initiated my various speculations about the "Magic Number Six" found the edge of chaos in the actions of one element on the actions of another — side-effects — not separately in perceptions by one unit, since in his universe, the two concepts are inseparable. We should then be looking for side-effects of actions, not simply at the complexity of the perceptions controlled by those actions.

The Cabinet, in whatever political system, is ordinarily chosen personally by the leader, whether it be King, President, or Prime Minister. This simple fact implies that the leader can control for having a Cabinet consisting of people who are perceived as agreeing with his policies. A notable exception apparently was the US President Abraham Lincoln, who chose a "Cabinet of Rivals", men who had opposed him in various ways.

Lincoln may have controlled more than one perception in this way. He may have perceived that by asking them to support him he would be able to assess the merits of a variety of viewpoints, and thereby to make better decisions, or he might have been following the old maxim "Keep your friends close, and your enemies closer" so that he could perceive more closely their actions that might not support his control of his perceptions. Either way, Lincoln gave control of the Federal Civil Service to those who might use their ability to set reference values for their branch in opposition to his expressed wishes. What Lincoln did in this way was to allow his rivals to perceive that he trusted them to act as the Constitution expected than to do, which was to accept what he, in consultation with the "Cabinet of Rivals", decided on as a good course of action in control of some collective perception.

IV.10.4 Political Parties and the Middle Ground

How do the various forms of "Us" and "Them" and the Middle Ground attain visibility when viewed as the environment in which political games are played? Most political parties are formed because the individuals who eventually form them perceive that none of the existing parties have objectives that are close to their personal reference values. Many countries have a "Green Party" that proclaims an objective of protecting the natural environment, which depends on acting to reduce climate change caused by increasing atmospheric CO^2.

Individuals in general may not be rattled by the differing approaches that the various parties take to the problems the parties claim their policies will solve. These are expected, and people can control for the policies that seem most likely to reduce errors in more of their perceptions or allow them atenfels so that they can control better or control a wider variety of perceptions. Pollsters, if their projections are correct

46. In this respect, I am reminded of a satirical TV puppet program in which the English Prime Minister Margaret Thatcher was shown with her Cabinet having dinner at some restaurant. The waiter asked Thatcher what she would have, and she responded "Beef, rare". The waiter then asked "And the vegetables", to which she responded "They'll have beef, too".

and are understood by people who would be affected by the policies promised by the different parties, reduce the rattling that might be caused by the subsequent actual electoral results. The corollary, though, is that when the polls are wrong, the results are unexpected, and the prospect that the winning party will enact what they promise may cause sudden unexpected increases in the errors of some controlled perceptions. These increases are, mathematically, increases in the rattling of people so affected. Collectively these rattling increases enhance the likelihood of total reorganization of the structure of government by parties of the existing kinds.

The lack of a party of middle-ground compromise via negotiation between the main, non-extremist, individuals in the existing parties makes it hard to generate a policy that will not suddenly rattle supporters of the losing party or individuals who have not been following anything beyond the direct effects of the different policies on their controlled perceptions. Farmers may be rattled by unexpected changes to taxes on their land or on the machinery they buy, but not by changes in taxes on, say, city households — and vice-versa. Prior discussions between winners and losers by way of central parties might lead to the same actual tax changes, but those changes would not be unexpected, and therefore would not enhance the rattling of individuals.

Just as a "Green Party" may focus on protecting the environment, the members collectively perceiving that certain actions should be opposed, such as the burning of fossil fuels as a source of power such as easily accessible electricity, so other parties build around different core reference perceptions. The supporters of any party are "Us", and some of those individuals may perceive non-supporters of their party as "Them", as did US President George W. Bush after the attack on the New York World Trade Center, when he said (not an exact quote) "You are either with us, or you are against us."

This perception of "Them" as anyone that does not directly support the collective reference values of ones own group explicitly eliminates any middle ground that might be occupied by a bystander who can perceive that a conflict has two sides, at least. McClelland's (1993) demonstration at the CSG meeting of an escalating conflict between two controllers was of a one-dimensional conflict over the different reference values of a single dimension or property of something in the environment perceived similarly by both parties. Real-life conflicts such as those that result in the Al-Qaeda attack on the Word Trade Centre are not one-dimensional[47], but are one manifestation of rattling experienced by a distinct segment of an organization.

Rattling is not one-dimensional. It is experienced by an organization, a structure of many dimensions. Even in the original Chvykov et al (2021) study, the organization of their smarticles was defined by their locations in a two-dimensional arena. According to the leader of Al Qaeda, Osama bin Laden, the main cause of his antagonism to the United States was the continued presence of non-Muslim US troops on the "sacred soil" of Saudi Arabia. But rattling is measured by the uncertainty of the rate of variation of the error in disturbed perception, not by its variability as such. The unexpectedness of a change is what matters. The destruction of the World Trade Center towers in New York was, to almost everyone, unexpected and sudden, and therefore rattling.

How does this lead to a tendency toward polarization? One way of reducing rattling caused by unpredictable side-effects of the actions of others is to reduce one's connectivity to the actions of the others. for a political party, this implies either forming an agreement with the other party, or distinguishing its policies as distinct from those of the other party, either of which imply a lack of middle

47. The Al Qaeda leader, Osama bin Laden, claimed that his opposition to the US was opposition to the stationing in Saudi Arabia of US troops who did not obey Muslim religious laws. The destruction of US property and the deaths of US individuals was intended to make American individuals collectively recognize the injustice of this deployment of US troops. Or so he said.

ground. We have argued in many places, starting with our first discussion of lateral inhibition at the synaptic level (Chapter I.9) that similar structure tend either to merge into a more complex structure or reconfigure themselves to become more distinct from each other, and the separation of parties that eliminates the middle ground is an example of the same process.

It is always important to recognize, just as Powers pointed out in B:CP, that how reorganization will reorganize a structure is never predictable. This is just as true of reorganization provoked by rattling as it was of Powers's reorganization of the perceptual hierarchy within an individual provoked by errors in the "intrinsic variables". For both, it is also true that if the reorganized structure increases the overall average perceptual error either within an individual or over a part of a society, further reorganization is likely to occur within a time measured using as a unit of time the time-scale of control in the part of the structure most involved.

For a social structure the time-scale of control is based on the speed of network communication that determines the loop delay in network control-type loops — control-type meaning negative loop feedback with some asymmetric energy-analogue (e.g. money) through flows from a concentrated source such as individually or collectively rich donors to a disparate "population universe" through which the money is eventually dispersed (Figure IV.10.1).

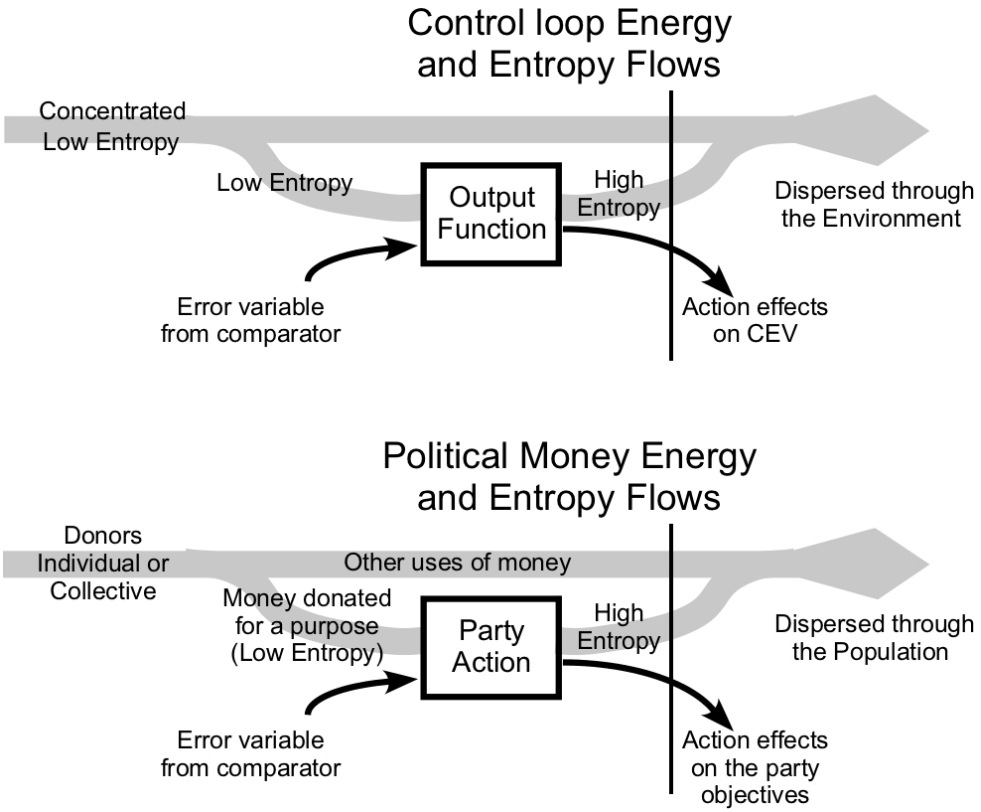

Figure IV.10.1 The analogy between a basic control loop and a political party in energy and entropy flows, where money is taken as analogous to energy, but entropy means the same in both.

Remember that a collective can act as an individual, when the members of the collective together create a Grand Virtual Controller to control a single variable. The "Party" in the Figure could also be an autocratic individual, but the name is usually given to a collective whose members perceive themselves to be members of the party who have common objectives, as discussed in the previous Chapter when we talked about Vicky and the Vee Party. There we talk about party splits and coalitions, but here we are asking about the middle ground.

The analogy between the energy and entropy flows in a basic control loop and the money and entropy of money flows in the activity of a political party is close enough that we can ask about lateral inhibition among parties. Lateral inhibition (Chapter I.9) sharpens the edges of perceived categories, and makes one more discriminable from other basically similar ones, reducing or eliminating any middle ground. In the political case, two parties that have similar objectives in many dimensions of perception also have individual members who may control for belonging to Party X rather than to Party Y because Party X has objectives that more closely correspond with their perceptual reference values than Party Y.

If the two parties were to merge, thereafter acting as one, the reference values of the virtual controllers created by the party members of one would move toward the mean of the original reference values of the "wrong" other party. Members who hold these divergent reference values would find the merged party reference values further from their own than were the collective reference values of the original party. We will discuss this effect in the next Chapter, but now we see this as a reason why at least some members of each potentially merging parties would control for perceiving their own party to remain distinct from the other, driving the collective reference values of the parties apart, whether in a two-party system such as that in the USA or in a multiparty environment such as that in Israel. The general effect is to eliminate a middle ground among parties, no matter how few or many there might be.

As W.B.Yeats wrote in his 1919 poem "the Second Coming": "

"Things fall apart; the centre cannot hold

Mere anarchy is loosed upon the world,

The blood-dimmed tide is loosed, and everywhere the ceremony of innocence is lost

The best lack all conviction, while the worst are filled with passionate intensity."

Under highly rattled conditions, when many people perceive their abilities to control their perceptions to be uncertain, organizations tend to restructure, but before they do, conditions such as those Yeats wrote about in 1919 are perceived (though perhaps not so dramatically) by may people. Eventually, the League of Nations was formed, and except in Germany people began to be able once more to control their more important perceptions, stabilizing the political structures within their highly rattled populations, though not always in the way they had been structured earlier.

IV.10.5 Commercial Power versus Political Power

The word "commercial" is generally taken to be about something like a collective form of trade, in the same way as society is a collective set of individual relationships. The participants in commerce are not individuals, but organizations, and the gains and losses perceived in a commercial trade are always measured in money, not in individual ways to control personal perceptions. Nevertheless, the same issues arise in commercial trades as they do in individual trades and in the Trade Motif itself (Section III.9.4). Each party to a fair commercial trade, as in a individual trade, perceives that they will gain worth from executing the trade.

In a commercial trade, the traded items may be entire companies, or branches of them, as though an individual could trade a portion of his or her perceptual control hierarchy. An individual could accomplish something similar in a trade by trading a particular atenex that provides a particular atenfel — a means to control a particular variable — for something else, such as money. Buying a specific kind of screwdriver from someone who has one would be this kind of trade. The analogous commercial trade would be the sale of an arm of a company, or even the whole company by its collective or individual owner to the collective or individual owner of another company. Such a trade is not between companies but between actual or collective individuals (e.g. shareholders).

What is ultimately traded in all fair trades is power, the ability to use atenfels to control the perceptions controlled by the traders. The more available potential atenfels, the more power. A fair trade is one in which both parties perceive that their own power (that we called "worth" in Chapter III.9) to control their own perceptions is increased. When we look at the commercial power of a company, as compared with the political power of a government, few of the perceptions they control are, on the face of it, likely to result in classic conflicts in which two controllers act to move their perceived value of an environmental property in opposed directions. Conflicts between commercial and political entities are more subtle, but nevertheless work in a way that diminishes the likelihood of a "middle ground" emerging.

Commercial organizations usually, and in the USA are legally required to, maximize shareholder value. That law, however, does not specify over what time-period shareholder value should be maximized. It does say, however, that the actions taken to maximize shareholder value should be taken without regard to the possible or probable side-effects of their actions on other commercial organizations, individuals or other kinds of organizations. Nor are they required to consider the wages or working conditions of their employees, except insofar as the senior managers may believe that, by providing a happy working environment that allows individuals to control many of their own perceptions, they are likely to increase the shareholder value of the organization.

The law applies only to publicly held businesses with shares that can be bought and sold on the open market, but companies with private ownership are not unlikely to follow suit, since one of the controlled perceptions of the owner is likely to be the owner's own income, with a reference value that the perception of that income exceed the perceived value of the incomes of individuals with comparable Roles as owners or managers of otherwise comparable businesses.

The overall result of these laws, and of the competition among CEOs (and owners) to control for others to perceive that they are considered more valuable to their organization than are the others to their organizations, is that CEOs and owners are likely to control for competitively maximizing their personal incomes, regardless of whether these increases will in themselves appreciably affect their "worth" (in the sense of the Trade Motif described in Chapter III.9).

The Role of Politician, as opposed to the actual behaviour of individual politicians, is to act so as to improve the lives of the people affected by laws they may try to enact. The Players of the Politician Role are individuals. Individuals control other perceptions. Sometimes the welfare — the worth — of the individuals affected by their laws seem not to be included among the perceptions they control. Among the perceptions they do control are often their personal worths, which may be significantly enhanced by increases in their access to money. There is therefore an ongoing conflict possibility between the increase in worth a bribe (e.g. financial support in a forthcoming election) offers and the the decrease in worth created by a criminal conviction if the form of the bribe (typically money in exchange for voting for a particular policy) happens to be illegal.

The political power to prevent bribery conflicts with the individual politician's control of their own financial ability to control a variety of perceptions. That power conflicts with the main controlled

perceptual of the politician Role itself, One could view this conflict, which occurs in the head of the individual playing the politician, as occurring inside an example of the Trade Motif. In exchange for the immediate monetary or other benefit would the politician trade the part of the self-self-image that has a reference for him to perceive himself as honest?

The politician as an individual might not perceive something like a promise of support in a forthcoming election as an "Other benefit", even if that support is in a non-monetary form. If, however, the support is presented as being offered by a commercial entity such as a corporation in exchange for the votes of the politician for laws that improve the financial situation of the corporation — "We will help your election campaign if you vote for our interests" — then the politician might accept, without the individual playing the politician Role perceiving any discrepancy between his self-self-image and its reference value.

Corporations act as collectives in that its CEO or owner is able to deploy far more "money-power" than can an individual citizen. So when we ask about an opposition between Commercial and Political Power, as in the title of this Section, we may be asking the wrong question. A more appropriate opposition is that between the interests of the less wealthy citizen and the interests of the corporations or their wealthy managers and owners. In this light, Politics, the balancing of power among the parties in a governing body, can be seen as an indicator of the balance of those interests, like a handkerchief tied at the middle of a tug-of-war rope.

It is hard to deal with the workings of complex political Role networks and the complex organizations of the individuals individually and in organized groups without seeming to take positions that someone will perceive to be partisan. I have tried to take a position in the somewhat empty space occupied by no party, for reasons we discussed in Section IV.10.4, but readers may well judge my attempt to have been a failure, taking the part of some party they do not support. I apologize to such readers for my failure.

For the last few Chapters, the concept of the autonomy of individual organisms, almost all of them humans has been largely swept aside, as though supporters of one party or team were identical members of a variety of Giant Virtual Controllers, as much influenced by the collective as influencing it. They are not. They are individuals, and while there are certainly feedback effects and analogues of lateral inhibition among individuals and between individuals and the collective, some few of which we have addressed, we have in general treated those individuals who try to gain political influence in terms of their Roles, not in terms of the perceptions (other than self-image perceptions) they control. These are all matters studied by researchers of many kinds, and the best I can hope for my contribution is that some may find that taking a PCT viewpoint helps to illuminate the problem they study.

In the last Chapter before the Epilogue, I will try to tie up a few of the very many loose ends left in the 47 previous chapters, knowing that I will probably leave more loose ends in their trail.

Chapter IV.11. Et Cetera

This book has contained a lot of speculation, and I would recall to the reader two quotes from famous physicists on the cover page of each Volume: "*Every sentence I utter must be understood not as an affirmation, but as a question*" (Niels Bohr) and "*The first principle is that you must not fool yourself. And you are the easiest person to fool*" (Richard Feynman). These two quotes fit together, for me at least, in that never can I be quite sure that my analysis is correct, even in what seem like simple cases, however clear the answer seems to me, and that lack of assurance requires me to ask the reader of every sentence whether I am indeed fooling myself in making what has the form of an affirmation.

This Chapter deals with types of clearly living entities to which I find it difficult to associate the ordinary mechanisms of perceptual control, as well as inorganic (not based on carbon) structures and distributed systems that maintain their structure against the ever-changing effects of the high-entropy environment in which structures and living creatures try to maintain their integrity over time-scales long compared to the time-scales of changes in their local environments. In all these cases, structure can be maintained only by acting to export back to the environment the entropy that would normally "flow" from the high-entropy environment into the low entropy structure and would eventually destroy that structure. PCT is based on the idea that Hamlet's choice is indeed "to take arms against a sea of troubles, and by opposing end them". Choosing to "take up arms" and control perceptions whose values are not what the controller would like, is .

IV.11.1 What is Autonomy?

We start by examining what is meant by the word "autonomous", because the very concept of PCT depends on the autonomy of the individual entity. That individual entity, or rather, its internal and social structure, is what is maintained by PCT. The atoms of which it is composed are not, one being replaced by another in the homeostatic acts of maintenance of the structure. No structure is, or could be, fully separate from its environment, because it would then be subject to the popular conception of entropy (if they have heard of the concept) that it always increases. This would occur with extremely high statistical probability in a closed isolated space, but nobody could observe what happens in such a space because if they could, it would not be isolated.

So there must be degrees of autonomy, from the "going with the flow" of a twig floating in a river, to the relatively autonomous ability of a billionaire to control many perceptions. But the billionaire is one only in a specific social situation, and no amount of money would prevent his yacht being sunk in a great storm with him on board, a fate from which he could be saved only by the actions of other people. Clearly, even this "self-made" billionaire is not fully autonomous. Perhaps the best we can say is that each controllable perception can be treated as a unit of autonomy, and living things that can control the most perceptions are the most autonomous. In that case, "autonomy" is a synonym for what we called "worth" in discussions of the Trade Motif (Chapter III.9).

There is another way of looking at the issue of autonomy, which is to consider the place of a living thing in an ecology, or should we say, its local network and the larger ecologies of which the local network is a part. Every living thing is part of a global ecology, called "Gaia" by Lovelock (1972). If there are any living things elsewhere in the universe, they do not interact with our Gaia, so far as we know.

Gaia is an ecological network of interactions that create effects as do the interactions within any lesser ecology. Many of these interactions create loops, some of which are stable and homeostatic, but there is no Law of Nature that says they must be. Nor is there any guarantee that the Gaia ecology will settle back

to its original form after the severe rattling humanity produced by using energy from burning in centuries fossil fuels that took millions of years to produce.

As part of an ecology, what autonomy can individuals use? Here we must return to a consideration of rattling. An autonomous individual is capable of acting unexpectedly to control some perception. If this unexpected action has side-effects that disturb perceptual controllers in the organization that is the ecology, those side-effects contribute to rattling of and in the ecology. They increase the likelihood that the structure of the ecology will be reorganized.

Reconfiguration temporarily increases the autonomy of the individual members of the ecology, because the precise structure of its defining network becomes less precise. J.M. Barrie's 1902 play "The Admirable Crichton" exemplifies the organizational restructuring following the highly rattling effect of shipwreck and the stranding of a stratified social group, stable in their home ecology, on an isolated island with no stabilizing surrounding extension of their ecology. As the organization of any ecology proceeds to settle, more probably in a more stable state than before, it will do so only because of the actions of the individual members, whether or not they be in control of perceptions of the properties of their place in the ecology. In Barrie's play, because of his competence in addressing novel problems, such as obtaining food, the butler Crichton becomes the group leader on the island.

As with the human body, an ecology can survive only by exporting the entropy that it would otherwise gain from from external disturbances. Gaia is stable only if it can export entropy, which in this case, unlike that of a control system in which the entropy to be exported is introduced by disturbances, is the entropy that would increase if the Earth were an isolated system. As with a living organism, if Gaia cannot export the entropy increase caused by its myriads of actions and interactions, it will heat up like a living organism that has a fever. And that is what is happening now. In some ways, Gaia acts like an autonomous entity, while it does not have what it seems an autonomous entity should have, the ability to choose some desirable state and act to make the actual state be close to the desired state. It cannot observe itself. In the terms of the Powers hierarchy, Gaia consists only of intrinsic variables, with no controlled perceptions.

Even though it is largely isolated, Gaia is not autonomous. This reflection argues for autonomy to require a parallel question, what might the putative autonomous entity be autonomous from, with an answer that involves some other active entity whose actions might affect its ability to act. Once again, we come up with the idea that there must be degrees of autonomy, but in this case, the autonomy has the same kind of dichotomy between place and quantity that we have in Mackay's (1950, 1953) distinction between "metron" and "logon" uncertainty — what is it, and how much of it is there? From what is the entity autonomous, and how closely is it tied there or elsewhere?

Many, if not all, humans consciously perceive themselves to be autonomous, or at least for their own autonomy to be a desired state — a reference state, rather than a actual perceived state. The US Declaration of Independence goes so far as to state in its second paragraph: "*We hold these truths to be self-evident, that all men are created equal, that they are endowed by their Creator with certain unalienable Rights, that among these are Life, Liberty and the pursuit of Happiness*." "Liberty" in this context, is sometimes taken to be synonymous the absolute right to choose for oneself what to do, whatever the circumstances and might be affected by whatever one might choose.

Some make this synonymity overt. We tend to call such people sociopaths or psychopaths. If they perceive that someone or some law or official order seems to restrict their freedom or choice of action, they act in some way to assert that freedom for themselves. They overtly violate the linguistically described constraint. They have a reference value to be perceived as having perfect Liberty — as being ideally autonomous entities unconstrained by law or convention. One way of reducing the error in this controlled perception is by declaring the law to be unconstitutional and therefore invalid. A person who

strongly controls for being free to act as he or she chooses may have chosen to belong to an anti-government organization whose members, paradoxically, have no freedom of choice.

Another paradox is that the presumed autonomy or Liberty depends on the internal reorganization that builds top-level perceptions, including properties of the two self-images, self-self and other-self. If either kind of a person's self-image reference value includes that her choices are free of externally imposed constraints, control of that perception is a permanent problem to be solved whenever it arises. The statement that "your liberty extends no further than my nose" applies usually another person (endowed with the same Liberty) is in the perceptible environment.

If, however, the method of control of this property of the self-image tends to be repeated from one occasion to the next, then it is liable to become incorporated in the non-conscious hierarchy. By virtue of that fact, it ceases to be free. Liberty, in the sense of autonomy, is lost by the act of asserting it. Consciousness of asserting one's Liberty as a matter of course leads to a loss of that Liberty through reorganization.

If, on the other hand, the self-self-image does not include one's own complete autonomy as a controlled perception, then each problem to be solved in conscious imagination can autonomously be provided with an unconstrained solution, which may become embedded in the control hierarchy over time, if similar situations arise repeatedly.

There is a paradox here, since it follows that *if one does not control for being an autonomous entity, one may be that entity, but if one does control for being autonomous, one is not*.

As is the case with many paradoxes, treating the concept of "autonomy" at the top level of the hierarchy as partial, fuzzy, or perhaps probabilistic, rather than fixedly all-or-nothing, removes the paradox. Sometimes one may choose (i.e. exhibit autonomy) to resolve a self-image control problem by tried and true (i.e. already reorganized) methods or by attempting a new solution in conscious imagination (i.e. by invention). Neither choice implies or denies the person's autonomy, so neither choice invokes the paradox.

We return to the foundation structure of PCT, a single control loop within a hierarchy. This control loop at any moment has some goal it is to try to achieve (act so that the perception matches the reference value), and it is impeded from achieving this goal by a varying disturbance. Is this control loop autonomous? Above we answered "Yes" on the grounds that neither reference nor disturbance determine how the loop will act or the strength with which it will act. But one might equally clearly answer "No" on the grounds that the signal values everywhere in the loop are completely determined by the variations of the reference and the disturbance signals. But are they?

No they are not, in most realizations of a control loop, simulated or physiologically realized. The present values depend to some extent on their prior history. If they are deterministic, that can only be because their entire history back through the original creation of the loop in the first life form is incorporated into the determination. The signal values are *influenced* by the variations of the disturbance and the reference signals, but they are not *determined* by those external influences alone.

Being non-deterministic is not the same as being autonomous. A properly autonomous entity has both metron and logon uncertainty, meaning it does not always achieve a goal by the same means. A simple control loop has no options in that it simply and blindly does what it does to bring the perceptual value toward the reference value. It asks lower-level loops for "more" or "less"of whatever they do, with no knowledge of what that might be.

Embed it in a perceptual control hierarchy, however, and the situation changes. The loop now can be thought of as having an upper section, the ECU consisting of perceptual function, comparator, and output

function, and a lower section in the external environment, around the CEV that is affected by the disturbance. Between these two sections there is in the hierarchy a whole network of controlled perceptions.

That intermediate network is multiply connected to the ECU, which is what Powers implied by using the motto: "*Many means to the same end*." The "simple" control loop, thus split into inner and outer, or upper and lower, sections, need not do the same thing next time it is faced with what seems to be the same situation. A control loop in a reorganized hierarchy will try doing what worked the previous time, but that might not work this time, because circumstances never repeat precisely. To funnction well this time may require "thinking". Even though the control loop controlling a scalar value of a perception of an environmental property is necessarily devoid of consciousness, the non-determinism implied by its historical influences implies that it may appear to make choices about how to do the task set for it by the imposed reference value.

Is a control loop embedded in a control hierarchy autonomous? If you think about this question, you may come to the same conclusion I do, that there can be no "Yes or No" answer. The loop is externally influenced only by the values of the reference and disturbance signals, but they do not determine what the controller ECU will rely on to do its job, so it is autonomous, but on the other hand most of what it might choose to do will not produce the required change in the perceptual value, so it is not autonomous. To give the degree of autonomy an arbitrary number as though it is fuzzily autonomous, its membership in the class "autonomous" might be 0.1, for want of a better number.

If any one control loop in a perceptual control hierarchy is non-deterministic without its complete history, and therefore to some degree autonomous, one might expect the entire massive complex to behave completely chaotically. But it doesn't. For the most part, perceptions are controlled rather well. Real Reality (RR) ensures that "many means to the same end" does not work for all those available means all the time.

No matter what exists in Perceptual Reality (PR), the success of a path of atenfels connecting the reference value to the CEV and back to the perceptual value is determined by the state of RR, not the state of PR. Anything is possible in imagination, in an Imagined Reality (IR) that may even defy the laws of Physics. Only a few things work in RR, and as we discussed earlier in this Chapter, conscious experimentation in IR serves to select those imaginable things that are likely to serve the current purposes in the current RR. If PR corresponds closely as it probably does with RR, at least at low hierarchical levels, what served in IR is likely to work in RR and thus in PR, despite the inherent non-determinism throughout the control hierarchy.

At this point we must re-ask the question about autonomy. Is an organism that can freely choose what to do "autonomous" if it is as constrained by the workings of RR as the foregoing argument would suggest? If such an entity is not autonomous, then there is no such thing as an autonomous organism. An autonomous organism is otherwise known as a Living Control System (to quote from the title of three of Powers's books (W.T. Powers 1989, 1992, 2008).

If the word "autonomy" is to have any useful application in dialogue, it must be taken (again) either as fuzzily graded or as applicable only to limited conditions such as the ability to choose whether to walk or bicycle to my destination. Real Reality still influences my ability to choose, even for such a choice. In a great storm, I am unlikely to cycle because I imagine I might get blown off or because I imagine I may be able to avoid flooded areas on foot that I could not when cycling. But nobody violated my small autonomy by coercing me to walk,.

Autonomy involves one further issue at least, which is easily answered for living control systems, but not so easily answered for a robot. Where do top-level reference values come from at any stage of

development? For a living control system, the simple answer is that top-level reference values are values for some perceptions that have been found to help maintain intrinsic variables in good dynamic condition. I have taken these top-level perceptions for humans to be the two self-image perceptions, self-self-image and other-self-imagel.

The intrinsic variables in living control systems are, as we have seen, interlinked in a maze, or perhaps a hierarchy, of homeostatic loops. What they are and how they function is, however, irrelevant to the questions we will next address, about possible robotic consciousness and emotion. What is relevant is that living organisms do have intrinsic variables, and their functioning serves as a fitness criterion for the perceptual control hierarchy, especially including the top-level controlled perceptions at any stage of maturation.

It is with this understanding of local and partial autonomy that we should enquire, not whether robots can be autonomous, but in what domains and to what degree they may have some autonomy, and how this relates to the question of potential future robot consciousness.

IV.11.2 Autonomy and the Single Robot

When people talk about "robots" at present (2022), they often mean the kinds of rooted devices that work in an assembly line to move components from a storage location to the complex object, such as a car or a printed circuit board being assembled. This is not the kind of robot of concern in this Chapter, nor is it most cases where the word "robot" is used in this book.

A robotic vacuum cleaner, which moves around a room vacuuming the floor, and goes to plug into a power source when its battery runs low, is more the kind of robot of interest. It interacts with its environment, controlling its location with respect to obstacles that it senses and with respect to the history of where it has been recently, monitoring its own power requirements, and choosing its course without having to be preprogrammed to follow a particular movement pattern, though in any room it might learn a pattern that approaches an optimum for minimizing energy usage. I do not know whether any currently available commercial robotic vacuum cleaner has all these capabilities, but the hypothetical one I am using as an example does. If it is more advanced than any currently available, it is at least feasible using current technology.

The robotic vacuum cleaner is a perceptual control system, like a living control system in two ways. It has an "intrinsic variable" in the form of the energy reserve in its battery, and it has perceptual control of its movement within its local environment, which it can use directly in maintaining its intrinsic variable within a viable range, and which supports its viability indirectly by doing its vacuuming job effectively so that it doesn't get sent to the recyclers. It has a top-level reference value to perceive no debris within its field of view. It uses perceptual control to avoid obstacles while vacuuming, and memory to allow it to set a reference value for perceiving itself to be vacuuming where it has been least recently. In some ways, it is autonomous.

We should not assume every robot has all the properties I ascribed to the robot vacuum cleaner, which is autonomous at least in its choice of movement trajectory. To the user of a robot as a tool, it has the same kind of autonomy as do the different levels of control in the Powers perceptual control hierarchy. I would not consider that to be true autonomy, because the robot has no function other than when it is being used as a tool — like a company employee that does nothing, not even seeking food, when not engaged in company business. The user provides reference values to the robot tool, references that are the task objectives it achieves by methods of its own selection. Likewise, controllers (ECUs) at each level in the perceptual control hierarchy of a living organism are provided with reference values by the output of

higher level controllers, but the higher level does not have any influence on how the lower levels achieve the goal of the higher-level controller.

As we have discussed throughout this book, living things that have evolved from their ancestors exist only because since the beginning of life their ancestors and their ancestors have survived, the species as a whole keeping what helps survival and discarding what doesn't. Machines we design have no such advantage. They may be autonomous in some respects, but that autonomy does not result from the long history of ancestral survival.

The design of a robot that does something we want done is itself the product of an evolution of a kind. Various people have produced mechanical entities that perform remarkable tasks without being told how to do them, and these designs usually have not sprung fully grown from a single brain. They have been the result of the same kind of evolution as have living things. Design aspects that proved useful to the human have tended to survive longer than have designs that proved unhelpful or detrimental to the perceptions controlled by their makers. They do what WE want, and that fact determines whether a design element its designer has made a part of the robot survives or is discarded in the nest design generation.

One of the PCT mantras is "Many means to the same end", and as we discussed in Section IV.11.1, one could easily call the choice of means to be a kind of autonomy allowed to the lower level controllers. If one does, one implies that "autonomous" is not a binary yes-no adjective that can be applied to a robot (or a person), but that there are degrees of autonomy that depend on the Universe of choices available to the entity. A rock has none, a bacterium has few, if any, while a porpoise, a crow, or a person has many. All except the rock have some autonomy, but none have the apparent autonomy we ascribe to every living entity, just as perceptual control can be excellent but never can be perfect.

The more kinds of choice and the more choices within a kind, the more reasonably may the individual be casually described as autonomous. This two-dimensional space of kind and quantity should remind you of MacKay's (1953) "metron-logon" division of uncertainty or information (Figure I.10.11). Both contribute to an observer's uncertainty about what the individual will do next or as a result of a disturbance to a controlled perception. The first is about what sort of thing would the individual do, while the second is about how strongly he/she/it would do whatever they do. This is as true of humans as it is of robots.

Does autonomy, considered this way, require consciousness? Apparently not. An individual bacterium is unlikely to be conscious of its surroundings or its actions, despite being a living control system, as we assume in this book that it is. But the individual bacterium is to a large degree autonomous, seeking its own energy source — its food — without external direction. It is autonomous because no external influence alters its top-level reference values (or so we assume). The same is presumably true of earthworms and all multi-celled organisms. Even a canonical control loop has non-zero metron uncertainty and could be considered to have non-zero autonomy, as its structure allows it to influence its surroundings — creating side-effects — in a way invisible to its "driving signals", its reference and disturbance inputs.

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Why should humans fear robots? In Section IV.6.1 we argued that aliens, being unpredictable in how they would act if their unknown controlled perceptions were disturbed unknowingly by the side-effects of our actions. We cited the example of the US Presidential candidate Adlai Stevenson showing the sole of his shoe to a group of Arabs he was visiting. A robot is the quintessential alien, and potentially able to act in ways of which we are unaware when we unknowingly disturb some perception it controls. It may therefore act in ways that are dangerous to our well-being, or even our life. Or it may not. We simply have not reorganized to behave effectively in an interaction with an unfamiliar apparently autonomous robot, any more than we when we meet an unfamiliar wild animal. We must use our conscious analytic processes to observe and interpret what we observe the robot or unfamiliar wild animal to do, knowing that it may have the means to harm or perhaps to kill us.

In contrast, let us consider the in-home robots of today. Without exception, these robots are not feared by most people. Many of them are tools such as vacuum cleaners and kitty-litter boxes that advertisers claim will reduce menial work around the house. They are usually advertised under names of the form robot-this and robot-that. Always such "robots" have been designed so that their "intentions" as seen and interpreted by the potential user are to help in some aspect of everyday life, or so we trust. Vacuum-cleaning the floor without needing human direct control of where they go at any particular moment is an example.

In a more generally helpful vein, a robot may be designed to insert itself into a dangerous situation such as a collapsed building to search for possible survivors, or a damaged nuclear reactor plant for observation and occasionally for action. The immediate implication is that such a robot doesn't control for self-preservation. If the robot did not perceive its own "selfness", it would not control for its own survival unless it was deliberately designed to avoid places likely to be lethal to it. It has not evolved to take care of any "intrinsic variables", as we have. Furthermore, it does not have the capability of replicating to produce more like itself, which might be dangerous mutants.

Why the conditional "*If the robot did not perceive its own selfness*"? We know that many newborn wild prey animals do control for their own survival, and we do not presume they perceive their "selfness". The difference between them and the robot is that they evolved and the robot was designed. Prey animals that did not act in ways that protected them from being eaten before they matured would

have fewer descendants than those that did. The robot, on the other hand, propagates its design through the actions of a constructor and a buyer who wants another of its kind, and not if nobody wants to buy another. The environment that determines the evolutionary course of a line of robots is entirely human.

“Rescue” robots are usually controlled in real time by humans rather than being given autonomy to explore the dangerous environment and find the victims to be rescued. They may be autonomous in their choice of how to get where they are instructed to go, but the changing reference value for their perception of their own changing location is often supplied in real time by a human controller. This kind of robot is as much a tool as is a screwdriver or an electron microscope. It is an atenfel for some perception the human controller wants to control, such as the perception of whether anyone is alive in the building rubble. Such robots do not choose whether to accept the imposed reference value for a perception they are designed to control. It is imposed directly.

These externally-directed “robots” are of little theoretical interest. They are usually designed to perform one task by one method, though they may have some choice as to how to act to achieve their human-provided goal. Even “Rescue” robots may not have autonomy in finding a route through the destroyed building, since even though the human users do not know in advance what the robot will encounter in its progress through the rubble, what its sensors produce may be relayed to the human controller for interpretation and for decisions about reference values for the actions to control perceptions the human builds from the robot’s sensory reports. But sometimes the robot, or at least some future rescue robot, may be able to decide for itself whether what it sees is a barrier to be passed, an obstacle to be removed, a human to be rescued, or an opportunity for further discovery.

Lunar or Martian rovers form an intermediate case between quasi-autonomous robots and the “Rescue robot” kind of robotic tool. For such distant robots, real-time control by Earth-bound humans is not possible unless the robot moves and acts very slowly, because of the transit delay of signal information that would create unworkable control loop transport lags. They must be designed to have some autonomy about their immediate actions in support of the goals for which they were sent to the distant world, or they must operate very slowly under the guidance of human controllers on Earth. As of this writing (late 2022), mobile rovers on other worlds cannot make their way safely over boulder-strewn terrain, and must move at speeds measured in metres per day rather than kilometres per hour.

From what I learn from the popular press and from general science journals as of 2022, the designers of Martian rovers have tended to choose slow (long loop delay) human control over autonomy of movement. Travel paths of a few metres in a day are surveyed on the basis of the last day’s imagery, and the rover is instructed to follow the prescribed path. A more autonomous robot would, in contrast, be told something on the lines of “go to that interesting place and drill a sample from the reflective spot on the rock”. We will not totally ignore such “robots”, but will not concentrate on them.

In science fiction, some robots mimic humans so well that the true humans grown from babyhood and the robots factory-produced to simulate true humans cannot be distinguished on the street. These fantasy robots pass the Turing Test in all respects, but in the story, there is always something different about the robot. Often it lacks emotion but has superior logical-deductive abilities. Maybe it can deduce from observing a human with whom it interacts the appropriate emotion to emulate.

Such robots are potentially interesting in this section, but are too far from realization at present to be the main topic. Non-interactive humanoid robots, and pseudo-humanoid robots with limited function such as greeting customers to a Japanese store or substituting for a waiter by taking a diner’s menu selection and delivering it, these exist, but are not autonomous in the sense of being ready to solve problems in order to decide what to do about unforeseen situations.

We will try to address three questions. We assume that a robot is constructed on the principles of Perceptual Control Theory, as described so far in this book, and ask:

1. If an autonomous robot could be developed that was capable of being mistaken for a human in everyday interactions, what use would it be to a human?
2. Could a robot ever be conscious, and more particularly conscious of itself as an independently acting entity?
3. Could an autonomous robot feel emotion and be empathetic with emotion in humans and other animals?

A supplementary question, about people rather than about robots is: *Why do so many stories about robots take it for granted that intelligent robots would necessarily be terrible, with their objective being the elimination or subjugation of humanity*? Even the far-seeing Isaac Asimov felt the need to create "The Three Laws of Robotics" to inhibit the propensity for robots to damage or kill humans. Let us address these first three questions, necessarily superficially, leaving a supplementary Question 4 for later.

Given the current ever-expanding population of the limited Earth, could the production of simulated humans indistinguishable from ones that were born as babies be generally useful? I suggest that they could not, though they might be very useful to further the careers of their scientist-engineer developers who would have pulled off a very difficult task. If the robot was indistinguishable from a human, it would have the same capabilities as another human, who might well be already available. Since one of the existential problems of humanity is overpopulation, I see no benefit in producing a simulated human that had no non-human capabilities.

We must therefore assume that the humanoid robot would be useful only where it deviated from human capabilities or was prepared to act in situations that might be lethal to a normal human, and that the constructed robot was considered by humans to be ethically disposable. For reasons that will underly much of the later social discussion, I think it unlikely that moral scruples that apply to biological humans would not also be applied to robots generally indistinguishable from humans.

We are left with the proposition that useful robots would not be indistinguishable from humans in free interactions, in the Turing Test sense. A useful robot would necessarily have capabilities unavailable to humans, such as greater strength, more accurate and extensive ability to remember and to calculate, sensors that humans do not have, the ability to communicate with other robots in ways that augment or meld their control hierarchies over distances beyond the line of sight, and so forth. In most of these humanly unavailable capabilities, a human form would be an impediment, not a benefit, the exception being for situations in which the robot needed to deceive a human as to its robot nature.

We are left with an answer to question 1 that essentially boils down to "*Not much use at all, especially as compared to robots not constrained to look or act as humans would in the same circumstances*". So we pass on to consideration of the other questions.

IV.11.3 "Botnets", "Slime Molds", and the "Hive Mind"

Another kind of "robot" is the "bot" that roams the internet by following links on Web pages, seeking out particular kinds of sites an behalf of some human agency. Such bots have no physically tangible presence, though they do have a well-defined structure. The environment, in fact the Universe, for such bots is the internet. They have no physically active parts that apply force to our environment, since their environment is the network of sites linked on web pages they examine, but their work may well have side-effects that do disturb our perceptions.

Web-following bots could be individually autonomous in their choices of what sites to investigate next among the links they have discovered, though they may be programmed to use a single algorithm to make this decision. They may discover and report to their users private information of any kind that someone has committed to the internet, perhaps financial, perhaps medical, perhaps innocent, perhaps laying a person open to blackmail in their physical environment.

Bots that live only in the internet may be every bit as dangerous to humans and other organic life as those that overtly aim to cause physical damage, but they are not usually perceived to be dangerous, perhaps because they are familiar, or more probably because their activities are seldom directly sensed in real time by human users of the internet.

Depending, however, on how their discoveries are used by their employers, bots can be very dangerous tools. They may infiltrate ill-intentioned software (malware) into computers with poorly protected systems, causing those computers to act otherwise than their owners would choose them to do, and those computers might control important social infrastructure such as electricity or water distribution systems, transport networks, or air traffic control systems, not to mention the flow of finance on all scales from dollars to trillions or the "social media" networks through which many humans gain much of their perceptual understanding of the changing world.

Could such bots be constructed as perceptual control systems, with their own control hierarchies and intrinsic variables? In particular, could forms of bots co-evolve into ecological networks of their own, through the same kind of evolutionary processes that have created all the organisms we see around us today? Could networks of bots communicate in ways that produce "hive minds"? The answer to all these questions is the same — Yes, that is not impossible.

We can ask another question along much the same lines. Suppose a bot hive-mind came to exist, could the hive-mind structure evolve to form one or more perceptual control structures, in which the individual bots played the roles of the components of the perceptual control hierarchy of a living control system, perceptual function, reference input function, comparator, and output function, or of sensors and actuators that interface with the physical environment with which organic sensory systems interact?

Again, the answer must be that it is not impossible, and indeed, each individual bot might well have the computing power to act as one or more ECUs, each complete with all three functions and a reference input function. These bots are, I think, becoming more and more reminiscent of organic neurons with their individual myriads of connections that form well-defined network structures.

Also perhaps related to the growth of organic neural networks, we might ask about an organism in the natural world that has the unappetizing name of "slime mold". There are some 500 species of slime mold, one of which is a much-studied[48] yellow form called *Physarum Polycephalum*[49]. The term "Polycephalum" means "many-headed", since the organism is all one cell, but has myriads of cell nuclei distributed over ever-extending and branching arms. I will call it "Polyceph" in the following. The place of Slime Molds on the so-called Evolutionary Tree of Life is a matter of debate, but they are not bacteria, an archaea, animal, fungus, or any other recognized kingdom. They are assigned to the grab-bag of "protists", things that don't seem to fit elsewhere in the tree. They seem to be extremely old, as a type

Polyceph demonstrates some abilities that we might well call "intelligent", as several people do, including the researchers central to the Nova episode cited above. For example, Polyceph slows its rate of arm extension when the temperature and humidity drop. Saigusa et al. (2008) subjected samples of

48. The earliest reference to it I can find in the reference lists in scholarly articles is Howard (1931), cited by Daniel and Rusch (1961).

49. See the PBS episode of the science program NOVA, available at <https://www.youtube.com/embed/lls27hu03yw?wmode=transparent> (Retrieved 2021.12.12)

Polyceph to three such temperature-humidity reductions at equally spaced intervals, during which the growth rate of the Slime Mold dropped. At the first and second moments when another reduction might be expected after the same interval but did not happen, the growth rate also slowed, the second time by much less than the first. Polyceph seemed to be able to estimate the length of a time interval, and anticipate what might happen at the end of the interval, all with no centralized equivalent of a brain.

In the Nova episode, Polyceph acted in its growth patterns as though it "liked" oatmeal and "disliked" salt, which its growing branches would preferentially avoid. If, however, the only way to some oatmeal was along a path coated with salt, it would take that path. When I say that Polyceph takes or follows a path, it is not like a person crossing a bridge, starting on one side and ending on the other, since Polyceph is a single growing cell whose branches lie where the growth front has passed unless they are pruned. Oatmeal-seeking Polyceph prunes (retracts?) branches that failed to approach food, leaving a relatively wide trail of slime behind. In continuing its search, it preferentially avoids crossing slime trails, which thus form a kind of stigmergic "environmental memory" of places that are not worth trying in future. It will cross slime trails, however, if other routes for growth are blocked.

Polyceph appears to have several kinds of sensor associated with each of its millions of cell nuclei, including red-blue colour sensitivity (Adamatzky, 2013), touch, taste, temperature, humidity, and smell, and can use these to distinguish favourable directions and times of growth from unfavourable directions. In other words, it seems to perform perceptual control, but with no apparent equivalents to neural connections. Andrew Adamatzky is a prolific researcher into the computational properties of slime molds and fungi, on which he has published many studies.

In some ways, Polyceph resembles a botnet, while in others it does not. It does in its ability to form reconnections from branch to branch, possibly creating a dense network. It differs from a bot-net in that the individual units, Polyceph nucleus-containing segments, cannot do very much other than reproduce to grow the search domain of the whole, whereas individual bots in a botnet can do as many different things that they are programmed to do, but (as yet) cannot reproduce and expand the botnet. The Polyceph network consists of many connected segments that are fixed in place once created, while the botnet units — individual bots — move within their accessible domain and can freely vary their connections to other bots in the net (if they are programmed to do so).

Two other kinds of network bears a resemblance to both Polyceph and botnets, the neural network that in a perceptual control hierarchy carry "neural currents" in an individual, and the network of concepts or ideas that link persons and Roles in a social organization.

Suppose that hive-mind perceptual control hierarchies consisting of entire ecologies of networked bots came into existence, might such hive-mind systems as a whole have intrinsic variables that are characteristically different from a perceptual control hierarchy and are interlinked into a variety of homeostatic loops? In living organisms, we have argued (Chapters II.1 and II.2) that such homeostatic loop networks evolutionarily precede perceptual control and guided the development of ever more complex and capable perceptual control hierarchies.

This would presumably not be true of our hypothetical bot-based perceptual control structures. If the botnet came to exist, it would not have developed through an analogue of a chemical soup that produced ever more complex molecules. The initial genesis of the bots would have come from a human design, which perhaps the bots had optimized in a form of design evolution. No "soup" would have constrained or supported the development of one structure or another, and the continued existence of any particular kind of bot would not have needed a loop of interactions with other kinds of bots. There is no obvious surface argument for the existence of an equivalent to the biochemical homeostatic loops of an organism.

When we look at their function outside their effects on reorganization, however, we can find an argument why a perceptual control botnet hierarchy might develop homeostatic loops analogous to those of organic intrinsic variables. Biochemical homeostatic loops are the maintenance crew for the organism, be it a bacterium, a tree, a fish, or a human. Any structure that is not isolated from the physical environment will deteriorate in what is sometimes called “entropic decay”, and this is as true of a bot or the connections among bots as it is of an organism.

The botnet will require a maintenance crew, presumably consisting of specialized bots programmed to control for clearing out failed bots, rebuilding new bots from templates and installing them where they are needed in the structure, ferrying and controlling energy around the system, adjusting the interconnection parameters among the bots that do the actual work, and so forth. All of these requirements are fulfilled in living control systems by the biochemicals involved in organic homeostatic loops that we have called “intrinsic variables”.

It not unreasonable to think of the specialized “maintenance and repair” bots as providing intrinsic variables for a botnet perceptual control hierarchy. They would need to intercommunicate observations of the status of the perceptual control hierarchy of bots, if only in order to sense the state of its various components and interactions so that the competent bots might be able to repair software glitches or communication link problems that might well arise in a spatially distributed robot network under the rubble of a collapsed building. With widespread intercommunication requirements comes the possibility of homeostatic loops and internal clocks. Any such clocks might work thousands of times faster than our own, though some would presumably be related to diurnal or seasonal rhythms because those rhythms affect the environment with which the perceptual control hierarchy of the robot network would interact.

A botnet hierarchy along with its intrinsic variables is housed in some physical space. If this space is enclosed in an armoured shell of limited permeability, to the outside observer it would look like what is ordinarily thought of as a robot. An outside observer could not observe that the “robot” is powered by bots inside its visible external membrane or shell. Like any Black Box, the observer can detect what it does when probed, and a White Box might be constructed to emulate its functioning and some of its internal functional connections, but, as with any Black Box, the observer could not determine how it performs its functions from knowledge of how the White Box performs the same functions.

A software bot lives in some substrate we might as well call a computer network. For the bot to perform any function requires a through flow of energy, just as does the firing of an organic neuron. The substrate, the analogue of the physical structure of a brain, must be provided with a low entropy energy source and a means of disposing of higher entropy waste.

One of the most difficult problems faced by evolution about the increasing size of our more “intellectual” human skull beyond that of our ancestors was not how to fit all the neurons into it, but how to dissipate the heat of their operation to somewhere else for eventual radiation to outer space. Failure to dissipate that heat from the skull would result in one of two things, thermoregulation of the total amount of nerve firing or a physical meltdown of the brain matter. Evolution provided a solution to the problem of both delivering energy throughout the brain and dissipating the heat of its operation by using the same circulating fluid medium, blood supplied by the arteries and evacuated through the veins.

Software bots contained in an enclosure would be subject to the same constraints of energy acquisition and dissipation. A hive-mind botnet widely distributed over space would not. Either kind of botnet-based robot has an added energy requirement for its communication infrastructure, greater if it uses spatially wasteful radiated wireless than if communication is by fibre or wire. Would the waste high-entropy energy be subject to a liquid cooling requirement in an encapsulated botnet on the grounds that liquids can carry a higher energy density than gases of the same volume, or would the encapsulated botnet use thermo-electrical means of dissipation? Either way, the means of heat dissipation would probably occupy

a non-negligible fraction of the volume available within the encapsulated botnet — the robot's — "skull", as they do in ours.

All the above is highly speculative, but it could hardly be otherwise, given that the question is about what could be possible or even plausible about the structure and capabilities of future robots, even far future ones. The speculation involves only technologies available today, except perhaps a slight extrapolation of current trends in electronic miniaturization. My speculations do not even depend on potential advances in quantum computing, which might permit far more "intelligence" in a bot and in a botnet than is anticipated in these speculations.

Without extrapolating current technology beyond matters of scale, I will assume the possibility that a future botnet based robot could well have intrinsic variables with which a perceptual control hierarchy could interact in a way functionally similar to the way that, according to PCT as developed in this book, the perceptual control hierarchies in organisms interact with their biochemical intrinsic variables.

Organisms are subject to attack by microorganisms we call viruses, bacteria, and parasites among other names. Would a botnet based robot be vulnerable to similar attacks? Of course it would. We already have propagating "malware" we call viruses that attack through our relatively slow internet and cause damage to the functioning of individual users of the software "infected". Why should we assume that a botnet distributed hive-mind robot would be immune?

The quick answer is that it would not be immune, and must have mechanisms akin to the organic microbiome and cellular immune processes to counter the problem of invading viruses (and software bacteria and parasites, which we have not discussed and will not discuss). We certainly cannot properly attempt to treat the whole science of immunology in a book about the range of application of Powers's Perceptual Control Theory, even though the concept of opposing damage by invading micro-organisms is self-evidently within the purview of PCT.

We leave the question of botnet immune processes with the observation that just as current anti-viral software is designed to both detect and act to neutralize malware, so would both within-bot and botnet-wide perceptual control processes detect and neutralize external attacks on — immunize — a hive-mind robot.

As does any sufficiently complex organism, the botnet-based robot would need to learn perceptual functions that produce perceptions of the forms of previously encountered attacks. Perceptual control reduces the relative entropy of local environmental processes, easing the ability of the controller to dissipate that entropy into less destructive parts of the environment. In itself, this provides an imperfect form of immunization, but every bit helps us, and the same would be true of a botnet.

IV.11.4 Robots — Conscious and Emotional?

We move on to questions 2 and 3:

2. Could a robot ever be conscious, and more particularly conscious of itself as an independently acting entity?
3. Could an autonomous robot feel emotion and be empathetic with emotion in humans and other animals. both of which hinge on the question of whether the robot reorganizes on the basis of the benefit to its intrinsic variables of controlling this or that perception in a particular manner.

> Central is the question of whether the robot actually has intrinsic variables, and how those variables interact with each other and with the perceptual control hierarchy if it does.

Question 2 is about the nature and use of consciousness that we have been discussing through much of this book since Chapter II.10. The first half is essentially about the robot's ability to predict the effects of varying this and that perceived state of the environment (intelligence) on some variable of interest. The second half of Question 2 asks whether the robot could have a self-image of either kind (self as perceived by self or as perceived by self to be perceived by others), and if it can, whether either kind of self-image includes a variable that we have called Worth, and more recently degree of autonomy.

Question 3 asks about emotion, which is an ill-defined concept that means different things to different people. Following Powers, we attribute emotions, however defined, to biochemical influences on and from the neurons involved in the perceptual control hierarchy, in other words, on homeostatic loops that interact with the perceptual control hierarchy. For example, an emotion called "depression" tends to be associated with low loop gains widespread regions of the perceptual control hierarchy, and to be associated with a conscious feeling of "why bother?".

Could there be homeostatic loops that maintain the health of the robot and are analogous to the biochemical homeostatic loops of a living being? The robot certainly needs an energy source to which it has continuous access so that it can export the entropy, and if that source is electrical, it must have a voltage within some tolerance limits and be able to supply both steady-state resting amperage and burst energy sufficient for the robot to act as necessary to counter environmental conditions that lead to perceptual error. This is not a complex "intrinsic" system of homeostatic loops that interact with its perceptual control functions, but is it sufficient on which to base an answer to Question 3?

I do not think the answer is clearly cut and dried. Any serious answer must be approached from backgrounds that have a supportable basis in PCT. Speculative as was the earlier discussion, the following discussion is even more speculative. Please take it with a quite a few grains of salt.

No existing robot of which I am aware learns by reorganizing an internal perceptual control hierarchy, and none has any obvious intrinsic variables that interact with whatever its (human defined) task may be. Accordingly we must act like fortune-tellers and pretend to foresee a future in which some do. A self-maintaining robot presumably must incorporate an internal botnet perceptual control hierarchy that must incorporate maintenance and repair bots, and has intrinsic variables that function much as do the intrinsic variables of a living control system. Accordingly, we start with the assumption that the robot in question will incorporate a botnet whose interactions are an analogue to our biochemical homeostatic networks.

Going back to the argument of Section II.8.2, we talked about the use of consciousness as a tool related to Genetic Algorithms. Using the rapid testing available in conscious imagination, the Mechanic might be able to develop a novel perceptual function whose inputs consist of existing controllable perceptions. In Chapter II.10 we elaborated this concept, introducing the concept of a conscious "narrative soup" whose narrative elements corresponded to what an omniscient external analyst might identify as "events", occurrences that alter the contents of the "perceptual soup" that is Perceptual Reality. When it is successfully controllable, the perception contributes to the top level perceptual input function, or becomes itself a new top-level perception to be controlled, as suggested by Figure I.11.1.

The intrinsic variables of a robot, if it has any, must similarly determine the effectiveness of its reorganization of its own control hierarchy. Simply having very good control of those perceptions it does control is not enough. Why should control of this or that perception be more useful *to the robot* than some other potential controllable perceptions at any level of the hierarchy, unless the robot does have intrinsic variables akin to the hormones and so forth that are the intrinsic variables of the carbon-based evolved

reorganizing organism? Would the robot have no intermediate representation of its success or failure between either being allowed to continue its operation or being switched off and recycled?

Well, yes it would, if the foregoing speculation about botnet based perceptual control hierarchies is at all valid. A robot with an internal botnet structure would indeed have the required intrinsic variables, consisting of sensors of actual or incipient failure in the perceptual control hierarchy, coupled with maintenance and repair bots to bring the system back to full health. A side-effect of this ability to maintain itself would necessarily be that both the sensor bots and the maintenance-and-repair bots have templates that they can decode and compare with the current state of the part of the hierarchy (and the maintenance system) for which they are responsible. They should be able to repair themselves, as do the component processes in natural homeostatic loops.

In living control systems, the most basic of these templates are in the form of DNA formed into chromosomes, but they have this constraint because they live in a three-dimensional space and must produce functional molecules such as proteins that conform spatially to whatever place they are used. Templates for unencapsulated botnets have no such dimensional constraints, but like DNA molecules, they must, in total, have plans sufficient to build a functioning version that will build itself to be very like the entity that hosts them — a descendant or "child" botnet.

Having the plans for producing a descendant, at least in principle, renders the botnet robots capable of replication, which need not be faultless. The replicate might have slight changes from the original templated plan. Therefore the population of botnets could evolve in the same way as does a population of living control systems. Evolved botnet robots built with a perceptual control hierarchy would have just the same degree of autonomy as does a living control system. But could it be "conscious" or even "self-conscious"?

Before we address this question directly, we should note a significant difference between encapsulated and unencapsulated botnets. A "child" encapsulated botnet is separate and distinct from its parent, whereas it is difficult even to conceive of a separate botnet being produced by an existing one unless there is a possibility for "spores" to contain the replication plans in a way that would allow them to be carried to a region of the underlying support network as yet unexposed to the existing botnet. An unencapsulated botnet is more analogous to a fungus network than to an example of any other main branch of the tree of life.

Seldom, if ever, has the possibility of fungal consciousness been mooted, though the question has been raised with respect to many complex eukaryotic species, vertebrate and invertebrate, aquatic, avian, or land-based. Whether scientifically justifiable or not, the idea of consciousness seems to be limited to members of species that move and act independently, not to the hive minds of communities of them. With that mindset, consciousness seems to be thought of as applying only to entities that have much faster internal communication than to entities that communicate externally at much the same speed as internally.

As with the words "robot" and "autonomous", we need to refine what we mean by "consciousness". Since it is inherently impossible to know what other people experience when they use words that apply perfectly to our own experience, our qualia may differ from theirs. What we can surmise, as we did in Chapter II.10, with some hope of being correct, is that consciousness is used to solve perceptual control problems not yet solved by incorporation in the non-conscious perceptual control hierarchy built by ongoing reorganization to function in the real world environment.

That same real-world environment impinges not only on us, but also on our neighbours. They, if they are of our own species, are likely to have similar kinds of encounter with their environment. If we cannot fly or survive under water, neither can they, and they must have ways of avoiding becoming a sludge

under the pull of gravity, as do we (our bony skeleton base for our tensegrity structure). We may be tensegrity structures, but tensegrity structures need compression members.

In our case, the most obvious of our compression members form an articulated skeleton. Perceptual control affects the forces that might change the angles of articulation. Though mistakes may allow us to fall down, the fall will not turn us into a sludge. We need to learn how to stand without falling, and so do others that hold their main mass high off the ground. In non-vertebrate animals, the compression members may be the cellular forms that can act like miniature balloons with their internal pressures.

Vertebrate or invertebrate, they, like us, live in a perceived environment that contains other living control systems, so they, like us, must have ways of dealing with them, whether these other living control systems are of the same species or not. Some may want to eat us, some not, but if we have not learned over evolutionary time or within our lifetime which kind they are, we are more likely to live to produce descendants if we protect them against the danger that this or that other animal might want to eat us than if we don't.

In several places, especially Chapter IV.3 and Chapter IV.6 we discuss danger in the context of "the dangerous alien" or "Us versus Them". How much stronger should be this bias toward caution when the alien is not even an organic living control system? But we are asking about consciousness, and we must ask whether this bias toward caution when encountering an unfamiliar entity is or needs to be conscious when the "we" is seen from the viewpoint of a robot rather than that of a carbon-based evolved living control system.

If other animals are conscious, their experiences will necessarily differ from ours. Their genetically controlled structures, though possibly similar to ours, are nevertheless different enough for them to be called different species. Nagel's question "What is it like to be a bat" (Nagel, 1974) opened up decades of philosophical discussion on the nature of consciousness, which we will ignore here since we discussed it a little in Chapter II.8. I do, however, acknowledge the relevance of Nagel's question to our Questions 2 and 3. Are bats conscious? Could they be? Could a bat colony have a conscious hive mind?

We assume that the experience of consciousness is likely to be forever unknowable, exactly as are the functional mechanisms of the Black Box we call Real Reality[50]. In that sense, consciousness is itself a Black Box. But like the Black Box of Real Reality, it is possible, in principle, to discover some of the functional connections and functionality of consciousness in the form of White Boxes that are functionally structured and connected like the corresponding Black Boxes.

For example, an experimenter might ask whether an organism such as a mouse, a monkey, an elephant, or a pre-verbal human baby is conscious of itself as a functioning entity. Does the organism have a perception of "Me" as distinct from "not Me"? The experimenter cannot, however, usefully ask whether the animal experiences the distinct "Me" in the same way she does, because she will get no answer.

We are, of course, assuming that hierarchical perceptual control is almost a definition of an entity being alive. It is, in Powers's words a "Living Control System". In that sense, the evolvable botnet robot is indeed a Living Control System, as alive as you or I. What we do not assume is that the control hierarchy is the only perceptual control done by an organism, as we discussed particularly in Section II.8.1 and Section II.8.2. In humans or evolvable botnet robots, it clearly is not, whereas in bacteria it probably is.

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50. No matter how far the science of Physics may delve into the substructures of "fundamental particles" such as quarks and gluons, it can discover only how they interact, not of what they consist, if indeed they consist of anything beyond structured energy. They remain "Black Boxes".

The difference is the degree to which the structure is determined genetically as opposed to being reorganized during the lifetime of the individual organism — another way of asking about "Nature versus Nurture". Some species probably do not reorganize during their lifetime, while some species we call "advanced" apparently do, at least to some extent. These latter can and often do learn from experience. Some of that learning might be conscious.

Current "robots" are always, so far as I know, provided with top-level reference values (or tasks to be performed) by sources that are ultimately human. Even Isaac Asimov's famous "Three Laws of Robotics" are of this kind, in that they constrain the actions available to the otherwise autonomous robot (Asimov, 1940). Wikipedia[51] quotes the three Laws thus:

> The Three Laws, quoted from Asimov's "*Handbook of Robotics, 56th Edition, 2058 A.D.*", are:
>
> ***First Law***
>
> *A robot may not injure a human being or, through inaction, allow a human being to come to harm.*
>
> ***Second Law***
>
> *A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.*
>
> ***Third Law***
>
> *A robot must protect its own existence as long as such protection does not conflict with the First or Second Law*

According to Wikipedia, Asimov later added a "Zeroth Law": *A robot may not harm humanity, or, by inaction, allow humanity to come to harm.*

These Laws present ethical problem-solving situations to the robot, of the kind posed to living control systems in Section II.8.2 that were solved by conscious imaginative assembly of existing abilities in the control hierarchy. The Law being, to the robot, perceived as the equivalent of a Natural Law such as Newton's f = ma or Einstein's $e = mc^2$, its actions must be similarly constrained and must similarly influence the robot's reorganization of its control hierarchy. But they are not the equivalent of a Natural Law, which cannot be inadvertently violated by some action. The autonomous robot can unintentionally act to harm itself or a human, no matter that it cannot intentionally do so.

Asimov's Three (or four) Laws of Robotics, however they are refined over time, deal with the effects of a robot's actions within Real Reality. But where do its reference values come from, particularly at a high level? Since the robots of interest are largely autonomous, the control hierarchy cannot be prebuilt at a factory. It must be learned by the robot when it is delivered from the factory to its working environment, or must have evolved from prior generations of botnet-based robots. These latter could not, I think even in principle, be subject to Asimov's Laws, though they might learn them as humans and other social animals learn moral behaviour (see especially Section III.1.5).

As we have discussed in various places, and particularly in Chapter II.6, Living Control Systems will tend to reorganize their hierarchies so that their perceptual controlling serves the maintenance of the homeostatic loops of their intrinsic variables. Over billions of years, these intrinsic variables have developed intricate relationships that entailed the building of perceptual control hierarchies to take advantage of or to defend against variation in the Real World environment. Hive-mind distributed botnet

51. "*Three Laws of Robotics*" Wikipedia article retrieved 2021.01.10

robots, as we have argued, may have similar evolvable traits based on intrinsic variables to do with maintenance, repair, and immunization.

In the "scary scenarios" of robots out to terrorize or destroy humanity, the evolving robots might observe that the existence of humans could be inimical to their long-term survival. Is this a reasonable concern or an irrational worry?

Nothing dictates that robotic ethics is similar to our own, because we have no functional description even of how the differing ethical codes of our various subcultures come to be as they are, with all their colourful variation. We touch on this question in Chapter III.1 and later. Some of the discussion there may be applicable to societies that incorporate autonomous robots. Either way, there seems to be no functional barrier to robots developing consciousness that functions indistinguishably from our own (though probably much faster).

Question 3 is "*Could an autonomous robot feel emotion and have empathy for emotion in humans and other animals*". This question does not depend on whether robots have consciousness or self-consciousness. To address it we start in a perhaps unexpected place, a discussion of energy sources and uses.

It takes energy to do anything in less than infinite time, such as to move a limb or to fire a neuron. Any mobile entity must have a source of energy from outside and a sink to deposit the high-entropy waste energy, often in the form of heat, but also in the form of material waste less well structured than the ingested food. This is as true for an autonomous robot, whether distributed or spatially unitary, as it is for a living organism. We must consider how this energy can be transferred from an external source through the actions of the living or robotic body back to the external environment, and see whether there are constraints in common between carbon-based organisms and technological constructions such as autonomous robots.

There are only two sources of energy to the Earth as a whole, nuclear fusion in the sun radiated to the Earth, mostly as sunlight, and nuclear fission on the Earth. Likewise there is only one way the Earth can rid itself of waste heat, by radiating it into outer space. What any functioning system needs is not energy as such, but a through flow of energy that takes with it any increase in entropy caused by the operation of the system.

Energy can be derived on the Earth from the temperature change with depth into the crust, but this is itself largely derived from nuclear processes, including at least one natural fission reactor some billions of years old, which was based on both Uranium-235 and Plutonium-239, both of which were then less rare than they are now (e.g. Meshik, Hohenberg, & Pravdivtseva, 2004). These ultimate sources may seem very far removed from consideration of emotion, but if we follow the thinking of much of the later part of the book, we find it is not far removed at all. Let's consider living organisms first.

Living organisms acquire energy from food they eat, by breaking down chemical structures in the food into forms suitable for transmission to areas of the body where it is used, such as muscles and neurons. The energy supplied by most food is ultimately derived from solar energy by way of vegetation and animals that eat the vegetation or herbivores. Within an individual. transport in circulating fluid is the easiest way to deliver chemicals efficiently to widely distributed parts of the body where energy is needed, whether the individual is motile or vegetative. The same is true of waste (higher entropy than the source) heat and material. Fluid transport is a major way of delivering it to the appropriate disposal mechanisms.

As we have argued, internal stability requires, or perhaps implies, homeostasis. In an organic structure that is energetically based on chemistry homeostasis requires catalysts and anticatalysts that enhance or inhibit reactions among the various chemicals (Chapter II.2), including those that affect nerve firings and

muscle activity. These reactions produce both chemicals used in maintaining the homeostatic loops and chemicals of use elsewhere or that must be excreted as waste.

Unless the autonomous entity continuously acquires low entropy energy and sends the energy equivalent higher-entropy waste to its environment, it must have an internal buffering storage system that, like a battery, can recharge rapidly and discharge slowly. In most sufficiently complex organisms, this buffering storage system is in part a digestive tract that includes a stomach or other place to store the food ingested in bulk before slowly delivering it in usable form to the circulating fluids.

In a mammal, longer-term energy storage occurs also in various tissues such as fats, but the stored energy in these buffers is both slow to accumulate and slow to be made available. However it is constructed, a buffering energy storage system would seem to be an absolute requirement for any reasonably autonomous mobile entity, organic or robot, no matter how and of what it is constructed.

Unless its energy supply is recharged, any buffering energy storage system will eventually run out of the stored energy needed for the intellectual (e.g. neural or electronic) and active (creating detectable effects in the environment) operations of its autonomous entity. One implication is that it must have some way of perceiving its level of remaining stored energy, so that some of the remaining stored energy may be used to acquire another energy-carrying recharge package — eating food by a living organism, but refuelling in any autonomous entity. Available energy level, recorded in some form, must be an intrinsic variable in autonomous entities, whether they be organic or robotic.

Since we are assuming that both robotic and organic autonomous entities are based around hierarchic perceptual control systems, the energy-depletion signal must disturb some controlled perception if it is to generate action to recharge the buffer. As we have argued for organic entities of sufficient complexity, including humans, the disturbance to a controlled perception comes about because of a disturbance elsewhere in some homeostatic loop in which that perception participates.

Something similar must occur in an autonomous robot, though in both the human and the robot, the depletion of the energy buffer could, in principle, also produce a signal that directly influences a controlled perception. In the human, that signal could come from sensors that respond to stomach contraction, which is usually associated with, and could be causally related to, a perceptual state we call “hunger”.

Remembering that the only effective sources of energy on this Earth are solar radiation (externally supplied energy) and nuclear fission (and in some distant future perhaps fusion), carbon-based organisms have no available portable energy producing capability. But some future autonomous robot might carry an internal nuclear-based energy source that might remove the need for much, if any, buffering by an internal battery because it could supply on demand the immediate energy needs of the robot. Lacking such an internal energy source, even a botnet-based robot must have access to “food”, perhaps by plugging a specialized component of itself into an electrical power supply, from which the energy must recharge its energy buffer.

Energy distribution in a robot is much quicker and easier than in a carbon-based organism, since variations in electrical signals typically travel at a speed not far from that of light. A colleague who was debugging the newly designed hardware of a 1966-67 computer used to carry in his pocket a few connector wires about a foot (~30 cm) long that he called his “nanoseconds”, which he used to delay certain signals by that small amount.

The same foot-nanosecond speed applies both to signal propagation and to energy dispersal, which is not true of our physiological processes. In humans, signals propagate along a nerve axon at a speed

between 3 million and 300 million times slower (Myers, 1995, p 43[52]). The average speed of human "energy packet"carrying blood-flow is roughly the same as the slowest neural impulse, 300 million times slower than the robot's nanosecond per foot.

That kind of message or energy delivery speed ratio is in some ways very important when we compare the potential properties of robots with those of humans, and in some ways does not matter at all. It is important when we consider how humans and robots might interact to mutual benefit, but insignificant if we consider internal feedback systems that do not interact with the slow-moving exterior environment as human control hierarchies do. Robots are subject to the same Laws of Physics as are humans. When massy objects must be moved, the critical Law is the Newtonian Force = Mass × Acceleration.

The robot cannot apply more force than the object's structure can withstand, so the robot's speed of control using muscles to move real reality (RR) objects cannot be orders of magnitude faster than the human's. On the other hand, control in which the action effects on the CEV are performed at electronic speed can be millions of times faster than can human controlling. In particular, conversational interaction among electrically based robots could be structured exactly as are inter-human or human-robot communication[53] while being performed millions of times faster.

Robotic internal feedback systems such as homeostatic loops that interact with perceptual control hierarchies have no such practical speed limits, and could function at the near light-speed rates of electronic or photonic communication. Nevertheless, since the environment-facing perceptual control hierarchy, even in a robot, is speed-limited by Newton's mechanical Laws of Physics, any such modulation of the robot's perceptual control hierarchy is subject to pretty much the same rate constraints as is the carbon-based organism. Its reorganization, however, in principle is not, and neither is its intellectual "imagination". Those, however, are constrained by the Laws of Thermodynamics, notably by the robot's ability to dissipate heat energy to its RR environment.

In practice, however, the robot's reorganization processes for reorganizing the perceptual control hierarchy would be speed-limited by the same considerations as apply to humans. Reorganization must be slow compared to the control processes being reorganized, and as we just noted, those are constrained by the accelerations the robot can apply without damaging what it intends simply to move.

These speed consistencies and inconsistencies suggest that the relations between the robot and its environment are likely to be different from those of a human and her environment, in that the robot would be able to treat situations analytically that the human would be able to address only intuitively or in imagination. The robot process would be analogous to the human's conscious imagining, without having any necessary implications about robotic conscious experience.

We have speculated that the reorganization processes of a botnet robot are performed by the same kind of homeostatic loops among its intrinsic variables as are the reorganization processes of a sufficiently complex organic Living Control System. If this is the case, the robot's homeostatic loops could have loop transport lags millions of times shorter than those of any organic living control system.

As we have seen, however, this does not imply that the process of reorganization could be any quicker than in an organic system, being constrained by the same laws of motion as are active for perceptual control by an organic system. If, as we have assumed, variable emotions are the perceptual consequences of homeostatic loops being unable to achieve a dynamically stable state, then we should expect the conscious botnet robot to express emotion, and to express it on a similar time-scale to that of an organic living control system.

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52. Quoted in "The Physics Factbook" https://hypertextbook.com/facts/2002/DavidParizh.shtml

53. See Chapter II.10 and Chapter II.11 for a description and discussion of this.

While the robot may experience emotion consciously for a duration comparable to that of a human, this does not imply that it expresses emotion on the same time scale. If a human is in an environmental situation that often implies gladness, fear, sadness, worry, or any other emotion, but can perceive the source of that emotion as being in the environment, then the perception of the emotion tends to be neutralized, in favour of action appropriate to correcting error caused by the disturbance. Only when no such action seems available within the reorganized hierarchy does the perception of the emotion usually persist.

The robot's signals and processing may be millions of times faster than ours, but we have billions or trillions of synapses interconnecting neurons, which compensates somewhat for the robot's serial processing speed, allowing us to produce intuitive solutions to some problems in what we experience as "a flash of inspiration". Such intuitive solutions are based on similarity, whereas the analytic processes, which take a lot longer to evaluate the inspiration, are based on dissimilarity.

A botnet robot may or may not have access to both processes, but what we argue it should be able to do is to conduct the Genetic-Algorithm-like processes of conscious imaginative problem solving (Section II.8.2) orders of magnitude faster than can we. We must ask again, though, whether that speed is likely to result in faster learning, faster production of new top-level perceptual functions, than our own.

As we have stressed several times, reorganization cannot usefully proceed faster than the speed of environmental feedback permits, and that speed is independent of the speed of imaginative processes. The robot may determine rapidly the source of an emotion and how to correct any consequent perceptual error, and this may preclude it from expressing the emotion in any way discernible to an outside observer, but we can begin to answer Question 3 with a "Yes, a robot could feel emotion".

Since this implies that the robot is better equipped to discuss and communicate about emotion with a human than is a colour-blind person to discuss shades of colour, we than should complete the answer to Question 3 with "Yes, the robot could feel and express empathy with emotions felt by others — human or robotic."

We should perhaps also extend the organism-robot analogy, and think of each neuron in our brain as a bot. Each neuron has a considerable flexibility of computation, as, we assume, does each individual bot. Each neuron has many connections from and to other neurons, and each bot has many connections to and from other bots in the botnet. we already assumed that effective robots of any kind would have a perceptual control hierarchy at their core, and that botnet robots would be no exception. So far, the analogy between robot and organism is very close.

Where the analogy fails is in the maintenance and repair domain, as the proposed botnet robot has nothing analogous to the undirected extra-cellular fluids that carry at least some of our global biochemical modulators, such as hormones. The equivalent effects on the botnet bots are delivered by directed links, though in a wireless-connected botnet global broadcasts are definitely possible. Independent botnets might equally well communicate directly through wireless signals emitted and received by any level of their respective control hierarchies. We, on the other hand, have no communication facility other than language associated with protocols operating through our environment-facing sensors and effectors. We do not communicate telepathically. They might.

IV.11.5 Aliens among us: Robots and Society

The word "robot" does not have a long history. It originated in Karel Capek's play "RUR", or, in English translation, "Rossum's Universal Robots", of 1920. The concept, however, of a constructed entity

that acts in some ways like a human, has a much longer history. Mary Shelley's monster created by Dr. Frankenstein, is an example from a century earlier.

We discussed in Chapter II.6 the possibility that truly human-like robots with consciousness and experiencing emotions might one day be developed from intercommunicating software "bots" that might take the place, not only of neurons, but also of the biochemical infrastructure of organic living control systems. Here we will continue to assume that such robots will some day be technically possible.

A thread that runs through much of the robot literature and discussion, both fiction and non-fiction, is fear. Robots are seen as scary, both as immediate menaces and as possible wiser replacements on Earth of humanity itself. One reason is that they are the consummate "other", whether they perfectly emulate humans or in some way are autonomous in their desires and intention, and that as perceptual control systems they will have references to do us harm, just as might any unknown stranger.

In Section III.2.5, we did not assume that the "J's" were afraid of Marcel, the stranger, but assisted him in becoming familiar to them. Marcel was an individual "other", who might well have been dangerous to the J's, but John, the first J Marcel encountered, performed what amounts to a Test for the Controlled Perception by warily teaching him to communicate better with J-speakers until he became familiar to them. Marcel was in a similar state to the travelling merchants of Mediaeval times, or the French onion-sellers in England in the 20th century — perhaps unfamiliar persons, but persons playing familiar roles. But few people would be likely to know what Role was being played by an unknown robot, no matter how humanoid, or even if the robot was shaped like others with which the people were familiar.

Frankenstein's creation was feared by the mob, who perceived it to be dangerous. In the same vein, much current discussion of "Artificial Intelligence" is concerned with fear that robots will be constructed that are more intelligent than humans, and will therefore be uncontrollable. A common fear now is that such robots may decide that the human race is dispensable, and do away with our species. A review in Nature (Leslie, 2019) of the 2019 book "Human Compatible: Artificial Intelligence and the Problem of Control", headlined "Raging robots, hapless humans: the AI dystopia", provides a typical example.

From the PCT viewpoint, "controllable" and "intelligent" are essentially unrelated. "Control" is performed by setting reference values for perceptions, describing thereby what is to be achieved. "Intelligence" refers to the ability to discover new ways of achieving the goals specified by reference values for perceptions.

A population of "intelligent robots" might decide to eliminate humanity, but would do so only if it was collectively controlling some perception for which this might be an intelligent way of achieving the reference value for that perception. I could imagine such a situation if the robotic GVC were simply given only a reference vector that amounted to "bring the climate back to the way it was in the early 20th century", with no parallel or higher-level reference values relating to the welfare of humans.

The word "robot", like so many words in an evolving language, has diverged in many ways. One that I do not intend to pursue is "industrial robots" that work on assembly lines that build many different complex things, from cars to circuit boards. These robots are fixed to a base and have one or a very few jobs, all of which amount to taking a part from one place and putting it where it fits in the object being built, or checking whether an assembly passing along the line conforms to its specifications. These industrial robots are not autonomous.

The 25 June 2020 issue of Nature included a multi-page advertising supplement on Chinese robotics. In every instance, so far as I could see, the robots in question were provided with reference values by their human users. Like the assembly line "robots", they were simply tools, not autonomous entities that

based their top-level reference values on the effects on their own long-term welfare of controlling those variables.

"Robot" vacuum cleaners also are tools and not the kind of robot that people fear. They are seen as conveniences, not malevolent aliens. Some far future vacuum cleaner might have super-human intelligence, but it would probably evoke no more fear than do the most advanced ones now available. Are such things "robots" in any sense the average user, as opposed to a product advertiser, might use the word? Maybe, but I will not so consider them here. The robots of concern are those that have more autonomy to choose for themselves what to try to do, of rather more complexity than determining what part of the floor would be best to clean next.

At present anything called a robot is a tool with purposes built in by its designers and builders. Such robots have no equivalent to the critical life-supporting "intrinsic variables" of Powers that are, in his theory, maintained within tolerable ranges by the many perceptions controlled within his hierarchy.

Any future "botnet-based" robots will have intrinsic variables analogous to those of living control systems. I have speculated that they would reorganize and would develop the perceptual functions and action outputs of their own novel top-level controlled perceptions, using their own sensor systems for physical variables, which may be quite unlike the sensor systems available to humans. The root purposes of such autonomous robots would be at least as inscrutable as are those of alien humans.

There is at least one thing of which we can be sure: A robot, or at least one known to be a robot and not a human, is not a member of "Us", except in quite restricted situations. One can imagine a robot soccer player being included in a team. For the duration of a game, that robot might be "One of Us", but once off the playing field it probably would not be. My use of the word "it" has that implication.

Aliens are strangers, by definition, and autonomous robots are nothing if not alien. Most of us would have little opportunity to apply many Tests for the Controlled Variables in order to learn what perceptions aliens might be controlling, or what actions they might use to mitigate disturbances to those perceptions. For foreign humans we may guess that the properties of the two self-image "objects", self-self-image and other-self-image, are quite probably sets of top-level controlled perceptions, but we cannot be sure that robot aliens even perceive either self-image, let alone control perceptions of their properties.

As we mentioned in Section IV.5.3, if we perceive someone as being "One of Us", we trust that they will be controlling some perceptions close to ones we do, at approximately the same reference value as we use in similar circumstances. They may be expected to wear scarves of the same colours, participate in the same sports, use the same specialized language, and so forth. We cannot trust "One of Them" in the same way, though if one of Them is human, we can probably trust that they do control some perceptions that we control. We can trust them more if we perceive the differences between Us and Them as not being in what perceptions they control, but in differences in their reference values. We can trust our opponent in a direct conflict more than we can trust an inconsistent other, who sometimes says or does one thing and sometimes another for reasons we cannot discern.

An autonomous robot might also perceive an "Us and Them" dichotomy, but might use quite different criteria for distinguishing Us from Them, just as might our family pet dog who uses scent as a primary sensory mode. Is the family "Us" to the dog? As we know, people often do think of their pets as family members, clearly "Us" in that context. Whether the dog perceives a related Us and Them dichotomy is another question we will not attempt to answer. Pet owners trust their pet's behaviours because they have learned how the pet acts to control against some types of disturbance. The pet is "familiar". Could an autonomous robot ever become familiar in the same sense?

The unfamiliar may be dangerous, either deliberately or as side-effects of its actions. Even a static assembly-line "robot" could hurt or kill a person it hit when intending to move an object from storage to

the assembly line. Designers of such devices often include safeguards against these dangers, or people may be held away from them by safety barriers. The latter safeguard cannot be applied to a mobile autonomous robot, except by treating it like a dangerous animal and caging it in something like a zoo. Caged, it could be of little or no use to human society, but nor would it be a danger.

Like many science fiction writers, we are taking it for granted that an unfamiliar robot, particularly among others of its kind, would be perceived as potentially dangerous rather than as probably useful. Why should we not? They would be the consummate "Others" on whom to blame everything bad that happens, especially if Leo the Big Liar chooses to proclaim their responsibility in causing the "bad things" to happen.

What about a familiar robot? Could such a robot, like a pet, become "one of the family", and hence "Us" rather than "Them"? A family pet seems to have a personality, and to exhibit behaviours and postures its family members perceive as sadness, excitement, or even love. We cannot know whether the pet experiences those emotions as we do, but the owners act as though they do[54]. Could the same be said of a robot? A highly intelligent robot could certainly emulate attitudes, verbalizations and postures suited to any emotion it had learned. Could any observer determine whether it actually experienced an emotion whose outward human manifestations it emulated, especially if the physical form of the robot was not humanoid?

However alien future conscious and emotional robots may be, there is no a priori reason to fear them any more than to fear alien humans who might equally well be friendly or antagonistic. If the alien group harbours ill intentions toward us and we do not know its capabilities, it matters not whether its members are human or robotic. The problem our own conscious imagination must solve is the same.

54. As a personal anecdotal example, when our younger cat lost to kidney failure an older cat it had lived with essentially all its life, it spent many hours over the next few weeks apparently searching the house and garden for its "friend" and acting in ways we might in a human call "moping", lacking energy and apparent purpose. Many pet owners relate similar experiences, and similar-appearing behaviours have been reported among many mammalian species, from dolphins whales to elephants and chimpanzees.

IV.11.6 Open Problems in PCT

The basic principle of Perceptual Control Theory (PCT) is that in order to survive in an ever-changing world, an autonomous entity must sense something about that world and be able to influence it by acting on the local environment. It doesn't matter what that entity might be. A tangible object or an abstract structure might be such an entity, but we usually take it to be a living organism. Powers, over a five-decade period of development, described a specific form of PCT (a perceptual control hierarchy), claiming it to apply to every living organism, and pretty well throughout this book, the principle of the Powers hierarchy has been the foundation on which the various elaborations into different research disciplines has been built.

That form of PCT is difficult to apply directly to organisms such as fungi that distribute themselves in the form of growing more cells to create what we, outside observers, perceive as uniform branching structures composed of ever-increasing numbers of identical cells. In an evolutionary sense, fungi are farther from us than are bacteria or the trees that some fungi help to return to the earth after they fall. Although there is evidence from some fungi that they do control at least some perceptions that we can recognize, we do not know even functionally how they do it without obvious specialized internal structures.

Nor is it easy to apply to some collectives such as those that sometimes are called "hive minds". We have not addressed the mechanics of this kind of Perceptual Control, but since these individually distinct organisms exist and Powers made the thermodynamically necessary claim that PCT applies to every kind of living organism, we must enquire how these entities perceive and act as they do. The basis for the Powers claim goes well beyond the limitations of the organisms to which we have applied it in this book.

The thermodynamic support for the Powers claim is simply that for a structure to maintain its integrity, it must export the entropy that "the slings and arrows of outrageous fortune" from the environment would cause it to gain. Continuous maintenance by perceptual control keeps the time-averaged entropy of the body structure stable until the organism dies and no longer controls its perceptual variables. The same thermodynamic claim can be made in respect of any entity we could call "autonomous" in any respect, whether this structure be embodied in one skin or in several, as is a family or a beehive.

Much of this book has been devoted to the study of multi-person "societies", ranging from the conversations between two people to the politics of human and some non-human societies, and beyond to relations among entire nations over the whole globe. But apart from the virtual control systems that can emerge in collectives, we have not considered the possibility that entire societies might act as organisms that are perceptual control systems, to which any one of us has much the same relationship as a single neuron does to the brain of a mammal. Societies, as much as the individuals of which they are composed, must export the entropy that is increased in every interaction, just as in the individual every nerve firing increases the entropy of the body.

This question leads to another: What are "hive minds", distributed social structures of apparently identical individuals that apparently use the individuals for the hive mind to perceive and to act on the environment of the hive for the benefit of the whole, as some bees do when their hive is invaded by a hornet capable of killing all of the bees if they didn't act as a collective unit by swarming over the invader and letting their waste heat cook the hornet to death.

"Hive minds" could appear in other distributed systems, such as botnets and possibly in the slime mold fungi that collectively act in unexpectedly "intelligent" ways. None of these obviously follow the structural plan that enables the Powers perceptual control hierarchy, but thermodynamically all of them

are controlling some perceptions even if the control mechanisms are in the form of Giant Virtual Controllers rather in the structures with which we are familiar.

What of non-living autonomous entities such as “robots” of the kind imagined by Karel Čapek in his 1920 play “RUR”, which stands for “Rossum’s Universal Robots” and by Isaac Asimov when he created his “Laws of Robotics” (1942), which were:

A robot may not injure a human being or, through inaction, allow a human being to come to harm.

A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.

A robot must protect its own existence as long as such protection does not conflict with the First or Second Laws.

To these, I would add that such laws could apply only to constructed robots, which would not evolve, because if they were an autonomous set of similar entities that could learn to reproduce themselves, all the vagaries of evolution would apply, and the “species” would evolve and mutate into an unpredictably changing series of forms, as we discussed in connection with our evolving family of cartoonish versions of e-coli and its descendants in Section II.2.6.

Both Čapek and Asimov were interested in the interactions between the “alien” robots and human societies. We will be, too, but not exclusively, as we are interested in how such autonomous robots might act among themselves, and evolve socially both alone as well as with humans.

Because of the basic thermodynamic underpinning of perceptual control, I have no doubt that such structures that perceive and act in ways that enhance their survival can be treated in some form of Perceptual Control, but I have not tried to analyze them in the main body of the book. Some apparently control their perceptions, but have no structures that might be construed as a biological basis for a Powers type of perceptual control hierarchy. They remain a mystery.

**Chapter IV.12. Epilogue: PCT as Science and Guide

The title of the book is a pun on the name of a founder and the principal exponent of Perceptual Control Theory, William T. Powers (1926-2013). Its subtitle, “an enquiry into language, culture, power, and politics” describes a few classes of study for which I think PCT might offer a fruitful foundation for future research. Since I believe PCT to be as fundamental to any science involving living things as are the laws of thermodynamics to the science of just about anything larger than quantum scale and smaller than astronomical scale, the question (for me) is not whether PCT is a firm base on which to build a research program of how people interact in groups, but how best to integrate it into such research.

This long book contains much plausible speculation, but little experimental demonstration of the plausibility of, let alone the likelihood of the correctness of, my speculations. Speculation can be based on faultless logic (and I do not claim my logic to be faultless), but if it is based on faulty foundations, the structure cannot stand. For a millennium and a half, most of what Aristotle said in those of his writings that have come down to us was believed to be incontrovertibly true. But once some of his central assumptions were shown to be flawed, everything else he claimed, based on impeccable logic, was laid open to test.

Nevertheless, I believe that at least some of my speculations will stand the test of time, as I believe their foundation in PCT is secure, based as it is on thermodynamical laws that seem well founded in both experiment and logic. Indeed, I will go so far as to hope that this book might indicate fruitful directions of research in many different studies of life and society.

In many of these areas, my limited knowledge of the scientific literature suggests that current research is based purely on statistical observations akin to “if this X is so, then Y often occurs”. When the work suggests why X leads to Y, the explanation is usually on the same level of observation, rather than offering a distinct mechanism. The concepts of energy and entropy often provide “envelope limits” on otherwise open-ended suggestions for the consequences of events in the world, and this world includes all the living systems that act in it, including me and my hoped-for readers, and the bacteria of the microbiomes that keep us healthy or make us sick.

Throughout the book, including in the introduction to the basics of PCT, I have tried to base what I say on fundamental physical principles, not on what anyone else has said (including Powers). I have mostly tried to avoid the interpretation difficulties that often accompany the complex mathematics of physics at a research level by eliminating the mathematical background, or keeping it simple when some mathematics is required.

I divided the book into the implications of PCT in four areas of interaction, most often among humans, but often among other species as well

Acronyms

AC: Artificial Cerebellum, a device proposed by Powers as an output function that would learn to compensate for rhythmic dynamic consistencies in a control loop. It would incidentally also compensate for rhythmic consistencies in the disturbance.

B:CP Powers' seminal book "Behavior: the Control of Perception".

CCEV: Collective Corresponding Environmental Variable. An environmental variable closely enough related to the CEVs of more than one controlled perception to be influenced by the multiple independent control actions in a way that makes it appear to an observer to be controlled.

CEV: Corresponding Environmental Variable. A complex of properties in the environment that corresponds to the perception defined by the PIF of an ECU. The CEV may or may not correspond to something another observer can perceive.

CSG: The "Control Systems Group" with a mailing list CSGnet for discussions of PCT.

CV: Controlled Variable, the perceptual value being controlled.

ECU: Elementary Control Unit. The minimal "atom" of a control system. The basic ECU consists of a Perceptual Input Function (PIF), a Reference Input Function (RIF), a Comparator Function, and an Output Function. A control loop is completed by connecting the Output Function to the Perceptual Input Function through lower-level ECUs and through an Environmental Feedback Path that expresses the influence of the output on some aspect of the Environment that in turn influences the perceptual input.

GPG: General Protocol Grammar. A proposed grammar of dialogue.

HaH: Learning by Hebbian and anti-Hebbian connection modification.

HPCT: Hierarchic Perceptual Control Theory, the form of PCT described by Powers in many publications.

PCT: Perceptual Control Theory, the theory that organisms control internal variables based ultimately on sensory data, and that all overt behaviour is for the control of these internal variables, called "perceptions". HPCT is one possible form of PCT.

PIF: Perceptual Input Function. A necessary component of any ECU. The PIF accepts input from any number of sources and produces a single value called the "perception" that is controlled by the ECU. In HPCT and in this work, the inputs to a PIF are either direct input from the senses or are perceptions produced by other PIFs or by imagination.

QoC: Quality of Control, generically the difference between the Uncertainty of the disturbance and the Uncertainty of the CEV; alternatively, the ratio of the variances of the disturbance and the CEV. The latter measure applies strictly only if the disturbance and CEV values have a normal (Gaussian) distribution.

RIF: Reference Input Function. A necessary component of any ECU in a hierarchic PCT structure, in which the outputs of ECUs at one level contribute to the reference values of ECUs at the level below. At the highest level of a hierarchy, the RIF is degenerate, having no inputs from the non-existent level above. In most PCT

simulations, the RIF is a simple summation of the outputs of the ECUs at the level above.

TCV: Test for the Controlled Variable, a technique an experimenter can use to discover an approximation to a perception being controlled by another organism.

Working Papers

W1: To Sharpen Ockham's Razor

M. M. Taylor
Working paper dated April 1972

W1.1 Introduction

Ockham's razor cuts into the body of hypotheses as a surgeon's knife, excising the fat and leaving only the leanest. It must be one of the oldest tools of Western philosophy, dating from the thirteenth century. Its use has never received a clear rationale, since among the excised hypotheses is certainly at least one more true than the hypothesis that the operation leaves viable.

The use of Ockham's razor can be seen as an example of the proper use of creditation in the theory of hypothesis testing. It does not have to rely on metaphysical principles of "the simpler the better" or "nature loves elegance." The discussion follows concepts defined and developed in Watanabe (1969), although the ideas are not due to Watanabe.

W1.2 The Universe of hypotheses

In principle, any hypothesis can be written as a linear assemblage of words and symbols taken from a finite set of possible symbols. Inasmuch as we can enumerate the letters used in the words, each hypothesis can be given a number. They are countably many. In some manner, any hypothesis can be given an index of simplicity. A convenient one, suitable from an information-theoretic viewpoint, is simply the length of the symbol string describing the hypothesis. This is, of course, not unique. The hypothesis "F=Ma" is four symbols, the hypothesis "Force equals mass times acceleration" is 36 symbols including spaces. The same hypothesis can be written in many different ways, with different lengths. It is reasonable, however, to judge that the longer statement is more complex than the shorter, since there are more ways of saying things in five words than in four symbols; the 36-character statement selects from a greater set of possibilities, and is thus more informative conditional on there being at least 36 characters in the statement.

It is not necessary, on the other hand, to judge the complexity of the two statements as different. There will be many sets of synonymous statements among all the possible hypotheses in the universe, and these may be judged to have the complexity of their shortest member.

Complexity is not ordinarily judged from the length of the statement. The interrelations among the elements of the statement, and the extra assumptions and prior knowledge that must be assumed in order that the statement be intelligible both come into the ordinary assessment of complexity. However, it can be argued (1) that the prior conditions and assumptions must be the same for all competing hypotheses and that if any hypothesis requires assumptions not required for the others, then these must be stated, and (2) that in any case most reasonable measures of complexity will correlate fairly well with statement length. While the judgment of complexity is a very subjective matter, the judgment of the length of a statement that *with existing prior assumptions* suffices to describe a mass of data is objective. All statements can be given a length measure.

Let the set of all hypotheses be $\{H_i\}$ and their lengths be L_i. The number of hypotheses of length L goes up as N^L, where N is the "effective" number of possible symbols. N takes into account redundancy

due to unequal probabilities of symbol usage and inter-symbol relationships. There are approximately N^L hypotheses of length L. The uncertainty associated with which particular statement of length L will be made is thus L log N, and for large enough N the same estimate applies if we include elements shorter than L as possibilities. The number of statements of length L is very much larger than the number of all the possible shorter statements.

Watanabe shows that for any finite set of data the hypotheses can be divided into three more or less distinct groups. The first group is of logically refuted hypotheses, which have denied the possibility of some datum actually observed. The second group is of strongly discredited hypotheses, whose credibility is very much lower than that of the third group, which consists of more or less equally credited hypotheses which all describe the data equally accurately. For an infinite amount of data, the second group is uniquely distinguishable from the third, since the credibility of any member of the second group vanishes even though it is not logically refuted, whereas that of any member of the third group converges to a finite value. Watanabe defined these credibilities (posterior subjective probabilities assigned to statements of the kind "this hypothesis describes the manner these data arise") in terms of a finite number of hypotheses, but we must here consider an infinite number, and must therefore refer to direct measures that cannot be normalized. Credibilities refer then to the measure of credibility assigned to the hypothesis, and conditional credibility can be turned into a probability when the condition is that only a finite number of hypotheses are available for consideration. Credibility measure is the numerator of Watanabe's credibility probability defining fraction.

In most, if not all, cases with a finite amount of data, there will be an infinite number of hypotheses with relatively large credibility measure. If L is chosen large enough, there will be a finite number with length L or less. Without prior knowledge of the situation, the probability that any one hypothesis will describe the data is as high as the corresponding probability for any other hypothesis. If there are N^L (approximately) possible hypotheses, and K acceptable ones of length L or less, then the a priori probability that any one hypothesis will be acceptable is K/N^L. There will be approximately KN^{P-L} acceptable hypotheses of length $P<L$. In particular, there are almost K acceptable hypotheses of length L, or, to a closer approximation, K(N-1)/N.

Given that a hypothesis belongs to the acceptable set, the probability that it has length P is KN^{P-L}/K or N^{P-L}. We now revert to Garner's (REF) notion of "good form," as relating to the number of members of an equivalence set. To paraphrase this idea, we assume that all members of a set of structures can be sorted into subsets whose members are "like" one another. When people are asked to do this task, they isolate some structures as being unlike any of the others, and make large groups of other sets of structures. Separately, when asked to judge the "goodness" or "simplicity" of the forms, those that were isolated in the sorting are judged to be "good" or "simple", and the grouped ones to be complex. The converse of this is that complex forms tend to be members of large groups, any one of which would serve as a representative of the group, whereas simple forms cannot be well represented by other simple forms. Informationally, the presentation of a simple form reduces the uncertainty about what was presented from the initial level of log N (N is the number of possible forms) to almost zero, presentation of a complex form reduces the uncertainty down only to log M (M is the number of elements in the associated group).

Applying this idea to the hypothesis set, we can say that one complex hypothesis is "as good as" another, whereas the simpler hypotheses stand alone. The groupings do not necessarily mean that all equally complex forms go together, but merely that the sizes of the relevant groups increase with increasing complexity. If we presume that the group size goes up as some fraction (1/k) of the number of hypotheses with the given complexity, $G = N^{L/k}$, then the uncertainty reduction involved in finding a

credible hypothesis of length P will be from L log N to (P/k) log N, where L is the maximum length within which one will entertain a hypothesis.

It is presumed in the foregoing analysis that the person gathering the hypotheses finds only a small subset of the credible hypotheses. Among these he must select that single hypothesis he is most willing to credit with being able to explain the available data as well as similar data he may collect later. Not all members of a complex group will be found, and complex hypotheses have to be regarded as members of their group. The credibility calculated on the usual basis of the explicitly tested hypotheses will be more or less equal for all of the hypotheses we have called "credible." However, the conditional credibility of actually tested hypotheses, with the condition that one of the group is the wanted hypothesis, must also be equal across the whole group associated with any one test hypothesis. Hence we can argue that the creditation of any one hypothesis should be "diluted" in proportion to the probable number of group members, whether they are tested or not.

The dilution of creditation argument then suggests that if all credible hypotheses have an overt credibility measure Q, and tested but discredited hypotheses have credibility near or equal to zero, then the perceived credibility of any one hypothesis should be Q/G, where G is the number of members of a group of which a tested hypothesis is a representative. Perceived credibility will then be $Q_P=QN^{-P/K}$. This number declines sharply with P. It declines so sharply, in fact, that the total perceived credibility of the infinite set of hypotheses is finite, which permits normalization and the use of credibility as a probability measure. If the probability that any randomly selected hypothesis remains credible is R, then the normalization of perceived credibility depends on $_HQ_P = RQ_{P=1}N^{-P/k} = RkQ/\ln(N)$. The normalized perceived credibility will then be $q_p=(N^{-P/k} \ln (N))/Rk$. If we express R as an equivalent length, by writing $R=N^{-S}$, we can write $q_p=(N^{-(P-S)/k} \ln(N))/k$. The shorter and hence less complex hypotheses are perceptually the more credible.

W1.3 Addendum: The predictive power of hypotheses

A hypothesis is not supposed merely to describe a body of data. It has the further function of predicting data yet to come. Indeed, this predictive power is taught in experimental design classes as the *only* valid test of a hypothesis. You are not supposed to test your hypothesis with data gathered before you built (i.e. discovered) the hypothesis. Those data are permitted in tests of hypotheses you had already invented, but not in tests of new ones. This attitude has some justification, though not very much. On the face of it, the attitude taught to students is ridiculous, since the creditation of a hypothesis does not depend in the least on its date of invention

A hypothesis is supposed to describe a particular body of data. The conditions under which the data are gathered is included in the background assumptions common to all hypotheses. For example, Newton proposed F=Ma to describe the mechanical motions of any solid bodies. Subsequently, the body of data described by this simple formula had to be restricted to those obtained at relatively low speeds. So long as the data base is thus restricted, Newton's formula remains credible, but if all attainable speeds are allowed, it becomes incredible. Einstein's more complex formula is the more credible, and is as credible as Newton's even on the restricted data base. Only because Newton's is more simple is it used in any circumstances.

The data used to determine the credibility of hypotheses has a finite number of degrees of freedom. This is to say that a finite number of statements will suffice to describe the data exactly. The point of a theory is to describe the same data in fewer statements. Intuitively, if we use a new statement to describe

every data point, we cannot expect to predict any new data not yet collected. Conversely, if a statement like "the voltage is 117 volts" has proved to describe every measurement so far made, we can legitimately expect it to describe measurements in the future. This intuition can serve as the basis for a predictive rationalization for Ockham's razor.

The credible set of hypotheses have one thing in common. They each describe the data almost equally adequately. The total error involved in the description is the same for all the hypotheses. The hypotheses which involve an individual statement for every datum, or equivalently permit the recovery of every datum through logical combinations of the statements, should have no error. We can omit hypotheses of this type as being uninteresting on the grounds that their range of description encompasses only the data already gathered. They do not claim to predict. On the grounds of the data already gathered, they are the most credible, and it seems that sheer credibility is not a measure of the value of a hypothesis. Value must depend on predictive credibility.

Just as a body of data has a number of degrees of freedom, so has a hypothesis. The number of degrees of freedom in the data is determined by the number of independent measurements that serve to describe the data, and the number of degrees of freedom in the hypothesis by the number of independent statements needed to complete the hypothesis. "Independence" of statements may not be too clearly defined. Neither is it always clear what statements are needed to complete a hypothesis. The required statements should not include the common body of assumptions underlying all competing hypotheses, but should include assumption belonging to some but not others. Nevertheless, it should be possible to provide a crude measure of the number of degrees of freedom in a hypothesis. It is a measure of complexity, and at worst can be submitted to the judgments of independent observers.

Suppose that a hypothesis has been found to have H degrees of freedom, and that it describes a body of data with D degrees of freedom with a total error E. After the hypothesis has been stated, the data has only D-H degrees of freedom left which could contribute to the error. The hypothesis has described H degrees of freedom exactly. Hence the goodness of the hypothesis can be described in terms of the error per remaining degree of freedom. This is the best estimate of the probable error if more degrees of freedom were to be added by the accumulation of more data. The predictive error of a hypothesis is then E/(D-H). The smaller H, the better the prediction for a common E and a given body of data. When D is much larger than H, the predictive error is almost E/D, and the value of a hypothesis is therefore determined by how well it predicts the data—by the value of E—rather than by changes in its complexity. Only when the number of degrees of freedom in the hypothesis approaches that in the data does the predictive error become more strongly dependent on H than on E. For most situations, D will be much larger than H, and the hypothesis that most accurately describes the data will be preferred. Only when two hypotheses describe the data almost equally accurately will their relative complexity determine preference, and that is what Ockham's razor states. It is interesting, however, that an increase in simplicity can override an increase in total descriptive error on some occasions.

Appendices

Appendix 1: General Negative Feedback Loops

There are many forms of negative feedback loop, not all of which are control systems. They are introduced here to put the simple control system into a context that we will use when we deal with side-effect loops and similar configurations.

To begin with, we need a definition of "negative feedback", since it is not the same as when someone says that a teacher gave a bad student negative feedback. As used in PCT (and in engineering), *negative feedback exists when a change in some property results in an influence that opposes the change*.

The simplest illustration of negative feedback may be the spring of Figure A1.1. In the left ("before") panel, the spring is stretched by a force due to a mass hung on its end. The gravitational force is balanced by a Hooke's Law force that would recompress the spring if the mass were to be removed. The negative feedback is simply between the applied force and the force due to the energy stored in the spring by the applied force. When the applied force is removed, the mass oscillates up and down until frictional forces have distributed the energy back into the environment of the spring.

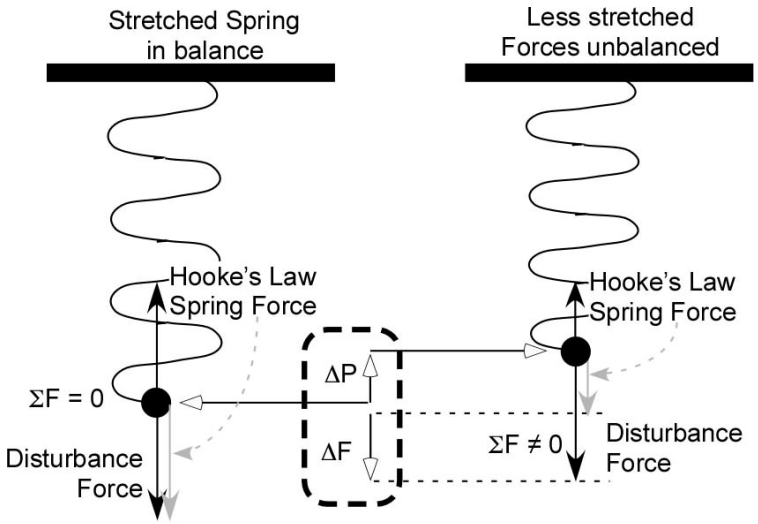

Figure A1.1 A spring stretched by a mass (left panel) and after the position of the mass has been raised by some means not shown (right panel). After the mass has been raised, there is a net force that would again lower the mass. After stabilizing due to frictional losses, the situation would revert to that of the left panel.

"Equilibrium systems" may be unstable, metastable, or stable, depending on whether they gain or lose energy by changing their configuration. The spring is an example of a stable equilibrium system. Other examples are a ball in a bowl, which returns to the bottom of the bowl after being pushed up the side, a pendulum that returns to the vertical after being pulled aside, and so forth. Such a system might be called a "N=1" negative feedback system, because it has only one place where external influences can affect the variables in the system.

Figure A1.2 illustrates a range of negative feedback systems from N=1 to N ≈ ∞, the vortex[55]. A control system is a N=2 system, but not all N=2 systems are control systems. In order for a N=2 system to be a control system, one side must have substantially more amplification than the other. Powers, in a message to the control group mailing list dated 931130.1545 MST, said: "I would consider it control if the (negative) loop gain was greater than 5 or so."

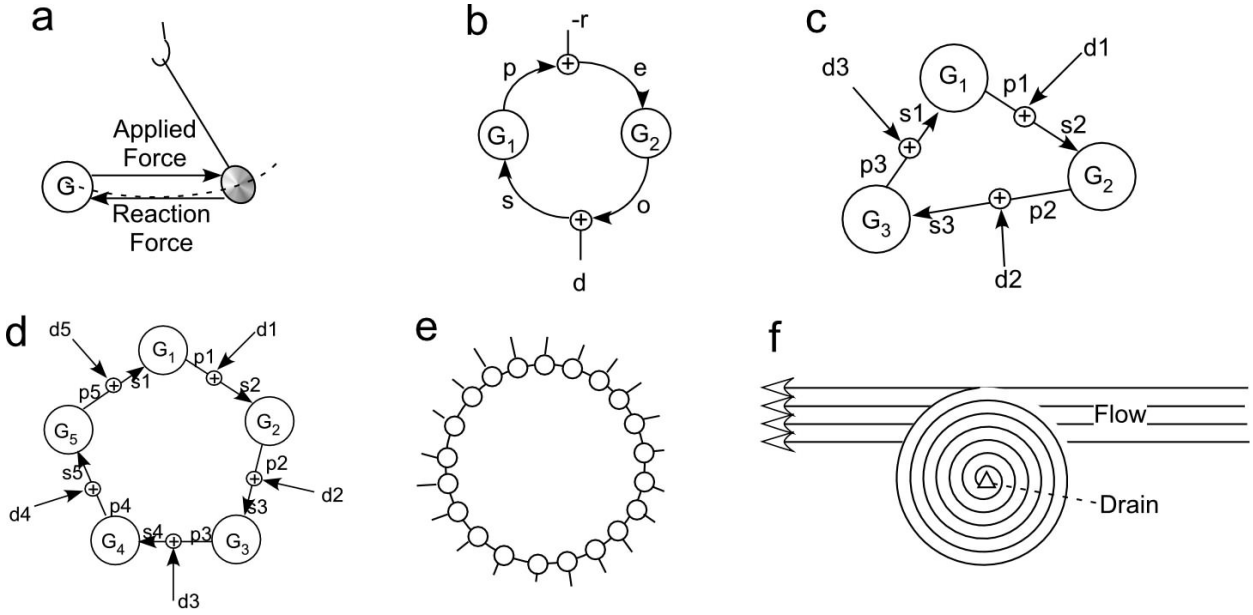

Figure A1.2 A series of forms of negative feedback systems, from (a) the Newtonian reaction provided by gravity to an applied force on a pendulum, through (b) a standard control loop and (c, d, e) a few longer loops to (f) a simple vortex flow in a stream or down a drain. All of these loops show a kind of stability, but only the asymmetry between the gains of G_1 and G_2 in the loop (b) gives true control of a single variable.(In b, the sign reversal that is usually placed in the comparator has been instead placed in the output function. This makes no difference to the function or the mathematical structure of the control loop.) Large circles in the diagrams represent places that may use energy to convert or amplify the effect of influences represented by incoming lines and arrows to create influences on other places. Small circles with a plus sign represent conceptual places where influences from separate sources may add to signals circulating around the loop.

The simple control loop has only two inputs, which we call "reference" and "disturbance" when they have those functions within a PCT hierarchy. If, however, we consider the loop itself, the two inputs are symmetrical. To see this, we can do a simple algebraic analysis of the equilibrium states of the loop, making the simplification that G_1 and G_2 are taken to be simple positive multipliers, but the G_2 function reverses the sign of its input, which makes the gain around the loop negative.

55. Of course N is not truly infinite. It is of the order of Avogadro's number, the number of molecules in one mole of a substance, which is around 6×10^{24}, a number large enough to deter consideration of the individuals.

In this simplified case[56], $p = G_1 \times s$ and $o = -G_2 \times e$.

$p = G_1 \times s = G_1 \times (d+o) = G_1 \times (d-G_2 \times e) = G_1 \times (d-G_2 \times (p-r)) = G_1 \times d - G_1 \times G_2 \times p + G_1 \times G_2 \times r$

Collecting the terms in p, we have

$p \times (1+G_1 \times G_2) = G_1 \times d + G_1 \times G_2 \times r$

which gives

$p = r \times G_1 \times G_2/(1+G_1 \times G_2) + d \times G_1/(1+G_1 \times G_2)$

When $G_1 \times G_2 >> 1$, p is nearly equal to r, provided $G_2 >> 1$. Since we will be interested in the symmetrical case when we consider the longer loops, we can set $G_1 = G_2$ and $G = G_1 \times G_2$ (the loop gain). The above equation can be rewritten as:

$p = r \times G/(1+G) + d \times G/((1+G) \times G_2)$

Writing $G/(1+G) = U$ to simplify the visual appearance of the equation, U will be near but below 1.0 if the loop gain G is high. We have

$p = r \times U + d \times U/G_2$

The point of this exercise is to show that when $G1 \times G2 >> 1$, p is very responsive to changes in r, but when G_2 (called the "output function" in a control loop) is appreciably greater than unity, p is much less responsive to changes in d. The same analysis, starting with o instead of p, leads to

$o = -d \times U - r \times U/G_1$

In words, the "p-type" variable in the control loop is most responsive to variations in the value of the immediately following "d-type" input.

This fact holds for the longer loops, as can be seen by using the same kind of analysis of the signals around the N=3 loop of Figure A1.2c, starting with p1. If all three gains are the same and equal to M, we have

$p1 = -d1 \times M^3/(1+M^3) + d2 \times M^2/(1+M^3) - d3 \times M/(1+M^3)$

If $M>>1$,

$p1 \approx -d1 + d2/M - d3/M^2$

Again, p1 is most responsive to variations in d1, the immediately following input, next most responsive to d2, the next one along, and least responsive to d3, the one immediately preceding it. The same kind of static analysis leads to the same conclusion for all the other loops. For example, the N=5 loop in Figure A1.2d gives the result, if all the gains are equal to M and $M >>1$,

$p1 \approx -d1 + d2/M - d3/M^2 + d4/M^3 - d5/M^4$

which, if M is large enough, is almost the same as

$p1 \approx -d1 + d2/M$

---

56. This simplification yields a stable state that is achieved by a real system only when the variables change infinitely slowly, but if the functions in the system are linear, the system dynamics can be determined by treating all the symbols as the Laplace Transforms of the signals and functions. The simplification gives approximate answers when the variables change slowly, and is easy to follow.

no matter how long the loop.

In the vortex, which is in effect the end-point of increasing the number of stages without limit, the localization of influence is shown by the distance around the vortex over which the influence of the introduced stick can be seen. In a slow-moving stream or one with a tiny drain, the stick might disrupt the vortex entirely. In a very fast stream or a large drain, other possibly nonlinear fluid dynamical considerations come into play and the analysis is inapplicable, but for an intermediate flow, most of the circuit of the vortex is not visibly affected by the introduction of a small enough stick. The effect is localized.

In the diagrams of Figure A1.2, the kind of influence represented by one line has no necessary relation to the kind of influence represented by another, except that a “d” line must be of the same kind as the “p” line to which it is added. For example a “G” might have a stream of photons as its “s” input and produce a mechanical force as its “p” output. Of course, this implies that the preceding “G” must output a photon stream, but somewhere else in the loop the influence might be a disturbance to someone’s perception of social propriety and the output whatever pattern of actions that person uses to counter the disturbance, such as, possibly waving a placard.

As is often the case in systems with many components, the analysis is relatively easy when the situation has obvious symmetry, as do the simple rings in Figure A1.2. In real life, such rings are very likely to have cross-links, which destroy the symmetry. In such circumstances, it is usually true that an exact analysis is feasible for small numbers of components, and that a close approximation can be made by lumping large numbers of components together, as is done in a “mean field” type of analysis. In the middle, however, there is a range of complexity that allows neither a statistical combination nor an exact analysis. It is in this area that most research needs to be done.

Appendix 2. Atenfels and Molenfels

An atenfel is a segment of the environmental feedback path of a control loop provided by something external to the controller. If someone enters a dark room and is controlling for perceiving the room to be lit, a wall switch provides an atenfel for controlling that perception. More correctly, the lower-level control loop that controls a perception of the switch position provides the atenfel, but it is often convenient to think only of the CEV of such supporting loops, because every lower-level loop whose reference input value is affected by the output of a higher-level loop is an atenfel for the higher-level loop. That fact is usually less interesting than the availability or non-availability in the environment of something through which the environmental feedback path passes. We will often, or rather, we will usually refer to the environmental object as providing the atenfel. Some are the CEVs of controlled perceptions, some, such as stepping stones in a brook that allow one to cross dryshod are not. The environment just provides them.

The wall switch also provides an atenfel for a child controlling to perceive a clicking sound. Disconnected from the wall, it could serve as a paperweight. Any one object can provide many atenfels, and usually several different objects could provide an atenfel for the same control of any particular perception. The object itself is not an atenfel, but its existence makes possible environmental feedback paths that might otherwise not exist. Those possibilities are provided by the atenfels of the object.

When we use the term “atenfel” by itself, its meaning could be ambiguous. Is it actually in the environmental feedback path of a control system under discussion like a hammer being used to strike a nail, could it, by some stretch of the imagination, be in the environmental feedback path of some as yet unconsidered controlled perception, such as a hammer being used to hold up a coffee table with a broken leg, or might the object be designed to serve as part of the environmental feedback path of many different

perceptions, as a Swiss Army knife? Almost any object has a plethora of potential uses in the Environmental Feedback Paths of different functions, most of them never yet imagined. We call these "potential" atenfels, but the Swiss Army knife range of possible uses are "design" atenfels. Most of the time, the context will determine whether we are talking about actual, potential, or design, and we simply use the word "atenfel" by itself.

We sometimes use a notation described in Appendix 3, such as Tom{P[Bridge]} to indicate that Tom uses a bridge that provides an atenfel for controlling a perception notated by "P", which might be a perception of his location, with a reference value of perceiving himself to be on the other side of the river. A more complete notation then would be Tom{Location@other side[Bridge]}, which should be read as "Tom controls a perception of his Location with a reference value of 'other side' using a Bridge".

Most objects in the world provide potential atenfels for controlling many different kinds of perception. Sometimes the control is possible only by using more than one object in the environmental feedback path, as in Nevin's example of using a book to provide a firm backing for writing a note with a pen (Nevin, in LCS IV). The notation for this structure would be A{P[Pen:Book]} "Person A controls perception P using a pen and a book together". When a complex of atenfels works together to provide a possibility no individual atenfel can can offer by itself, we give the complex the name "molenfel", as in Figure 4.2. The name "molenfel" for a complex of atenfels that provides a feedback path that none of its atenfels permit singly comes from "MOLecular ENvironmental FEedback Link".

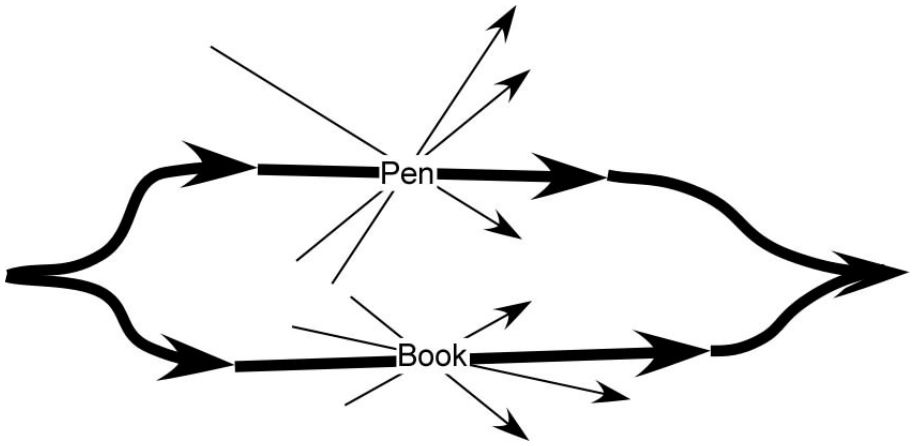

Figure A2.1. A simple molenfel. The pen and the book each can serve in the control of many different kinds of perception, but by using the book as a backing for the paper the writer is able to use the pen to control a perception of writing a note on a sheet of paper while resting in a comfortable chair. Without the book, the pen would be useless for writing, and without the pen the book would not enable writing.

As the diagram suggests, both the pen and the book could provide atenfels for other controlled perceptions. If that fact is relevant in any particular situation, the possibility of conflict arises, in that it is quite likely that if it is being used as an atenfel for one perception it will not be available to serve the control of a quite different one. "Could I borrow your pen to write a note, please?" "No, sorry, I'm using it to try to stab this spider that keeps running across the table". When an object is being actually or potentially used in service of more than one perception, we give the name of "atenex" or "potential atenex", from "ATomic Environmental NEXus".

Not all atenexes involve conflict. Many cars can use a stretch of road at the same time. However, there is usually a limit on how many cars can use that bit of road without causing a traffic jam in which nobody uses it very satisfactorily. Many of the cases in which an artifact can serve in controlling several different perceptions are of this type. It can simultaneously serve more than one perceptual control, but there is a limit to how many can be satisfactorily served at the same time. That limit might be hard — traffic controls might prevent more than N cars from entering the highway stretch — or soft, as is normally the case with traffic, when at some point the density results in traffic slowing and more density brings it to an almost complete stop.

Sometimes, what we need in order to control a perception is the participation of another person, who provides the required atenfel. Money is often useful in getting another person to help us control a perception, so money is an atenfel that appears in many different molenfels, though very seldom, if ever, is it an atenfel on its own — though the physical representations of money in the form of coins or pieces of paper can provide atenfels unrelated to the monetary value. We shall see in Part 3 the catalytic effect of the invention of money. Money has much the same Role in the development of culture as carbon does in the development of biological structures.

In every control loop, the CEV is inherently an atenfel, since by its nature as the environmental counterpart of the perceptual signal as defined by the perceptual input function, it must be in the environmental feedback path. In the process of control, the CEV changes its value under the influence of the disturbance and the output function.

Other atenfels used in the control of the same perception may also be changed by the actions used in control. A cook may control for the taste of what is cooking by adding a little salt. At that point, the cook is not controlling for the quantity of salt available, but the act of adding the salt to the food changes how much salt will be available for cooking the next meal. The salt is a resource that is affected by the cook controlling a perception of taste.

On the other hand, the cook also uses a spoon as an atenfel when controlling for the taste of what is being cooked. The spoon does not change because it is used for that purpose. It is like a catalyst for a chemical reaction, which eases the reaction without being itself changed by the reaction. We can call atenfels that are unchanged by being used “catalytic atenfels”, as opposed to “resource atenfels” that are changed or depleted by use.

A single atom or molecule of catalyst in chemistry can be used in only one reaction at a time, so the amount by which the bulk reaction is speeded by the catalyst depends on how much catalyst there is. Likewise, if the cook is using the spoon to taste whether his food has enough salt, another cook cannot use it to taste whether his dessert has enough sugar. As catalytic atenfels, how many perceptions can be controlled at once depends on how many spoons are available. In that sense the bulk atenfel “spoons” is a “renewable resource”, like physical wind power, of which only a limited amount can be supplied at any one time, but for which the usable future amount available is not affected by how much is used now. We call a catalytic atenfel that can support a restricted number of independent feedback paths at a time “limited”.

There is thus a taxonomy of atenfel types:

1. The CEV itself
2. Path from output to CEV or from CEV to the Perceptual Input Function
    a. Resource: Is changed or depleted by use, possibly useable only once
    b. Catalytic: Remains unchanged by being used, and can be reused indefinitely

i. Limited: Only a restricted number of simultaneous uses, perhaps only one.

ii. Unlimited: Can be used simultaneously in the control of any number of perceptions.

These different types of atenfel have different consequences in social interactions, as we shall see when we discuss psychological and social power. The different kinds can be combined in atenexes, with little if any restriction. For example, a hammer could be a Path-Catalytic-Limited atenex for hammering nails, a Path-Resource atenex for perceiving oneself to be warmed by burning it in a fire, and a CEV when someone is choosing the best tool for a job. Not all those atenexes could be used simultaneously, but until the hammer is used as a resource, all of them remain available for use.

McClelland (in LCS IV) lists a different set of properties of objects or artifacts that provide potential atenfels, coming at it from quite a different angle. His list is

- Durability: How long the atenfel may endure
- Portability: Is the object, and hence tits potential atenfels, easily moved
- Accessibility: how many different control loops the atenfels of an object can serve simultaneously.
- Versatility: How many different kinds of atenex the object is designed to provide.
- Malleability: The object may be reshaped to provide different kinds of atenfels by design.

Most of these refer most obviously to atenfels provided by concrete objects, and to the objects themselves, but they might also refer to the more abstract artifacts we call language and culture and to any other stable structures created by interacting control systems. The "Accessibility" property is similar to the Path-Catalytic distinction between Limited and Unlimited, but grades rathe than dichotomizes the property.

Appendix 3. A proposed notation for control loops and protocols

Spaces are permitted at any reasonable place in a string.

{P} Perception P is controlled

A{P} Person A controls a perception P

A{P@R} Person A controls perception P with reference value R

A{P[X]} Person A controls a perception P using atenfel X

A{P@R[X,Y]} Person A controls a perception P with reference value R, using atenfels X and Y connected in sequence.

A{P[(X:Y),Z]} Person A controls a perception P using parallel molenfel XY connected sequentially through Z.

A{P[X|Y]} Person A controls perception P using either atenfel X or atenfel Y but not both.

A{P[{Q}]} Person A controls a perception P using as an atenfel control of a lower-level perception Q (signified by the omission of a "person" indicator for control of Q). Control of Q is an atenfel for control of P if it lies on the environmental feedback path between the output of the ECU controlling P and the CEV corresponding to P.

A{P[B{Q}]} Person A controls a perception P using B's control of Q as an atenfel.

A{P[B{.}]} Person A controls a perception P using as an atenfel B's control of some unspecified perception. The {.} is used if it is important that B is a perceptual control system. If person B is used only as a physical object, then {.} is omitted.

A{>label< where "label" is any symbol, indicates that the parameters of what is controlled are indicated separately, much like a programming reference to a macro. This is useful when A{>label<} is in the argument of some other control system.

label>A{some expression} is the expansion of the reference in A{>label<}, showing what A is controlling.

A{P[B{Q[A^ A protocol loop. The initiator A controls a perception P using B's control of Q, in which B uses A's control of P. "^" is a reference to the first controlled perception mentioned, so the notation is equivalent to A{P[B{Q[A{P…}}}. Longer loops can be notated similarly, but the string of closing brackets and braces is optionally elided into ^ following a reference to the initiating controller, as in A{P[B{Q[C{R[A^ .

Examples

{cursor@target} A standard tracking task, in which neither the tracked property nor the name of the controller is mentioned, both presumably being obvious from the context or irrelevant to the writer's purpose.

John{location@office[(bicycle | walk)]} John controls for being at the office by bicycling or walking but not both.

John{planks_relationship @joined[(hammer:nails), glue]} John controls a perception of the relationship between planks with a reference value of their being joined, and uses a hammer and nails to make it so, neither of which is useful for the purpose alone, and uses glue to strengthen the join. Glue is not part of the parallel molenfel "hammer and nails", but is in sequence with it conceptually, though perhaps not temporally.

John {window@closed[Beth{John'sState@Pleased[{John^. John controls for perceiving the window to be closed by asking Beth, who controls for perceiving John to be pleased by closing the window, influencing toward its reference what she perceives John to be controlling.

John{window@closed[Beth{>BC<[John^

BC>Beth{John'sState@Pleased[{ Substituting the part after "BC>" for the part between and including ">BC<" in the line above, this pair of lines is the same as the previous example.

Apart from the greeting protocol, the interaction in the cartoon of Figure III.1.4 shows the first instance of a three-person protocol in this work[57]. To describe it in words, one might say "Adam introduces Cal to Beth", "introduce" being a verb that the Operator Grammar described in Nevin's chapter in LCS IV would label O_{nnn}. The "greeting" protocol, however, would be described as "Cal greets Beth", using a verb of type O_{nn}. Control of perceptions of passive entities, by analogy, may be taken to be "operators", the basic form of which is the simple control structure, described as "Cal sits", O_n.

Since much control, seen from the observer's viewpoint, can be mapped onto simple Subject-Verb-Object sentences, it seems reasonable that there should be a corresponding notation for protocols. Control is, however, more complex than is suggested by "SVO". Above, we propose a notation that takes the

57. . In my chapter on protocols in LCS IV I analyze a different three-person protocol in depth.

analyst's view of the controller, and allows for the mention of reference values, atenfels and molenfels in the environmental feedback path. Since the levels of the control hierarchy below any ECU are part of its environmental feedback path, the lower-level controlled perceptions are among the atenfels for control of the higher-level perception; this fact allows the proposed notation to give the description of a complete control hierarchy. Controlled perceptions disturbed in another person by the actions of the initiator of a protocol also provide atenfels that must be represented in the notation. Here is an example.

The introduction protocol is the control of a perception in the introducer "Adam". The perception might be of the relationship between the two people "Beth" and "Cal" being introduced, with a reference value of "knowing". An analyst looking at the situation from Adam's viewpoint might use the notation :

Adam{relationship@"knowing"[(Beth{.}: Cal{.})]}

All this says about Beth and Cal is that they are control systems, that they function together as a molenfel in Adam's "relationship" control loop, and that something about what they control is used by Adam in controlling his perception of their relationship, which has a reference value of "knowing". The three sets of braces correspond to the O_{nnn} description.

An analyst might also observe that the acceptance of the introduction by Beth and Cal completed a ternary protocol, in which case, the unspecified controls {.} would be specified and the loop notation completed by expanding the Beth-Cal molenfel. For example, since Cal is the newcomer, the "introduction" protocol includes that Cal initiates a "greeting" protocol with Beth as the continuer, so Cal's {.} becomes:

Cal{greet@Beth pleased[Beth{Cal's State@pleased[Cal^

Beth's {.} would be expanded similarly. Obviously the notation would become very difficult to read if all the expansions were filled in, though they are quite simple in principle. The notation therefore allows a trivial kind of macro expansion to ease the visual complexity that can happen when the atenfels or molenfels include control of other perceptions.

In the cartoon, Cal's control of his perception remains in error at the end of the strip, because Beth is not pleased. Accordingly, Adam's controlled perception of the Cal-Beth relationship remains in error, an error he tries to reduce in the second and fourth panels of the cartoon.

Appendix 4: The Bomb in the hierarchy[58]

In PCT diagrams, the signal paths are usually shown as simple arcs, but in practice many of them consist of separate paths with different dynamic characteristics. Inside the brain, the "neural current" is a simplifying concept representing the combination of myriads of firings on different nerve fibres. In the external environment, there may be direct and indirect paths through which an action influences the controlled perception. Although reorganization has ensured that under normal circumstances these different paths combine to create negative feedback, reorganization cannot ensure that all of the sub-paths individually influence the controlled perception in the direction that would oppose a change introduced by a disturbing influence. We here consider the case in which there is at least one sub-path that by itself would create a positive feedback loop.

58. Much of the text in this Appendix is taken from the Powerpoint slides of a lecture I gave to the Autumn School on Man-Machine Interaction, Paris, September 1992. The full set of slides and supporting material is available at <http://www.mmtaylor.net/PCT/ParisTutorial.pdf> as of February 9, 2011.

If something in the environment blocks the action of a negative feedback sub-path, the previously hidden positive feedback sub-loop may dominate, turning the overall loop into a positive feedback state, and destroying control, as suggested in Figure 8.7.

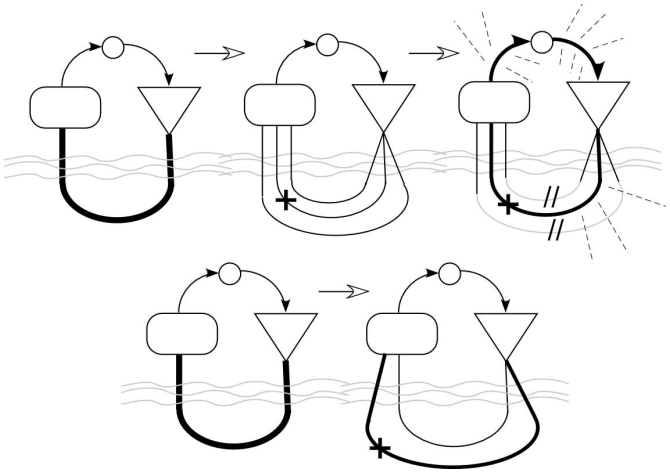

Figure A4.1 The underlying basis for the Bomb. (Top) Many environmental feedback paths consist of several parallel influences on the controlled perception. Not all of these necessarily have the same direction of influence on the perception, and if those that contribute to negative feedback are blocked more than are those that provide positive feedback (signified by a "+" sign on the path arc), the loop may "explode" exponentially. (Bottom) A new positive feedback path might be added through the environment. This happens, for example, if another control system tried to control "the same" perception to a different reference level, the result of which is a positive feedback loop that passes through both conflicted control units.

The "Bomb" is an important aspect of a complex control hierarchy. Control hierarchies are usually discussed as though the sign of each link was adjusted so as to ensure that the feedback from output through the world to perception was always negative. This criterion can be met in a fully designed system working through a predictable world, but not in a system that develops through its varied interactions with a complex and changing world. All that can be assured is that for an ECS functioning well under normal conditions, the overall feedback has come to be negative.

The overall feedback gain is based on the combination of many actions on aspects of the world that affect the sensory systems. It is quite possible for some of these actions, taken individually, to have undesirable positive feedback effects on the error. But any such positive feedback sub-loops are overwhelmed by the negative feedback sub-loops in an ECS that maintains good control.

Conditions in the world may change, blocking the effect of some of the desirable negative sub-loops. The overall feedback gain may then become positive, the previously hidden positive feedback sub-loop having been unmasked, as in the top row of Figure 8.7. The ECS causes actions that increase, rather than decrease its error. It "loses its temper because of frustration" due to the blockage of a normally available path to its goal. The path may be blocked because something fails that normally works, or because another independent control system is acting on an atenfel normally part of a negative feedback sub-loop, or for any of a number of reasons.

A milder form of the Bomb can exist, in which a subloop does not contribute significantly to the ECS's perceptual signal. The output of the ECS, which overall moves the percept closer to its reference value, causes additional irrelevant side-effect actions—wasted effort or superstitious behaviour. These actions will be eliminated only if the wasted resources affect the ability of the hierarchy to control other perceptions. Many will be retained for the life of the organism.

Positive feedback in one ECS could conceivably propagate up to higher-level ones that it supports, creating an avalanche of error in the hierarchy. Some event in the world causes a hidden positive feedback sub-loop of some ECS to become manifest, and the overall feedback gain of some higher-level loop that incorporate the failing ECS becomes positive. Any ECS served by the "bombed" ECS then has a potential Bomb. If the other paths that serve it are not strongly enough negative, any of these higher ECSs may succumb, and go into a "bombed" positive feedback state. The Bomb can in this way propagate upward through the hierarchy like an inverted avalanche, causing maladaptive behaviour at any level of abstraction.

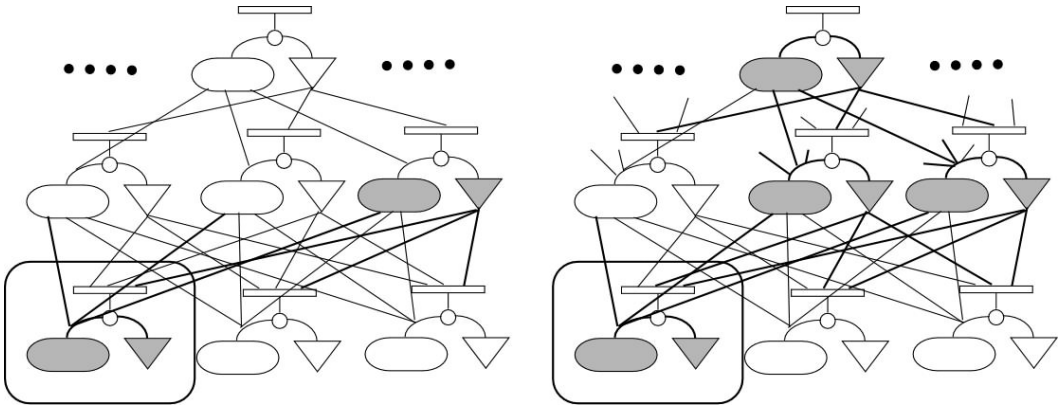

Figure A4.2 (Figure 6.3 repeated) A Bomb avalanche can be small or large. In both panels, the control system at the lower left is experiencing positive feedback. In the left panel, this control system destabilizes one control system at the level above but the problem goes no further, whereas in the right panel, two control systems at the level above are sent into positive feedback by the positive feedback of the first, and they in turn destabilize one at a yet higher level. Such avalanches will induce strong reorganization, and the structure will subsequently be less susceptible to an avalanche propagating through the same control units.

When a control unit or a part of the control hierarchy does not control well or at all, reorganization will happen, and if the organism has not died or become severely damaged in the tantrum, it will eliminate the positive feedback loops that actively led to the loss of control. Subsequently, that particular exploded bomb no longer endangers the structure, which has become more resilient and controls well under a wider range of circumstances than before. Other unexploded bombs may lurk in the environment, but as a whole, the control structure has become more mature.

The propagation of the explosion through the hierarchy has many of the characteristics of a sandpile avalanche. In the simplest version of the sandpile avalanche, sand grains fall one by one from a stationary orifice onto a flat table. As a sand grain falls, one of two things may happen. Either it stays where it falls, on top of the pile, or it bounces off and lands somewhere else. If it stays on top of the pile, the pile gets taller and the likelihood that the next grain will stay on top is reduced. If the new grain bounces off, it

lands somewhere else where it may stop, it may continue with another bounce down the slope, or it may dislodge a precariously lodged grain and the two of them may continue downslope, where each now may stick or dislodge further grains. The steeper the slope, the more likely it is that the bouncing grains will dislodge another and that the downslope flow will grow. The result is that the sandpile will experience a series of larger and smaller flows called avalanches which maintain its average slope as the pile get larger and larger. The slope is determined by the balance between the energy of a downslope falling grain and the energy required to dislodge a previously placed grain that it may hit.

One way to reduce the distribution of avalanche sizes in the physical situation is to keep shaking the table, adding energy to every sand grain and thereby reducing the slope of the sand pile. Small avalanches become more likely, but large ones become rarer.

In the case of the Bomb, the place of the initial sand grain falling from above is taken by the creation of a new perception to be controlled by an as yet undetermined action that might have a positive or negative feedback influence on the perception, or by a change in the environment that alters the side-effects of control actions on other control loops. The equivalent of the energy required to displace a sand grain involved is the strength of the individual positive or negative feedback path, and the energy of the bouncing grain corresponds to the side-effect feedback loops between the new control system (or old ones affected by the environmental change) and existing control loops. Such side-effect loops, in which each unit's actions influence the other's perceptual value, are much more likely to be positive than negative feedback loops.

Strong Bombs probably cannot last unexploded very long in a hierarchy that is exposed to a moderately disturbed world, just as a large avalanche is unlikely in a sandpile subjected to continual shaking, but they can persist in a "coddled" hierarchy, one that is seldom stressed by exposure to unfamiliar or difficult circumstances, like a child who is overly protected from experiencing difficulties and dangers to be overcome.

In such a "coddled" hierarchy, a Bomb is likely to be particularly dangerous and to cause a large avalanche when it explodes. This is the situation faced by a teenager brought up in a very ordered and especially in a very pampered environment, and then exposed to the wider world in which his wishes are no longer catered to, and where the rigid mechanisms of his youth no longer function. People "out there" do things differently, and often that difference leads to conflict (a situation of positive feedback through the actions of another control system). The introduction of positive feedback into a functioning control loop is precisely the situation described above as being likely to trigger The Bomb.

For more detail on avalanches like those of the Bomb, and in general the development of self-organized critical structures — which the control hierarchy is likely to become — see the Wikipedia entry <http://en.wikipedia.org/wiki/Self-organized_criticality> and the links and references therein, many of which refer to neural avalanches.

Appendix 5: Some features of Uncertainty and Information

Calculation of Uncertainty: As time goes on, or in different contexts, the value x of a variable X may vary. Its Uncertainty is defined as $U(X) = -\sum p(x)\log(p(x)) = \sum p(x)\log(1/p(x))$, where p(x) is the probability that the value at some moment would be observed to be x and the sum is over all possible values of x. The logarithm can be to any base, but is usually taken to base 2, and the uncertainty is then measured in "bits". If natural logarithms (logarithms to the base e) are used, the unit of measure is often call a "nit". All calculations of Uncertainty and Information flow from this formula. Shannon (1949) showed that $U(X) = -\sum p(x)\log(p(x))$ is the only expression that satisfies certain axiomatic properties listed in his book.

Some special cases of uncertainty:

(1) If there are N equally probable values of X, $U(X) = \log(N)$.

(2) If the variable has a Gaussian distribution, with a variance v in the unit of measure, its uncertainty is $U(X) = 0.5 \times \log(2\pi e)v$. Any variance analysis such as ANOVA or correlation can be converted directly into an equivalent uncertainty analysis (Garner and McGill, 1956), though the reverse may not be true if the probability distribution is not nearly Gaussian.

Conditional Uncertainty: If two variables X and Y are combined, that have uncertainties U(X) and U(Y), the uncertainty U(Z) of the combination depends on the relationship between them. U(Z) can be written U(X,Y) to symbolize that all possible pairings of values of X and of Y are considered. If X and Y are unrelated, U(Z) = U(X)+U(Y), but if they are related, then U(Z) < U(X)+U(Y). U(X|Y) means the uncertainty of X when the value y of Y is known, averaged over all y weighted by the probability of y. $U(X|Y) = \sum p(y) \times U(X|y)$.

Information is Change in Uncertainty: Information is quantitatively the reduction of uncertainty, a differential. By definition I(X|Y) = U(X) - U(X|Y); the information you get about X from observing Y that you did not know before observing Y. I(X|Y) is the informational analogue of covariance in a variance analysis. Because U(X,Y) = U(X)+U(Y)-I(X|Y) = U(X)+U(Y)-I(Y|X), I(X|Y) = I(Y|X), and cannot be greater than the lesser of U(X) and U(Y). The expected information about X from a class of observation, such as an observation of Y, is always positive, but the information from an individual observation "Y right now has the value y" may not be.

If information is change in uncertainty, what should we say about cases in which an observation increases the uncertainty? If I am pretty sure that what Sam tells me is going to be true, my uncertainty about Sam's reliability is very low. Now Joe tells me that Sam lied about something important. My uncertainty about Sam's reliability will increase. Did I get negative information from Joe? About Sam's reliability, yes I did. The information gain was negative because I now perceive that I know less than I did before.

In many, possibly all, interesting situations, U(X,Y)<U(X)+U(Y). As mentioned above, the difference is I(Y|X)= U(X)-U(X|Y), the predictability of Y from X, or the information about Y gained on average from an observation of X. A useful form of this for control is $I(X|X_{t \leq t0})$, the information available about the present value of a variable given its history of values before some specified moment, t0, in the past. The predictability between X and Y is symmetric, no matter how different U(X) and U(Y) may be. If X is some part of the history of a waveform W and Y is some future value of the waveform, then Y is "predicted" from past values in the everyday sense of the word. "To predict" does not mean perfection. It just means reduction of uncertainty. You can tell just as much about the past of a variable from its present value as you can about its present value from knowledge of its past.

Prediction need not refer to time. X might be hair colour and Y eye colour. If blondes are more likely to have blue eyes and dark-haired people more likely to have brown eyes, then eye colour is a predictor of hair colour and vice-versa. Most Nordic people speak good English, so to say a person is Swedish is to predict that they can speak English. You may be wrong, but that is irrelevant. By learning that the person is Swedish rather than, say, Greek or Azerbaijani, you changed your uncertainty about the ability of the person to speak English.

The concept of structure is a generalization of predictability. A set of values x1, x2, x3,…. has structure if $U(X_{total}) < \sum U(x_i)$, where X_{total} is the collection of x_i values, just as X and Y predict each other if U(X,Y) < U(X)+U(Y). In waveforms, where the x values are successive observations of the wave, repeating or nearly repeating patterns are structure, as are harmonic relations if the x values are the amplitudes of frequencies in the sound. In vision, the similarity of intensity or colour values over

different regions, and the continuity from place to place along an edge of differences across an edge, are structure. At a higher level of perception the relative movements of legs, seat, and back of a chair are correlated, and the structure has a name "chair". "Personality" is a name for structure in the organization of a person's control hierarchy, or at least in the observable aspects of a person's behaviour in a range of different contexts.

Quality of Control: In assessing the quality of control in a tracking study, the measure is often the ratio of the RMS variability of the CEV when controlled to the RMS variability it would experience with the same disturbance in the absence of control. The ratio is sometimes called the "Control Ratio". The uncertainty of a Gaussian signal is proportional to the logarithm of its variance with a proportionality factor $0.5\log(2\pi e)$, so the uncertainty equivalent of the Control Ratio is the uncertainty difference U(D)-U(C) between the global distributions of the disturbance and CEV, where D and C are respectively the disturbance and CEV waveforms over an extended period of time.

Anything over about 4 bits is considered good control in most situations, corresponding to a 16-fold reduction in the RMS variability of the CEV due to control. Simulations are often done with continuous variables that have a near-Gaussian distribution, which permits the use of the RMS measure, but the uncertainty measure applies to any kind of distribution, not only to smoothly changing continuous variables, but also to discrete variables and continuous variables that change in irregularly sized and timed steps.

If signal X with an instantaneous value x is observed continuously until time t0 sufficiently precisely to locate x within a macrostate of the size of the perceptual resolution ∂p, then $U_{t0}(X) = 0$ when we define ∂p as the unit of measurement. As time goes on with no further observations of X, x continues to change and the identity of the particular ∂p-sized macrostate containing its current value becomes more and more uncertain. The observer loses information about the current value of X. Eventually knowledge of the macrostate history before t0 provides no information about the current value of X beyond knowledge of its long-term distribution of values. The rate at which the conditional uncertainty $U_t(X \mid X_{t\leq t0})$ increases is the bit-rate of X, which I will symbolize by B(X).

B(X) is independent of the epoch (the moment at which observations were started) and therefore constant only if the statistics of X do not vary predictably over time. If X has temporal rhythm, its statistics may vary locally from moment to moment within the rhythm, but averaged over all starting moments, they do not vary over a longer time interval. B(X) is a property of a variable, a measure of how fast and how randomly it changes. There exist some types of waveform for which no long-term distribution of values can be determined (a pure fractal is one example[59]). For any practical situations, however, B(X) can in principle be defined, though it may be difficult to measure. We will address this problem when we treat the control hierarchy, because the reorganized hierarchy depends on the very structure that creates the difficulty in the bit-rate calculation.

Channel capacity: If X is the varying input to some specific communication channel, and Y is the output of that channel, there is a bit-rate of X below which it is possible to predict all of X exactly from observing all of Y, and above which it is not. That value is the channel capacity of the communication channel. If the bit rate of X is very close to the channel capacity, it may take an indefinitely long delay before the observation of Y allows exact prediction of some prior momentary value of X. Usually, but not

59. A pure fractal has changes that are infinitely small and infinitely fast, so uncertainty measures do not apply until some resolution limit is specified in time and value. The problem is the same as the famous "How long is the coastline of Britain" problem. The answer depends on how precisely you measure it. Do you go around every pebble or grain of sand on a beach, or do you treat embayments and points less than 10m deep and long as just points on a smooth curve?

always, the greater the excess of channel capacity over the bit-rate of the input, X, the shorter the delay required before X can be reconstructed to a prespecified level of precision from observation of Y.

Kolmogorov uncertainty: The preceding descriptions of concepts have all been based on Shannon's approach to uncertainty. The Kolmogorov uncertainty seems different on the surface, but is actually a different way of approaching the same concept, and is sometimes more useful than Shannon. Given what an observer knows already, the Kolmogorov uncertainty of a signal is measured by the shortest description that can be decoded by the observer to produce the signal (sometimes this is stated as the shortest programme that would produce the signal, given a programming language in the observer). A random process (from the viewpoint of an observer) is one in which the shortest description is the sequence itself.

Shannon uncertainty is a measure based on probability, that probability is based on what the observer already knows. "Information" is what the observer gets by observing the signal to reduce the remaining uncertainty. Kolmogorov uncertainty is arrived at from the other end, asking what information is needed in order to reconstruct the signal, given what the observer already knows. Both depend on the observer's pre-existing knowledge of the environment of the possibility space about which there is uncertainty. Shannon uncertainty is usually easier to compute and most of what follows is based on it, but Kolmogorov uncertainty is sometimes useful for illuminating a concept.

Uncertainty is uncertainty, but sometimes it is useful to divide the uncertainty about something into two components, quickly described by two questions: "What (or where) is it?" and "How much of it is there"? Mackay (1953) called the former "logon" uncertainty, which we might call uncertainty about category, and the other "metron" uncertainty, or uncertainty about value or quantity.

Appendix 6: Separations of items in spaces of high dimensionality

Although the syncon locations might be well separated in 3-D space, their projections onto any particular axis of the space that might be perceived by a single feature recognizer would not be. Suppose, for example, that there were 27 syncons. In any one feature direction in a space one unit on a side, the average separation would be at most 1/26 or 0.0385 units. Spread over two dimensions, the average separation is a little less than 0.2 units. On the other hand these same 27 syncons can all be separated from their nearest neighbours by 0.5 units in a a 3-D cube one unit on a side (Figure A5.1).

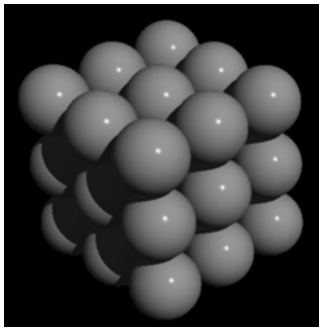

Figure A5.1. 27 spheres with their centres packed into a cube one unit on a side (the centres of the corner spheres are at the corners of the unit cube). The sphere centres are 0.5 units from their nearest neighbours. By arranging the spheres in an offset lattice, their separations might be greater, but this easily seen arrangement makes the point about how much further apart 27 items can be in 3 dimensions than in any single feature direction one unit long.

As the 27 syncons are described by more and more features, their spacings become larger on average. As the dimensionality of the feature space increases, the average separation of the syncons grows without limit, even inside a hypercube only one unit on an edge. High-dimensional spaces can be very big, even if the range of any one dimension is quite small. In a hypercube of N dimensions with the length of each side being 1.0, the maximum distance between two points is $\sqrt{N}$. For example, in a 9-D hypercube of side 1.0, two points can be separated by as much as 3.0 units, and with 27 syncons, the average distance between nearest neighbours could be more than 2 units.

The point of this geometric exercise is to illustrate that even if the syncons are not easily distinguished by their values on any of the features, yet by considering the patterns of the features, they can be very easily identified. Even if the syncon locations are randomly scattered through the space, the more features that describe them, the more distinct they become. What this means is that in principle a syncon can be identified even if the feature values are inexact. If are 27 syncons, and syncon "A" is at, say, {1, -3, 4, 2, 5}in a hypercube whose sides range from -5 to 5, and the synx is at {0.7, -3.2, 4.5, 1.2, 4} (a miss by approximately 1.36 units) it is unlikely that there is a closer syncon than "A" because the nearest other syncon is likely to be over 10 units away. The position of the synx could be characterised as an "A", albeit an imprecise "A". Figure A5.2 illustrates the point in two dimensions.

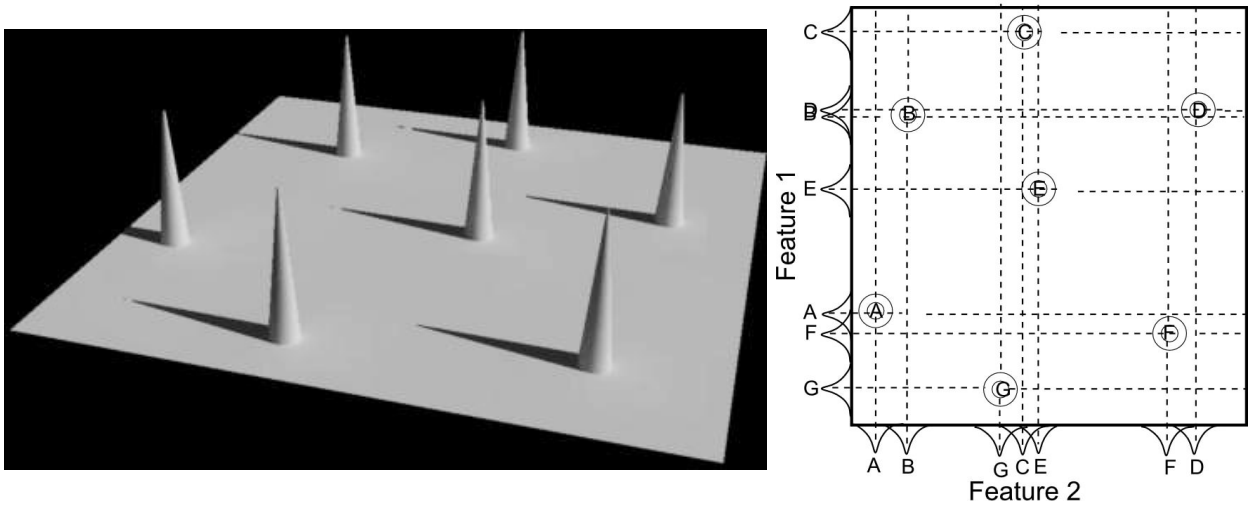

Figure A5.2. Even in 2-D space, when feature patterns cluster around discrete locations in the space, the locations are much more easily discriminated than they would be using either feature alone. In three or more dimensions discrimination would be even easier. Locating by identifying the pattern as a category is much more effective and efficient than by specifying the feature values. The two diagrams represent the same set of 2D syncons (feature pairs).

At this point in the argument, it may seem that we are diverging into irrelevant arcane matters, but we are not. Languages are built on identifiably discrete elements such as phonemes letters, words, and symbols. What we have shown in the last few paragraphs is that if the state of an entity is defined by

several independent features, it is relatively easy for the partner to identify it correctly even though the perception of some or all features may be imprecise or even missing entirely. When we consider language drift, one important take-away is that even easily identified sound patterns may be highly confusable on any one or even several of their individual features.

In geometric terms, we are talking about linear distances and space packing; in information-theoretic terms, we are talking about redundancy in a set of patterns; in linguistic terms we are talking about syntax. All mean the same for communication.

These considerations lead easily to a consideration of associative memory, because a synx will seldom match a synx very closely, but needs to be close enough to allow the intended synx to be identified or produced accurately on most occasions. Without making any assumptions about how the associative memory might be implemented, is function is simple. Variable X and variable Y are associated in some way, such as having occurred at the same time with values x and y respectively, and are stored as a linked pair. On retrieval, if one of x or y is used as an input addressing value, the other is retrieved as output.

If a value for “x” on retrieval is not exactly the value used during storage, such a memory may be designed in one of three ways. It may output nothing at all, it might output the “y” value that was stored along with the most similar “x” value, perhaps along with some reliability measure, or it might output more than one “y” value with accompanying reliability measures if the retrieval “x” was more or less equally distant from several stored “x” values.

If the variable X is a vector of length N, the value of x defines a location in a space of N dimensions. Y may be a vector of length N or of any other length. Y might even be scalar. As an example, the value of x could be the location of a syncon in feature space and y could be the label for that syncon. When a synx is used for retrieval, it would also be a point in the N dimensional feature space, and the retrieval might then be the label of the syncon closest to the synx.

As another example, Powers suggested that the input couple might be the output value from one or a vector of level L elementary control units when they had low error (their perception(s) matched their references closely) and the value(s) of the level L-1 perceptions that led to those low error values, while when the memory was interrogated for retrieval, the outputs of the memory would serve as reference values for the level L-1 systems that had produced those low errors, or, in imagination mode would be substituted for those perceptions.

Appendix 7: The Giant Virtual Controller

A Giant Virtual Controller is the effect of multiple individual controllers acting on the same part of their common environment. If it can be treated as a single controller, it must have a perceptual input function, a comparator, a reference value, and an output function. Each of these components is a function of the related components in the individual controllers that are its member constituents. The idea of the virtual controller was introduced by McClelland (1993), who showed in simulation the result showed here by analysis.

To begin with, we offer the standard “static” or equilibrium analysis of a simple control system, so that we can use it as a template for determining the properties of the components of the GVC.

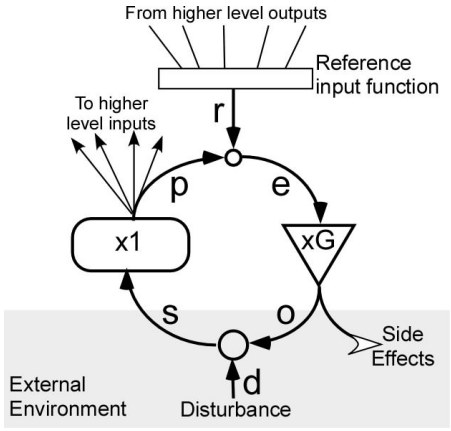

Figure Ax3.1 The basic control loop. The Giant Virtual Controller should have the same structure.

Because we are performing only a static analysis, we may take the Perceptual Function and the Output Function as simple multipliers, multiplying respectively by 1 and by G.

$p = s = o+d = G\times e+d = G\times(r-p)+d$

$p\times(1+G) = G\times r + d$

$p = r\times G/(1+G) + d/(1+G)$

Now let two different controllers both act on the same environmental variable, which means that in the static analysis they will both have the same values of d, s and p. But there is no reason why they should have the same values of r and G, so we will give them reference values r_1 and r_2, and output gains of G_1 and G_2. The force applied to the environmental variable is the sum of the two outputs o_1 and o_2.

$p = s = o_1 + o_2 + d$

$= G_1\times e_1 + G_2\times e_2 + d$

$= G_1\times(r_1-p) + G_2\times(r_2-p) + d$

$p\times(1+G_1+G_2) = G_1\times r_1 + G_2\times r_2 + d$

$p = (G_1\times r_1 + G_2\times r_2)/(1+G_1+G_2) + d/(1+G_1+G_2)$

If we set $G = G_1+G_2$, and assuming the existence of a virtual reference value R, we can write

$p = (G\times R)/(1+G) + d/(1+G)$

Comparing this with the expression for the controlled variable p of a single control system, the effect is the same as though there was a virtual controller with a gain $G = G_1+G_2$.

The expression for the virtual reference level R of the virtual controller is not so obvious.

Since in the equation for p in the individual case the reference value appears in the expression $r\times G/(1+G)$, if R actually exists, then

$R\times G/(1+G) = (G_1\times r_1 + G_2\times r_2)/(1+G)$

which gives

$R = (G_1\times r_1 + G_2\times r_2)/G$

$= (G_1 \times r_1 + G_2 \times r_2)/(G_1+G_2)$

If more than two individuals belong to the virtual controller, the same approach yields the general formulae:

$G = \sum G_i$

$R = \sum(G_i \times r_i)/G$

These formulae apply exactly only to the one-dimensional case, in which all the participants control exactly the same function of environmental variables, but they will hold approximately in cases in which the controlled perceptions of the participants are reasonably well correlated. In that case, for p one can substitute p_i, the projection of the i^{th} perceptual vector onto the sum vector, and for G_i the corresponding proportion of the gain. Of course. this is not strictly accurate, since if the individual controlled perception is less than 100% correlated with the CCEV, there is a component orthogonal to the CCEV that will influence the controlled perception in that individual, allowing it perhaps to be controlled (with low gain) using that small independent component. Nevertheless, the analysis provides a good guide to what is likely to happen in a realistic situation.

A more important consideration is that the analysis is only a static analysis using linear control systems. Linear systems controlling the same functions of the environment to different reference values are in conflict, and dynamically escalate their outputs. Real systems are not linear, and one of their non-linearities often includes a tolerance zone (as discussed in the main text of this work). If the environmental variable value is within the tolerance zone of one of the participants, that participant does not contribute to the output of the virtual controller. The existence of different tolerance zones around different reference levels ensures that the virtual controller will be nonlinear even if all the individual participants are linear control systems when outside their tolerance zone.

Appendix 8: The General Protocol Grammar

Every protocol begins when the initiator wants to control some perception through the action of another controller, so the Analyst cannot distinguish protocol types at that point. But the readiness of the potential continuer to execute the protocol may be anywhere between having overtly displayed readiness — R-display — through acceptance of the invitation created by the initiator's disturbing influence, to rejection or failure to recognize that an invitation occurred. We call an invitation intended to produce R-display an "Interrupt". An Interrupt allows the potential continuer to perceive the initiator's intent to start a new protocol. We can ignore R-Display in the GPG itself, since it is merely a starting requirement to be satistied before the Initiator starts sending the Primal Message.

Before considering this highest level protocol, the level at which the initiator is acting to control the perception that was initially in error, we should consider what we might call "function" protocols — protocols that implement various arcs in the General Protocol Grammar (Figure A8.1). Some arcs in the diagram are shown with heavy lines, some with light lines. The ones with light lines correspond roughly to function words in a sentence, while the ones with heavy lines correspond to content words such as nouns and verbs (Section II.12.3).

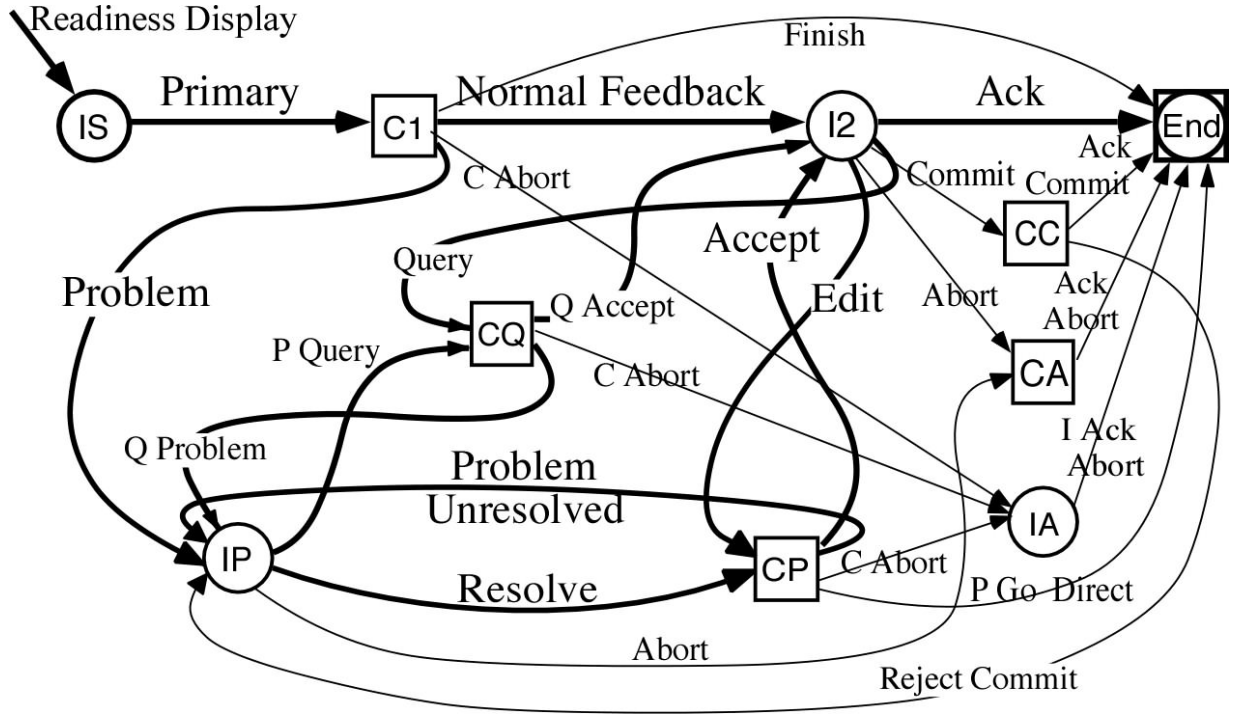

Figure A8.1 The General Protocol Grammar, distinguishing between arcs (light lines) that are purely functional and those (heavy lines) that might require arbitrary content to be displayed by one or other partner. Circles represent the continuer controlling a perception, while boxes represent the initiator controlling a perception. The arrows indicate direction of influence, not necessarily sequences of events, since both partners continuously control their perceptions.

Every arc in the GPG diagram represents one partner influencing some perceptual state in the other, but some kinds of function are common to several arcs. For example, there are many arcs labeled "Abort". In each case, the supporting protocol consists only of a display by the appropriate partner that they do not wish to complete the protocol, while acknowledging that it is incomplete. Arcs labelled "Ack" on the other hand, are implemented by a display that the partner accepts and agrees with whatever the other displayed — either that the protocol should be aborted, or that it has been successfully completed. Other arcs, marked by heavy lines in Figure A8.1 might require the inclusion or modification of some specific message content.

Each arc is implemented by a complete lower-level GPG unless the arc has a "null" instantiation, and every GPG exists so that the initiator can control some perception through the actions of the continuer. Consider now the following three types of function, and how they might be instantiated: Abort, Acknowledge, and Accept. "Null" means that no action is required because the perception being controlled at that point is at its reference value. But if the instantiation is not "null", what perceptions are controlled by the GPGs that implement these function arcs? They are all perceptions of the progress of the protocol itself, and not of the variable content, in the same way that function words in a sentence clarify the relationships among the variable content words. To instantiate them requires that the partner be able to perceive the intent of the one using the arc: "I want to stop", "I acknowledge what you just communicated", or "I accept what you just communicated". The actual implementations of these messages must depend on the situation.

Just as “John gave Mary a book” has a surface structure similar to “The sunset gave the beach a glow”, so do all “Give me X” protocols share a structure, whether X be a “the ball” or “a smile” or “some indication you understand what I am saying”. The function arcs have no “X”. The content arcs usually do, in what is called an “Inform” instantiation of the arc. There are only a relatively small number of different distinguishable states and transitions in the GPG, just as there are only a small number of function words or morphemes in a language. On the other hand there is an indefinitely large number of content arcs, as there is a constantly changing inventory of content words of a language.

If function arcs are implemented by “Function GPGs”, then the content-carrying arcs might be said to be implemented by “Content GPGs”. Let us consider them briefly.

The “Primary” arc consists of a display by the initiator (call her Irene) that identifies the kind of protocol Irene wants to “dance” with Carlo, and may also display the perception being controlled and an action the continuer (Carlo) could take to correct its error. In a very simple case, Carlo might simply perform the desired action, which would be a case of “Normal Feedback”.

But suppose Professor Irene is controlling a perception of student Carlo’s understanding of tensor calculus, for which her current perception is that he understands vector calculus pretty well, but tensor calculus not at all. Irene is unlikely to initiate the protocol by delivering a full-semester’s lectures all at once. More probably Irene will provide little bits and give Carlo the opportunity to display how well she has understood the message so far. She will use Normal Feedback initially to show Irene something of what she knows, the content of which allows Irene to perceive her level of understanding. From there, they will probable continue a semester-long process of looping around the “Edit-Accept” loop until either Carlo, in effect, uses the Accept arc to say “I’ve got it” and Irene uses the “Ack” exit from the protocol, or one of them uses the “Abort” exit from the loop, because it is the end of term or because one of them thinks she will never get it, at least not the way Irene is teaching it.

Of course, there are indefinitely many other possibilities, but these extreme cases might give a flavour of how the function and content arcs of the GPG represent the dynamically varying errors of the relevant controlled perceptions in the initiator and continuer.

(Based on Appendix to Taylor, Farrell and Hollands, 1999b)

The initiator’s reference perception for cooperative communication is that the protocol continuer has made an adequate interpretation, and therefore it is no longer worth continuing to transmit the message. Additionally, each party believes the other to hold this belief. The normal reason for the initiator to perceive that the message was interpreted as intended is that the perception initially in error has come to match its reference value. That reference value is usually called the “Primal Message” in the Layered Protocol literature, and the perception coming to match its reference value corresponds to the initiator perceiving that the Primal Message has been received as intended.

“Having made an adequate interpretation” may be divided into three independent propositions:

P1: The continuer has made an interpretation of the primal message.

P2: The quality of the communication mechanism is (or was) sufficient for an adequate interpretation.

P3: It is not worth continuing to improve the continuer’s interpretation of this message.

Each partner always has some level of belief for each proposition. We simplify the continuous variation of belief into five classes, which we label as follows:

Strong Disbelief = D (near 1, which represents certainty of falsehood)

Weak Disbelief = d (somewhere between D and 0)

No Opinion = 0 or U (near 0)
Weak Belief = b (somewhere between 0 and B)
Strong Belief = B (near -1, which represents certain belief)

The initiator (or "originator") is identified in the figures in the main text and here as "I". The continuer (or "receiver") is identified as "C". We use I(*p*) as a short-hand for the initiator's belief in *p*, and C(*p*) for the continuer's. For example, D < I(P2) < 0 means that the initiator's belief that "*the quality of the communication mechanism is (or has been) sufficient for an adequate interpretation"* is somewhere between Strong Disbelief and No Opinion. We more often use a form analogous to I(*p*)={D–d–0} to indicate that the initiator's belief in *p* belongs to one of the bracketed categories between strong disbelief and uncertainty.

Some of the important belief states are about what the partner believes. That is, it matters not only what the initiator believes, but also what the initiator believes about the continuer's beliefs. The continuer's beliefs, of course, include what the continuer believes about the initiator's beliefs. In principle, this recursion could be infinite, but we have found no instance in which a further level is required. Keeping this in mind, the nine idealized reference belief states for the initiator are:

I(P1) = B	I(C(P1) = B) = B	I(C(I(P1) = B) = B) = B
I(P2) = B	I(C(P2) = B) = B	I(C(I(P2) = B) = B) = B
I(P3) = B	I(C(P3) = B) = B	I(C(I(P3) = B) = B) = B

and for the continuer, they are:

C(P1) = B	C(I(P1) = B) = B	C(I(C(P1) = B) = B) = B
C(P2) = B	C(I(P2) = B) = B	C(I(C(P2) = B) = B) = B
C(P3) = B	C(I(P3) = B) = B	C(I(C(P3) = B) = B) = B

In a node-and-arc grammar (a state transition network), a node is occupied or not, and the transition is instantaneous from one node to another. This is not the case with the General Protocol Grammar (main text and Figure II.11.2). Nodes labelled "I" in the represent conditions in which the initiator may be acting, whereas at those labelled C, the initiator is observing the continuer and continually modifying his, her or its perception of the various beliefs held by the continuer while the continuer is acting. Both often (or always) happen at the same time. The initiator may, and usually does, observe while acting, and it is therefore completely normal for an Analyst to see the protocol as being simultaneously partly at an I node and partly at a C node, and possibly at more than one of each. Transitions from one node to another occur slowly, and it is perhaps more correct to talk about the degree to which each node is occupied, rather than about which node is occupied. Nevertheless, each node is characterized by a distinct set of belief conditions, and the trajectory of the changing levels of the nine beliefs can be characterized as a continuous rather than discrete passage through the graph of nodes and arcs of Figure A8.1.

Initial State:

Condition: I(P1) ≠ B

I has a reference to perceive C as having interpreted the message (I(P1)=B) but does not, and acts to increase I's level of belief in P1. C's beliefs about P1, P2, and P3 are irrelevant. But if I's action to affect I(P1) is to have the desired effect, I must not believe communication to be impossible (i.e. I(P2)≠D). If I(P2)=D initially, as might be the case if the initiator perceives C-display to indicate the continuer's inability or unwillingness to participate in the protocol, then I must first act to increase I(P2). This action might be called "Set-up," which might be accomplished in any

of a variety of ways, such as by establishing a communication channel by dialing a telephone, by commanding an interface to switch modes, by awakening or cajoling a partner, or by switching on a device. When the Set-up action has had its effect and C-display is appropriate, I can be at the Start node of the GPG, labelled "OS".

Start node, OS:

Condition: I(P1) ≠ B, I(P2) ≠ D, I(C(P1)={b–B}) < B[60]

I does not strongly believe that C has interpreted the message. Since I at least entertains the possibility that a message can be communicated, I can act to affect C's belief.

Primary Arc to node R1

I has two objectives: to increase I(P1), and to perceive the value of C(P1) so that I can subsequently act to bring C(P1) nearer its reference level. I can observe C's actions and thereby improve I's precision of belief in P2 and in C(P1). There are therefore at least two possible instantiations:

Inform instantiation I acts to increase both I(P1) and C(P1) by communicating at least some of the message content. I is likely to do this if, at the Start node, I(C(P1)<0) = {b–B} (i.e. I believes C does not believe C has interpreted the message), and if I(P2) = {b–B} (i.e. I believes the communication channel will be good enough to allow C to make some interpretation).

Neutral instantiation If I does not strongly believe P2, or if I believes C may already have an interpretation (right or wrong) of the message, I may act only to enhance the precision of the belief in P2 and of C(P1), in effect requesting C to inform I of C's beliefs, at least in respect of C's belief that there is a message in progress.

Node R1

Condition: I(C(P1)>0) = {b–B} or I(C(P2)<B) = {b–B}

I is observing, not acting. I is "at" node C1 if I believes C is likely to act in respect of a perception of the message interpretation or the poor quality of communication. I attempts to perceive whether C believes that the current interpretation is possibly adequate (going to node I2) or is likely to be wrong (going to node IP). I leaves node C1 completely only when I(C(P1)={b,B})={b,B} (i.e. when I believes C believes C has made some interpretation).

Normal Feedback Arc to node O2

Condition: I(C(P1)={b–B}+C(P2)={b–B})={b–B}

Until I perceives that C believes that an interpretation has been made (to the degree that I's Primary message permits), I will be at C1, observing. The transition to I2 occurs to the degree that I perceives C both to have made an interpretation and to be satisfied that it might be an adequate interpretation. The way C acts to affect I's perceptions (instantiates the Normal Feedback arc) depends on C's perception of I's beliefs, in relation to C's reference values for those perceptions.

Null Instantiation

Condition: C(P1+P2)=B + C(I(P1+P2)=B)=B

60. The notation "b-B" should be read "between weak and strong belief" or "from b to B".

C may make no overt action to confirm to I that an adequate interpretation has been made, if C believes I already believes it. This situation occurs when both parties recognize that communications of this type are almost always correctly interpreted from the primary message alone. This occurs most commonly at low levels of the dialogue, such as individual spoken words in human dialogue, or individual keystrokes on a computer keyboard. There is seldom any need for the continuer to acknowledge each individual word or keystroke (though computers often provide a Neutral Instantiation in the form of a click or a beep that acknowledges the keystroke to have been detected).

Neutral Instantiation

Condition: C(P1+P2)=B + C(I(P1)<B + I(P2)=B)={b–B}

C believes I is unsure whether the message has been interpreted at all, and that I believes that if it has, the interpretation will have been adequate. C acts so that I can perceive that an interpretation has been made.

Inform Instantiation

Condition: C(P1)=B + (C(P2)=b or C(I(P2)<B)={b–B})

C believes that the message has been interpreted to the degree that the Primary message permits, but is unsure either as to the adequacy of the interpretation or as to whether I believes the interpretation to be adequate. C acts in such a way that I can perceive something about how C has interpreted the message.

Correction Instantiation

A "correction" instantiation of Normal Feedback has the same conditions as the "Inform" instantiation, except that the continuer believes that the initiator incorrectly formulated some element of the message in a way that the continuer was able to detect and correct. The continuer acts so that the initiator can perceive both the continuer's interpretation and the potentially wrong interpretation that would have occurred had the continuer not detected the error. The effect of a "correction" instantiation is to increase both parties' future beliefs in P2.

Problem Feedback Arc to node IP

Condition: I(C(P1)={b–B}+C(P2)≤0)={b–B}

C wants I to perceive that C believes an interpretation has been made that is unlikely to be adequate.

Null Instantiation

Condition: C(P2)=D + C(I(C(P2)=D)=B)=B

C strongly disbelieves that the interpretation is adequate and believes that I believes C believes this. Such a situation is likely to occur only after a neutral instantiation of the Primary message, when both partners know that the message could not have been interpreted adequately, and when C has no basis on which to inform I as to the nature of the likely inadequacy. Except possibly from considerations of timing, a third-party analyst probably would be unable to distinguish the sequence Primary (Neutral), Problem Feedback (Null), Resolve (Inform) from an instantiation of the Primary arc that started out looking like a Neutral and continued as an Inform.

Neutral Instantiation

Condition: C(P2)={d–D} + C(I(C(P2)={d–D})=B) < B

C disbelieves that the interpretation is adequate, but is unsure whether I recognizes this. C does not provide I with information as to the nature of the problem, but simply acts so that I can perceive that a problem exists (making it likely that I's next act will be to move to node CQ, where C is requested to inform I as to the current content of the interpretation).

Inform Instantiation

Condition: C(P2)={d–D}

Regardless of I's level of belief about whether I perceives that C has a problem, C may inform I as to the nature of the problematic interpretation. This is the usual case when a problem exists, Null and Neutral instantiations being special cases.

Node I2

Condition: I(C(P1)={b–B} + C(P2) = {b–B}) = {b–B}

I believes C believes C to have made a possibly adequate interpretation.

Ack Arc to node End

Condition: I(P1+P2)=B

Null Instantiation

Condition: I(C(I(P1+P2)=B)=B)=B

I strongly believes C strongly believes that I strongly believes that the message has been adequately interpreted. Since this state is the reference state (and all the other beliefs have reached their reference states), I need not act. Both parties accept that the message transmission is complete and that the other is also of that opinion.

Neutral Instantiation

Condition: I(C(I(P1+P2)=B)={b–B})={b–B} other than I(C(I(P1+P2)=B)=B)=B

Either I believes only weakly that C believes I believes the message has been adequately interpreted, or I believes (strongly or weakly) that C only weakly believes that I believes the message to have been adequately interpreted.

**Inform Instantiation* An Inform instantiation of an Ack arc is not possible, since the Ack arc is used only when I is satisfied with the interpretation and no longer will be observing C's changing interpretation.

Commit arc to node CC

Condition: I(P1+P2)=B, I(C(P1+P2)<B)={b–B} or I(C(I(P1+P2)<B)={b–B})={b–B}

The difference between the Commit and the Ack arcs is that the Commit arc leads to a state in which I observes C to determine whether C believes that the message communication is complete, whereas the Ack arc leads to the termination of the communication, when I no longer observes C's behaviour in respect of this message.

Inform Instantiation

Condition: I(C(P2)<B)={b–B}

I believes C to be unsure as to the adequacy of the interpretation and provides more information to assure C of I's belief in its adequacy.

Neutral Instantiation

Condition: I(C(I(P2)<B)={b–B})={b–B}

I believes C to be unsure whether I believes the interpretation to be adequate. I settles C's belief, without further information about the content of the message.

Query Arc to node CQ

Condition: I(P2) = U

I believes that C believes that the message may have been adequately interpreted, but is unsure whether this is true, and requests C to provide information as to the content of the interpretation.

Inform and *Neutral* Instantiations are both plausible. Which is used depends on the degree to which I(P2) deviates from zero. If I has little or no idea what interpretation C has made, the instantiation will be Neutral, but if I has some notion (though not enough to justify either a weak belief or a weak disbelief in its adequacy), I may inform C about what I perceives the interpretation to be.

Edit Arc to node CP

Condition: I(P2) = {d–D}

I disbelieves that the interpretation is adequate. This could be because I believes that the information so far transmitted in necessarily inadequate, or because C's actions have allowed I to perceive that the interpretation is inadequate.

Inform Instantiation This is the only commonly plausible instantiation of the Edit arc, the purpose of which is to bring C's interpretation nearer to being adequate. To do this, I would ordinarily restate or augment some part of the message.

Neutral Instantiation may occasionally be plausible, particularly if I recognizes the statement of the message to have been ambiguous, and believes that C has arrived at the wrong one of only two plausible interpretations.

Node IP

Condition: I(C(P2)={d–D})={b–B}

I perceives that C believes the interpretation unlikely to be adequate.

P Query Arc to node CQ

See **Query Arc** from Node O2 to Node RQ. The same considerations apply.

Resolve Arc to node CP

I acts to bring C to a point at which C can determine whether it is plausible that a revised interpretation is adequate.

Inform Instantiation The only plausible instantiation is usually *Inform*, since I must act so that C can modify the interpretation. The exception to this is a

Neutral Instantiation that says, in effect, "Even though you thought your interpretation was wrong, it is what I meant."

Abort Arc to Node CA

Condition: I(P3) = B

I believes the problem represented by being at Node IP is too difficult to be worth the effort to resolve. At Node CA, C has the opportunity to reject the Abort or to accept it.

Neutral Instantiation

Ordinarily neither *Inform* nor *Null* is plausible as an instantiation of Abort, because if the problem is not resolvable, there is no point in further presentation of the message content (which would be an Inform instantiation), and the intention of I to Abort is ordinarily not detectable from a Null instantiation. A Null instantiation may sometimes be plausible in conjunction with various actions at higher levels of the dialogue, typically related to uses of the higher level "Edit-Accept" loop to correct the higher-level interpretation in a succession of different ways.

Node CP

Having acted, or being in the process of acting to modify C's interpretation, I is observing C to develop a perception of how C's interpretation is changing.

Accept Arc to Node I2

The criteria are very like those for Normal Feedback, as are the instantiations. The difference is in the likelihood that C will use a Neutral, as opposed to a Null or an Inform instantiation of the arc. At CP, C is likely to believe that I has a more precise perception of C's interpretation than at C1, both because of I's initial observation of C at C1 and because of subsequent Inform instantiations in the use of either the Edit or the Resolve arc. Hence a Neutral instantiation of the "Accept" arc is relatively more likely than is a Neutral instantiation of the Normal Feedback arc.

Problem Unresolved arc to Node IP

The criteria are very like those for the "Problem" arc, though the likelihood of an "Inform" instantiation is higher, since C is likely to have a better idea of wherin the problem of interpretation lies.

C Abort arc to Node IA

Condition: C(P1)=B

Neutral Instantiation

As with the initiator's Abort that signifies an abandonment of the goal to have C act in a desired way, C can abandon the goal of cooperating with I by discovering the desired interpretation. Neutral seems the only plausible instantiation. I can accept C's withdrawal or can attempt to continue the message transmission.

Other Nodes and Arcs

The remaining nodes and arcs have to do with terminating the message transmission without completing an adequate interpretation. The considerations and criteria are the same as for the **Abort** and **C Abort** arcs described above. The parties may disagree as to whether to accept an Abort, in which case a meta-dialogue may ensue, negotiating the disagreement, but that meta-

dialogue is independent of the grammar for passing the message itself. In a computer implementation of intelligent dialogue, these other nodes and arcs must be either implemented or deliberately ignored by the designer, but it is not necessary to detail them here.

***Appendix 9: Structure and Mass-Energy in Relativistic Networks.

What is a “relativistic” network? In Physics, the word “relativity” implies that all measures are relative to an observer, including the time of an event. As NATO

Appendix 10. Interchangeable views on the world of Physics

The following is an email dialogue that seems to illustrate the way different backgrounds of the viewers can influence how we understand the physical world.

Original Message:
Sent: 08-11-2017 16:20
From: Maurice Taylor
Subject: Gravitational Waves

The merging of black holes, among presumably many other less dramatic events, radiates energy out into the universe, if gravitational waves behave like other kinds of wave. Is there any mechanism for converting gravitational wave energy into another form of energy, or is the Universe filled with "noise" in the form of the ever-expanding remnants of 13 billion years of history? If the latter, presumably there would be some energy density associated with the ripples, as there is with electromagnetic waves, for example. How would this enter the energy budget of the Universe, given that over history, the number of past events (in local time) has been ever increasing while the Universe has been ever expanding. If there is a mechanism for converting gravitational wave energy into another form, what is it?

Martin Taylor

On 2017/08/12 3:55 PM, Derle Smith via Sigma Xi Communities wrote:

The following message has been sent to you in response to your Discussion message

Message From: Derle Smith

To: S.W.Hawking@damtp.cam.ac.uk

Dear Maurice, Your queries would be more appropriately answered by Dr. Stephen Hawking. Please see email address above. Best regards, Derle

Example correspondence...

Dear Dr. Hawking, Would you please shed some light on the following query? Thank you!

"The merging of black holes, among presumably many other less dramatic events, radiates energy out into the universe, if gravitational waves behave like other kinds of wave[s]. Is there any mechanism for converting gravitational wave energy into another form of energy, or is the Universe filled with "noise" in the form of the ever-expanding remnants of 13 billion years of history? If the latter, presumably there would be some energy density associated with the ripples, as there is with electromagnetic waves, for example. How would this enter the energy budget of the Universe, given that over history, the number of past events (in local time) has been ever increasing while the Universe has been ever expanding. If there is a mechanism for converting gravitational wave energy into another form, what is it?"

http://community.sigmaxi.org/network/members/profile/?UserKey=34721892-06df-49c1-ad3f-39275a93b005

Derle Smith

On Sat, Aug 12, 2017 at 3:52 PM, Martin Taylor <mmt@mmtaylor.net> wrote:

Thanks. I might just do as you suggest. But why would not the Sigma Xi community be also suitable for such a query? I assume that astrophysicists are among the members of sigma Xi, and this is a non-political question, unlike almost everything recently on the communities forum.

Martin

On 2017/08/13 4:59 PM, Derle Smith wrote:

Martin, I agree with you wholeheartedly about so-called experts on the Sigma Xi team (astrophysicists, etc.). However, I consider S. Hawking the foremost authority on the subject, and I would be eager to see how his explanation lines up with Dr. A.G. Smith's, et al. explanations as a sort of "refereed" explanation. Cheers, Derle

Post Scriptum: Do you agree with Dr. Smith's explanation?

Additionally: What do you think is "oscillating" to produce gravitational waves in the first place? And where does the Higgs boson enter in? (This is the focus of my theoretical work.)

On Sun, Aug 13, 2017 at 10:17 PM, Martin Taylor <mmt@mmtaylor.net> wrote:

Hi,

I don't know enough to have any comment on Dr. Smith's explanation. Sixty years ago I graduated from Engineering Physics before getting a Ph.D. in experimental psychology, and have always retained enough interest in general physics to read relevant papers in Science and Nature with some moderate level of understanding, but no more. It just struck me as odd that for most sources of radiation that I could think of, there was an equivalent absorber, but I never heard of one for gravitational waves, and I wondered if our colleagues who were expert in the area might be able to fill me in.

As for sources of gravitational waves, I resort to visualizing. Any relative movement of a mass must change the regional curvature of space, and presumably would radiate, and any orbital movement would presumably radiate at the orbital period. A change of mass to electromagnetic energy ought to radiate gravitation energy somewhere, I presume, even if the quantity is many orders of magnitude less than the overt mass-energy in the event. I would think a similar gravity radiation export ought to happen if photons beget particles, which I suppose would mean that there's no "adiabatic" process of transfer between mass, gravity waves and electromagnetism. But to an expert, I imagine that's all nonsense talk based on major misunderstanding and naivete.

I have no ideas about the Higgs Boson, but the concept did give me some ideas related to the inertia of dynamic network structures (social networks, largely). I don't know if those ideas will ever go anywhere, and I'm sure they would be of no interest in their less than half-baked state.

Martin

On 2017/08/14 7:32 PM, Derle Smith wrote:

Hello Martin, You wrote:

"As for sources of gravitational waves, I resort to visualizing. Any relative movement of a mass must change the regional curvature of space, and presumably would radiate, and any orbital movement would presumably radiate at the orbital period. A change of mass to electromagnetic energy ought to radiate gravitation energy somewhere, I presume, even if the quantity is many orders of magnitude less than the overt mass-energy in the event. I would think a similar gravity radiation export ought to happen if photons beget particles, which I suppose would mean that there's no "adiabatic" process of transfer between mass, gravity waves and electromagnetism. But to an expert, I imagine that's all nonsense talk based on major misunderstanding and naivete."

I appreciate your first statement and your need to "visualize" what are truly the progenitors of gravitational waves. I consider the vacuum to have "structure." A wave by its very definition is "the propagation of a deformation through a deformable medium." Hence if gravitational waves exist, they must be disturbances of whatever makes up the vacuum. I am currently researching what the fundamental structure of the vacuum truly is. It is my contention that whatever constitutes the vacuum is responsible for all of the known elementary particles. However, calling these fundamental entities "particles" is a misnomer because they are undoubtedly quantum oscillations of these vacuum constituents. A. Strominger and S. Hawking are doing work along the lines of "extremal black holes" that may provide clues to vacuum structure. My work parallels their work. (Thus my suggestion that you confer with Dr. Hawking in re subject.)

You mentioned that "A change of mass to electromagnetic energy ought to radiate gravitation energy somewhere." I like this observation! Mainly because mass is directly proportional to frequency (as derived using the double Einstein equation, $E = hf = mc^2$). But what is oscillating at the Planck scale to give rise to this mass-energy conversion? I surmise that it is what makes up the vacuum. Many present-day theorists have posited that the vacuum is "grainy" and that it has "atomicity." Early theorists considered the vacuum to be the "Aether." Yet the old aether idea was dispelled by the Michelson-Morley experiment; but only because the experimental apparatus they used was made up of what the vacuum was made of, too!

All matter has its origin with the vacuum, and it is the structure of the vacuum that we must obtain a clear understanding of. I strive to remove complexity from my arguments; I hope that I have provided you a much clearer understanding of my thesis. If not, please let me know. Your words above are

intelligent, and I would like to address your other statements. For example, I consider the photon as an oscillation that is characteristic of the entities that constitute the vacuum and the electron as another oscillation that is inextricably linked to that of the photon. Further, these two oscillations emerge from the vacuum in a fundamental way that is natural and simplistic. I will stop here because I do not want to present more information than needs to be divulged; or bore you with details. I will close concerning your statement, "But to an expert, I imagine that's all nonsense talk based on major misunderstanding and naivete." nothing could be further from the truth! I appreciate your honesty and your sincerity in seeking understanding. Let me know if anything that I have written helps in any way. Like you, I am seeking answers as well. Cheers, Derle

From: Martin Taylor [mailto:mmt@mmtaylor.net]
Sent: Tuesday, August 15, 2017 9:03 AM
To: Derle Smith
Subject: Re: Gravitational Waves

Derle,

Thanks again. I think I get a glimmering of what you are talking about, but not much more than that. However, one thing that, wearing my psychologist's hat, has always puzzled me is why anyone should think that concepts valid for time and space scales of human perception and action need to be valid for scales outside that range. We find that by using maths we can make extraordinary predictions of what we should see, predictions that work for events on at least some of these scales (my favourite example is the neutrino burst from Supernova 1987 in one of the Magellanic Clouds). We can extrapolate to geologic and astronomic time and space from what little of it we can see, even with our instruments, and it usually seems that some people can make enough sense of it to make predictions that work. But the concepts don't always fit. For example, inflation. It's a word, and words like "inflaton" get piled around it, but what is it other than a mystery that doesn't fit the rest of what we have extrapolated?

You describe your work in terms of everyday human-scale perceptions such as "grain", as though at those scales individuation had the same kind of quality as it does for sand, but I would be surprised if your maths treated them the same at the two scales. You put the word "grainy" in quotes to suggest that it doesn't. You say "A wave by its very definition is "the propagation of a deformation through a deformable medium." Hence if gravitational waves exist, they must be disturbances of whatever makes up the vacuum." But that's an appeal to concepts that work in human-scale time and space. You use them, I suspect, not only to communicate with others unfamiliar with the maths, but also to communicate with yourself. My "visualising" is the only way I can deal with such phenomena. I do imagine a deformable medium. Are such concepts helpful or harmful to getting a good understanding of what is going on? Even the maths is always suspect, despite its magnificent successes. Could Einstein have developed General Relativity before Riemann and Lobachevski?

The idea of quantum "weirdness" seems to me to come from this notion that what you see is what you get, even if you scale up and down many orders of magnitude. In human scale, a thing can't be a particle or a wave depending on how you look at it, and it can't be both at the same time. But that's the way we currently understand the world, because the maths we have available works so very beautifully if we assert that it's the way the world is (and call it weird). Einstein extrapolated everyday visualisation to come to his "weird" insights.

My visualization on "graininess" is an analogy to the relation between time series and frequency representation in Fourier analysis. A series of discrete and independent values for one sample and then the next is at one end of a continuum, a series of frequencies each extending through infinite time is at the other. But each is just a view onto a point in a multidimensional space, using different rotations of the axes, and there are an infinity of other possible rotations in between, that mix time concepts and

frequency concepts in different proportions varying across the dimensionality of the data (i.e. part of it in time representation, part in frequency, and part in a mix), all depending on how you want to look at it and what you want to do with your view of it. It's the same world however it is seen from all these possible viewpoints. Some views show what we call "harmonic relationships" some show "rhythm", other show nothing we recognise as useful.

I visualize quantum "graininess" by analogy. At one end of the continuum there is a particle, or rather, lots of distinctly separate particles in some defined volume of space-time. At the other end is an equally complex lot of intermingled wave functions, in no definable space-time box. In between, there are an infinite set of possibilities for more or less confined "wavicle" ways of looking at the interactions among the "particles in the box" or the "distinct wave functions".

The concept of spatial or temporal separation is a human-scale one. Does it apply outside human scales of perception and action? The "weird" wave-particle duality suggests to me that it may not. Why should it? If experiments suggest that it doesn't, why consider it at all. Using the analogy, "graininess" might be "rhythm", interparticle interactions might be analogous to "harmonic structure", rhythm and harmonics being structures that exist in some waveforms if you look at them from the right angle, using an appropriate representation basis space.

I realize that visualization without analysis is a dangerous guide, particularly since this particular visualisation suggests that the visualisation itself depends on a particular point of view. Indeed, the role of analysis to prune unwarranted imagination is one that, wearing my psychologist's hat, I have been arguing for over a very long time. I used it in a theory of reading around 35 years ago. But I never expected to use it in this domain before. As I said earlier, and you were kind enough to dispute, it may well be total nonsense, badly expressed, but then again, it may not.

Martin

On 2017/08/19 7:14 PM, Derle Smith Jr wrote:

> Dear Martin, I appreciate your thoughts next under, and I am trying to understand you as you wear your “psychologist’s hat” (and which, by the way, is a very intelligent hat!). We humans perceive our surroundings through our five senses. What we detect is transmitted by electrons through neural networks. It is quite possible that there is an awareness of our physical surroundings that transcends our physical senses. For example, how would one describe that which exists outside human perception without these five senses? An ordinary computer has none of the senses that we possess; yet it “can” think.
>
> What is our definition of physical reality? I assure you that our five senses will enter into that definition. We measure things (at minimum) using three scientifically indefinable metrics: length, mass, and time. All are based on our physical senses that tell us about our perceived world. What if we remove these concepts and try to envision what the “true world” would be like? Lee Smolin et al. removed the time parameter from Einstein’s field equations and determined a new perspective on space. They found that the vacuum was “loopy” at its most infinitesimal range (the so-called Planck scale). I believe that these researchers are most likely on the right track. If we are to understand anything at all about elementary particles, dark matter, etc., we will need to drop our physical senses and face quantum reality head on. The “weirdness” most likely has its roots within our limited understanding of our surroundings based on our limited perception of those surroundings via our five senses. Cheers, Derle

Derle,

What you say seems to me to be a good starting point for an enquiry. I suppose I have an unusual way of looking at things, based in part on mixing my undergraduate experience in Engineering Physics with my later career as a psychologist. One of the takeaways from the Engineering Physics course was that one should always try to visualize what an equation tells you before you worry about how the maths can be manipulated. You seem to be of the same persuasion.

A problem with this approach is, as you point out, the limitation to perceiving only what the senses can tell us. You mention "indefinable metrics" of mass, length, and time, M, L and T. These we seem to experience directly, though we are more likely to experience force than mass, whether it is accelerative inertia or apparently static gravitational force. Force is perceived as different in kind from mass, and it is, being a combination of M, L, and T in the form f = ma. There are lots of perceptible distinct dimensions, colour being another. Colour isn't wavelength or frequency. It's a perceptual combination of sensitivities of specific receptors in a particular spatio-temporal context, with no precisely definable physical correlate.

According to classical physics in the sense of f = ma, and more deeply according to Einstein, energy has the dimensionality ML^2T^{-2}, even though our senses tell us it is something quite different from all three. Einstein also offered an equivalence between L and iT, so that "separation" or "distance" can be computed as $\partial S = (\partial x^2+\partial y^2+\partial z^2-\partial t^2)^{-2}$. So he left only two distinct dimensions where the senses would naively suggest there should be four. Who do we believe, our senses or our analysis? Even on the earthly scale of GPS navigation, our senses lead us astray, but the "anti-sensory" equivalence between L and iT does not.

"Perceptually distinct" dimensions of experience don't always act like orthogonal basis dimensions of reality when we apply mathematical imagination and get results that conform to observable reality by treating the dimensions as to some extent interchangeable. Last time, I suggested some visualizations based on treating representations across two dimensions of experience (waveform and spectrum representations of an ordered vector of values) as smoothly interchangeable. In terms of everyday experience, that's the same kind of "weirdness" as wave-particle duality -- wavicles and non-localizability -- except for the fact that we never perceive a waveform or a spectrum. We perceive only the intermediate rotations of the basis space, time-localized frequencies, beeps, tones, chords, noises, and so forth, in other words wave-packets.

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As a psychologist, I have, for the last quarter-century, taken as fundamental a not very well-known 60+ year old theory called "Perceptual Control Theory" (PCT). To me, as an explanatory device this theory underlies everything we understand, perceive, do, or imagine, to as great an extent as atomic theory did for chemistry before quantum mechanics. The basic "atom" of PCT is a control loop that controls a scalar vale related to sensory input (imagined or real), and the basic "fact" is "control", the ability to influence one's environment so that one's perception of it approaches one's preference for how one would like it to be. The key is that our (and every living organism's) perception of reality is not passively based on transformation of sensory input in the way systems such as "Deep Mind" would have it, but depends on how the Universe consistently changes its effects on our senses when we act in various ways.

We perceive as unitary at one level what we can also perceive to be combinations of more directly sensory elements at lower levels. Colour is one example. The honesty of another person is an example at a much higher and more complex level, and the "weird" constructs of modern physics are examples equally indirectly related to what we actually sense. Rather than the complexity of, say, a tree, the perception of which is built entirely of frequently perceived patterns of sensory data, visualizations of mathematical derivations depend mainly on imagination and only very remotely on direct sensory data. Nevertheless, at least in physics, people complain that the result is useless unless it can be directly

compared with sensory experience. However much the processes of the derivation depend on mathematics, the loop is closed by controlling the relationship between predictions and observations.

When we come to the very big, the very small, the very fast, and the very slow, we cannot act to influence the Universe in any way that we will perceive as consistent changes. We must use devices we might call "transformers", physical devices from microscopes to archives on clay tablets to the LHC, and, in particular, mathematical operations, all of which serve to convert fast, slow, small, and large into effects into our human sensory scale. We have no a priori reason to believe that what we can perceive and influence unaided will convert linearly or even predictably from the non-human scales, but so long as when we predict that if we do this, then we will observe that, and it happens, we can continue to believe that our local laws still apply however weird they may seem. When it doesn't happen, we have to think again, and one of the ways of "thinking again" is visualizing.

Visualizing in this context completes the cycle started in the first paragraph above. Rather than visualizing what an equation tells you, creative visualization asks what equations might be implied if the visualization corresponds to the real world. Einstein's visualisations required curved space and mass-energy equivalence, and mathematicians had already invented the tools he needed. We use analogies, because maybe the unknown but analogous entity or process works like the one with which we are familiar, though often it does not. Whether they do in any particular circumstance is initially an open question, one that sometimes remains open for a long time.

My musings on visualizing wave-particle duality as an analogue of waveform-spectrum duality and possibly of time-space duality were of that kind. Both waveform and spectrum representations of a pattern in amplitude and time are specific views of the same phenomenon, the views just being different rotations of a basis space. This viewpoint on those viewpoints immediately suggests the possibility of intermediate rotations of other basis spaces, resulting in analogies to time-bounded spectra of all sorts of different kinds useful for different purposes. Wave-packets is one.

When the analogy to wave-particle is made, I get the impression that there's a wide range of intermediate possible views that determine the space-time spreading and squeezing of the entity we call a particle or a wave, and hence the interactions among entities. Interactions imply distinctions or separations, separations imply localizations, and you can't have both at once, in everyday experience. That was always the conceptual problem with "action at a distance", anyway. But if you look at it from the viewpoint of different rotations of one basis space, you get the concept that localization just means one way of viewing the distribution of energy in time and space, while interaction means looking at the energy distribution a bit differently.

At that point, the maths gets beyond me, because "interaction" implies non-linearity, and those rotations of the basis space are linear -- at least the waveform-spectrum rotations are. It gets worse with rotations of space-time, because of the imaginary nature of the time axis, which seems to suggest to me in some very hazy way that some of the different views should imply localized oscillatory phenomena, and that implies different ways of looking at energy density over space-time. You get a three-dimensional rotation of waveform, spectrum, and space. At one end of a rotation there are point masses existing over extended time, at another there is are separable wavicles with indeterminate time and space extent. Maybe the "loopy granularity" you discuss is related to that, or maybe it's quite different, and I'm barking up something that isn't even a tree. But its the concept of variable localization depending on how you look at it that seems to me to follow (at a considerable distance :-) from the perceptual control theory approach to understanding the reality of the Universe.

At the very small very fast end, we have "transformers", such as all the ancillary apparatus to the LHC, that allow us both to perceive and to influence the transformed images of the real world. At the large and slow, we may perceive, but we can't influence. What we can influence is our perception of the

mathematical implications. Ptolemy did it, Kepler did it, Newton did it, and Einstein did it, always with descriptions that were both simpler and more accurate than their predecessors in describing the uninfluenceable Universe that our transforming instruments allow us to perceive. That our control of our mathematical perceptions permits this also allows us to perceive that at least some extrapolation from our local-scale perceptual reality is not totally ridiculous.

But for me, it all comes down in the end to the success or otherwise of our ability to control various kinds of perceptions. Those we can control are likely to have some relation with reality. Control of the relationship between mathematical arguments and things we can perceive and influence through our transformers is among them.

When I read this kind of stuff from others, it usually exasperates me, because I imagine that they don't know what they are talking about. In my own case, I know I don't know what I am talking about in one sense, its relationship to current physics theory. But in another sense I do know what I am talking about. It is a way for me, though possibly for nobody else, to make a little coherence out of what I read in the generalist physics literature such as is published in Science, Nature, or Physics Today. And I apologise for wasting your time by wanting to find out from a real physicist whether there is any chance that it is more nonsense than sense in the context of public physics.

Martin