

A Guide to Implementing the Theory of Constraints (TOC)

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Introduction

This large and substantial section has sat around without a home of its own since late 2008 and in early 2014 I put it back where it came from – as a “calve-off” from the paradox of systemism. I have probably spent more time on this “page” than any other. In truth there is a little more to be done yet. Somewhere near the end you will see a “stop here” and you ought to stop there because the remainder is incomplete at this moment. I hope that this page will help you to understand how and why we know and understand what we know and understand. We know and understand much more than we can tell and this page will to help to formulate some of the conceptual coat-hangers needed to deal with this.

Let's Get Started

I try to teach students that in scientific research you start from *two* beginnings, each of which has its own kind of authority: the observations cannot be denied, and fundamentals must be fitted. You must achieve a sort of pincers maneuver (Bateson, 1979 pg xxviii).

This page is an endeavor to bundle together, and make personal sense of, a collection of fundamental thoughts by; Gregory Bateson, Michael Polanyi, Thomas Kuhn, Ikujiro Nonaka, Hirotaka Takeuchi, Russell Ackoff, and Elliott Jaques, and which might be broadly termed epistemology, or about how we know what we know. Why should I choose to concentrate upon these people and what they have to say? I choose to, simply, because their thoughts matter to me. Their thoughts matter to me, and matter a great deal at that, because they inform how I am able interpret modern industrial systems and the way in which people construct and operate these systems – for better, or more commonly, for worse. We should all know such things in order to avoid the latter and encompass the former.

It was the recognition of tacit and explicit knowledge, of individual and group interaction, and an understanding of whole systems that I will loosely call “recent” epistemology or ontology that was important to me even before I had a formal understanding of their underpinnings. Indeed, when I first tried to make formal sense of this I confused myself “no end” with older “traditional” epistemologies and ontologies. Eventually I had to split these out into their historic sequence; “traditional” first, “recent” last, and some partial cross-over in-between. This will become more apparent as we work through this page.

Steven Jay Gould in one of his essays mentions the notion of “context of discovery” and “context of justification” (Gould 1996 pg 94). How we actually discover things and how we later justify

that discovery are never quite the same. He called this the “logic” and “psychologic” of scientific conclusion. As a scientist my concept of paradigm – which ultimately this page is about – is buried somewhere in the past within my own experience and within my own context of discovery, however, on the healthcare pages I have built a context of justification that I extend back to one of my earliest lectures as a student of the earth sciences. That section may therefore also help you to understand my understanding of paradigm.

What then of Theory of Constraints? Well I believe that “cost world” and “throughput world” resonate with anyone who understands paradigm, and I credit Thomas Corbett in his book on Throughput Accounting (Corbett 1998) for placing Theory of Constraints formally within a paradigmatic framework. I purchased Kuhn’s *The Structure of Scientific Revolution* (1962) several months later but it didn’t become fully relevant to me until several years on. In the intervening period, while in Japan, I read a text by Nonaka and Takeuchi called *The Knowledge-Creating Company* (1995) which had a profound impact upon me because it formally recognized the tacit/explicit dichotomy that I both understood from past personal experience and that I was also able to “see” at that time everyday within the workplace. My understanding of paradigm at that stage is recorded in a page in the strategy section. I have not revisited that page since and neither do I intend to. I hope that this page builds a firmer base upon that former page.

Nonaka and Takeuchi did not mention Kuhn, but they did draw from Gregory Bateson and Michael Polanyi. This is also the first time that epistemology became a conscious concept for me. Gregory Bateson had appeared in various places for a number of years prior to this within the context of Neuro-Linguistic Programming and eventually I got to his original work, and then that of Michael Polanyi. I finally “squared the circle” with the work Russell Ackoff. And to my current way of thinking I was “stuck” in my synthesis of this knowledge until I became aware of several of Ackoff’s concepts. It is Ackoff’s hierarchies that I “hang” everything else off of – as you will see.

About the only one still left out in the cold is Karl Popper, despite having sat on my Amazon wish list for more years than I care to count, he will have to remain there for some time to come. His concepts *are* important and are included here, if not directly referenced, as I have relied on other peoples’ reporting of these to-date rather than examine them first-hand.

Referencing Conventions

This page makes extensive use of quotations, that is because it is what other people have had to say that is so important, so why not extract it verbatim. As a consequence I’ve reverted to “type” and have used scientific referencing conventions of author and date within the text, with the addition of the specific page numbers so that people know exactly where to look to follow things up. However, nothing is simple. Several of the texts that I have used of Bateson, Kuhn, and Ackoff are compilations of previously published papers. I think that ideas ought to be credited with the priority of publication so where the reference is to a compilation I have put the original year of publication first, followed by the date and page reference of the compilation. If nothing else, it will give people a better feel for how long we have known so much of this material. The primary genesis of the ideas of Kuhn and Ackoff goes back to the early 1940’s. Significant parts of Polanyi’s 1958 work were published in papers between 1952 and 1958.

Epistemology And Ontology

Epistemology is “*how we can know anything*” (Bateson 1979, pg 4), or “*the history of knowledge; in other words how you know what you know*” (Bateson, quoted in Dilts 1998 pg 16). Epistemology is the philosophy of knowledge (Taleb 2007, pg 20) and as knowledge is the “mother of all sciences,” then epistemology is also the philosophy of science (Taleb 2004, pp 48, 49). For a brief and hard to beat summary of the philosophy of science, contrasted with the methodology of science, by Russell Ackoff please [check here](#). Otherwise lets continue.

Philosophers have recognized and separated two sorts of problem. There are first the problems of how things are, what is a person, and what sort of world this is. These are problems of ontology. Second, there are the problems of how we know anything, or more specifically, how we know what sort of a world it is and what sort of creatures we are that can know something (or perhaps nothing) of this matter. These are problems of epistemology (Bateson 1972, pg 313).

So not only is knowing how we know important (epistemology), but what we know “of” is also equally important (ontology). Ontology is about the existence of beings or things and their groupings or hierarchy. Hierarchy, and in particular logical types and errors of, becomes an important thread in this page and part of the reason for the paradox of systemism.

Epistemology and ontology present us with a problem of huge relevance.

In the natural history of the living human being, ontology and epistemology cannot be separated. His (commonly unconscious) beliefs about what sort of world it is will determine how he sees it and acts within it, and his ways of perceiving and acting will determine his beliefs about its nature. The living man is thus bound within a net of epistemological and ontological premises which - regardless of ultimate truth or falsity - become partially self-validating for him (Bateson 1972, pg 314).

The concept and acknowledgment of self-validation within epistemology and ontology is another important thread that will repeat itself on various levels throughout this page. Bateson; an anthropologist, uses totemism to illustrate self-validation (1979, pp 133-135), and Polanyi uses poison-oracle of the Azande in a similar fashion (1958, pp 287-294). Polanyi describes how even anomaly can be accommodated, in fact, must be accommodated within this circularity. Our epistemology and ontology are clearly cultural. Let’s briefly look at this; it is important to our discussion.

Oriental And Occidental Epistemologies

I have used the concept of Nonaka and Takeuchi of tacit and explicit knowledge throughout this website, and implicitly in my work before I ever knew that I was allowed to think such things. Much earlier in the page on Leadership and learning we saw this diagram;

To From	Tacit	Explicit
	Socialization	Externalization
Tacit		
Explicit	Internalization	Combination

This is an epistemological view.

There is also a similar ontological view. It was un-drawn, it was staring me in the face, and now I finally see it. Let's have a look at this.

To From	Individual	Group
	Socialization	Externalization
Individual		
Group		

Nonaka and Takeuchi's ontological dimension is; from individual, to group, to organization, to inter-organization – a hierarchy of groups of people in a business process.

Nonaka and Takeuchi recognise that;

Epistemologically, ...Westerners tend to emphasize explicit knowledge and Japanese tend to stress tacit knowledge. Ontologically, Westerners are more focused on individuals, while the Japanese are more group oriented (1995, pg 243).

I couldn't encapsulate the end-state cultural differences better than that, although clearly it is a continuum. Bateson, originally an anthropologist, also frequently draws distinctions around occidental interpretations as distinct from oriental ones. It seems that the epistemologists are acutely aware of the social context.

But there's more. There is to me an apparent paradox between eastern and western approaches. Why is tacit knowledge, which is individually generated, so important within the group-centric oriental context? And, why is explicit knowledge, which is group generated, so important within the individual-centric occidental context?

The paradox dissolves the moment that we realise that they are complementary, and that opposite epistemological and ontological approaches need each other, in support of each other. Let me explain. The ill-economy of tacit knowledge transfer can only flourish where groups are strongly bound and long lasting, forming a stable accessible reservoir. Conversely, where groups are strongly bound and long lasting tacit knowledge transfer cannot help but happen. This is the oriental case.

The ill-economy of individuals competing against one another can only flourish where explicit knowledge transfer occurs, forming a stable accessible reservoir. Conversely, where explicit knowledge transfer occurs, individuals cannot help but compete against each other. This is the occidental case.

These are end-points for sure, but having experienced degrees of both cultures I can attest to their validity. It is the ontological part – the "conflict" between individual and group – that causes us more grief in our attempts to manage modern business systems in the West and underlies the fundamental cloud and the paradox of systemism. But we are getting ahead of ourselves. We need to go back to far more fundamental issues first. Issues of how we know what we know. Here is an outline of the plan.

The Plan

In the first instance, I set out, biased by Bateson without doubt, to establish a few issues around sense and perception. Then I invoke Ackoff's DIKUW model to establish a description of; data, information, knowledge, understanding and wisdom – the components of the acronym. Curiously DIKUW is commonly embraced within popular “knowledge management” – at least within the internet – but truncated to DIKW, “understanding” having been omitted from the sequence. In fact the whole sequence can, like a telescopic rod or an oriental fan, expand out or contract in depending upon whether or not both structural and functional issues are separated out or combined in.

DIKUW is a hierarchy, and I need to establish that, and to flesh it out in order to “hang” all of the other arguments from, for indeed they too are predominantly hierarchical across the same continuum. I proceed do this with;

- § Traditional epistemological and ontological arguments

- § Cross-over between traditional and more recent arguments

- § Recent and business epistemological and ontological arguments

I then return to some of deeper issues of Bateson and Polanyi around paradigm, then finally addressing current business issues regarding the systemic nature of such things. So lets start at the start with sense and perception.

Sense And Perception

We forget all too easily in our modern world that all that we know of comes via our senses. Our sense of touch, sense of smell, sense of taste, sense of sight, sense of hearing. For a pre-verbal child, this is indeed all that the child knows – percepts built upon their sensing of their immediate environment. I never fail to be amazed at the annual National Agricultural Fieldays where there is a large (and one would think forbidding) cattle trough full to the brim with dark rich sweet smelling molasses – something that nowadays almost no small child, and in these cases clearly verbal and rather mobile, has any concept of. And yet with amazing dexterity the smallest quickly run up to the trough, tip toe in order to eyeball the fluid surface, and then up and over goes the arm with a finger extended into the molasses, nothing untoward happens as a consequence, and so the molasses covered finger is swiftly brought back towards the mouth and in it goes. It is at about this time that the other subtle, complex, and not so sweet flavors become apparent to the juvenile experimenter, and in the next fluid motion the finger is withdrawn from the mouth and swiftly wiped straight down the front of their clothing! Experiment over; what the nose told, the mouth did not confirm, let's move on. It happens child after child after child, year after year.

But what is it that the senses sense? What is it that alerted our child experimenters to the molasses? Difference was the trigger, our senses sense difference. In the case of the molasses a different smell, a difference (absence) of restraining barriers, a difference in sight. And all above threshold.

... science is a *way of perceiving* and making what we may call "sense" of our percepts. But perception is based upon *difference*. All receipt of information is necessarily the receipt of news of difference, and all perception of difference is limited by threshold. Differences that are too slight or too slowly presented are not perceivable. They are not food for perception.

It follows that what we, as scientists, can perceive is always limited by threshold. That is, what is subliminal will not be grist for our mill. Knowledge at any given moment will be a function of the threshold of our available devices of perception (Bateson, 1979 pp 26, 27).

Bateson also made much of the fact of “double description” addressed in more detail further on. Two sets of differences always give rise to the potentiality of differences between the differences – his information. In terms of our own sensory perception Bateson thought it not co-incidental that we have two eyes, two ears, and two nostrils mounted a small distance from each other. To this we should add the two lateral lines of fish, so perfectly effective for sensing the transmission of movement in their incompressible surrounds.

What better way to generate difference – especially from a stationary object – than from two different measurements taken at the same time. Moreover movement of head or body allows the movement of these sensory organs around their axis, and a new set of data to be obtained. Step it out a little and we can make a paired sensing at each of two instances in time at the same place if the “target” is mobile, or a paired sensing at each of two instances in time at two different places if the “target” is stationary. Each mechanism has the potential to generate difference and more importantly differences about difference.

Sensory Awareness And Extension

Polanyi gives us a telling story of sensory extension using the example of a hammer and a nail (1958 pg 56). The hammer becomes an extension of ourselves. The user has “subsidiary” awareness of the shaft of the hammer in the palm of the hand and “focal” awareness of the head of the hammer and the head of the nail. Subsidiary awareness and focal awareness are mutually exclusive, stop to think about how you type and look for the keys and you will stop typing, you have focal awareness of the screen and subsidiary awareness of the keystrokes (and aggregations of keystrokes for that matter). When you are going downhill on your mountain bike you have subsidiary awareness of the front and rear brakes and focal awareness of the bike/terrain interaction. Stop to think about the brakes for a moment – that is bring them into focal awareness – and you will surely come off. As they say, trust me, I know.

Sensory Awareness And Instrumentation

Well, a small problem, we don’t see, for instance, into the ultraviolet or infrared of insects, nor do we hear the higher frequencies of bird call – hearing instead a syncopated tune with some of the call apparently missing. Nor do we hear the low frequencies of a trumpeting elephant – just the high frequency overtones. We “overcome” these natural limitations of threshold by (recent) sensory extension – normally instrumental. Both Polanyi and Bateson address these instrumental issues.

Sensory Awareness And Scale

Instrumentation aside, there are scale issues which simply confound our human senses. Things that are; astronomically too far, microscopically too small, geologically too infrequent, geologically too large, chronologically too long, or chronologically too slow, are all effects of scale which are quite beyond our immediate senses. Much of scientific paradigm has revolved

around the initial rejection, then later acceptance of these scale issues. In many cases it is not just our percepts that are challenged but also our precepts as well. To this we must add another aspect, our social environment. I will assert that part of our current industrial and organizational problems come from the sociologically too-similar. There are important sociological differences afoot that are consequential upon industrialization, but we fail to recognize them because they are apparently too similar to what we already know.

Not only can we not predict into the next instant of the future, but, more profoundly, we cannot predict into the next dimension of the microscopic, the astronomically distant, or the geologically ancient. As a method of perception – and that is all that science can claim to be – science, like all other methods of perception, is limited in its availability to collect the outward and visible signs of whatever may be truth.

Science probes; it does not prove (Bateson, 1979 pg 27).

Sensory Awareness And Logical Type

Leading on from the sociological issues, within any scale there is yet another trap for our perception, and that is the effect of a change in logical type. In 1927 Bertrand Russell and Alfred Whitehead raised the issue of errors of logical type where we pass from member of a set to the set itself, or from a collection of sets to a superset, but fail to note any step-wise change in the naming, rules, or logic that occur in consonance with the step-wise increase in logical type. This is Bateson's summary;

The central thesis of this theory is that there is a discontinuity between a class and its members. This class cannot be a member of itself nor can one of the members *be* the class, since the term used for the class is of a *different level of abstraction* - a different Logical Type - from terms used for members (Bateson, 1972, pg 202).

Problems need to be solved at a higher logical level than that at which they were created. Failure to recognize this, I will assert, in conjunction with the failure to recognize the change in ontogeny from individual to group of individuals, and from groups of individuals to groups of groups of individuals, lies at the core of the paradox of systemism.

There is only one account of errors of logical type in the academic business press that I am aware of and that belongs to the Shingo Prize winning piece by H. Thomas Johnson (2006) "Lean dilemma: choose system principles or management accounting controls, not both." If the name is familiar to you, then you have the senior author of a seminal work from 1987 "Relevance Lost: the rise and fall of management accounting." How is it that something so fundamentally important is so little known?

Although it is Bateson who seems to me to be principally involved in the more general raising of awareness of errors of logical type, others have too, for instance Polanyi in *The Tacit Dimension* addresses levels of hierarchy (1966, pg 36)

... each level is subject to dual control; first by the laws that apply to its elements in themselves and, second, by the laws that control the comprehensive entity formed by them.

... the operations of a higher level cannot be accounted for by the laws governing its particulars forming the lower level.

Ackoff does similar things with systems and their parts

... the essential properties of any system, the properties that define a system, are properties of the whole which none of its parts have. ... the explanation does not lie inside the [entities]; it lies outside of them (1994 pg 11).

In business a far more prosaic application of this error is to consider that the parts that constitute the business, and even the individuals within distinct part, should be in competition with one another, when the real competition is with other firms, not with ourselves. Don't think for one moment that what I am drawing out on this page isn't directly applicable to the science of business.

DIKUW – Data

If everything that we know of comes via our perception of our senses, and our senses perceive difference, and only difference above a threshold, then it follows that difference is the data of our worldview. At least that was my erroneous logic until recently. In fact;

'data' are not events or objects but always records or descriptions or memories of events or objects." Always there is a transformation or recording of the raw event which intervenes between the scientist and his object. ... In a strict sense, therefore, no data are truly 'raw' and every record has been somehow subjected to editing and transformation either by man or by his instruments (Bateson 1972 pp xxv-xxvi).

So, I stand corrected. Records or descriptions or memories of difference are the data of our worldview. Note that we have two forms here; explicit records or descriptions, and tacit memories. They are all abstractions of reality regardless of the form. Why then should I make so much about tacit memory or tacit knowing – which if not already apparent I hope will become more so. And the reason is that physical presence, which tacit knowing presupposes, raises the possibility of greater context, and of serendipity, I may learn to notice things that I didn't even know that I wanted to notice at the time, or immediately prior to that time, and which are invisible to any explicit record.

Data are measures of difference about; where, what, when, whom, and how many. Data are, ontologically, about the "thinginess" of an object or an event. Let's summarize this in a diagram.

Logical Levels For Knowledge

Differences

Data

Know-What Where When

Let me expand things a little here, Bateson (1972, pp 457-458) liked to use the analogy of the territory and the map and I found tacked away in my notes a long extract which explains that differences – our data – are indeed abstractions. I want to because it illustrates the relationship between data and difference, and also because Polanyi uses the notion of a map as a useful analogy for theory as we will later see.

"What is it in the territory that gets onto the map?" We know the territory itself does not

get onto the map. That is the central point about which we here are all agreed. Now, if the territory were uniform, nothing would get onto the map except the boundaries, which are the points at which it ceases to be uniform against some large matrix. What gets onto the map, in fact, is difference, be it a difference in altitude, a difference in vegetation, a difference in population structure, difference in surface, or whatever. Differences are the things that get onto a map.

But what is a difference? A difference is a very peculiar and obscure concept. It is certainly not a thing or an event. This piece of paper is different from the wood of this lectern. There are many differences between them - of color, texture, shape, etc. But if we start to ask about the localization of those differences, we get into trouble. Obviously the difference between the paper and the wood is not in the paper; it is obviously not in the wood; it is obviously not in the space between them, and it is obviously not in the time between them. (Differences which occurs across time is what we call "change.")

A difference, then, is an abstract matter

Senge's partitioning of complexity into detail and dynamic components means that we now have to take cognizance that;

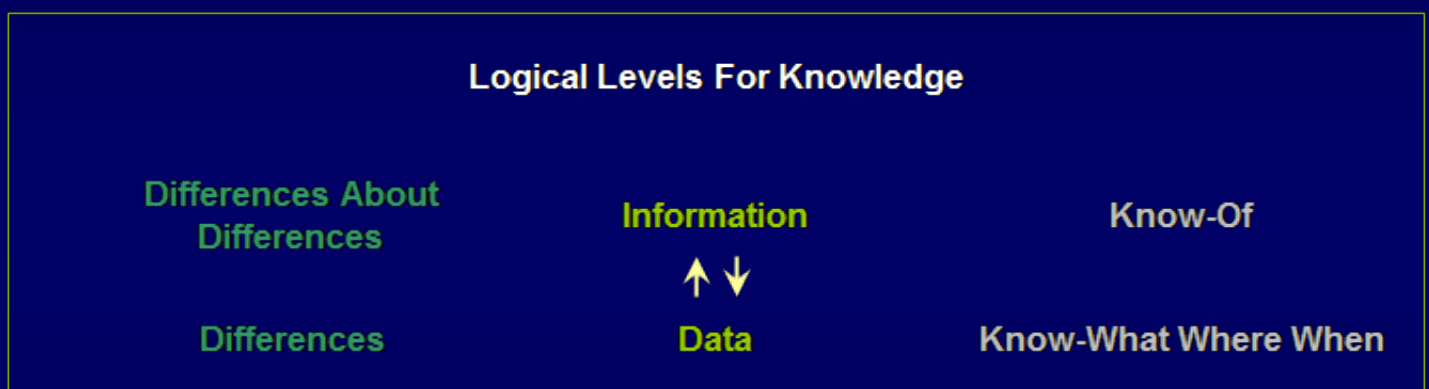
§ Detail complexity = know-what

§ Dynamic Complexity = know-when *and* know-where

This is the very first level in our DIKUW hierarchy. Let's look at the next level, information.

DIKUW – Information

"Information consists of differences that makes a difference" (Bateson 1979, pg 92). I guess that to be entirely internally consistent I would have to say that information consists of records or descriptions or memories of differences that makes a difference. Nevertheless this does highlight the hierarchical nature and I have added this to the diagram. We have a new level, a level for information. Information is of a higher logical type than data so I have drawn it hierarchically above data.



There must always be more data than the information that we seek. Some of the data is redundant, that is it says the same thing in a different way. Some of the data has no relevance in terms of the information that we currently seek.

Information is a record or description or memory of difference about differences about; where,

what, when, whom, and how many. In other words what we “know of.” The distinction between data and information is functional, not structural, structurally they are the same (Ackoff 1991/1999 pg 170). So functionally we have a hierarchy as drawn, but structurally we do not have a hierarchy at all and the two collapse together. As already expressed, not all data is information, information is “the answer to the question asked” (Goldratt 1990, pg 85), in other words information depends upon what we already know and wish to confirm or what we don’t know and wish to seek out, knowledge in other words. So what then is knowledge?

DIKUW – Knowledge

Elliott Jaques (2006, page pair 20) provides a definition of knowledge as follows;

The aspect of mental processing that goes on in words constitutes our knowledge:

All knowledge is verbally articulated, and is held in memory.

You may sense something, but if you cannot state it, you do not *know it*.

Knowledge is the mental processing that goes on in words – hold onto that thought. Hold onto it because this caused me a great deal of concern and I need to address that issue here and now so that we can re-address it more fully later. This definition of knowledge concerned me because it specifically excludes what I understand as tacit “knowing” from being knowledge. If you sense something but cannot state it, you do not know it! I now understand this viewpoint better as a truly Western epistemological definition – that is, knowledge must be explicit – but it is still one that is difficult to accept from someone who was so in-tune with the shop floor.

In fact Jaques fully understood that the underlying tacit component is not verbal but rather is; sensing, or unconscious, or intuitive. He calls it “skill” and combines both explicit knowledge and tacit skill as “skilled knowledge” or K/S in his shorthand and observes it teleologically as “applied capability” (2006, page pair 18).

Specifically;

$$AC = ! \text{CMP} \cdot V/C \cdot K/S$$

That is; applied capability is a function of the complexity of mental processing as affected by values and commitment and knowledge and skills. In other words, what you are capable of is determined by your innate ability, how much you value and are committed to the task at hand, and your accumulated knowledge and skill that is applicable in this instance. We tend to get better at what we like, and maybe like more what we are better at – within the limits of our innate ability.

Complexity of mental processing, the thing that I have perhaps mislabeled as “innate ability” is, in a Jaquesian sense, much more than just an IQ view of intelligence, and much more than we can address here. But introducing intelligence into the mix does allow me to flag an important observation about the intelligence trap raised by Edward De Bono (1982). If you have ever had to deal with intelligent people you might want to [check this out](#).

If we start to look around for more definitions of knowledge, especially amongst the epistemologists, we soon find full admission for the tacit component. Ackoff and Emery (1972, pg 46) in discussing the individuality of psychological systems look at the response capabilities

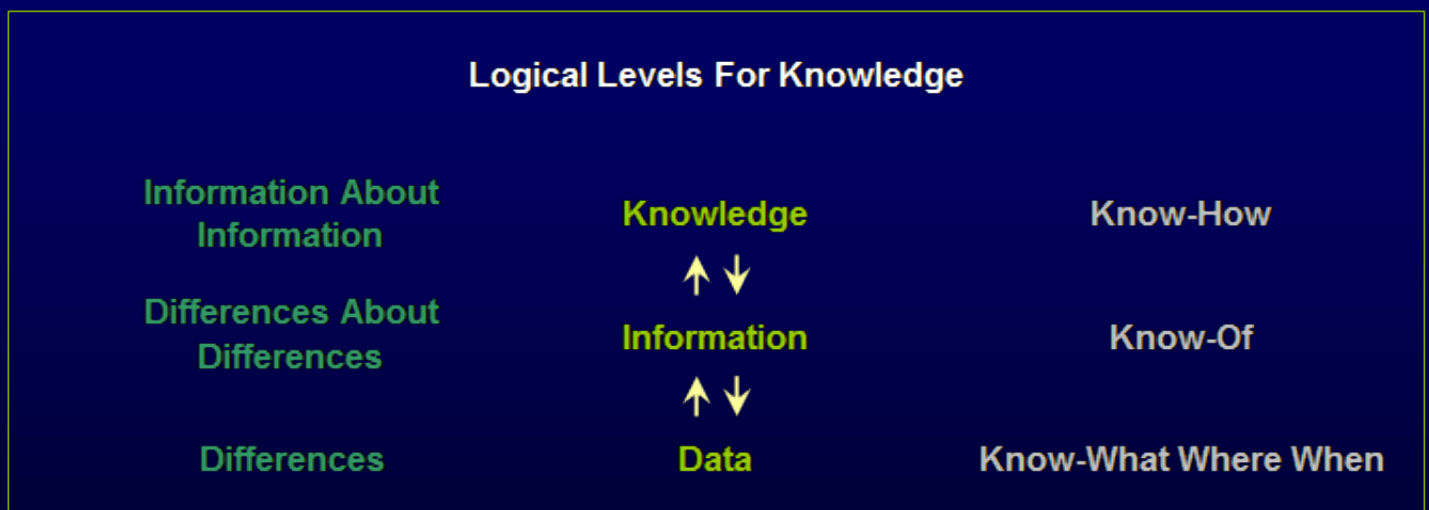
in terms of knowledge, understanding, and intelligence. They assert that knowledge is used in at least 2 senses;

(1) Awareness or possession of a fact or state of affairs.

(2) Possession of a practical skill.

The first sense is used in the context of “an individual’s true beliefs or what he is aware of” and the second sense is used in the context of knowing-how to do something rather than knowing-about or knowing-of something. The two other terms; understanding and intelligence we shall return to in a later section, because there is in fact huge commonality between Ackoff/Emery, and Jaques. Both recognize that knowledge is explicit. Both also recognize that skill is tacit. Both recognize the aggregation of the two is something called applied capability or response capability.

Let’s update our hierarchy to reflect this new level. Knowledge is about know-how, not know-of or know-about, it is of a higher logical type than information, it is information about information. Let’s draw this.



There must always be more information than the knowledge that we seek. Some of the information is redundant, it says the same thing in a different way. Some of the information has no relevance in terms of the knowledge that we currently seek.

A last word. For Deming knowledge came from theory (1994, pg 106) and I will introduce theory into the argument in a few sections hence. But note also, that Deming’s acknowledged source about systems, and I suspect ultimately epistemology and his Theory of Profound Knowledge, came from Introduction To Operations Research (1957) by C. West Churchman, Russell L. Ackoff, and E. Leonard Arnoff. Ackoff and Deming also collaborated in a number of presentations. Understanding Ackoff helps to understand Deming.

DIKUW – Knowledge As Belief And Commitment

Both Jaques, and Ackoff and Emery, are very close in their definitions of knowledge to that of Michael Polanyi’s division of explicit and tacit knowing – practical and intellectual (1966, pp 6-7). Polanyi in fact replaced explicit “knowledge” with “belief and commitment” (1958, pp 299-324). Semantics maybe, but here are Ackoff and Emery saying the same thing (1972, pg 46); “what an individual truly believes or whatever he is aware of, he *knows*.”

Therefore, I've removed knowledge and replaced it with belief and commitment – because this is what it really is.



Polanyi (1958, 1996) uses the term “heuristic passion,” and I have to admit that for a long time I mis-read this in terms of the meaning that I had come to know through operations management as “rules of thumb;” things the we know to work well without necessary understanding how or why they work. The meaning of the Greek root is “to find.” The older and more fundamental English usage of “heuristic” is to enable a person to discover or learn something for themselves. So now, rather belatedly, I understand heuristic passion to be a passion to discover or to learn for ourselves.

Polanyi says what we know is a belief, Ackoff says what we believe we know, and I think that we should leave it at that.

DIKUW – Understanding

Let's now examine the piece that many people care not to care for – understanding. Understanding and knowledge (sorry I have to use that word again but you now know where to map it) are to each other as information and data are to each other. That is they are structurally the same but functionally different. Functionally, understanding is of a higher logical type than is knowledge. Whereas knowledge deals with know-how, understanding deals with know-why. Understanding is beliefs about beliefs and commitment. Let's draw this in.

Logical Levels For Knowledge & Understanding



There must always be more knowledge than the understanding that we seek. Some of the knowledge is redundant; it says the same thing in a different way. Some of the knowledge has no relevance in terms of the understanding that we currently seek.

If we were to view this hierarchy structurally we could collapse it in to two layers, data and information in one layer and knowledge and understanding in another higher layer. Functionally, however, we must expand it out into the 4 layers that we have here. Each layer is of a different and higher logical type than that of the lower layer.

Is the distinction between knowledge and understanding real? Clearly it is. Is it worthwhile to pursue then? I think so. Consider one of the classic examples of diffusion of innovation – scurvy. The first controlled experiment using lemon juice was carried out in 1601, but it took until 1795 for citrus to be adopted as protection against scurvy by the British Royal Navy, and until 1865 by the merchant marine (Rogers 2003, pp 7-8). Now, if you look at this example, there are two aspects, the know-how and the know-why. The know-how was available as early as 1601, the know-why – that vitamin C deficiency is the causal agent of scurvy – wasn't known until very much later; in fact 1932, and there were very many confounding issues along the way. It is infinitely more difficult to accept know-how in the absence of the requisite know-why. The other common example that springs to mind is hand-washing in medicine. The know-how long preceded the know-why and the know-why, as with vitamin C, was paradigmatic in nature because the causal agents were of a different scale and unknown to us at first.

To data, information, knowledge, and understanding we can add one more aspect, wisdom. And to do so we must entertain some slightly different aspects. Let's have a look at this.

DIKUW – Wisdom

Wisdom, like knowledge, initially caused me some concern, and again that concern was derived from the definitions of Elliott Jaques. Jaques and Clement (1991, pp 76-79) recognise wisdom as an essential aspect of capability for effective managerial leadership;

which everyone knows about but which is difficult to capture in words.

wisdom has to do with the soundness of a person's judgement about the ways of the

world, about what people are like and how they are likely to react.

This follows on immediately from their discussion of knowledge and skills and values. And it is values that Ackoff asserts that makes wisdom different from other aspects of our knowledge hierarchy (1999, pg 171).

Wisdom deals with values. It involves the exercise of judgment. ... A judgment of the value of an act is never independent of the judge and seldom is the same for two judges.

So both Jaques and Clement and Ackoff agree that wisdom is a judgment issue, Ackoff asserts that the judgment is relative to values.

Moreover, values are an ethical and aesthetic pursuit (Ackoff 1998, pg 26);

The production of data, information, knowledge, and understanding are primarily functions of science. The production of *wisdom*, which presupposes all four, is primarily a function of ethics and aesthetics because it involves the conscious insertion of values into human decision making and evaluation of its outcomes.

So, what to do? Ackoff has split wisdom off from; data, information, knowledge and understanding, and few others – Jaques and Clement excepted – seem even remotely interested in addressing such issues. Fortunately Ackoff provides a clue in the above by the division between science, and ethics/aesthetics. He uses the ancient Greek philosophic division of the pursuits of man (Ackoff 1978/1999, pg 139. See also Ackoff 1998 above). The divisions are;

- § The scientific – the pursuit of truth
- § The political-economic – the pursuit of power and plenty
- § The ethical-moral – the pursuit of goodness and virtue
- § The aesthetic – the pursuit of beauty

I introduce these now to show the “side-branching” that values introduce into our argument, and also as a precursor to a better understanding of leadership which we will return to in due course. Ackoff considers these classes not to be exclusive – clearly we can understand that something that is scientific might also so be political-economic, and as we will see also aesthetic – but he does consider them to be exhaustive.

This is how our diagram must now look.

Logical Levels For Science And Ethics/Aesthetics



Wisdom is off-set; it is understanding with values. But is it hierarchical? That is, it of a higher logical type than plain understanding? I think that the answer must be yes. There must always be more understanding than the wisdom that we seek. Some of the understanding is redundant; it says the same thing in a different way. Some of the understanding has no relevance in terms of the wisdom that we currently seek.

If knowledge and understanding are the know-how and know-why of science, then wisdom must be the know-worth of science, ethics, and aesthetics. We will return to this soon enough.

Knowing that we mentioned intelligence and then left it alone at the time, we shouldn't mention values and leave them in the same situation. We need to know right now, what are values? And to answer that question I turn to Jaques (2006, page pair 16);

What you value is what you want, what you would give priority to – things that attract you, that you will work for or fight for, that give direction, that determine how much you will put into something.

Values, especially personal values, are so important and so understated in modern enterprise and yet they are hierarchically superior.

Robert Dilts (1998, pp 36-37) uses a hierarchy known as neurological levels, or more simply as a network of logical levels, and which I have previously used in the powerpoint called Values Beliefs and Industrialization. It is values and beliefs that drive the capability of an organization and for a modern serial dependent (industrial) organization this also determines its effectiveness.

Now let's go back a step.

There is a commonality between the work of Jaques and that of Ackoff and Emery that I want to return to.

Jaques said **Applied Capability** is a function of;

Complexity of Mental Processing , Values & Commitment, Knowledge & Skills

Ackoff and Emery said that **Response Capabilities** are a function of;

Intelligence, Knowledge, and Understanding

Really the only difference is the apparent omission of values and commitment in the Ackoff and Emery description – and having said that, they argue for an “intention” (relative value) function at the same level as knowledge so in fact all the same elements are present (1972, pg 58). The key mapping however is Ackoff and Emery’s use of “intelligence” and Jaques use of “mental processing capability.” Ackoff and Emery define intelligence as having to do with the rate at which a subject can learn, and learning in-turn is an increase in degree of knowledge or understanding over time (1972, pg 52). Jaques (2006, page pair 18) argues that mental processing is;

The mental processes by which you take information, pick it over, play with it, analyze it, put it together, reorganize it, judge and reason with it, make conclusions, plans and decisions and take action.

Complexity of mental processing is;

The maximum scale and complexity of the world that you are able to pattern and construe and function in, including the amount and complexity of information that must be processed in doing so.

So, I will assert that in essence, Jaques and, Ackoff and Emery, are pretty much on the same target and we should take some satisfaction from that.

Data To Wisdom Is Hierarchical

I have tried to stress that data to wisdom is hierarchical; that is each layer is of a higher logical type than the layer below, and in order for that to be the case there must be more members in the lower layers than in the higher layers. We should draw it as a pyramid, I’ve been economical (lazy) and drawn it as a “ladder,” rung upon rung. I will impose a pyramid upon this latter on.

Data To Wisdom Is Recursive

Data to wisdom is recursive. It doesn’t start at one point and progress step-wise up or down the “ladder,” rather we jump from place to place – around and around – and build out to our final picture. How we view this depends upon the concept of generality. The concept of generality is Ackoff again, and we will come to this in a moment or two.

Data To Wisdom Requires Experience – Experience Requires Time

Data to wisdom requires experience, and experience requires time. It goes without saying and so I must say it; recursion takes time. Time allows one to experience the same or similar sets of occurrences – maybe over and over – and to build a better understanding as a result.

The if ... then of causality contains time, but the if ... then of logic is timeless. It follows that logic is an incomplete model of causality (Bateson, 1979, pg 55).

Cyberneticists (and mechanical engineers before them) were deeply concerned with the role of feedback – I wanted to say obsessed – and more the temporal component of such. In the often cited example of a steam engine governor, one that feeds back too fast, and equally one that feeds back too slow will cause the machine to fail in one direction or the other. Bateson is simply saying here that logic takes no account of these timing issues whatsoever and is therefore an incomplete model. There is more on the incompleteness of cause and effect later.

Cause & Effect, Producer & Product, Means & Ends, Stimulus & Response

Goldratt was a physicist and thus used what I will call “mechanistic” cause and effect, and which he would have more correctly called effect-cause-effect (Goldratt 1990, pp 22-35). And this approach has spawned some amazing graphical “trees” which show the relationships between these elements. This type of logic makes a distinction between necessity and sufficiency. Ackoff defines these two terms as follows;

Text

But Ackoff also makes the point that we as scientists have for a long time been “lying” to ourselves because;

Text

Now I have never seen producer/product logic and assume that it is no different from cause and effect, except that it acknowledges insufficiency. But I want people to recognize that indeed the problem of distinction between what is necessary and what is sufficient, and having got there how much sufficiency is sufficient is well recognized. Anyone who has ever done a process map or a project plan will know exactly this problem – what degree of “granularity” to leave in and what to leave out.

Ackoff is also fond of the terms “means” and “ends.” Which I take to be cause and effect, perhaps with a little bit of the particulars and the general mixed in. Means and ends is often a useful set of terms in a business setting rather than cause and effect. People understand it much more intuitively.

But all of this is still largely mechanistic; fine for “closed” physical systems, but not for “open” biological or social systems. The cyberneticists took exception to this and proposed stimulus and response;

In general in communicational systems, we deal with sequences which resemble stimulus-and-response rather than cause-and-effect. When one billiard ball strikes another, there is an energy transfer such that the motion of the second ball is energized by the impact of the first. In communicational systems, on the other hand, the energy of response is usually provided by the respondent. If I kick a dog, his immediately sequential behavior is energized by his metabolism, not by my kick. Similarly, when one neuron fires another, or an impulse from a microphone activates a circuit, the sequent event has its own energy sources (Bateson 1972, pg 409).

Of course the response of the dog may no longer be mechanistic but we have certainly strived

for a long time to retain it as deterministic. Ackoff also deals to that by advancing the notion of “purposefulness” (Ackoff & Emery 1972), but we should leave that for another day.

Three Levels Of Generality

Deming (1994, pg 102) defined knowledge in terms of theory but we haven’t addressed theory within our hierarchy yet. We need to do this, here is what Deming had to say;

Knowledge is built on theory. The theory of knowledge teaches us that a statement, if it conveys knowledge, predicts future outcome, with the risk of being wrong, and that it fits without failure observations of the past.

Rational prediction requires theory and builds knowledge through systematic revision and extension of theory based on comparison of prediction with observation.

Let’s add a rider to this from Jaques and Clement (1991, pg 77);

Unsound theories distort our experience, narrow our vision, and leave us none the wiser about the effects of our actions on others. Action without sound theory is folly.

So where does theory fit into our epistemological hierarchy? Ackoff (1962/1999, pg 302) supplies part of the answer in terms of levels of generality.

One statement can be said to be more general than another if it *implies* and *is not implied by* the other; that is, if the truth of the second necessarily follows from the truth of the first and not conversely. Scientific statements are about things under certain conditions. The larger the class of things to which reference is made, and the more inclusive the set of conditions, the more general is the statement. ... The less general a statement, the more *fact-like* it is; the more general a statement, the more *law-like* it is. Hence, facts and laws represent ranges along the scale of generality. There is no well-defined point of separation between these ranges. ... A *theory* is a still further generalization.

Fact, law, and theory are hierarchical, if not also of different logical types. Let’s draw these.

Three Levels Of Generality



I have added arrows between them because one informs the other in an iterative and recursive way. I know that seems contradictory to what Ackoff stated, but it seems to me that a change in a law for instance may well generate a change in the relevant facts.

Fact, Law, & Theory

Now I want to stitch the simple hierarchy of; fact, law, and theory into our previous hierarchy of data, information, knowledge, understanding, and wisdom. This is how it looks.



It looks a bit sparse at the moment but that is alright, there is much more to fit on here yet. I've staggered the 3 levels of generality between the 4 levels of data, information, knowledge and understanding. The rationale is more aesthetical than logical, but it helps to reinforce that the two threads are related to one another but not necessarily in lock-step. For instance one can have a theory which accounts for observable cause and effect (know-how of knowledge) without necessarily accounting for the know-why of understanding. For instance, gravity sucks, but we still don't know why (but it also keeps a lot of physicists off the streets and firmly in their chairs).

Theory has a particular property as explained by Polanyi;

A theory, moreover, cannot be led astray by my personal illusions. To find my way by a map I must perform the conscious act of map-reading and I may be deluded in the process, but the map cannot be deluded and remains right or wrong in itself, impersonally. Consequently, a theory on which I rely as part of my knowledge remains unaffected by any fluctuations occurring within myself. It has a rigid formal structure, on whose steadfastness I can depend whatever mood or desire may possess me (1958, pg 4).

A theory, being more general than a fact, is always at "risk" of new facts – or so it would seem. Deming states (1999, pg 104) and many people accept at face value that, "No number of examples establishes a theory, yet a single unexplained failure of a theory requires modification or even abandonment of the theory." Now I could well accept that for something like "this process under investigation does not work as expected because, and a hypothesis is put forward. Subsequent data might indeed invalidate that "local" hypothesis, that after all would

seem to be the genesis of plan, do, check, act (PDCA). But it doesn't work at higher levels of generality.

Moreover it takes a Harvard palaeontologist, the late Stephen Jay Gould (1993 pg 440) to track this more public misconception to one Francis Galton (Darwin's cousin) in his autobiography and quoting T. H. Huxley in conversation with Herbert Spencer;

... a beautiful theory, killed by a nasty, ugly little fact.

It was in fact uttered in acerbic sarcasm.

In actuality, in the early stages of new data/theory, science may be quite unsure which to believe;

Often scientists cannot get the numbers that compare well with theory until they know what numbers they should be making nature yield (Kuhn 1977, pg 193).

Moreover;

In principle, a law or theory can be disconfirmed by just one contradictory fact. But in practice the fact which appears to contradict the law or theory is itself always subject to doubt. Consequently, there have been many historical instances where facts which appear to contradict laws or theories have been rejected in order to maintain a law or theory in which the scientist had more confidence than he did in the fact (Ackoff 1962/1999, pg 305).

Kuhn goes one step further;

If any and every failure to fit were ground for theory rejection, all theories ought to be rejected at all times (1962/1996, pg 146).

What produces such confidence? The answer is the general utility of the current theory in its current form. The real problems begin when we no longer doubt the contradiction, and instead might chose to explain away the anomaly or ignore facts and keep the theory. To explain this we need to add one more level of generality. And it actually mirrors the other side better than I could hope. The entity that is currently missing is paradigm.

Paradigm

Paradigm isn't an über theory, paradigm is hierarchically superior to theory, a single paradigm can account for multiple theories. For instance consider the paradigm of continental drift or plate tectonics, which replaced the former assumption of a static earth's surface. This paradigm must allow for the all of the observations of the volcanologists, and of the sedimentologists and also those who study the rocks that are squeezed in-between – the metamorphic geologists. And it ought not just apply uniquely to our planetary sphere but find utility in other planetary spheres as well. It not only explains our old observations better, it causes us to seek out whole new classes of observations that we didn't even know that we were interested in.

Let's draw paradigm in its appropriate place.

Knowledge & Levels Of Generality



Maybe it is coincidental, maybe it is not, but paradigm is also value laden – as is wisdom. In terms of Bateson's logic, I am now doubly bound to place paradigm where I have, by virtue of its hierarchy and by virtue of its value content. And being so constrained I am even more certain of the validity. So where are the values in paradigm? Back to Thomas Kuhn (1977, pg xxii);

My own work has been little concerned with the specification of scientific values, but it has from the start presupposed their existence and role. That role does not require that values be identical in all scientific communities or, in any given community, at all periods of time. Nor does it demand that a value system be so precisely specified and so free from internal conflict that it could, even in abstract principle, unequivocally determine the choices that individual scientists must make.

Scientific paradigm is value-full and the value is derived from the deep sociology that binds various groups of scientists together.

Traditional discussions of scientific method have sought a set of rules that would permit any *individual* who followed them to produce sound knowledge. I have tried to insist, instead that, though science is practiced by individuals, scientific knowledge is intrinsically a *group* product and that neither its peculiar efficacy nor the manner in which it develops will be understood without reference to the special nature of the groups that produce it. In this sense my work has been deeply sociological, but not in a way that permits that subject to be separated from epistemology (Kuhn 1977, pg xx).

Note carefully that both Ackoff and Kuhn distinguish between scientific philosophy (epistemology) and scientific methodology. It is the methodology that is carried out by individuals, but the underlying philosophy (explicit or otherwise) is a group undertaking. Polanyi (1958) extensively develops the tacit component of this argument.

If you think that paradigm doesn't have a social context, then think only of Copernicus seeking out God's perfection in the solar system within the pre-supposition of perfect circular orbits –

which he *never* abandoned. Or consider the incontrovertible evidence that European glacial moraine presented for the aftermath of the biblical flood. Epistemology and ontology are inextricably mixed-up. Science is cultural, but at least it moves away from falsehoods by eventually challenging them and removing them.

Scientists – that is, creative scientists – spend their lives in trying to guess right. They are sustained and guided therein by their heuristic passion. We call their work creative because it changes the world as we see it, by deepening our understanding of it. The change is irrevocable. A problem that I have once solved can no longer puzzle me; I cannot guess what I already know. Having made a discovery, I shall never see the world again as before. My eyes have become different; I have made myself into a person seeing and thinking differently. I have crossed a gap, the heuristic gap which lies between problem and discovery (Polanyi 1958, pg 143).

Paradigm In Ethics, Aesthetics, And Politics/Economy

Does paradigm only exist in science? I think not. Even though Kuhn coined the term to explain the way in which science progresses and contrasted this with the pre-paradigm schools in some of the more recent “social” sciences, these are the same pre-paradigm schools of thought that previously existed in early science.

Think of ethics for instance. Once, not very long ago, ownership of slaves – regardless of race – was an accepted practice. Even today, there are countries where entrenched social orders essentially impose a full servitude, or subjugation, even if actual ownership is no longer a question. We have come a long way, and not very far at the same time. It is paradigm in nature.

Think of aesthetics, the arrival of the camera (the ones that took film) released artists from the task of faithfully recording places and people and sparked-off impressionism – the abstract recording of places and people – and of emotions. And in doing so we “lost” the knowledge of the role and skill of using equipment such as the camera obscura which had been an essential component prior to impressionism. The arrival of impressionism was paradigmatic, the skills of realism were lost in the process.

What about politics and economy? Well if you read *The Economist* you will soon learn that they don't give up on “banging-on” about Japan and how the sooner companies there “reform” themselves along Western lines the better. They do this about once a quarter, which over the years becomes rather tiresome. Sometimes, for variety, they also pick on the Germans, the Italians, or the French. What do we have here? A paradigm, a paradigm called the Anglo-American model. This is the model that you follow if you want to destroy your own industry in your own country (then pretend that it was more efficient to “off-shore” it).

So what then is the difference between paradigm in science, and paradigm in ethics, aesthetics, or politics and economy? The answer to that is that science has an external reference – the natural world. That still doesn't make it easy to “prove” anything, but it does make it immeasurably easier to probe against this reference (even though we do this within our cultural and value-laden ways). In all of the social aspects, however, we become an indivisible part of the whole in which we are trying to carry out the validation on. In all paradigm we are caught in what Bateson terms double description.

Paradigm, Knowledge, And Double Description

Bateson tackles the notion of the intractability of double description;

Every abduction may be seen as a double or multiple description of some object or event or sequence. If I examine the social organization of an Australian tribe and the sketch of natural relations upon which totemism is based, I can see these two bodies of knowledge as related abductively, as both falling under the same rules. In each case, it is assumed that certain formal characteristics of one component will be mirrored in the other.

This repetition has certain very effective implications. It carries injunctions, for the people concerned. Their ideas about nature, however, fantastic, are supported by their social system; conversely, the social system is supported by their ideas of nature. It thus becomes very difficult for the people, so doubly guided, to change their view either of nature or of the social system. For the benefits of stability, they pay the price of rigidity, living, as all human beings must, in an enormously complex network of mutually supporting presuppositions. The converse of this statement is that change will require various sorts of relaxation or contradiction within the system of presuppositions (1979, pg 134).

Even the Copernican Revolution was a double description. Copernicus was a rector of the Catholic Church in Poland, he was seeking God's perfection in the universe by attempting to provide a better explanation for the planetary orbits as viewed from the earth. His logic was harmonizing or simplifying, and enduring, but his accuracy or practicality at the time was no better than the system that he sought to replace.

Paradigm, Knowledge, And Double Bind

As an extension of the concept of double description, Bateson also used the concept of a double bind, developed from his observations of schizophrenic patients and anything schizophrenic ought to be eminently suited to business – right?

Since hospitals exist for the benefit of personnel as well as - as much as - more than - for the patient's benefits, there will be contradictions at times in sequences where actions are taken "benevolently" for the patient when actually they are intended to keep the staff more comfortable. We would assume that whenever the system is organized for hospital purposes and it is announced to the patient that the actions are for his benefits, then the schizophrenic situation is being perpetuated. This kind of deception will provoke the patient to respond to it as a double bind situation, and his response will be "schizophrenic" in the sense that it will be indirect and the patient will be unable to comment on the fact that he feels he is being deceived (1972, pg 225).

Double binds are incredibly important concepts in a business setting. The paradox of systemism, at its heart, is a double bind. We fear for our sense of identity but we believe that we are unable to say so.

Double binds are not simple dilemmas, but rather where simple dilemmas are compounded by falsified contexts, supported by patterns of interpersonal communication which ensured continuation of the denial that a falsified context existed (Harries-Jones, 1995 pg 135).

Jerry Harvey's development of the concept of group think around negative fantasy (1988) – the so-called Abilene Paradox – is a brilliant example of the more general case of a falsified context that is “undiscussable,” indeed is intended to be exactly that.

Paradigm, Knowledge, And Circularity

We have already noted that Bateson finds that man is bound within a net of epistemological and ontological premises which become partially self-validating, or in other words circular.

Polanyi was more direct on this point;

Any enquiry into our ultimate beliefs can be consistent only if it presupposes its own conclusions. It must be intentionally circular (Polanyi, 1958 pg 299).

We tend to recoil against assertions of circularity whereas epistemology considers it part of the territory. In a quote that I always have the greatest difficulty tracking down Harries-Jones in his exploration of Bateson's thinking has this to say about circularity;

Bateson took the position that inductive science may abhor tautology, but nature does not. Logicians may regard any method which does not permit the insertion of independent criteria between the first and subsequent statements as suspect or falsifying, but this does not hold in nature. Tautology occurs in nature because nature does not 'think' in either inductive or deductive terms. In natural contexts, the formal 'cause' of that which is necessary may be defined by that which is necessary (Harries-Jones, 1995 pp 178-179).

We know this more commonly by examples such as; survival of the fittest, where the fittest are clearly those that survive. We are troubled by the circularity, whereas nature and epistemologists are not.

Paradigm, Knowledge, And The Role Of Language

I wonder how many times I have been taken aside and told that my “language” is causing an issue, and asked why I don't use plain English as that would be easier for everyone. Yes sure, it would be easier, but then no one would understand. Moreover, more commonly than not the requester is using, at the very least a technical jargon, or at the worst some obfuscation management-speak, without even being aware of it – such is life. Language is important to all participants.

One thing that binds the members of any scientific community together and simultaneously differentiates them from the members of other apparently similar groups is their possession of a common language or special dialect. ... In learning such a language, as they must to participate in their community's work, new member acquire a set of cognitive commitments that are not, in principle, fully analyzable within that language itself. Such commitments are a consequence of the ways in which the terms, phrases, and sentences of the language are applied to nature ... (Kuhn 1977, pg xxii).

Polanyi said much the same as the extract from Kuhn above;

For just as, owing to the ultimately tacit nature of all our knowledge, we remain ever

unable to say all that we know, so also, in view of the tacit character of meaning, we can never quite know what is implied in what we say (Polanyi, 1958, pg 95).

Polanyi explains the interaction of language and paradigm more fully and much better than I could hope to reproduce – I stopped at this [extract](#) for many months. Do the justice of reading it. The key to everything that we do is in those few pages.

Paradigm, Knowledge, And Elegance And Simplicity In Science

This may be the point at which my lack of exposure to Karl Popper finally catches up with me. I want to start with the concept of simplicity in science and then say a little about elegance or indeed harmony.

As a scientist it something of an implicit assumption – to this one at least – that there is inherent simplicity in science. And I guess that in part is a result of tacit absorption or socialization. Let's use something as basic as the periodic table – basic that is to us today, we take its organizing capability for granted. There is an inherent simplicity about the periodic table and such confidence in its underlying principles that in the early days at least, the “holes” in the table were the targets of fruitful research. But that is a kind of an after-the-fact, post-discovery justification, a narrative fallacy if you will. But why do we seek such apparent simplicity?

The text book Popperian answer is that as we simplify an idea, its applicability must become more and more general – that's what Ackoff was saying in his law of generality – and that has been the main tenor of our discussion of the DIKUW hierarchy. The Popperian argument is that as an idea becomes simpler and more general and applicable to more and more instances, the chances of proving that it is wrong or that it is incomplete, or that it is in need of revision increases. Failure to uncover such instances as the breadth of the haul increases also increases our confidence that indeed the idea is valid.

Increasing confidence that an idea is valid is, of course, not proof that it is correct. To make that claim would be an inductive fallacy. We can only continue to find that it is not incorrect; we can only continue to fail to disprove it.

Harmony rather than elegance is the term that Copernicus used to argue for a heliocentric universe;

“Harmony” seems a strange basis on which to argue for the earth's motion, particularly since the harmony is so obscured by the complex multitude of circles that make up the full Copernican system. Copernicus' arguments are not pragmatic. They appeal, if at all, not to the utilitarian sense of the practicing astronomer but to his aesthetic sense and to that alone ... they could and did appeal primarily to that limited and perhaps irrational subgroup of mathematical astronomers whose Neoplatonic ear for mathematical harmonies could not be obstructed by page after page of complex mathematics leading finally to numerical predictions scarcely better than those they had known before (Kuhn 1957/2003 pg 181).

Harmony or elegance is an expression of simplifying widespread applicability. It is the explanation of a large array of occurrences, without recourse to special pleading to explain specific effects. Kuhn explains that anomaly always requires the invocation of special cause (Ref).

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Paradigm, Knowledge, And Anomaly

Anomaly is explained (away) by specific cause (not to be confused with the special cause of statistics). Specific cause, or rather a number of specific causes becomes somewhat in-elegant. It begins to look like special pleading.

Specific causes may be expeditious for some, but they become in-elegant for others. What is tolerable anomaly for one because of the overall benefits that accrue from that tolerance is intolerable for another, and that is the point of departure for new theory or new modification of existing theory, or indeed paradigm.

This is how knowledge progress when we are bound within a circularity of partially self-validating. Premises that find greater and greater utility through simpler and simpler verbalizations. The answer is that knowledge progresses through the presence of anomaly.

Seed and remnant

Doubts about a prevailing world view usually begin with the appearances of *dilemmas*. A dilemma is a problem or a question that cannot be solved or answered within the prevailing world view and therefore calls it into question (Ackoff, pg 14 referencing Kuhn)

Polanyi describes how even anomaly can be accommodated, in fact, must be accommodated within this circularity (in context of epicyclic reserves and Azande example).

However, Kuhn, writing independently and after Polanyi, does offer a way out as we have already seen. The “seed” of the new belief is embedded in the old belief and the remnant of the old belief remains embedded in the new belief. This is how we can get around the language issue.

Polanyi in his book *The Tacit Dimension*, mentions “Meno’s paradox” from Plato where it is said;

that to search for the solution of a problem is an absurdity; for either you know what you are looking for, and then there is no problem; or you do not know what you are looking for, and then you cannot expect to find anything (1966/2009, pg 22-24).

And more from the same page (24) to re

Restart

What Have We Achieved – A Coat Hanger Of Sorts

In the preceding work we established the hierarchical nature of;

- Data, information, knowledge, understanding, and wisdom
- Fact, law, theory, and paradigm

All within the context of science, ethics, and aesthetics. This is a coat hanger of sorts from which I now want to hang a number of continuums, for instance; epistemology and ontology,

analysis and synthesis, induction and deduction and so forth. The material that follows is the pictorial “ordering” in my mind of these related concepts. I also want to group these into “traditional,” “cross-over,” and “recent” examples. Those of the traditional are more to do with science and philosophy and recent are those to do with business, cross-over is caught somewhere in the middle ground. These distinctions are not so important; they are more along the lines of a temporal ordering. What I hope is that in the end this ordering will help you, and it has helped me, to get a hand on a significant array of interrelated concepts.

Maybe it is better to refer to these as continuums rather than hierarchies. We already know from Ackoff’s concept of generality that what something “is” depends upon where you are in relation to it, and this will become clearer as we progress through the first several of these examples. Ackoff (1981/1999, pg 17) suggests for example that synthesis and analysis that they are complementary entities;

Like the head and tail of a coin, they can be considered separately, but they cannot be separated.

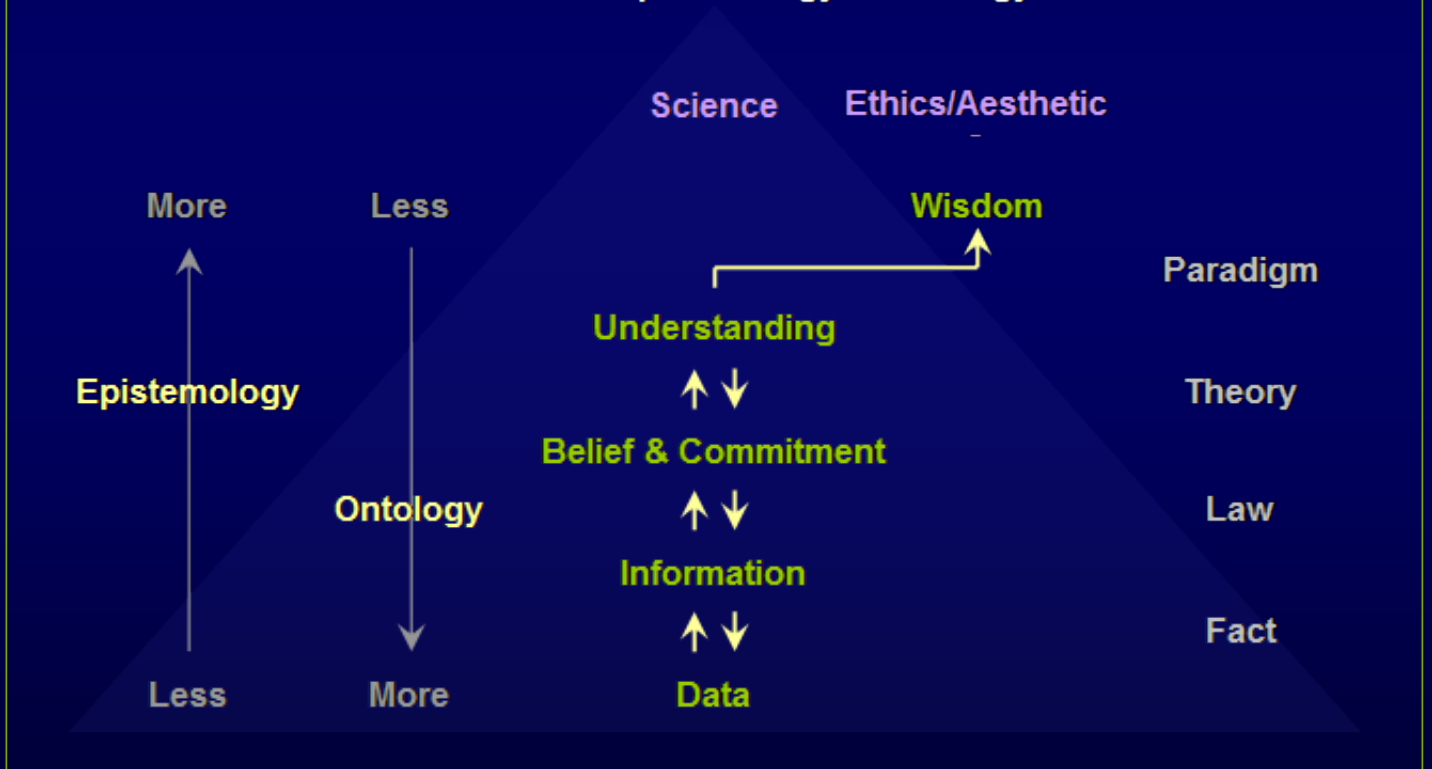
Other pairs immediately spring to mind, such as; strategy and tactics, or leadership and followership. It is these pairs that appeal to me and although we might place leadership “above” followership, or strategy “above” tactics, Ackoff’s distinction above is probable more correct. What will become apparent is that one is more dominant at one end of the continuum – almost of the total exclusion of the other – and vice versa. In-between we have complementary admixtures of the two.

I want to go and hang some of these pairs (coats) on the coat hanger that we have constructed. Let’s do that.

Continuum – Epistemology & Ontology

The first thing that I want to “hang” on this coat hanger is the concept of epistemology and ontology, because they are central to almost everything that we will discuss. We already know that they are intertwined and inseparable, but each is stronger at particular ends of the continuum.

Continuum – Epistemology & Ontology



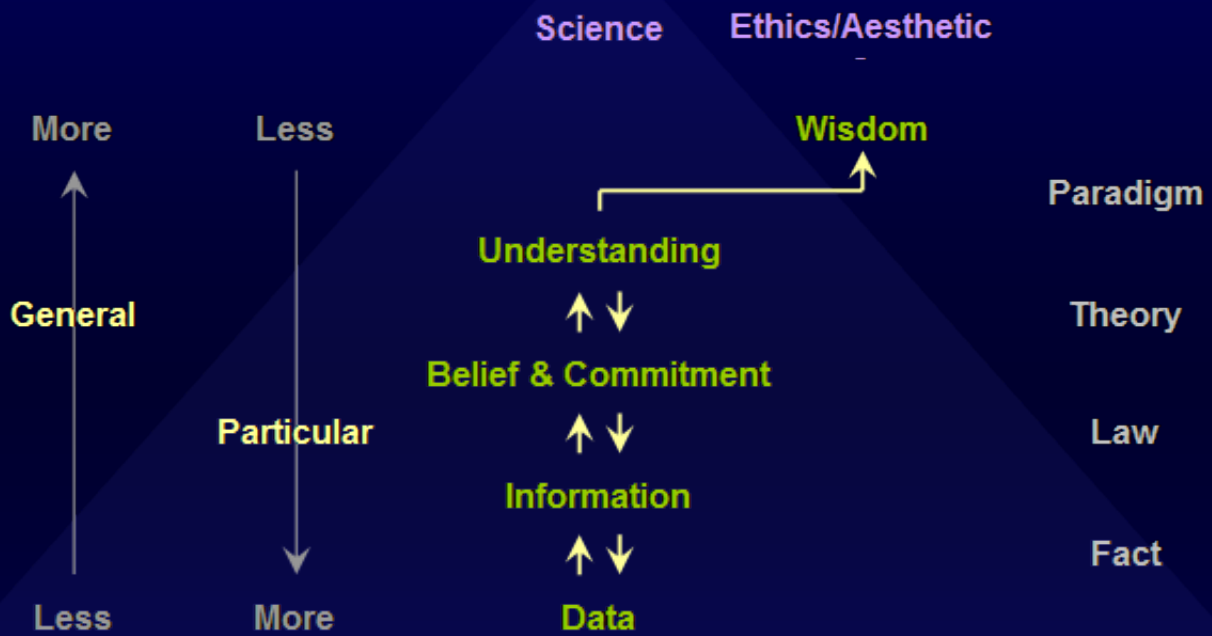
I've also added a triangle at last, and as promised, which I will address more fully in the next section. All that I wanted to show here was that as we move more and more towards understanding and wisdom, the more and more we are addressing issues of epistemology or how we know what we know. As we move more and more towards information and data, the more and more we are addressing issues of ontology or what we know of.

I now want to separate out some traditional ontological aspects and then some traditional epistemological aspects. This separation maybe a little arbitrary, but I will repeat it again for so-called "cross-over" ontology and epistemology, and fail to make the distinction at all as we move into pairs that are more related to modern business.

Continuum Within Traditional Ontology

Let's start with the pair of the general and the particular. In fact that is what we have been doing all the while – moving from the particular; data, information, and facts, towards the general; understanding, wisdom, and paradigm.

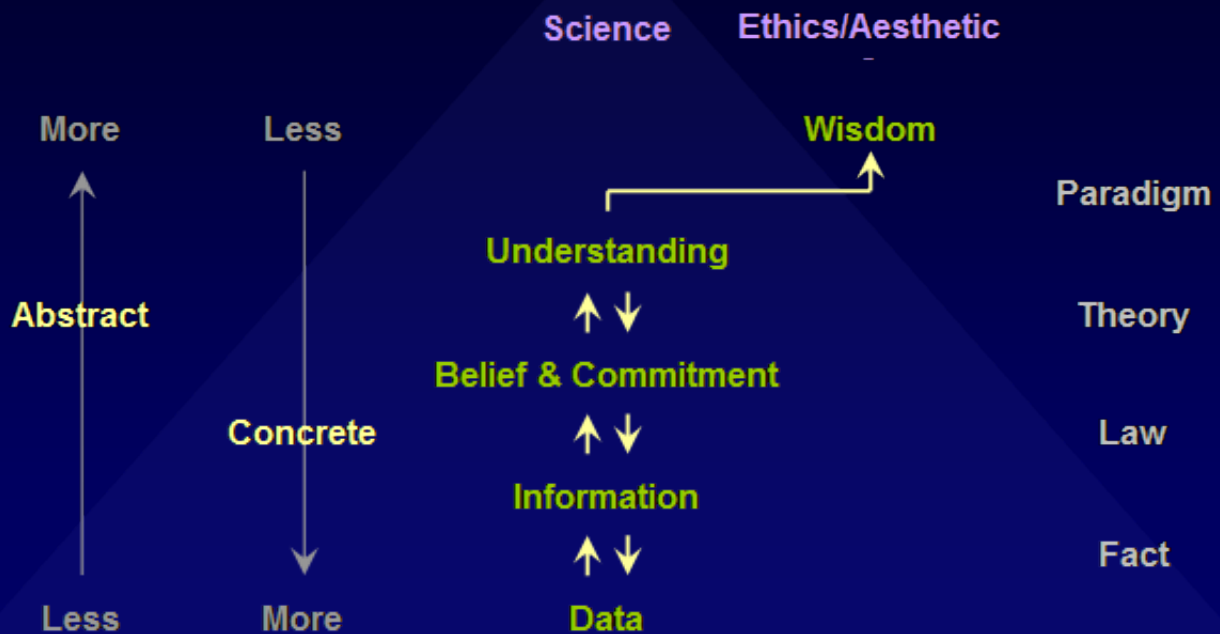
Traditional Ontology – The General And The Particular



The triangle simply reflects the growing aggregation, or summing, or grouping that occurs as we move from the lower part of the diagram to the top, and equally as we move from the top of the diagram to the bottom.

Very often, as we move from the bottom towards the top matters become more and more abstract, and as we move from the top towards the bottom matters become more and more concrete.

Traditional Ontology – Abstract And Concrete



It is worthwhile to mention here that Jaques (2006 pg 23) considers that there are 5 levels of abstraction within this more simple continuum from the concrete to abstract. They are;

- § Pre-Verbal
- § Concrete Verbal
- § Symbolic Verbal
- § Conceptual Verbal
- § Universals

He argues for a recurring stepwise development of logical thought at each level (Jaques and Cason 1994). That is about as much justice as I can do to that concept here and now. I strongly recommend investigating their approach.

Continuum Within Traditional Epistemology

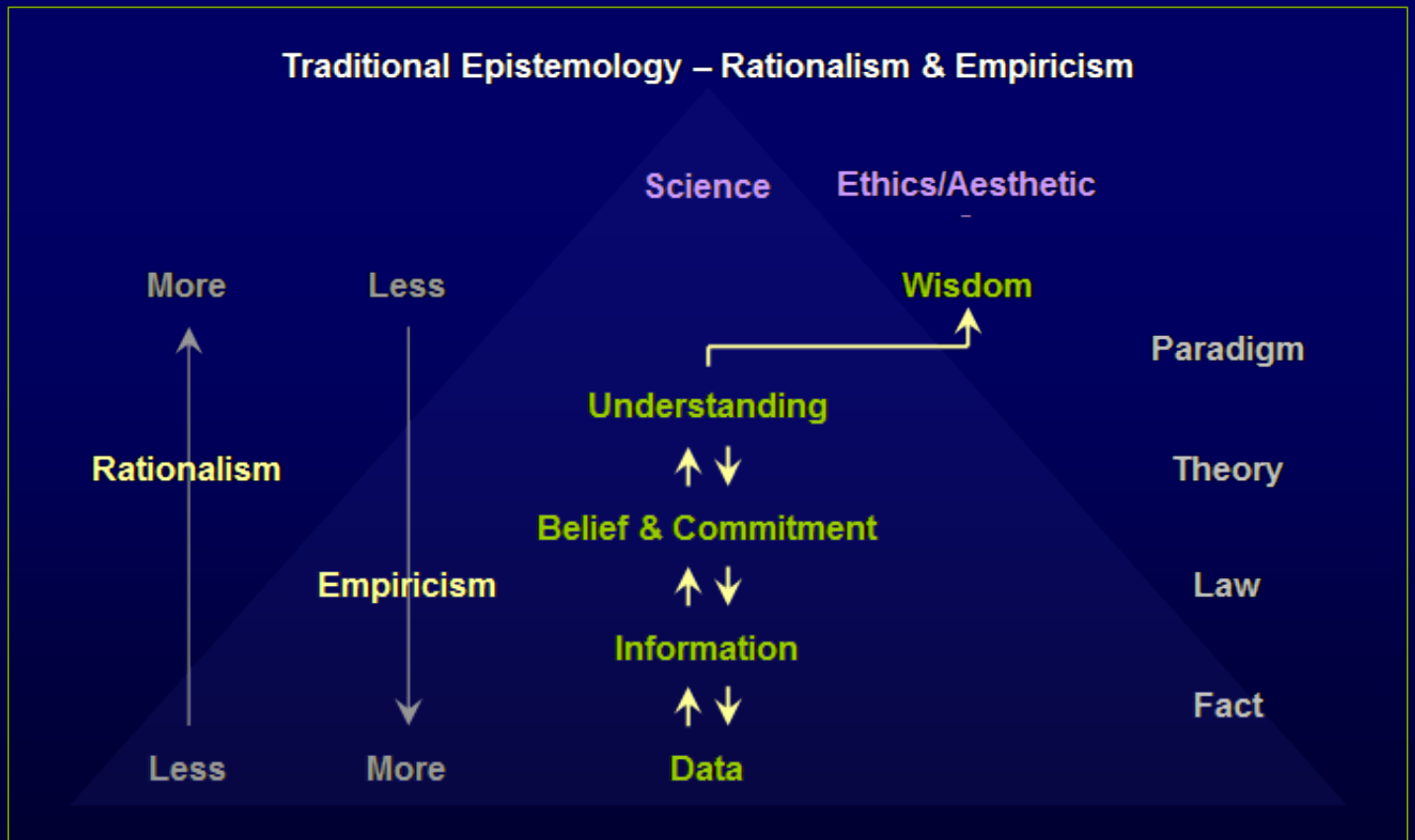
Having established where our concrete and our abstract map ontologically, we can proceed (circularly without doubt) to epistemology. There are two epistemological traditions in Western philosophy (Nonaka and Takeuchi 1995 pp 21-22). They are;

- Empiricism which argues inductively from sensory experiences
- Rationalism which argues deductively from abstract constructs

Let me expand these out or else they will cause immediate confusion with the diagram above'

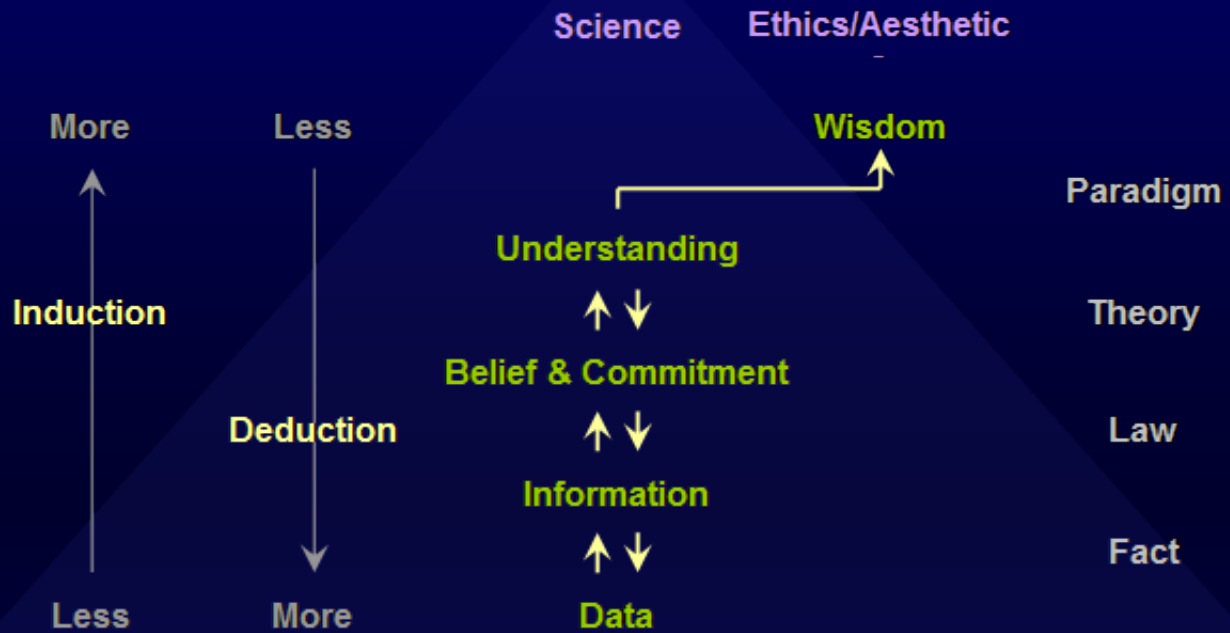
- Empiricism which argues inductively from sensory experiences to abstract constructs
- Rationalism which argues deductively from abstract constructs to sensory experience

These are now drawn below;



It follows then that induction maps to empiricism and deduction maps rationalism;

Traditional Epistemology – Inductive & Deductive Inference



Now an important point, Ackoff and Emery (1972 pg 114)) argue that;

The inferential process may be either deductive or inductive ... since beliefs in generality may differ, what appears to be deductive to one person may appear to be inductive to another.

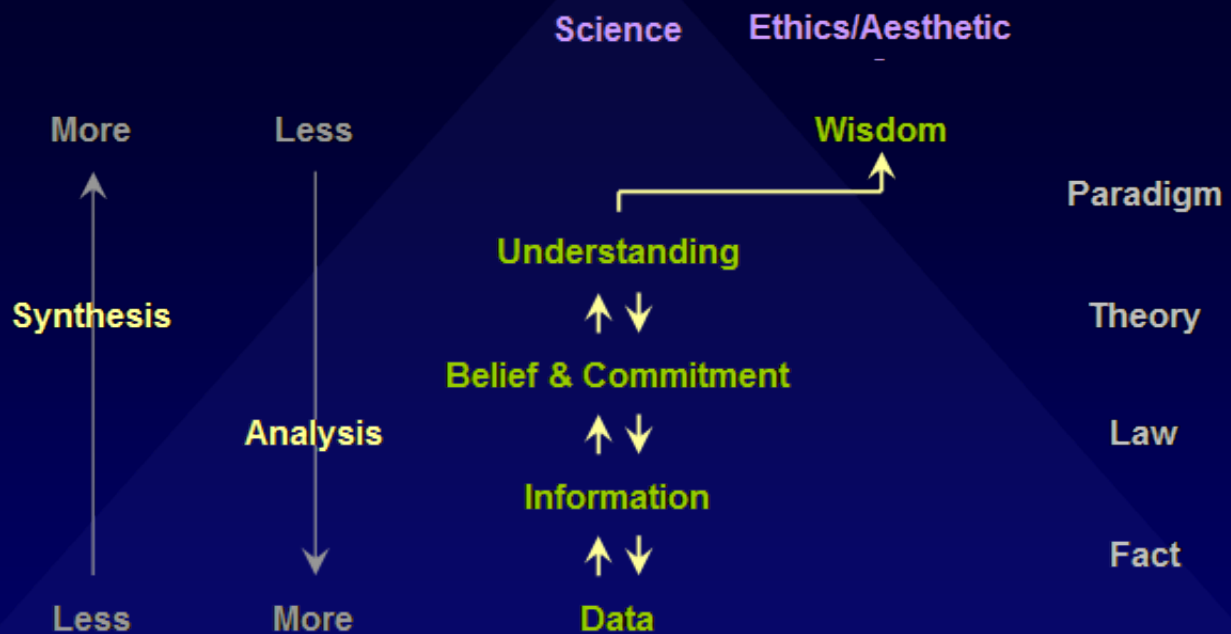
In a similar vein, Bateson (1972 pg xxv) notes the clear difference between his own habits of thought and those of his students who were trained to think and to argue inductively from data to hypothesis – the left-hand side of my arrows, but never to test such hypothesis against knowledge derived by deduction from the fundamentals of science or philosophy – the right-hand side of my arrows. We continue to propagate this error whenever we teach the methodology of science as science and fail to teach the necessary philosophy of science.

Ackoff and Emery's comments are relative, Bateson's are absolute.

Induction is synthetical – taking many particulars and making fewer generalities from them, deduction is analytical – taking fewer generalities and making many particulars from them.

Let's add this;

Traditional Epistemology – Synthesis And Analysis



Now consider the following carefully;

These two approaches should not (but often do) yield contradictory or conflicting results: they are complementary. Development of this complementarity is a major task of systems thinking. Analysis focuses on *structure*; it reveals *how things work*. Synthesis focuses on *function*; it reveals *why things operate* as they do. Therefore, analysis yields *knowledge*; synthesis yields *understanding*. The former enables us to *describe*, the later to *explain*. (Ackoff 1981/1999, pg 18).

There are interrelationships between know-how and know-why, knowledge and understanding, description and explanation.

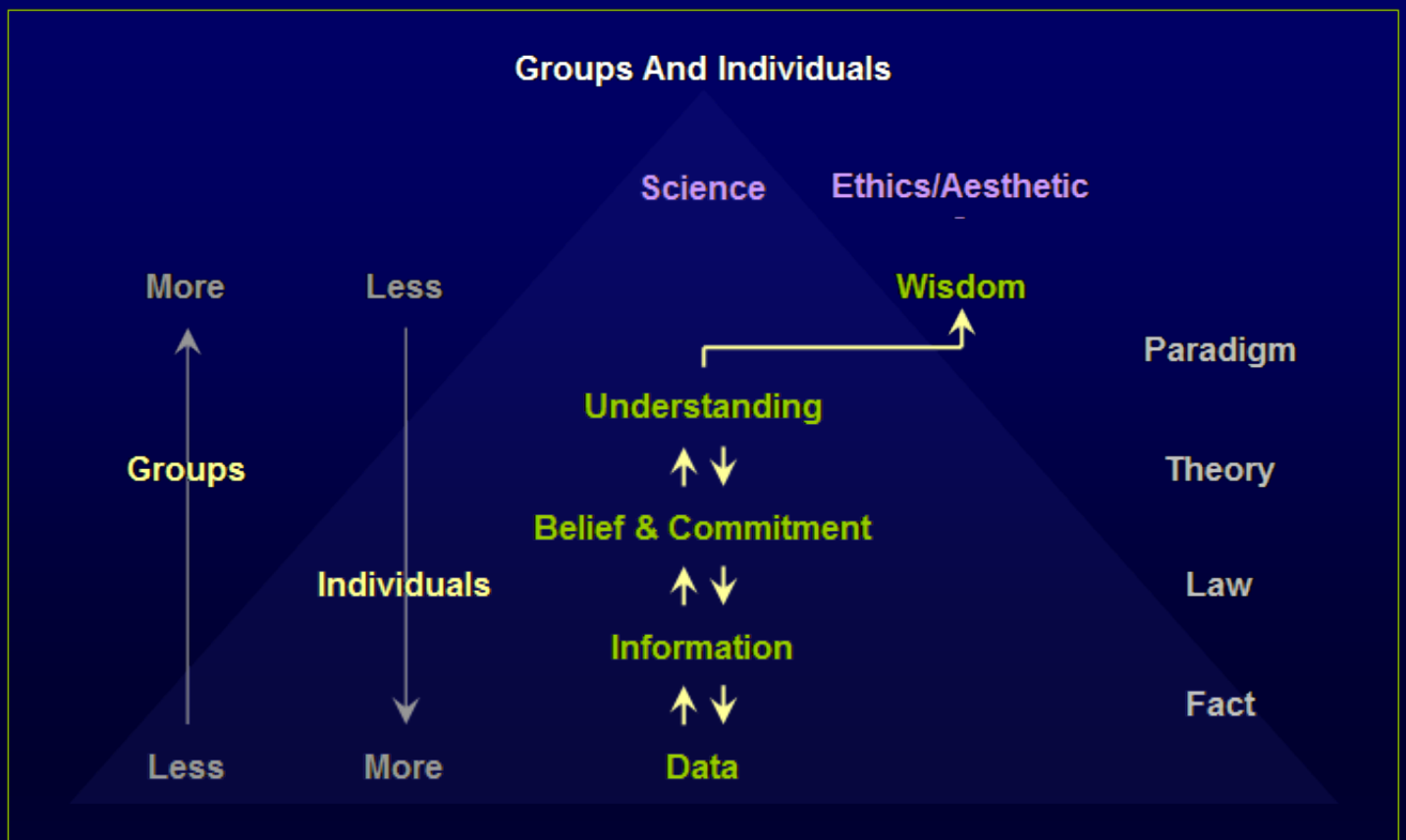
One would think that, a first blush, analysis is more objective than subjective and that synthesis is more subjective than objective, but the realities are reversed. Let's look at this;

Traditional Epistemology – Subjective And Objective Reasoning



As we move from the particular to the general via inductive inference we become more and more objective. As we move from the general to the particular via deductive inference we become more and more subjective. The rationale might not be immediately apparent, so let's look at two more pairs which should help to make sense of this situation.

The first of these pairs is that of groups and individuals and then that of explicit and tacit knowledge.



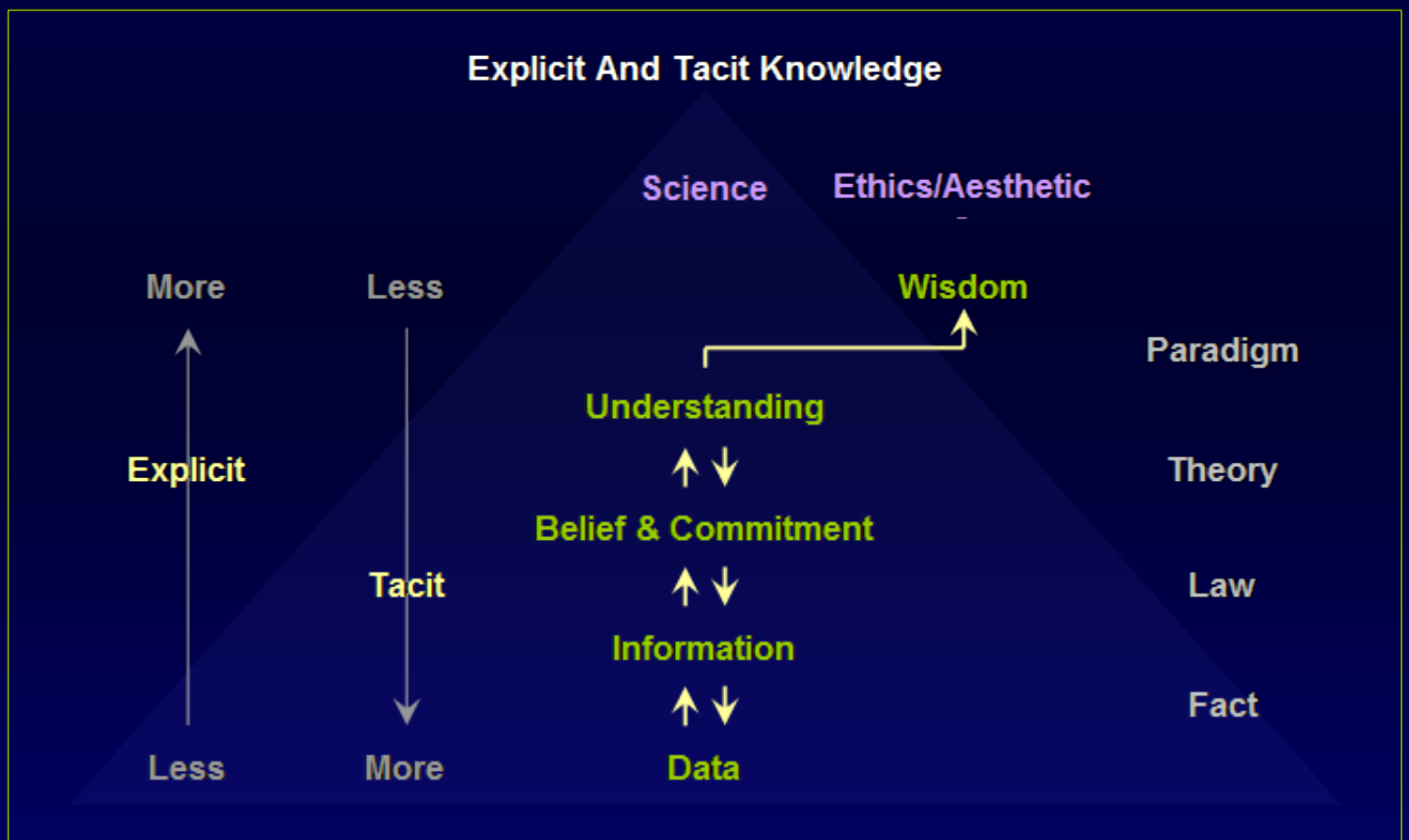
Objectivity and induction map together because as we move towards the more general we deal not just with the concrete but more and more the abstract, we move from the sense of an individual to the sense of senses of the group. We deal with the objectivity of the group not the subjectivity of each individual.

And conversely subjectivity and deduction map together because as we move away from the more general and we deal not just with the abstract but more and more the concrete, we move from the sense of senses of the group to the sense of the individual. We deal with the subjectivity of the individual concerned and not the objectivity of the group.

Let's return to Polanyi's analogy of the map, and recognise that map making is a group affair – not that of individuals (save for lone geology students sweating these things out in splendid isolation as an apparent test of one's skills).

Polanyi said; "To find my way by a map I must perform the conscious act of map-reading and I may be deluded in the process, but the map cannot be deluded and remains right or wrong in itself, impersonally." The map remains objective (rightly or wrongly), but the map reading is subjective.

That brings us to the second of the two pairs; explicit and tacit knowledge.



As we move inductively from; the particulars to the general and from the concrete to the abstract, the “knowledge” becomes more and more explicit, less and less about the self and more and more about the group. Once again it becomes more objective.

Conversely, as we move deductively from the general to the particulars and from the abstract to the concrete, the “knowledge” becomes more and more tacit, less and less about the group and more and more about the self. It becomes more subjective.

This family of concepts form two end-points of a continuum;

- Empiricism, Induction, Synthesis, Objectivity, Groups, Explicit
- Rationalism, Deduction, Analysis, Subjectivity, Individuals, Tacit

This is traditional epistemology and ontology. Having made “order” out of that let’s check some of the more recent aspects in each of epistemology and ontology and then combined aspects for business. But first there are two more hoary chestnuts to address. Inductive fallacy and abductive reasoning.

Traditional Epistemology – Inductive Fallacy

There is a small issue here where I confuse fallacy and fallibility, both are applicable and I need to clean this up

Nassim Nicholas Taleb (2004, 2007, 2012) goes to some length to warn against the risk of inductive fallacy. Geologists ought to know this; we have been caught out before. For about a century and a half Charles Lyell’s theory of uniformitarianism guided, in a paradigmatic sense, the work of geologist who learnt to inspect the past in terms of rates and types of activity seen in the present. An amazingly productive thesis – except it wasn’t completely correct. Out went

uniformitarianism and in came catastrophism and punctuated equilibrium in the 1980's. Except if you are going to throw the baby out with the bath water, put a rope around its ankle. Both aspects are indeed correct. They follow the same power law and are a continuum, but our short lifespan precluded us, for a while, from understanding infrequent and extreme events.

But isn't that science in action? Isn't that exactly what Deming said; that the theory of knowledge teaches us that a statement, if it conveys knowledge, predicts future outcome, with the risk of being wrong, and that it fits without failure observations of the past.

We can't know everything about the future, in fact we can hardly know anything about the future, so the admonition around inductive fallacy isn't that that induction could be fallible because it *must* be potentially fallible at all times – otherwise it isn't science, it is faith. The admonition must therefore be a warning against treating induction as infallible when potential it is not. I think the meanings have become confused.

Let's redo this another way. It isn't because the inductions are fallacious/fallible, then must be, it is because we are fall

Caveat Emptor.

Ackoff (1962/1999 pg 302) comes to the rescue with his treatment of generality.

General statements are of two types. The first type refers to a class of events or conditions each instance of which has been observed. The second type refers to classes of things and/or conditions some of which have not been observed and all of which can never have been observed. If, for example, we observe that each of four pots of water boils at 100 °C, and make a statement to this effect, then this statement is of the first type. If we infer from these observations that the boiling point of water at standard atmospheric pressure is 100 °C, we have made a statement of the second type. The term law is normally restricted to general inferential statements of the second type which in addition assert a causal (deterministic or probabilistic) relationship.

Let me try and draw this;

To the left we have an inductive system with confirmatory particulars from the past and from which we have inferred a generality. If we assume that is now infallible and it is of the second type of generality – the case where we can't know all of the instances – then it is potentially wrong or incomplete. Moving to the right, deductions based upon this generality might, in the future, be disconfirmed. We would then have new particular in the past from which to modify our inferred generalization. To me this *is* science.

Once again, the fallacy is to consider the inference infallible (the first type of generality) when it is not (and of the second type of generality).

Traditional Epistemology – Abductive Inference

I've mentioned abductive logic on a number of occasions, it intrigues me, and my first acquaintance with this concept occurred in an essay of Stephen Jay Gould (1996, pg 94);

"...while biases and preferences often impede understanding, these mental

idiosyncrasies may also serve as powerful, if quirky and personal, guides to solutions. C.S. Peirce (1839-1914), America's greatest philosopher of science, even coined a new word to express the imaginative mode of reasoning involved in such mental leaping: abduction, or 'leading from' (one place to another), to contrast with the more sedate and classical modes of deduction, or logical sequencing, and induction, or generalisation from accumulated particulars (all from the Latin *ducere*, 'to lead').

Bateson championed the concept (1979 pp 133-134);

We are so accustomed to the universe in which we live and our puny methods of thinking about it that we can hardly see that it is, for example, surprising that abduction is possible, this it is possible to describe some event or thing (e.g., a man shaving in a mirror) and then to look around the world for other cases to fit the same rules that we devised for our description. We can look at the anatomy of a frog and then look around to find other instances of the same abstract relations recurring in other creatures, including, in this case, ourselves.

This lateral extension of abstract components of description is called *abduction*, and I hope the reader may see it with a fresh eye. The very possibility of abduction is a little uncanny, and the phenomenon is enormously more widespread than he or she might, at first thought, have supposed.

Metaphor, dream, parable, allegory, the whole of art, the whole of science, the whole of religion, the whole of poetry, totemism (as already mentioned), the organization of facts in comparative anatomy - all these are instances or aggregates of instances of abduction, within the human mental sphere.

But obviously, the possibility of abduction extends to the very roots also of physical science, Newton's analysis of the solar system and the periodic table of the elements being historic examples.

Conversely, all thought would be totally impossible in a universe in which abduction was not expectable.

Once again, let's draw this;

Here I want to show that abduction serves as a link between one or more inductive/deductive systems. In way it is pattern recognition. The pattern that is recognized is the thing that we call logic. The story may change (solar system to periodic table) but the logic stays the same.

Goldratt's Cloud is an abductive reasoning tool. The rules are embedded in the location of the entities and the arrows that join them. The descriptions, however, vary from environment to environment. Moreover the cloud is an abductive tool for making sense of dilemma – a logical tool for making sense of *illogic*. I don't think that the rules are well understood, but they ought to be. I have described the rules elsewhere. And for good measure let's reiterate, the cloud is a tool that uses analysis to force us into synthesis. It is a very very clever piece of work.

We can use (and I do use) the abductive logic of Goldratt's Cloud to map between the Copernican Revolution and modern industrialization. On the face of it there is no similarity between the solar system and modern industrialization – right? That's what I mean by different environments, and yet the structure of the story is the same, and one informs the other. That is

the power of abduction.

As an interesting aside, John Pourdehnad in his introduction to Ackoff's posthumous book, *Differences That Make A Difference*, records that Ackoff wouldn't consider the term abduction for inclusion in that book. He didn't consider it as significant in comparison to inductive or deductive reasoning, even though later proponents of his Design Thinking were advocates of abductive logic (in Ackoff 2010, pp ix-x).

Stop Here!

Continuum Within Cross-Over Ontology

I now want to "hang" 3 pairs that concern ontology on the framework that we have been using. They are; the whole and the parts, set and subset, and class and members. I've called them "cross-over" because they are somewhere between traditional and modern business use. There are 2 cross-over epistemological pairs to follow.

Let's look at the whole and the parts.

Subordination quote from Bateson pg 337 – he calls it complementary and has to exist between individual and larger system.

Maybe here a discussion of the omission in Deming 1994 1st and 2nd editions.

Text

A set and a subset; a class and its members are abstractions of our minds. But they exist non-the-less. Consider the living individuals in a species, or the number of differing species in

Continuum Within Cross-Over Epistemology

There are two cross-over pairs that are epistemological, they are; integration and differentiation, and expansionism and reductionism. The first come from Boyd via Osinga (2007, pg 71) and the second from Ackoff (date, page)

Very closely related to synthesis and analysis, but I particularly like the pair of integration and differentiation.

Both Bateson and Ackoff make much of the interdisciplinary aspects of knowledge after the second world war. This is expansionism in action. People from different disciplines being exposed to expertise within other disciplines. Also quote Polanyi here, depth vs breadth so that on is held together by a chain of relationships.

Continuum Within Business

Text

Text

On an earlier page, Leadership and Learning, I accepted the argument of Zaleznik (1992) that leaders and managers are different. Maybe, now, I should modify that to some extent and say that the roles of leaders and management are different – but that they may well be embodied in the same individual at the same time. Mintzberg (2004) taking Zaleznik to task rejects a distinction between management and leadership because; “managers have to lead and leaders have to manage.” Both Ackoff’s Law of Generality and Jaques Requisite Organization provide some resolution to this conundrum.

A colleague sent me an “old” paper on leadership that took it right outside of the business context and especially the context of managerial or military hierarchy, and that provided a better context for leadership than I had hitherto had. If we tease out the role of leadership from that of management, then too, I think that we must tease out the role of teacher, or more especially, the role of mentor. Sure, they all fold back into one as Mintzberg attests for leadership and management. But in a nice case of analytical reductionism, these three separate strands are better understood first as the constituent parts, and only then later as an interrelated whole.

I need to refine the argument further because Ackoff makes such a distinction between, management and leadership and also management and administration. I’ve tried to draw this below as a hierarchy.

For Ackoff (1998);

“Administration consists of directing others in carrying out the will of a third party, using means selected by the same party.”

“Management consists of directing others in the pursuit of ends using means both of which have been selected by the manager.”

“Leadership consists of guiding, encouraging and facilitating the pursuit by others of ends using means, both of which they have either selected, or the selection of which they approve.”

But there’s more.

... leadership requires an ability to bring the will of followers into consonance with that of the leader so they follow him or her voluntarily, with enthusiasm and dedication. Such voluntarism, and dedication are not necessarily involved in either management or administration.”

For this reason leadership is primarily an aesthetic function and I have tried to draw this in context by placing it with the ethics/aesthetics of wisdom rather than the science of knowledge. And of course having said that, I have to acknowledge that there is more than a smattering of aesthetics in science too.

All that I am trying to show is that the higher in the hierarchy (both real and the logical types depicted) less and less is administration, more and more is management, and leadership.

Rather like the subordinate/superior relationship in strategy and tactics, people must lead their

subordinates and be held accountable for their outputs, which is essentially the act of providing managerial support to their superiors. Each position is the embodiment of both qualities, but the qualities are fundamentally different.

Jaques defines a manager thus;

as a person who is held accountable for the outputs of others, for sustaining a team capable of producing those outputs, and for giving effective leadership to that team.”(2006 pg 35)

The last word however should go to Ackoff (1991);

Inspiration without implementation is provocation, not leadership. Implementation without inspiration is management or administration, not leadership. Therefore, leaders must be both creative, in order to inspire, and courageous, in order to induce implementation.

Drucker, P. F., (2006) Classic Drucker, pg 35

Effective executives do not make a great many decisions. They concentrate on what is important. They try to make the few important decisions on the highest level of conceptual understanding. They try to find the constraints in a situation, to think through what is strategic and generic rather than to "solve problems." They are, therefore, not overly impressed by speed of decision making; rather, they consider virtuosity in manipulating a great many variables a symptom of sloppy thinking. They want to know what the decision is all about and what the underlying realities are which it has to satisfy. They want impact rather than technique. And they want to be sound rather than clever.

Originally published 1967

I have a quote of Drucker's which has become something of a favorite;

Effective decision makers ... follow a rule which the military developed long ago. The commander or an aide goes and looks. The reason is not that effective decision makers (or effective commanders) distrust their subordinates. Rather, they learned the hard way to distrust abstract "communications" (Drucker 1974/200%, pg).

Abstract communications are of course a form of explicit knowledge, the nice paradox that I observe is that not only do the decision makers prefer the original tacit knowledge; they must by definition experience it tacitly as well. And that point seems to have been overlooked. All of their experience is also brought to bear on the whole situation by going to the actual place, talking to the actual people and seeing the actual situation.

Of course the substitution of explicit knowledge for first-hand knowledge is also a convenient foil against knowing everything that one *should* and having to exercise moral and ethical responsibility (put skin in the game) and do something. One can also with little effort discount other's explicit data or its interpretation and thus generate a nice phony conflict that now excuses two sides from having to exercise moral and ethical correctness. And you know the solution to this – get more data.

Let me put it to you that leaders (and followers) exercise discretion about the ends, superiors (and subordinates) exercise discretion about the means.

This is where you load it up with Jaques – and also leadership/and or mentoring.

I couldn't resist this. It is the earlier description of ##### as head and tail of the same coin that resonated with me. Exploitation and subordination are exactly that. They are hierarchical, exploitation above subordination and subordination more plentiful than exploitation.

There is an aspect within leadership and management that also includes “teacher” or “mentor.” The word “teacher” is apparently more appropriate to institutions of learning (and maybe explicit instruction) than to institutions of work (and maybe more tacit skill-based learning). In the latter situation, the term “mentor” appears to be more appropriate.

Harking back to the apparent paradox between tacit learning and groups in Japan and explicit learning and individuals in the West; note too how much more important the teacher or mentor or sensei is in oriental culture and contrast that with how much more important the “book” is in occidental culture.

This follows because it encapsulates all of the above and is a fine way to close off.

One person's exploitation is another person's subordination; equally one person's subordination is another person's exploitation. Head or tails? In a relative sense it is often hard to tell, in an absolute sense one is hierarchically superior to the other, and in order to have an absolute sense one must know the system and its goal.

Mechanization, Communication, Computation, & Automation

Ackoff (1981 in 1999, pp 24-25) Also instrumental issues.

Ackoff (1996/1999, pp 318-319)

Systems thinking, expansionism and objective teleology provide the intellectual foundation for what may at least tentatively be called the *Systems Age*. The world-view they yield does not discard that of the Machine Age but incorporates it as a special case. Machines are understood as instruments of purposeful systems: purposeful systems are no longer conceptualized as machines. The Post Industrial Revolution is as logical a consequence of systems thinking as the Industrial Revolution was of mechanistic thinking. In this second revolution man seeks to develop and use instruments that do *mental* rather than physical work: artefacts that *observe* (generate symbols), *communicate* (transmit symbols) and *think* (process symbols logically). Together these technologies made possible the mechanization of *control*, *automation*.

Last Word – Colonel John Boyd

There is an undercurrent in Boyd's work – or rather in other people's descriptions of Boyd's work – that has always suggested that tacit learning was a very important component of his thinking. I

illustrated this using Coram's description of the evaluation of the Y-16 and Y17 on the much earlier page on leadership and learning. I also asserted the use of tacit learning in the success of Boyd's "outside roll" when discussing decision cycles on the page on the OODA "Loop." So it was a pleasant surprise that more recently I found that Boyd's reading list – the one that he recommended to other people – included the shorter works of Bateson and Polanyi; being *Mind and Nature*, and *The Tacit Dimension* respectively.

More surprises were to come. After the structure and diagrams of this current page were well developed and the detail was being filled in, I received a copy of Frans Osinga's *Science, Strategy and War: the strategic theory of John Boyd*. Osinga devotes an entire chapter to science and epistemology. He needed to because in fact Boyd was familiar with Polanyi's major work – the source of the notion of tacit knowing – and also the work of Kuhn and scientific paradigm. And although Ackoff is not cited, the work of Ackoff's collaborator, Emery is, and so we can be fairly certain that Boyd also understood systems thinking in the holistic form that Ackoff espoused. None of this richness is apparent from the recommended reading list.

Remember that Boyd discovered a theory that let him describe the effectiveness of fighter aircraft whereas no one before him had had the insight to do so. Effectively he created a paradigm – and from that instant onwards there was no going back to the former pre-paradigmatic "schools" of understanding. He read military history backwards (Osinga 2007 pg 29) and so it is highly likely that he developed what Thomas Kuhn describes as "recapturing out-of-date ways of reading out-of-date texts" (1977 pg xiii). In other words he was aware of defunct paradigm via military history. He then created a new paradigm called Maneuver Warfare. Osinga shows examples where Boyd manifests a "Polanyiist/Kuhnian" inspiration (2007 pg 63-64). There is no way that OODA can be read without an understanding of paradigm (well it can be read but it won't be understood). That was my earlier assertion in drawing a commonality between CRT-Cloud-FRT and the OODA Loop. The cloud is a paradigmatic instrument.

And so it is rather strange, but also strangely gratifying, to find that the work of Bateson, Polanyi, Kuhn, and Ackoff informed Boyd to such a considerable extent. I invite you to read Osinga's chapter on "Science Boyd's Fountain", to better understand just how central these works were to him and to better understand the significance of the OODA Loop.

Summary

If your interest has been piqued, then at the very least read Gregory Bateson's *Mind and Nature* and Polanyi's *Tacit Dimension*. Bateson was foremost an anthropologist, and Polanyi a physician turned scientist; both however were epistemologists to the core.

References

Ackoff, R. L., and Emery, F. E., (1972) *On purposeful systems: an interdisciplinary analysis of individual and social behavior as a system of purposeful events*. 2008 Aldine Transactions edition, 288 pp.

Ackoff, R. L., (1998) *A systemic view of transformational leadership*. *Systemic Practice and Action Research* Vol 11, pp 23-36. also at <http://www.acasa.upenn.edu/leadership.pdf>

Ackoff, R. L., (1999) *Ackoff's best: his classical writings on management*. Wiley, 356 pp.

Bateson, G., (1972) Steps to an ecology of mind. University of Chicago Press, 533 pp.

Bateson, G., (1979) Mind and nature: a necessary unity. Hampton Press edition (2002), 223 pp.

Corbett, T., (1998) Throughput Accounting: TOC's management accounting system. North River Press, 174 pp.

De Bono, E., (1982) De Bono's Thinking Course, Ariel Books.

Deming, W. E., (1994) The new economics: for industry, government, education. 2nd edition, The MIT Press, 247 pp.

Dilts, R. B., (1998) Modeling with NLP. Meta Publications, 292 pp.

Drucker, P. F., (2006) Classic Drucker, Harvard Business School Press, pg 181. Originally published in Sept-Oct 1988 Harvard Business Review as Management and the World's Work.

Goldratt, E. M., (1990) The haystack syndrome: sifting information out of the data ocean. North River Press, 262 pp.

Goldratt, E. M., (1990) What is this thing called Theory of Constraints and how should it be implemented. North River Press, 162 pp.

Gould, S. J., (1993) Eight Little Piggies: reflections in natural history. A foot soldier for evolution. pg 440.

Gould, S. J., (1996) In the mind of the beholder. In: Dinosaur in a haystack, Penguin Books, pg 94.

Harvey, J. B., (1988) The Abilene paradox and other mediations on management. Lexington Books, 150 pp

Jaques, E., (1991) The control of process variance: and the sustainment of quality, just-in-time working and continual improvement in all functions and at all levels of organization. Working Paper 1011, Cason Hall and Company, 6 pp.

Jaques, E., (2006) Requisite organization: a total system for effective managerial organization and managerial leadership for the 21st century – revised second edition memorial. Cason Hall & Co., 137 page pairs.

Jaques, E., and Cason, K., (1994) Human capability: a study of individual potential and its application. Cason Hall & Co., 165 pp.

Jaques, E., and Clement, S D., (1991) Executive leadership: a practical guide to managing complexity. Cason Hall & Co., 317pp.

Johnson, H. T., and Kaplan, R. S., (1987) Relevance Lost: the rise and fall of management accounting. Harvard Business School Press, 269 pp.

Johnson, H. T., (2006) Lean dilemma: choose system principles or management accounting controls, not both. Published in, Lean Accounting: a living systems approach to lean management and learning, Stenzel, J., ed. John Wiley, 2007.

Kuhn, T. S., (1957) *The Copernican revolution: planetary astronomy in the development of Western thought*. 24th printing 2003, Chicago, 297 pp.

Kuhn, T.S., (1962) *The structure of scientific revolutions*. The University of Chicago Press. 3rd Edition 1996, 212 pp.

Kuhn, T. S., (1977) *The essential tension: selected studies in scientific tradition and change*. Chicago University Press, 366 pp.

Mintzberg, H., (2004) *Managers not MBAs: a hard look at the soft practice of managing and management development*. Berrett-Koehler, 464 pp.

Nonaka, I., and Takeuchi, H., (1995) *The knowledge-creating company: how Japanese companies create the dynamics of innovation*. Oxford University Press, 284 pp.

Osinga, F. P. B., (2007) *Science, strategy and war: the strategic theory of John Boyd*. Routledge, 313 pp.

Polanyi, M., (1958) *Personal knowledge: towards a post-critical philosophy*. Chicago University Press 1974 paperback edition, 428 pp.

Polanyi, M., (1966) *The tacit dimension*. University of Chicago Press 2009 edition, 108pp.

Rogers, E. M., (2003) *Diffusion of Innovations, Fifth Edition*. Free Press, 550 pp.

Taleb, N. N., (2004) *Fooled by randomness: the hidden role of chance in life and in the markets*. Random House, 316 pp.

Taleb, N. N., (2007) *The black swan: the impact of the highly improbable*. Random House 366 pp.

Taleb, N. N., (2012) *Antifragile: things that gain from disorder*. Random House 519 pp.

Zaleznik, A., (1992) *Managers and Leaders: are they different?* Harvard Business Review, May-Jun, pp 99-109.

