On the Framing of Systems and Cybernetic Models

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Most writing on systems and cybernetics is within the scientific frame of modelling in terms of objects characterised by attributes. There are two clear exceptions, Stafford Beer in the construction of the Viable System Model, and Peter Checkland in the construction of Soft Systems Methodology. These two authors frame their approach in a transformation process, the purpose of which lies in the eye of the beholder/observer defining the process, and characterised by its relationship to its context. I start from the Heraclitian notion that in the world in which we find ourselves all is flux and change. Using the frame developed by Beer and Checkland, I propose that this process view is fundamental to developing models and understanding of the stability we find in phenomena in our world. I explore the necessary structures to achieve coherence and adaptability and show that the learning process is essential. I designate this approach '*systemic process thinking*', and show that it can be considered a distinct paradigm which fits the Heraclitian view of a dynamic world. It is necessarily constructivist, improves on Whitehead's Process Philosophy, and has considerable modelling power. I also show how the Western WEIRD approach has been derived from this.

— SYSTEMS THINKING
— CYBERNETICS
— PROCESS PHILOSOPHY
— WEIRD THINKING

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Framing

The purpose of framing is to choose the way in which we think about something in order that the explanation or story we tell is done in a way which conveys our idea effectively. An appropriate frame simplifies our idea so that the model we are describing is more accessible.

Congruence between frame and the territory I perceive simplifies model building and gives much better insight and understanding. For example, when exploring maps in an atlas, you will know to be careful in the way in which you interpret a map of the world. To map the world, the spherical earth must be flattened so that it may be drawn on a page. The two dimensional framing putting the map on a page inevitably distorts the relationships between different parts of the territory making calculations of distances problematic. Using coordinates appropriate to a flat page to describe geometric shapes on the curved surface of a sphere can be done, but leads to complexity and difficulties in understanding. Whereas putting the map on a globe and using latitude and longitude or spherical coordinates as the basis for the modelling makes the distance calculations as simple as possible. The shared symmetry, between the frame chosen and the situation being modelled simplifies the understanding and the calculations. In many situations under scrutiny symmetry between the base frame and the situation under investigation plays a guiding role in choosing an appropriate modelling basis.

Two Ways of Thinking

Aristotle made the distinction between two different ways of thinking illustrated by the following description of a house.

> [...] as is the case with a house; the rationale will be something like 'A covering preventative of destruction by wind, rain and sun'. But while one philosopher will say that a house is composed of stones, bricks, and beams, another will say that it is the form in these things for the given purposes. Who then is the natural philosopher among these? Is he the one who defines a house in terms of its matter and knows nothing of its rationale, or the one who defines it only in terms of its rationale? Or is he the one who defines it on the basis of both? (Aristotle, *De Anima* trans. by Lawson-Tancred 1986, 129)

The foundation of Western science and its underlying philosophy, the starting point of which is often attributed to Parmenides (c515-450BCE), is based upon the first of these ways of thinking; that is that the world out there is a world of objects defined by their attributes. The developments in the 17th century in science and philosophy established the dominance of this approach (Deely 2001, Diamond 2013). The development of calculus by Newton and Leibniz overcame the problem of modelling motion in Parmenides' static conception, so that this approach became the accepted way of thinking about thinking. Henrich et al. (2010) describe this approach as WEIRD thinking (Western, Educated, Industrialised, Rich, and Democratic) and point out that this way of thinking is not only of recent origin but a way of thinking still confined to a relatively small part of the world.

> Analytic thought involves a detachment of objects from contexts, a tendency to focus on objects' attributes, and a preference for using categorical rules to explain and predict behaviour. (Henrich et al. 2010)

This Western way of approach dominates and inhibits the Western way of thinking. Because we focus on the object, any relationships that the object has to its environment move into the background. Relationships are not forefront in this way of thinking, and therefore we have seen ourselves as separate and apart from the natural world. We are now beginning to realise that this way of thinking may have already guaranteed *Homo sapiens*'s own early evolutionary extinction.

WEIRD thinking leads to the belief in a 'real world' which can be termed *naïve* or *direct realism*. The belief in this 'real world' gave rise to the idea of knowledge detached and independent of the knower. Thus '*objective*' has in common usage come to be an adjective in the description of a situation, or reportage which carries the meaning that this is the 'correct' or 'real' view that all should believe, independent of any particular observer. As a result of the success of the WEIRD approach originally in physics, other disciplines, including biology, psychology and economics, also adopted this worldview. From there this worldview became dominant in the Western world (Deely 2001). WEIRD thinking is an approach that informs us directly of things and their attributes, assumed to be a description of the thing as it is, rather than what we would perceive in the particular circumstances in which we were looking. WEIRD thinking does account for the geometrical sense of *perspective* perfectly adequately in that we understand that objects that have spatial extent can appear in various forms due to distance or their 3-dimensional shape, but there is much more to the concept of perspective as I will describe.

In contradistinction to the WEIRD approach my starting point is the alternative that Aristotle describes in which purpose is central. It is therefore a teleological approach. The purposeful rationale of Aristotle's house perhaps can be better described in the form of a process which transforms a constantly changing variable environment on the outside to a calm interior conducive to comfortable living. Unfortunately, most of Heraclitus' writing is lost but we do know from the references that have survived that the writing of Heraclitus (c 540-480BCE) (Khan 1979) was considered very important in his own and later times. His underpinning philosophy has been interpreted as 'all is flux and change'. We must note that whilst the environments of all living forms change, living forms survive and through their lifetimes remain identifiably themselves. However, after the ancient Greek philosophers it wasn't until the 1878 publication of Claude Bernard's *Les Phénomènes de la Vie* that it was noted that that it was remarkable that in a world of constant change the internal environment of animals remained constant. Walter Canon in his 1932 book *The Wisdom of the Body* coined the term 'homeostasis' for this phenomenon. In an environment of flux and change the question that needs to be answered then is: - how is this stability achieved? The answer to this question lies in the science of *cybernetics* defined by Norbert Wiener as "the science of control in the animal and the machine" (Wiener 1948). The science of cybernetics gave rise to the more general discipline of Systems Thinking, but in the beginning it all remained within the extant WEIRD paradigm. However, in the late 1970's and early 1980's two authors, Peter Checkland and Stafford Beer, framed their work differently.

Peter Checkland (1981) had come up against the weakness of the extant systemic approaches based within an object frame while exploring the use of Systems Thinking to understand and manage organisational problems. He found that standard techniques failed and as a result developed the approach which he called Soft Systems Methodology (SSM). This approach takes the key step into the teleological process world by setting a *Root Definition* as the starting point for building a systemic model which is a *process* model. The *Root Definition* defines the relationship between the model to be constructed using the systemic frame and the environment of this process. Thus the model to be constructed has the form of a purposeful input (from the process environment) → process → output (to the process environment) structure. I will use the word 'purpose' rather than Root Definition to define this co-evolutionary relationship between a system and its environment following Beer (Beer 1979; 1985). However, it should be noted that in common usage the word 'purpose' does not generally mean the whole of the relationship of the system to its environment but usually relates only to one major output of the system concerned. For example, the purpose of a nuclear power plant is usually thought of as the production of electricity, one output, but with no reference to waste which we still cannot safely deal with, another output, nor indeed any reference to the necessary inputs.

Soft Systems Methodology is a learning technique based on a process frame which sets out to explicitly take into account the different perspectives of those involved in the situation being modelled. It does this by encouraging the various participants to define their own purpose leading to their own subsequent system models. If no agreement can be reached on a single purpose, the SSM process thereafter encourages the participants to seek agreement on possible action to be taken, without necessarily moving from their own systemic modelling of the situation. Hence the purpose of SSM is to move from a position where participants in a complex problem situation have different perspectives on that situation and understand the situation differently, to one where problem-solving action is agreed, despite those multiple perspectives.

Stafford Beer spent time in India during the Second World War, and during that time made a study of Eastern philosophy to add to his previous study of Western philosophy. This experience gave him a perspective unrestrained by WEIRD thinking and set him on a unique path over subsequent years. The transition from an object base to a *process base*, synthesising his Western and Eastern experiences can be traced through his writings in the development of the *Viable System Model*. This development evolves from *Cybernetics and Management* (1959), written from a Western scientific perspective, to *Heart of Enterprise* (1979) which starts with a clear statement of the subjective process nature of process modelling i.e. using the frame of a purposeful *input → process → output* structure. At the outset Beer says:-

> So where does the idea that Systems in general have a purpose come from?

IT COMES FROM YOU!
It is you
the observer of the system
who recognises its purpose. (Beer 1979, 8)

Beer formulated an approach to process philosophy including the role of cybernetic control. His approach aligns the basic building block, the purposeful *input → process → output*, to the process phenomena under consideration.

These two approaches by Beer and Checkland, to the problem of formulating systemic models in a complex situation, are now two well-established approaches with extensive literatures of use. Their development and increasing use in the application of Systems Thinking illustrates the move from what I will designate as *systemic object thinking* based in the WEIRD frame; to the understanding that the most powerful modelling of an interconnected world is obtained through what I will designate as *systemic process thinking*, an approach based in a process frame.

The Systemic Process Approach

The philosophical approach I am taking to understanding 'understanding' is the *Pragmatist* philosophy originated by Charles Sanders Peirce. William James states that Pierce's Pragmatist philosophy proposes that our beliefs are "*rules for action*", and to develop a thought's meaning it is sufficient to "*determine what conduct it was fitted to produce; that conduct is for us its sole significance*" (James 1907, in Thayer 1982, 210). Whilst this approach was originated by Peirce, it was subsequently developed by William James and John Dewey. James further says that:

> There can be no difference anywhere that doesn't make a difference elsewhere – no difference in abstract truth that doesn't express itself in a difference in concrete fact and in conduct consequent upon that fact, imposed on somebody, somehow, somewhere, and somewhen. The whole function of philosophy ought to be to find out what definite difference it will make to you and me, at definite instances of our life, if this world formula or that world formula be the true one. (James in Thayer 1982, 212)

Both the psychology and the systems thinking literature propose the concept of *mental models* (e.g. Johnson-Laird 1983, Senge 1990). A mental model is a structure within a brain and nervous system that recognises input signals and if relevant to the animal's immediate situation transforms the input signals to action. Modern approaches to neuroscience also use this concept, for example Antonio Damasio (2006), describes mental images and the way in which they are held, formed and used within the vast structured neuronal network of a brain. A mental model is, therefore, a structure which is a purposeful system; it receives inputs and transforms those inputs by some process to an output or outputs. It can be a response system involving the whole living entity, a tiny part of a nervous system multiply-coupled to other systems, or anything in between. I propose that the purpose of a mental model in any living form is to enable the prediction of the state and configuration of the environment in the future relevant to the living form concerned, given the state and configuration of the environment now, so that the living entity can by some means enhance its survivability.

In this systemic process approach, mental models are exactly *rules for action* and it is the resulting conduct that is the *sole significance* (James above). Pragmatism as defined by Peirce, James and Dewey is therefore a very practical philosophy, which fits the systemic process approach to understanding, namely that the processes of evolutionary learning and individual learning construct understanding and response to environmental circumstance. What is important is that the more precise thinking given by a systemic process approach really does make a difference in action. As James argues:

> ...the tangible fact at the root of all our thought-distinctions, however subtle, is that there is no one of them so fine as to consist in anything but a possible difference of practice. (James in Thayer 1982, 210)

But from this systemic perspective there is no "true one" as James has it in the previous quotation. Each of us has a unique set of lifetime experiences from which we may learn and, therefore, a unique set of models, and in any situation there are mental models which are more or less useful.

Ernst Von Glasersfeld (1995) developed *Radical Constructivism*, a modern version of this pragmatic approach to learning and understanding which he characterises as follows:

> Radical constructivism is uninhibitedly instrumentalist. It replaces the notion of 'truth' (as true representation of an independent reality) with the notion of 'viability' within the subject's experiential world. Consequentially it refuses all metaphysical commitments and claims to be no more than one possible model of thinking about the only world we can come to know, the world we construct as living subjects. (Glasersfeld 1995, 22)

Radical Constructivism aligns with Pragmatism in its instrumentalist approach, but changes the understanding of 'truth' to experiential 'viability'. This use of the word 'viability' matches exactly that of Beer's use in the development and use of the Viable System Model. A mental model is viable if it stands the test of experience. I interpret what James means by "world formula" as the set of mental models in use at any one time, and "true one" as the viable model in the sense defined by Von Glasersfeld. Hence, I conclude that with the foundation of Pragmatism, originating with Peirce, through to von Glasersfeld's Radical Constructivism there is a coherent logical foundation for systemic process thinking, which replaces the reliance on 'reality' in the underpinning of WEIRD thinking. Importantly within this way of thinking about thinking it must be remembered that each individual is unique and understands the world in a unique way. They have a unique perspective on any situation the evidence for which comes from Checkland's experience of the failure of the WEIRD approach in complex management situations.

The Basic Systemic Process Thinking Frame

The frame within which systemic process models are constructed involves the following precepts:

1. Models are constructed from a particular perspective, that of the observer/definer of the model. Models are therefore always subjective.
2. The purpose of a system process model is defined by the relationship of the process to its environment as defined by the observer/ definer.
3. Systems can be analysed into subsystems, and further, can be envisaged as a subunit of a super-system. Hence system process models are inherently fractal in nature reflecting the fractal nature of natural ecological systems. The idea that modelling, starting from a systemic process base, necessarily leads to a fractal structure was first developed by Beer in his series of books developing the Viable System Model (VSM). This necessary layered or fractal structure of any organisation achieving viability came from a synthesis of logic in the management of an organisation and the structure of the human nervous system (Beer 1972; 1979; 1985).
4. Systems form an interconnected network of processes.
5. Systems can also be considered a subunit of a schema-system. Commonalities of purpose can be recognised across different exemplifications of a system type. For example, Plato's ideal bed (Plato, trans. by Lee, 1987, 362) is such a schema-system because a bed can be recognised across different exemplifications of the same relationship situation, due to their common purpose. For example, a straw mat, or four poster bed, and other objects in the same relationship situation which all share the purpose – to provide a place to sleep. In the same way Beer's Viable System Model is proposed as such a schema system for a viable human organisation in that any viable human organisation will exhibit that basic underlying organisational pattern.

Whitehead's Process Philosophy

The focus on process as the centre of the systemic process definition *input → process → output*, and the systemic process models being interconnected networks of processes, brings the concept of process to the fore. The most important contributor to an understanding of process and its associated philosophy was Alfred North Whitehead (Whitehead 1978). The first publication of *Process and Reality* in 1929 preceded the development of Systems Thinking. Whitehead's formulation of his Process Philosophy relates directly to the systemic process formulation (Asby 2021, 134). Whitehead's central idea is an 'actual occasion', that is a situation point in time where a person perceives the need to respond. In Whitehead's formulation an '*actual occasion*' comes into being by drawing on, in his language 'prehending' past actual occasions in a process of 'concrescence'; the many past actual occasions coming together to form the one present actual occasion. In Whitehead's nomenclature the 'this' and 'that' of '*subject*' and '*object*' now refer to the current actual occasion and the past actual occasions. When the subject actual occasion B prehends an object actual occasion A, it imposes its perspective. As a result, this process draws from A only the aligned elements of data, and eliminates those elements of A which are not aligned to B's perspective. Whitehead refers to this as the carrying over of feelings from A to B. The use of the word '*feeling*' extends the usual usage but carries the same meaning e.g. a feeling of anger might be carried forward from one occasion to another. Whitehead's terms, *actual occasion, subject, object, feeling,* are evidence of an object-based approach which makes the language and formulation of the ideas at odds with the underlying ideas he wishes to convey. Donald W. Sherburne (1966) describes Whitehead's approach as an 'atomistic system' referring back to the ancient Greek Philosopher Democritus, the originator of the idea of a fundamental particle of matter which is in concept an object. However, the systemic approach developed by Beer, which is the foundation of Beer's and Checkland's approach, conceptually aligns with the processes that the modelling is seeking to represent. In this systemic approach the relationships between purposeful systems, the inputs and outputs, are conceptualised as dynamic flows, flows of information and/or of material. Whitehead's formulation can be related to this systemic process approach by considering snapshots taken at different times corresponding to the 'actual occasions; the evolution, the 'prehending' taking place between snapshots. From a systemic point of view Whitehead's formulation is an object-based formulation in the traditional scientific way, and secondly Whitehead avoids any hint of teleology as would be expected from in a traditional scientific argument even though clearly processes are teleological (Asby 2021).

The Additional Cybernetic Frame

Holding steady in a changing environment is achieved in all circumstances through exemplifications of the basic control model. In the late 1940s and early 1950s it was recognised that the mathematical modelling of control systems in different disciplines had produced the same understanding, and a series of conferences, the Macy Conferences (Foerster editor 1951) were held to explore these issues. It was recognised that the control model is a schema system which can be recognised in all such situations. For a cybernetic frame I therefore add the following precepts to those above.

1. The *basic control model* of cybernetics is defined as consisting of a system to be controlled; a sensor on the system to detect a variable to be controlled; a comparator to compare the actual value detected by the sensor with a required value input from outside, and an actuator to operate on the system to cause return to the required value in case of deviation.
2. Control is subject to Ashby's *Law of Requisite Variety* (Ashby 1956). W. Ross Ashby was a British psychiatrist who first demonstrated the importance of *variety* in understanding control. The

number of possible states of a system is what is defined as the *variety of the system*. *Variety* here has a technical systemic meaning which fortunately more or less coincides with its usual meaning. He showed that, in order to achieve sustainable control of a system, the variety of control actions by a controller must be at least equal to the variety of the disturbances which the system could be subject to. This is the *Law of Requisite Variety*. For example, the state of a motor vehicle travelling along a road is described by its lateral position on the road and its speed along the road, so we need at least control systems to manage these two variables – the person driving is the comparator, and needs the steering mechanism, and the accelerator-brake combination to arrive safely at their destination.

3. Control is subject to the *Conant-Ashby Theorem* (Conant & Ashby 1970). The *Conant-Ashby Theorem* follows from the Law of Requisite Variety and states that the quality of control of a situation depends upon the quality of the model built into the controller. For example, in slippery road conditions the number of potential states of the car system increases: normal driving does not include skids. Understanding how a car behaves in those conditions, having a superior, higher variety model of car behaviour and how to control it, makes for a more skilled and safer driver. If the *variety of potential command*, i.e. the variety of control actions of the control system, is inadequate, control will not be maintained.

Control situations are inherently complex because they involve parts of a system relating to each other in a fractal structure. Relating means communications taking place between the parts of a system. The communication channels are *two-way feedback structures*. Beer, from his practical management experience came to the conclusion that it is the way in which a human organisation relates to its environment and the way in which the parts of any organisation relate to each other that determines how that organisation evolves through time.

4. A control system is subject to the *Suboptimisation Theorem* (Katz and Kahn in Systems Thinking, Emory ed.). The *Sub-optimisation Theorem* states that optimisation of a whole system cannot be achieved by separately optimising the parts. In any system there will always be a requirement for restrictions on the freedom of action of the sub-units in order to maintain cohesion of the whole. In other words, there must be feedback control loops whose purpose is to restrict the freedom of action of sub-units so that the coherence of the whole system can be maintained.

The fractal nature of an organisational structure requires that control systems populate the model in the same fractal way. It is from these underlying ideas that Beer developed his Viable System Model as a model of what is necessary and sufficient for a human organisation to be capable of adapting to a changing environment. (Asby 2021) has extended the VSM approach to model how animals act, react, and adapt to a changing environment.

The Process Modelling of Learning

The brain and nervous system processes incoming signals from the environment and produces responses to those incoming signals. William James was one of the first to describe, in a way that is coherent with modern neuroscience the ability of the brain and nervous system to change, due to both maturation and experience. He also identified the systemic feedback nature of the change process, the basis of learning. This feedback loop operates between a living species of animal and its environment: the species and the environment coevolve. Neuroscientific research has shown that this feedback loop is essential for normal brain development in children (Denes 2016). There are windows in the maturation process of a developing child wherein interaction with the environment must take place for normal brain development to progress. Once the window closes, brain plasticity reduces and full competence is not achieved.

The base unit of the brain and nervous system, the neuron, is a system: it receives inputs from its environment and transforms those inputs into outputs to its environment, just like any other biological cell. A neuron's purpose is to receive electrical inputs from a variety of other neurons, and if those inputs reach a threshold level, fire to distribute electrical output to a variety of other neurons. Neurons can be connected to up to 10,000 other neurons and can transmit a signal over a considerable distance within the nervous system and brain of an animal. Neurons form a complex interconnected web of systems, so that the electrical signals flow through this web of interconnected cells. This is exactly as I require for systemic process modelling. The structure of any neuronal network determines the relationship between the inputs to that network and the outputs from that network; models are encoded in the collective action of neurons.

Recognising Difference and Similarity

I once wanted to increase my ability to name the particular species of the small birds that I observed. This meant that I would need to refine my ability for differentiating between species, in what were for me very similar experiences. I needed to be able to differentiate between, say, observing a robin and a sparrow, recognising the various differences in appearance and behaviour. With practice I was able to do that. My model of a small bird was differentiated into two separate models one each for the robin and the sparrow. In any situation where control is necessary, developing an ability to differentiate between similar situations, in this way, increases the variety of control responses exactly as required by Ashby's Law. Thus being able to differentiate out two or more response sub-systems from an existing response system is perhaps the simplest way to extend response patterns to increase variety of potential command.

The second way of extending possible response patterns is to develop the ability to respond to new challenges - those that have never been met before. A living entity in a changing environment will naturally need to modify its responses as its environment changes, but will also need to cope with challenges that it has not encountered before. This second ability is a more powerful way of increasing the variety of possible control

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responses, and significantly increasing the variety of potential command. At any one time a brain and nervous system will contain sets of mental models for use in different situations. These sets of models are not necessarily connected. I suspect we have all experienced meeting someone out of their usual context and finding it difficult to identify them. Recognising the context we are able to choose response models appropriate to that environmental circumstance. I therefore propose that a brain and nervous system has the ability to review and compare models from different circumstances and extract from that comparison what is common. That new common pattern of recognition and response can then be used to evaluate and react to new experiences that have commonalities of pattern with the original models. Piaget (1954) describes a number of examples of young children exhibiting multiple models prior to synthesis, for example:

> At 1 [year]; 3 [months and], (9) [days] Lucienne is in the garden with her mother. Then I arrive; she sees me come, smiles at me, therefore obviously recognises me (I am at a distance of about 1 metre 50). Her mother then asks her: "Where is papa?" Curiously enough, Lucienne immediately turns toward the window of my office where she is accustomed to seeing me and points in that direction. A moment later we repeat the experiment; she has just seen me 1 metre away from her, yet, when her mother pronounces my name, Lucienne again turns toward my office.
>
> Here it may be clearly seen that ……. I give rise to two distinct behaviour patterns not synthesised……: "papa at his window" and "papa in the garden" (Piaget 1954, 58)

Piaget describes a process of learning derived from his examples that aligns with the learning process implied by the modelling I describe here. This second way of increasing the variety of potential command can be envisaged as the construction of a schema-system from two or more existing systems. The development of a schema-system in this way enables the development of new sub-systems and the concomitant increase in variety of potential command using the first method described above. Being able to recognise a generic pattern is a powerful aid to learning, possibly even the root of creativity – being able to synthesise different experiences to create something new (Koestler 1970). To be creative I need to seek different experiences in new circumstances, and new contexts; my brain will take care of the rest.

The two learning processes taken together form a simple but powerful learning mechanism, which increases the range and accuracy of recognition and response and permits the interpolation of new levels within existing recognition and response systems. These two learning abilities, recognising difference and recognising similarity, are rather simple to describe in these systemic terms. In the first case I am developing the ability to differentiate between two similar processes where a singular recognition and response system is refined into two or more sub-systems. In the second case, I identify a schema common to two different recognition and response systems and then use that schema to guide reaction to a new situation. A schema-system once developed from two systems, can give rise to new sub-systems using the first learning process. Both these possibilities increase the variety of responses available to environmental disturbance and therefore according to the Law of Requisite Variety increase the chance of survival.

These two learning processes, recognising difference and recognising similarity, can be designated *Open Learning* and *Constrained Learning*. The existence of a new schema-system will *open* new possibilities. On the other hand, the development of sub-systems to an existing system will be *constrained* to possibilities of recognition and action already experienced but now refined. George Lakoff (2008) proposes that 'conservative thought' is framed in a hierarchy of authority. Anyone is free to act as long as they act within the rules laid down. Clearly, within such a system all learning is constrained. Accepting unquestioningly a particular frame allows only the possibility of elaborating response sub-systems within that frame; *constrained learning*. Lakoff proposes that 'progressive thought' is built on caring and empathy together with the responsibility and strength to act on that. Having empathy entails not requiring conformance within a particular frame but being open to learning from others and *their* way of living. Within a framework of protection and empowerment people can come together to interact with each other despite their differences. If they do this they will, through comparing and contrasting their own ways of living with other ways of living, learn of the commonalities through the process of *open learning*. Further support for this model of learning comes from the work of William Perry (1999) which describes in general terms how a mind develops principally using open learning as described above but in some cases only developing to a point beyond which embracing the uncertainty implied by the complexity of that person' environment seems overwhelming, and there is a reversion to constrained learning.

The Relationship Between the Object Frame and the Process Frame

The foundation of the systemic process modelling approach defines a model as a system that produces a particular output from a given input in a brain and nervous system. This aligns with the *holistic reasoning* of Henrich et al. (2010):

> Holistic thought involves an orientation to the context or field as a whole, including attention to relationships between a focal object and the field, and a preference for explaining and predicting events on the basis of such relationships. (73)

The idea of a 'system' hides complexity. The same *object*, a hospital, a railway or a company organisation, can be modelled in different systemic ways depending upon the purpose allocated by the modeller. We each construct our own world from our own personal experiences. Each of us has, as a result of our own unique set of past experiences, a mindset of mental models from which we construct our own *perspective* on any situation we encounter. This means that the same pattern of signals will be perceived differently by different people; each will perceive and interpret that pattern according to their particular mindset. Each will construct models of the same *object* as a system from their mindset which reflects their *perspective*. An accountant designing a hospital with the purpose of minimising costs will design that hospital rather differently from a doctor designing that hospital with the purpose of providing the best patient experience. In these two cases the hospital's relationship to its community will not be the same. This is not to suggest that each of these people is unable to embrace the other perspective through learning, but that we are dependent on the mindset we have in the moment.

The important understanding gained is that if I view something for the first time, my eyes receive signals from the scene I observe. My brain singles out a section of that scene because it perceives a boundary. Light is scattered by something in my visual field which appears as a coherent whole. Light falls on what we term an object, and is scattered by that object to my eyes. What I see is a system; light, the input, is scattered, the process, and my eyes receive the output of the scattering process. Subsequently if I change my perspective to this something I see for the first time, the scattering produces a different image but my brain will automatically synthesise the perceptions from these observations using *open learning* as described above. I would be developing a schema-system from the synthesis of the commonalities of my different observations. If I go on to take more observations, then all the time I am enhancing my schema-system model. As Piaget (1954) describes, this normally happens naturally, early in life, when an infant starts to move about, changing its perspective on the world it finds itself in.

When something becomes very familiar from those many observations, in the end I forget that each time I view that thing, I do it from a particular position. I make a particular *observation* from a particular *perspective* which has a particular relationship to whatever it is that I am observing. But it is that single step, the single observation, which is fundamental – my 'object' model is built from many such single steps. Once my brain has built that schema-system model, it recognises the object, very quickly from the pattern of scattered light reaching my eyes from any observational perspective.

The use of the word *perspective* here denotes viewing from a particular spatial point: the geometric interpretation of the word perspective. For each position I stand in, for each perspective I take, the pattern of reflected light reaching my eyes is different. It is my brain which then over time, using open learning, synthesises these different patterns to form the schema-system model. The schema-system model and those many relationships are telescoped into no relationship at all in the abstract. But the model in my head is still a schema-system model ready for use when that object appears in my visual field. The processes of synthesis of different perspectives into an object model honed by evolution works well in perceiving and reacting to events in the natural world, but when we come to complex situations, for example understanding a functioning hospital, with variety beyond our capacity to span, we are misled by our assumption of object. We are each limited and encased in our own limited 'bell jar' of experience (Plath 1966). But if we are open to learning, those limits expand as Perry describes.

Conclusion

Underlying my systemic process approach is that 'out there' is understood as a network of interacting systems that I perceive, but models are developed to the point that systems can be recognised from multiple perspectives and now thought of as objects. Thus, there is always an interplay between system and object as Aristotle suggests. Systemic process models abstracted from specific experiences are the fundamental building blocks from which object models are constructed. That models are constructed, either through lifetime learning, or species learning becomes the central tenet of understanding the development of a brain and nervous system. This works well in coping with the world around us, but we then carry this learning into situations in which it does not apply. Both the failure of Checkland's initial attempts at solving complex management problems and his subsequent great success with Soft Systems Methodology are explained by the understanding that the systemic process approach brings.

Driven by the enormous success of Western thinking as a foundation for scientific advance, philosophical attempts have been made to explain holistic approaches in terms of WEIRD thinking – e.g. Nagel (1961). Nagel defined four types of explanation which he labelled 1) The deductive model; 2) probabilistic explanations; 3) functional or teleological explanations; 4) genetic explanations. Western thinking and, in particular, Western scientific thinking is based firmly within the first and second of these and has either rejected the last two as invalid or, with Nagel, attempts to explain them as derived from the first two. I turn that argument on its head and explain object thinking in terms of systemic process thinking.

There are vital differences between systems constructed with different purposes in mind, and as Beer (1966) notes, discussions between politicians with different perspectives find it very difficult to reach agreement. Framing the world in terms of objects will result in a rather simplistic world view compared to one built on being aware that in complex situations a multiplicity of different possibilities exists. Being unaware that different starting perspectives assume without recognition different purposes in constructing a view leads to much misunderstanding. Evolution has equipped *Homo sapiens* with a more sophisticated brain and nervous system than other mammals, but it evolved in a context of small hunter gatherer tribes. Whilst there were differences in aspects of culture across the world, those differences were seldom encountered, and lifestyles had much in common. Technology has massively increased our ability to communicate across both time and space but also the variety of life experiences. A city banker has little life experience in common with a migrant agricultural worker. We assume that a communication once sent will be understood as we intended. But that is hardly ever the case. In hindsight it is not unexpected that the primary and 'natural' systemic process way of thinking is that practised throughout history and most of the world. And also, as might be expected, the Western way of thinking has arisen as a sophistication which enables flexibility but we pay a price by losing precision and losing sight of the dynamic interconnectedness of the world around us.

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As a systems scientist with a background in mathematical physics, and management my tentative conclusions are that systems science and cybernetics started life in the Western world after the second world war as a traditional scientific endeavour framed in the Newtonian tradition. In my teaching experience students, having been trained in a Western tradition, have great difficulty in appreciating the necessary change to thinking in process terms. Authors writing on systems thinking and cybernetics whilst accepting the Newtonian frame slip into a process frame and seem unclear of the frame in which they are writing. I would propose that there is a clear distinction between the 'object' and 'process' frames which should be investigated further.

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