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Misguided missiles

For the United States, *The Day the World Ended* was only the beginning of the nuclear arms race. While most countries were winding down their military efforts after the end of WW2, the American military-industrial complex (as it was later called by Eisenhower) chose instead to extend its global reach. One means of doing this was to capitalize on its lead in nuclear-weapons technology – an enterprise which would bring immense power and wealth to those who owned the means of production, as long as the public could be persuaded to subsidize its continual growth. And the means of persuasion were already in place: the advertising and marketing industry was itself exploding, in order to carry out the deliberate policy of promoting unlimited consumption in order to keep the wheels of industry turning (Worldwatch Institute 2010, 11-16). The arms race was somewhat unusual in that the ‘consumer’ had to be persuaded to buy into something that was of no use to him personally, and indeed was intended *not* to be used. The credible *threat* of using it was supposed to keep everyone safe from the Enemy. Of course if the threat were ever carried out, the

consumer himself was likely to be consumed as a consequence; so the military-industrial complex was essentially terrorizing the taxpayer into financing the means of his destruction (at worst) or exploitation (at best).

Future generations may find it hard to imagine why the public went along with this program, but it was ideal for the captains of the Complex, because it meant that the nuclear arsenal would have to be constantly updated in order to stay ahead of the opposition. The USSR did its best to provide the mirror image necessary to make the 'race' look real. Of course, the American propaganda never spoke of "staying ahead"; the pitch was to "keep up (or even "catch up") with the Russians." But the public had no way of knowing what the real situation was, since the information was often 'classified' as secret, while the corporate media took on the task of 'manufacturing consent' (Herman and Chomsky 1988). The owners of these corporate media, essentially the same elite group who profited from weapons production, 'sold' it to the American public under the slogan of "defending freedom"; the media also advertised themselves as the 'free press,' meaning in practice that their owners could use them freely to serve their own interests. (This pattern continued into the 21st century, though the media image and identity of 'the Enemy' had to be constantly revised and updated after the dissolution of the Soviet Union toward the end of the 20th.)

The cutting edge of weaponry speedily progressed from the A-bomb to the multi-megaton H-bomb. After that, the main focus shifted to improvements in 'delivery systems.' Bombers were relegated to a backup role with the advent of *ballistic missiles* (rockets with nuclear warheads). By the late 1960s an ICBM (InterContinental Ballistic Missile) could be aimed and fired at targets halfway around the world, and could get there in a matter of minutes rather than hours. But, like a bullet emerging from a rifle barrel, it would follow a path predetermined at launch time, and might miss the bull's eye by a mile. Of course, a weapon that could level an entire city didn't need to be terribly accurate, especially when you had thousands of them, many of which could be launched from submarines at sea. By 1980 the U.S. arsenal had grown so massively redundant that most of it could serve no

purpose in an actual nuclear war except to 'make the rubble bounce,' as some analysts put it. Something new was needed to keep the wheels of the industry turning at top speed, so the innovators turned their attention to *guidance systems*. As Martin Luther King remarked, it was an age of guided missiles and misguided men. And ironically, the next advance in lethal technology was achieved by taking a page from the book of life itself.

Inner maps

Unlike its ballistic predecessors, the 'cruise' missile developed in the early 1980s resembled a robot airplane on a suicide mission. Though relatively slow, short-range and low-yield, it could deliver its payload to a target as specific as a single building. Thus it represented the first generation of 'smart missiles' (and later, 'drones'). What made them so smart was an *internal guidance system*. An onboard computer was programmed with a flight plan, an electronic map of its route, and coupled with an onboard video camera. Thus the system could 'read' the territory *en route* and compare that reading with what it 'expected' from its reading of the onboard map. If it detected a mismatch along the way, the system could steer the missile to correct its course and realign it with the map.

This amounted to a crude simulation of living systems, which are typically *guided from within*. This is most obvious with animals like ourselves. Each of us begins life as a single cell, which promptly begins to divide and *develop* toward its biologically destined state as a specific kind of mature multicellular organism. The development process is guided by a 'map' *within* the original cell and included in each of its descendants. This 'map,' the *genome*, is a single text read by the cell's internal process of chemical analysis and synthesis, typically producing a specific protein as interpretant of a specific section of the DNA molecule, or sometimes regulating other interpretive processes. The genome is thus a sign within the cell, read by a process which is part of it, and interpreted in the context of the whole situation in which the cell participates. As the cells differentiate and the body articulates

itself, contexts multiply and organize themselves into hierarchies: cells into structures such as organs, and structures into various systems (nervous, circulatory, digestive and so on). As the context organizing the whole process, the body thus becomes more *complex*.

But the body as a whole has a context as well, which we may call its environment or its *medium*. As the relations between the body and its context become more complex in the course of development, so does its *behavior*. This too is guided by an internal 'map' – or rather by a continuous *mapping* process. Since a body's immediate environment is much less predictable than the patient process of growth, its behavioral guidance system needs to be fast and flexible. Every animal needs a *nervous system* to read the world and respond in real time. 'Real time' for us is the time-frame in which feeling, thinking and *doing* take place. The historical time-line stretching 'back' into the past and 'forward' into the future (or turning in a circle like the seasons) is an abstract dimension onto which we map our memories and expectations of living through changing situations.

The system which guides your present path into the future couldn't work without some kind of memory, or map of your past. The persisting traces of your enactive being-in-the-world are incorporated into the 'map' which guides your behavior just as the genome guides your development. The main differences are that synaptically-encoded memory is far more variable and volatile than the genetically-coded, and that *some* of it can be consciously evoked or 'recalled.' The laying down of those traces is called *learning*, which writes the subtext of memory. I call it a 'subtext' because the guidance system consults it behind the scenes, as it were, looking for familiar patterns according to which the scene to which you are attending might make sense. This enables the system to anticipate what might happen next and what sort of move might suit the occasion. The predictable sequence of events is virtually compared with what actually happens: significant differences are noted as new memories, and thus the learning loop continues.

Psychologists distinguish various kinds of memory, including *procedural* (knowing how to do things) and *semantic* (knowing facts or features of the world). All animals have both kinds, to

varying degrees, and the 'internal map' of which we speak here includes both. Humans also seem to specialize in another layer of mapping, called *episodic* or *autobiographical* memory, which enables you to 'replay' at will various events in your personal life (and to imagine possible futures). This enhancement of the human guidance system appears to be undeveloped or absent in other animals. We humans also seem to have more *working memory* at our disposal, which allows us to temporarily rearrange and recombine selected features of our mental maps. But however special the human mind may be, we can be sure that it has evolved from the same original source that engendered all the habits, and all the inhabitants, of planet Earth.

Structural coupling

The cruise was a far more sophisticated machine than a ballistic missile, but it still couldn't hold a candle to a *complex adaptive system* such as an animal. Having been endowed with primitive forms of memory, perception and motor control, it could correct its own course, within narrow limits. But it couldn't *change its own map*. An organism, to the extent that it can *learn*, is always mapping its world, modifying its map-in-memory as circumstances change. Both the machine and the animal are 'given' an initial map of some kind (neither begins with a 'blank slate'), but there the resemblance ends. The machine's map is programmed in a formal language by a human designer to serve an explicit purpose. The organism's internal map is a set of relatively vague propensities which articulate themselves in the course of development.

In every animal capable of learning, anticipation and perception are constantly modifying one another. Thus the internal map of memory is updated to remain relevant even when the territory changes. The animal is always renovating some part of itself, you might say, so that its structure stays *coupled* with that of its changing environment, provided that the latter doesn't change too radically. This *structural coupling* (as Maturana and Varela called it) means that the animal's moves can remain relevant to its situation.

The ability to restructure oneself adaptively must be more

general, and more permanent, than any of the specific structures involved in the process. The recipe for its development is encoded in the genome, which the growing structure itself interprets to produce whatever matters at the moment to the self-modifying process. Since structural coupling enables the organism to survive and reproduce, the structural features encoded in the genome have been indirectly shaped over generations by the constant coupling of its ancestors with their ambience. Thus the genetic text, as the memory of that long-term coupling, is a micro-map of ancestral habits. In biology, the lineage continued by the passing on of that genetic text is called the *genotype*; the actual body of that lineage, living and reproducing itself in the world, is called the *phenotype*. Individual organisms are instances or *tokens* of these *phenotypes*.

Individual lives play variations on the genetically-coded themes in order to synchronize with the larger music of the ecosystem. Each organism thus incorporates (embodies) the experience of its ancestors as the *possibilities* of its own experience. The genetic heritage guides the learning process only in this vague and indirect sense, not in real time. Nor does individual experience directly modify the genetic text. But a new kind of guidance system – indeed, a whole new world – emerges for any lineage that can *symbolize* what it chooses to remember and transmit symbolic texts from time to time, from token to token of its type, as humans do. Now we have the beginnings of an *external* guidance system embodied in cultural artifacts. Find ways to preserve these symbolic forms in durable media, and you have a system almost as permanent and stable as the genome yet almost as flexible and dynamic as your own memory. Such an external guidance system, and the externalized memory on which it depends, can only be made of *symbolic* signs.

The symbolic species

The *symbol* is one of three basic types in the most widely used Peircean classification of signs, the other two being the *icon* and the *index*. They differ in their relations to their objects, and therefore function differently in semiosis. Any map (for instance, a road map) is an *iconic* sign. It gives you an overview of the territory

it maps, representing the arrangement of objects (roads and towns) within that territory by the arrangement of its own parts (lines and dots). Its accuracy, or truth, consists in its resemblance to the territory that it maps, i.e. the correspondence between its own structure and that of its object. But how do you know what its object is? An icon, as such, doesn't tell you what in the world it might represent or correspond to. For that you need an *indexical* sign.

A pointing finger, or anything that actually directs your attention to an object, is one kind of *index*. But *indicating* does not have to be intentional: a symptom is an index of a disease, and thunder is an index of lightning. An index does not have to resemble the form of its object, as an icon does, but must have some *real connection* to it (Peirce, EP2:163), as opposed to a merely mental connection. A *symbol*, on the third hand, does not require either a resemblance or a 'real' connection to its object. What it does require is that it *will be interpreted*, by a mind prepared to do so, as a sign that *means something*. Fulfillment of that condition depends on common habits formed, or conventions adopted, by the symbol's users. This is what endows symbols with far more flexibility (and more polyversity) than icons or indices alone can have. The habitual consensus which makes a symbol meaningful can only begin by connecting an icon which carries the *significance* of the symbol with an index which *denotes* its object. After the connection becomes habitual, the original iconic and indexical functions involved in the symbol may be weakened or submerged beneath the symbol's role in the language or habit-system which is its context. Thus a linguistic symbol tends to lose its direct connection to the real world beyond the virtual world of the language itself – unless the user of the symbol can recreate the original act of meaning, refreshing the life of the symbol through her use of it.

Suppose someone hands you a map of some territory that you don't recognize. You might ask, 'Where is this place?' or 'What's this a map of?' You are asking for an index to what this iconic sign represents. But how can anyone point at the territory represented by a typical map? Only by locating it on another map of greater scope, such as a globe; or by indicating its location on a *virtual* map, such as your background knowledge of geography. This is what the

label on the map does, by giving the territory a *name*. A name is a symbol which can work as an index in a virtual world. For instance, if the map you're holding is labelled 'Manitoulin Island,' that might tell you where the territory in question is, even though you're not there now, even if you've never been there. But if you've never heard of such a place, it's not a feature marked on your mental map of the world. In that case you might have to do an internet search for it, or look it up in the 'index' of an atlas, in order to locate it. Then you might be able to point to it on a globe, which is an icon of the earth. But then you'd be pointing to it *virtually*, mentally mapping one icon to another. This you can only do within the cultural frame we call 'geography,' which is part of an external guidance system. You have to know your way around that virtual world (internalize its basic structure) in order to use artifacts such as maps and globes to navigate the real world.

Learning a symbolic system (such as a language) enables you to carry such virtual or 'inner' spaces around with you, so that you can refer to people, places and patterns which are not currently 'visible' through any of the sensory pathways bringing you the latest news from external reality. It also enables you to observe *relations* between things, which are never directly perceptible through the senses (Deely 2009). What you gain from this is the ability to imagine *other possibilities*, alternate universes differing in various ways from the current situation. Some of these other possibilities may be worth realizing (or approaching, or avoiding), and thus have crucial implications for a *guidance* system. But investing your attention in virtual spaces is also risky, because they tend to proliferate, especially when they can be reproduced externally. Anything that can be used as a medium of dialogue within the cultural universe (or of dialogue with the incomparably greater universe beyond) can also turn into a *substitute* for the real world which it originally represents. Anyone who gets wrapped up in abstract maps is at risk of losing touch with the territory. Living that way is like trying to eat a menu, or eat money.

It's a peculiarly human predicament to be enveloped in virtual worlds, even addicted to them, because the human is the symbolic species (Deacon 1997). This does not mean that symbol use is exclusive to humans, only that other animals don't use them to construct elaborate external guidance systems as we do, and thus

aren't immersed in symbol systems as we are. They don't need to be, since they can inform themselves in simpler ways. The honeybee's dance maps the way to a food source; the warning calls of monkeys, birds and prairie dogs can indicate the presence of specific dangers and trigger standard responses. It's the more abstract relationships that the "non-symbolic" species have a hard time referring to. *Semiosis* pervades the biosphere, but only humans do *semiotics*, because human animals not only use signs but also know *that there are* signs. The semiotic practice of some animals is clearly learned rather than "hard-wired," and the existence of local variations motivates us to speak of animal 'languages' and 'cultures'; some animals internalize fairly complex communication systems; but only humans have come to rely so much on external artifacts for guidance. In the 21st Century we have reached a turning point in the human journey because we are beginning to notice the unintended consequences of our addiction to artificial systems.

In a sense, then, the burning question is how we can pull our heads out of those virtual clouds and get our feet back on the ground. True-hearted poets and prophets are forever trying by symbolic means to break our addiction to conventional symbols. There's a saying in the *Blue Cliff Record*: 'The Path is fundamentally without words. We use words to reveal the Path' (Cleary and Cleary 1977, 166.) We might liberate ourselves from our own habits by recovering the original iconic and indexical functions of the very symbols we are now using. In the case of this book, it's your role as reader to carry out that mission; the symbols you are now reading are presently out of the author's hands. But this chapter aims to explain how the mission might be carried forward by looking into the biosemiotic roots of our symbolic guidance systems.

Re: presentation

To be sentient is to be guided by what I've called an internal 'map.' That name refers (symbolically of course) to the part of you which enables your structural coupling with your world by linking experience to behavior. In animals with brains, it is primarily the

brain's map of the body that monitors (through the nervous system) the state of the various subsystems that keep the body functioning (Damasio 2010). Since the body's well-being requires responses to events in its environment, parts of it (eyes, ears, etc.) are specialized to bring us news of what's going on out there. Thus the brain's map of the body includes an indirect mapping of the environment, or rather of the body's relations with relevant aspects of it.

What we call *consciousness* is a mental activity specialized for dealing with internal or external matters that require immediate attention. The brain's continuous mapping of the body runs deeper than consciousness, but triggers awareness when something unusual shows up, attracting attention to it. This internal 'map' is not symbolic in the way that an external map (as a cultural artifact) must be. It represents the state of the body indexically, and thus does not represent the external world in the same way that a road map does (by visual correspondence). As Rodolfo Llinás (2001, 14) puts it, the representation in the brain is isomorphic, not homomorphic, to external reality. It is an icon, not of the external world, but of the bodymind's intimate relations with it. To an observer who could look into your brain and *see your seeing*, it would not look anything like what *you* are seeing.

This 'map' is an 'inner world' consisting of your habits, which are structurally and pragmatically coupled with whatever patterns you sense in the 'outer' world. The inner world is related to the outer as lock and key, or hand and glove, or predator and prey are related. The one is not a copy of the other but its complement. The organism's reading of the world, or recognition of patterns in it, is an internal process, and it's the patterns of this process that we refer to as 'the map.' Any reference to internal 'maps' or 'representations' will mislead you if you picture them as pictures.

Cybertime

Part of our external (cultural) guidance system is the formal, scientific study of *internal* guidance systems. One such science was among the theoretical spinoffs from WW2, though it was not as well known as other sciences with more spectacular (and

profitable) applications, such as nuclear physics. Norbert Wiener, a founding practitioner, named it *cybernetics* after the Greek word for 'steersman,' κυβερνήτης (which also referred metaphorically to a 'guide' or 'governor'). One of its discoveries was the *feedback loop* as an element of simple guidance systems. An example is the thermostat circuit which regulates temperature in a house by turning on the furnace when it's too cold, and then turning it off when it's made the house hot enough. This represents an elementary guidance system: it controls one function of the larger system (the house) by keeping a single variable (temperature) within optimal limits. It controls a process by monitoring the amount of its product and responding accordingly. This is called a *negative feedback loop* because it responds to increases in the amount of product by *decreasing* or reversing the process that generates it. A navigation device that makes course corrections can use a negative feedback loop to prevent it from 'oversteering' (turning too far in the right direction). This kind of *homeostatic* regulation is also found, in more complex forms, in living systems.

A *positive feedback loop*, on the other hand, is one that always acts to *increase* the variable which it monitors. The hotter it gets, the more it turns up the heat. Positive feedback loops are essential to life itself, and probably played a key role in its origin (Loewenstein 1999, 81). Within any dynamic system, they 'amplify particular variations, leading to the emergence of novelty' (Granic, in Lewis and Granic 2000, 274). Negative feedback, on the other hand, stabilizes a system so that its habits can be consolidated. Lacking this kind of self-regulation, positive feedback can produce the explosive growth of a nuclear chain reaction, or a malignant tumor, which is a slower version of the same pattern. Instead of the Golden Rule, we get escalating cycles of revenge and retribution. Global warming is also a positive feedback loop: it increases the likelihood of forest fires and of methane release from frozen swamps, which in turn release more greenhouse gases into the air; the melting of polar ice increases the amount of heat absorbed by sea water as it reduces the amount of solar radiation reflected back into space by the ice. If you respond to the heat by turning on an air conditioner, you reduce the local temperature in the room, but you increase the global temperature by increasing energy consumption. This pattern, like addiction, is hard to see from the

larger-scale system. Each cell in your body, through its interactions with other cells and substances in its neighborhood, contributes to the work of some system or organ. Those larger-scale systems in turn interact with others to carry on the processes which constitute the body as a whole. Likewise, you have an identity or 'personality' to the extent that you play a role in a social system, interacting with other role-players. You are like a cell in the body of the city, and your body is like a community of cells. Of course such a cross-level comparison would also reveal differences; for instance, some communities are looser than others. It would be much harder for one of your cells to move to another body (and survive) than for you to move to another city. It's different with some other species, such as honeybees: for them, it makes more sense to think of the beehive rather than the bee as the individual organism (Tautz 2008).

As an organism, you also play a role in an ecosystem, and its internal structure constrains what you can do. So does a higher-scale system which is both social and ecological, such as a city. If you live in it, you generally have to play by the city's rules, most of which are implicit rather than explicitly legislated. But your moves within that system consist of interactions with other entities of the same scale as yourself. You don't interact directly with a city or state, any more than a tree interacts with a forest. Nor does a holon interact with the next lower level, since the rate at which events happen there is too different. Indeed, this is *definitive* of a difference in scale, 'a difference in size so great that no dynamic interaction is possible, only constraint communication' (Salthe 1993, 322; see also Pattee 1973). The very existence of a holon depends on the separation of its internal dynamics from those of higher or lower levels.

This is the crucial difference between a holarchy and a social or political hierarchy, which is based on some kind of ranking order among different holons *of the same scale*. Some of the confusion arises when the higher ranks or 'stations' in a social hierarchy are taken (or take themselves) to *represent* a higher-scale holon such as a community, nation or religion. We see this clearly in Shakespeare when the King of France is called 'France,' or the Duke of Albany 'Albany'. Though it's not always so obvious, some such *metonymy* ('part for the whole') pervades political

discourse. The only government entirely free of hierarchy would be a pure *heterarchy*, a network of holons in dialogue, with no one representing a 'constituency' or making decisions on behalf of the whole community. A political heterarchy would self-organize and develop as an organism does, without central control (see Thelen and Smith 1994).

From the perspective of human experience, the *basic level* in the hierarchy of scales is the scale of things with which the human body can directly interact. Special sciences can map events at much higher and lower scales, but the further our *focal level* is from this *basic level*, the more abstract our ideas of what goes on there. We have to use devices such as microscopes, telescopes, statistical calculations and computer models in order to see them at all. In our moment-to-moment decision-making and practice, we can ignore what's going on at atomic or subatomic levels, since those events rarely make any detectable *difference* in our lives. And at higher levels, macroscopic conditions provide the stable setting of the human drama, as it were – 'all the world's a stage' which remains relatively constant while the players make their entrances, exits and other moves. What we can see beyond the biosphere is relatively constant, mostly changing too slowly for us to see the changes as *events* from the basic-level perspective. (That's why an event such as an eclipse and supernova is so remarkable.) The constants in our lives provide the context of our being, but it's mostly the variables that attract our attention. – Until suddenly something we've always taken for granted as a constant, such as the planetary climate, begins to change as an unexpected consequence of our own success ... and we have a crisis on our hands.

Biotension

You can't tell a *truth* without using symbols, but symbols also make it possible to lie, and to propagate lies. When external guidance systems are invested with authority and established as institutions (churches, states, corporations and so on), the scope and consequences of deception can be vastly magnified. The propaganda campaign which sold the nuclear arms race to a

gullible public, for instance, was only one example of the gospel of growth and consumption incessantly preached through the corporate media. All of this follows quite naturally from the ascendancy of symbolic systems. No wonder the linguist Dwight Bolinger, around the same time that the cruise missile appeared, published a book entitled *Language, the Loaded Weapon*.

But this is hardly an original observation. Indeed, it's already implicit in a 2500-year-old pun by Heraclitus:

The name of the bow [βίος] is life [βίος], but its work is death.

— (Wheelwright 1959, 100)

One point of such a pun is the relatively arbitrary connection between names (and other symbols) and their objects, which entails all sorts of accidental collisions and collusions of usage as linguistic habits develop and diverge. This opens the way to myriad misunderstandings even without the intent to deceive. But there's also a hint here of deeper relations among *life*, *work* and *death*: for life really is like a bow. Heraclitus hints at this in another fragment:

People do not understand how that which is at variance with itself agrees with itself. There is a harmony in the bending back, as in the case of the bow and the lyre.

— (Wheelwright 1959, 102)

Bow and lyre alike owe their usefulness to a double tension. Each of them works by pulling the two ends of a string in opposite directions, creating what we might call *static* tension (the bow bends because the string's length is fixed). Once the string is 'tuned' in this way, it can be plucked – bent back and released – thus harnessing the energy latent in the static tension to send forth a sound-wave or an arrow. This 'bending back' (παλίντροπος) is a *dynamic* tension. The double tension here is a source of creative and destructive power alike. And what does this have to do with life? *Living systems maintain a state of dynamic tension*, and thus take the double tension embodied in bow and lyre to a higher level. The paradoxes and ambiguities we've seen in symbolic signs, along with the creative tension which drives dialog (as shown in Chapter 2), have deeper roots in the systemic nature of life itself.

Self-organizing systems

The English word *system* comes down to us from the Greek σύστημα, which meant primarily 'a whole compounded of parts' (LSG). Peirce (CP 4.5, 1898) defined a *system* as 'a set of objects comprising all that stand to one another in a group of connected relations.' A more recent definition by Mark Johnson (1987, 87) places more emphasis on the whole made up by this connection of parts: 'A system is an organization of interconnected, interdependent individuals or elements that work together to form a functional unity.' Recent systems theory tends to focus on this *functional* unity, which is completely different from the unity of a mere collection of objects or things or stuff. Unlike a pile of sand or a pool of water, a living system actively defines itself by sustaining an *internal process*.

A machine such as an internal combustion engine may have both functional unity and internal process, but both are fully determined by forces or agencies outside the system. The process going on inside an *organic* system, on the other hand, actually defines the system: it determines, in the course of its development and self-maintenance, what's *inside* the system and what isn't. By developing its own identity and reproducing more of its kind, with variations, it becomes capable of evolving. Machines and other artificial constructs are 'developed' by others and so limited in their self-maintenance that they play no active role in their own evolution. The difference between organic and mechanical structure is a matter of reciprocal relations within the organism: 'in an organized body, every part exists for the sake of all the others as all the others exist for its sake' (Kant 1787, Bxxiii). Neither the parts nor the whole exist for the sake of a purpose intended by some *other* (separately embodied) system.

In order to develop or evolve, an entity has to *change* while *continuing* to be the same entity. A living system or organism, whether individual or species, is a process that persists by changing itself. In other words, it *self-organizes* in dialogue with its environment. This self-organizing process has been called *autopoiesis*, another term introduced by Maturana and Varela. An

autopoietic ('self-making') being is one who 'becomes distinct from its environment through its own dynamics' (Maturana and Varela 1992, 47). You might ask how it can have 'its own dynamics' *before* it 'becomes distinct,' and indeed it is a deep question in science how such a cyclical process could have self-started. But a precise answer at this point would be premature, and *autopoiesis* is not an answer to that historical question. Rather it addresses the conceptual question about what kind of system can be alive: 'the being and doing of an autopoietic unity are inseparable, and this is their specific mode of organization' (Maturana and Varela 1992, 49).

Not all systems are *organized* in this way. The solar system, for instance, is not autopoietic. But it does furnish a condition necessary for the emergence of self-organization: an *energy gradient*, i.e. a *difference* between the high concentration of matter/energy in the sun and the relatively cold and empty space around it. This creates an energy flow from source (the sun) to sink (outer space). In every system containing an energy gradient, the flow from source to sink will continue, as if trying to move the whole system toward a state of equilibrium – a homogeneous blend in which all *differences* between parts would disappear. The sun makes no attempt to maintain its own state; it just radiates in all directions the energy it produces by consuming its own substance. But the planets which happen to lie within range of that energy flow, being of a much cooler disposition, present opportunities for the sun's radiant energy to be harnessed by entities which do self-organize and maintain their structural integrity, for a while. These are the autopoietic unities, which from a thermodynamic point of view appear as *dissipative structures*. This name was applied to them by Ilya Prigogine because they are all energy consumers, which entails that they always *dissipate* energy in the very processes of self-construction and maintenance. They constitute the biosphere, and thus 'the entire terrestrial system is maintained at a steady state very far from thermodynamic equilibrium' (Depew and Weber 1995, 409).

Some dissipative structures, including organisms, develop their own identities: they define themselves, or create and maintain a boundary between internal and external processes. In this sense they are *closed systems*. However, since they are

powered by external energy gradients, they must also be *open* to flows of matter and energy across whatever boundaries they have made. They must be *selectively* open in order to maintain their *operational closure* (as Maturana and Varela called it). To the extent that they have autopoietic unity, or definite identities, they appear to have “purposes,” special interests to which their internal processes are partial, so that some things or events are more *useful* to them than others. *Energy*, to them, is the flow which can be harnessed to do *work* – a concept built into the word itself, etymologically speaking, since ἔργον is the Greek word for ‘work.’ However, *some* energy is always wasted in any process. Thus the possibility represented by *energy* is realized in two different forms: *exergy*, the part which is actually used to do work; and *entropy*, the part which is useless or ‘wasted.’ The Second Law of thermodynamics guarantees that in any isolated system (i.e. one lacking any possibility of input or output), entropy is bound to increase. The ultimate limit of that irreversible increase would be the state of thermodynamic equilibrium, in which energy would no longer flow because it is already evenly distributed, with no sources or sinks. It follows that any open system, such as a dissipative structure, exports entropy to the surrounding system to the extent that it uses energy to do work.

Every dissipative structure embodies the tension between entropy and order: the more *alive* it is, the more it clings to its closure and keeps its distance from thermodynamic equilibrium. Its operational closure depends on keeping its internal processes and gradients in homeostatic ‘balance,’ a kind of *static* tension which is probably the physical basis of our psychological sense of ‘balance.’ But since it has to consume energy and export waste products in order to maintain that inner balance, it also serves the cause of equilibrium in the larger system in which it participates. That’s the *dynamic* tension driving the ongoing exchanges between the dissipative structure and its encompassing ambience. The necessary connection between the static and the dynamic creates the double tension that makes life like a bow or a lyre. All of the complex organization we find in nature and culture alike is rooted in this palintropic ‘bending back.’

Autonomy and simplicity

The cruise missile, since it can't change its own structure, can't change its behavioral habits. This makes it relatively simple to map, guidance system and all. Also, aside from its artificial or 'contrived' nature, the cruise is simpler than any organic system in another respect: it moves only in three-dimensional space. When we speak of its internal 'map,' we are tacitly reducing its dimensions to two (since 'maps' in our experience are generally flat). But we are making a far more drastic reduction when we speak of the internal 'map' of an organism, for the world in which the animal moves is multidimensional. Any guidance system, in order to be internalized, has to make such 'reductions,' and any *description* of a guidance system has to reduce complexity even further. Any map which is useful as a guide has to be simpler than the system it maps *and* the system reading it. Guidance systems economize by generalizing and ignoring insignificant details.

To develop the familiar *path* metaphor a bit further, let us refer to the body who is 'taking' (or 'making') the path as the *subject*. In the Latin age of philosophy, this word referred to anything existing independently of any other subject's awareness of it, i.e. any real *thing* (Deely 2001, 2009). In that older sense a rock is a 'subject'; a rolling stone takes its own path down the mountain, but does not move unless some external force moves it, and once in motion (like a ballistic missile) it has no control over its path. More recently (since Kant), the term is usually applied to a *living* subject, or *sentient* being, an *autonomous agent* moving under its own power, acting under its own control, and internally *self-regulating* (a direct translation of *autonomous*). In this modern sense, then, neither a stone nor a computer nor a cruise missile nor a remote-controlled robot is a *subject*, insofar as its actions are directed entirely by previous or present input. It does not (quite) rule out a plant, which can grow and change its own shape and orientation; but the more predictable a being's behavior on the time scale basic to us, the less we relate to it as another *self*. And the more we recognize it as an animal like ourselves, the more it appears to us as a *subject* in the modern sense (though circumstances can sometimes prompt us to override these default assumptions). You recognize something as alive only when it can *surprise* you by doing

something unexpected – which couldn't happen if you weren't *expecting*.

He who does not expect will not find out the unexpected, for it is trackless and unexplored.

— Heraclitus (Kahn 1979, 31)

Expecting is what an internal guidance system does, though it doesn't become aware of doing that until some *difference* appears between the expected course of events and what actually happens. This is how an expecting body (or *anticipatory system*, as Robert Rosen called it) knows from the inside that it's alive. But the attention is normally directed outward: if something out there appears to be *doing* whatever surprises you, it will look *alive* to you. By recognizing the living, you begin to track and explore the unexpected.

We begin to learn about life when we recognize autonomy in others. We learn to predict that they will behave unpredictably. Invoking the simplifying notion of 'cause and effect' often allows us to predict (and thus control) the moves of machines, but this does not work so well with organisms, unless we force them into mechanical roles. The movements of a living being are guided by internal processes and propensities, not solely by the physical forces acting on its body from the outside. It is not passively moved by impact but *responds* in its own way to perturbations. A tiny 'impact' can trigger a massive response if it is *significant* to the organism, and often the triggering signal results from moves initiated by the organism in the first place – a sign of the difference between the *complex* and the merely complicated.

The hierarchic and self-organizing nature of living systems ensures that their guidance systems *cannot* be simple, and *must* be internalized to some degree. Internalized complexity of guidance is what we call *intelligence*, or sometimes *wisdom*. At any level, the body's inner guidance system is informed by a running dialogue with its ambience. The behavior of a cell in the human body is constrained by its genetic makeup, but more immediately determined by the situation in which the cell finds itself, for this determines how the genes will be expressed. Likewise the social situation determines how people present themselves (Goffman

1959). This ‘determination’ however is flexible, not ‘deterministic,’ to the extent that the being is sentient (alive, awake, conscious, ...).

If we had to make *all* of our choices consciously, we’d never get anywhere. A good guidance system simplifies the decision-making process by making most of our decisions for us automatically (in which case we are not conscious of them as ‘decisions’). In any situation which the guidance system recognizes as requiring a response, it has a default response (a habit) ready to be enacted. The choice only comes to our notice if some mismatch appears between the default and the current situation.

Each mature human has developed an onboard, internal guidance system incorporating threads selected from our biological and cultural heritage, woven on the loom of mindful presence, creating and recreating a unique blend of habits, knowledge, beliefs, principles, motivations and so on – the patterns that make us who we are. The diversity of these patterns arises directly, though paradoxically, from the common ground of human nature: our embodiment as organisms living and moving in, with and through a physical, biological, social and cultural environment. How we live depends on how we read that constantly shifting environment, and how we imagine other ‘places’ in behavior space.

This brings us, in our quest for guidance, to the counsellor, the teacher, the healer, the sage, the expert – even to the ‘self-help’ shelf in a bookstore. Seeking beyond ourselves is wise, given the limitations of one’s knowledge and our infinite capacity for self-deception. Yet there’s a problem here: we can also be deceived by others, even (or especially!) when they only want to help. How can the blind know that their leaders see better? If you can distinguish between good and bad advice, why do you need advice?

Corporation and conscience

You find yourself at the focal level of a hierarchy of levels, each organized at a different scale. So it is with all systems. The life of each level emerges from patterns of dynamic interaction at the level below, shaped and stabilized by the continuity of its role in the level above. Each level maintains itself by imposing some constraints on lower-level interactions. For instance, a cell

maintains a membrane which defines (actually *creates a boundary* around) its component chemical processes. This closure makes meaningful interaction between the cell and other beings possible, by preventing the cell from dissolving in its medium or being lethally disrupted by events in its environment. But any complex adaptive system must also be *open* to the flow of energy and matter through it; otherwise it has no means of reconstituting itself, as a dissipative structure must. It must also be able to sense differences or discontinuities between its inner world of expectation and its actual encounters with the outer world. The *experience* of these differences, if it triggers recognition of patterns in their occurrence, makes a difference to the system's habit structure, and thus *informs* it – otherwise it could not *adapt* to a changing reality. We can say, then, that it must be open to *information* as well. We will return to this in a later chapter. In the meantime ...

Of what material is your experience woven? You might say it's the nerve cells in your body, but it's really their coordinated systemic *activity* which constitutes the biological basis of your experience. Not one of your neurons could carry *your* experience, or anything like it. If it is the subject of *some* experience, in the sense that you are the subject of yours, the form of that experience is likely to be as different from yours as the scale of your body differs from that of the neuron. It must arise from the conversation among the still smaller entities composing them, each playing a role constrained by the cell's own self-organization. And we are in the same boat with respect to any systems of a higher scale than our own. Whatever consciousness they might have is beyond our direct experience, however we imagine or theorize about them. As Peirce observed, 'None of us can fully realize what the minds of corporations are, any more than one of my brain cells can know what the whole brain is thinking' (EP1:350). By 'corporations' Peirce is referring generally to entities animated by '*esprit de corps*,' systems constituted by human membership and thus existing at a scale higher than the human body.

The advent of cultural institutions as external guidance systems has put us humans in a peculiar position. Consider the *king* as a prototype of such institutions. His authority is derived from the higher-scale entity (the 'kingdom') whose will and well-being he symbolizes. As a guidance system, this authority is

internalized with respect to the larger scale (the community with its cultural extensions), but externalized with respect to each *member* of the community, each subject of the king. The individual who idolizes this authority figure longs to be *guided from without*, while life itself calls him to be *guided from within*. Obedience to authority can relieve this tension by saving the subject the trouble of taking responsibility for his relations to others. When such obedience becomes a communal habit, the ruler himself can become immune to advice; deaf to the experience of community members, he can ignore the difference between his self-interest and the communal interest. Then we have a bogus (artificial) hierarchy trying to do the work of the *heterarchy*, the community as network; guidance is replaced by domination.

Consider this advice about advice offered by Jesus in the *Gospel of Thomas*:

(1) Jesus said, "If your leaders say to you, 'Look, the kingdom is in heaven,' then the birds of heaven will precede you. (2) If they say to you, 'It is in the sea,' then the fish will precede you. (3) Rather, the kingdom is inside you and it is outside you. (4) When you know yourselves, then you will be known, and you will understand that you are children of the living Father. (5) But if you do not know yourselves, then you dwell in poverty, and you are poverty."

— *Gospel of Thomas* 3 (NHS)

The source of genuine guidance cannot be *located* either within or without. We humans, being addicted to *social* hierarchies – class systems, power structures, ranking orders and the like – tend to forget this. When we hear of a 'kingdom' we automatically look for a king, and we habitually think of a 'father' as a patriarch rather than a progenitor. Thinking along biological lines might help to change these habits, since the 'kingdoms' of biological classification have no kings, and the common ancestor of all earthlings is neither power-driven nor male. Guidance is a process, a *dialogue* between self and other, between inside and out, rooted in the very nature of living systems. In that sense we can say that the fishes and birds *have* preceded us, as 'sons of the living father' which is life itself as

pervasive process. Selfhood as we know it has *evolved*, and our conscious decision-making is a refinement of natural selection itself, played out on a micro-scale in time and space (compared to the evolutionary process).

The technology and practice of corporate enterprises such as the arms race, the 20th-century Cold War, and the 21st-century 'War on Terror' become *decoupled* from their consequences because they cease to be guided from within; and none of the contributing members are supposed to notice this, lest they interfere with the corporate program. A *corporation* in the legal sense of the term is an artificial person: it has been legislated into existence by some institution, in order to allow natural persons to invest in an enterprise while protecting themselves from some of the legal or financial consequences. Corporations are well designed to be invested with unaccountable authority, precisely because they are not human and incapable of intimate communion with humans. With the help of such institutions, the symbolic species is capable of a truly sinister dexterity.

This is a crucial consideration when we look to such larger systems, or their representatives, for guidance. That we should do so is perfectly natural: just as the internal dialog grows inward from the external for each of us, internal guidance systems develop under the influence of external guidance, from parental authority on up. We create social institutions in order to serve human needs and simplify human choices. But as a higher-scale system develops its own identity, every step 'up' in the hierarchy is further removed from human interest, from the basic level of embodied human experience. Whether hijacked by privileged people to serve their own ends, or using people as resources to serve its own 'bottom line,' the corporate interest is alien to the human interest. In other words, a corporation – like a cruise missile – has no *conscience*.

The word *conscience* is derived from Latin *con* (together) and *scire* (to know). This 'suggests the gathering of knowledge' (Damasio 1999, 232), but *knowing together* as the root meaning of the word could also imply that it develops through dialogue, intersubjectively. Your conscience guides you by evaluating courses of action, before or after you commit to them, in a more comprehensive way than self-interest alone could manage. Yet it takes a human-scale self, acting independently, in tension *with and*

against the collective interest, to develop a conscience.

Clues to the underlying concept are revealed in the word's history of usage and grammar. According to OED, the Old English term *inwit* was replaced in Middle English by *conscience*, both terms having a sense similar to today's *consciousness* as well as today's *conscience*. These two concepts are as closely related as the two words; Damasio (1999, 232) points out that some languages use the same word for both. In English, *conscience* was originally a 'noun of condition or function' like *intelligence*, with no plural – not a 'count' noun. We still speak of 'the voice of conscience' in this way, but more often we speak as if a person could have a private conscience of his own, so that we can speak of "your conscience," "my conscience," "a" conscience. This makes sense because the voice can only be heard by a self, a "subject of experience"; but it also conceals the genesis of *knowing together* in *dialog*, which can be internalized but never institutionalized. Guidance based on implicit recognition of our common humanity transcends any and all external guides. It takes a human being to commit a human act, or commit to a human path, and nothing less than a whole, impartial, fully human judgment is good enough to guide one's choice when it comes to the crossroads. Here at the crux, every judgment is the last judgment, because every deed is irreversible.

For a human, *conscience* is the ultimate and intimate guidance system.