THOUGHT ABOUT THOUGHT
Twenty-Four Centuries of Now-and-Then Development and the Consequences

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The Problematic Situation and the Cardinality Thereof

Let me begin by defining what I mean by the cardinality of a Problematic Situation. Very simply, it is the number of problems that a well-informed group of people believe would characterize a problematic situation.

Cardinality of One and the Academic Prototype. If the cardinality of the situation is one, so that only one problem characterizes the situation, I will call that an academic prototype, since most of what a student encounters in academia is the problematic situation of cardinality one.

The Tacit Asssumption. Riding along with the Academic Prototype we might say that there is a tacit assumption: if the student resolves enough situations of cardinality one, this will equip the student to resolve situations of any cardinality when the student enters that mysterious realm that academics often refer to as the "real world".

The Empirical Behaviorists of the The Late Twentieth Century

In the second half of the twentieth century, a group of people whom I choose to call the "empirical behaviorists" attacked the validity of the tacit assumption. I don't believe that they did so deliberately or openly or with malice aforethought. But the net effect of their work, in my judgment, was to completely invalidate the tacit assumption upon which a large amount of the academic enterprise has rested comfortably for lo these many years.

I speak of people like **George A. Miller** who wrote of the "magical number seven" as setting an upper limit to how many ideas could be brought into short-term memory at any one time, and of **Herbert A. Simon** who repeated Miller's experiment and concluded that the number was closer to five, and to **John N. Warfield** (yes, it's me) who concluded that the number was really three, because if you allowed the three ideas to interact, the interactions together with the three would use up the totality of seven.

Then I speak of people like Irving Janis who looked at what people do in small groups and found them unable to reach consensus and instead found them willing to fake consensus in the interests of group harmony via what he called "groupthink", pretending to agree when they did not, and **Graham Allison** who found and documented this type of behavior at the highest levels of government in the Bay of Pigs incident. And I speak of people like **Anthony Downs** who found the behavior of bureaucrats to be selfserving in the face of public interactions, which can be explained thoroughly not by deep-seated dishonesty but rather by inability to manage the cognitive aspects of the issues with which they are confronted.

Driving the Last Nail in the Coffin of Cognitive Limitations

Suppose it should be true that problematic situations with more than just a handful of component problems are beyond the ken of the human being and that, by failing to recognize this, or by choosing to ignore it, academicians have missed the boat on an area of greatest importance. Suppose that this failure is really at the root of situations like the failure to be prepared for and respond in a timely way to Hurricane Katrina. Is it really possible to make the case?

George J. Friedman, retired as chief technical officer of the Northrop Corporation, had an almost unique opportunity to study why large systems failed. Here was a company that designed and produced large systems for the government. This company had access to plenty of money, very-well educated people, and the best computer equipment that money could buy. George's main responsibility was to study why the systems failed.

His principal conclusion was that they failed because the people who designed the systems lacked the cognitive apparatus required to encompass the cardinality of the systems. This would be readily explained by knowing that they had no education in systems of high cardinality, and therefore would only work with such systems using the experience that they had with systems of lower cardinality and, as we have mentioned, such experience and talent is very severely limited.

Then there is a fellow named **Klaus Krippendorff** who understood that complexity is a creature of the mind, not something that can be ladled out of an object like soup out of a soup bowl, or cut out like a knot out of a piece of wood, and who understood that it represents a fact of life relative to human limitations that translate into human fallibility as noted by several excellent philosophers, including our own **Charles Sanders Peirce**.

Motivation to Study Thought About Thought

It would be easy enough to start blaming universities for indifference, in light of the foregoing. But let's instead do what should have been done some time ago, and what now needs to be done, and that is to review what has been learned about our thought processes, and what we can now do to improve our ability to work with problematic situations of cardinality higher than three–perhaps much higher than three–and in the process, do so with quality control.

Who knows? Perhaps we will find that the situation is much better than we have any reason to expect, given that we have, at least collectively, ignored this area for so long. And perhaps we can finds a prescription for what to do improve the situation dramatically.

To make the presentation somewhat easier, I will skim through it very superficially, just using pictures of the individuals involved to give continuity, and then to the extent time permits, I will go into more detail.

I want to introduce things with **Father I. M. Bochenski** who wrote a classic research book titled A HISTORY OF FORMAL LOGIC. The word “magnificent” is too mild to describe this labor of love. Much of what I tell you comes from this work.

Aristotle and Abelard: The Prose Beginnings

Aristotle produced the syllogism, a 3-part structure comprised of a major premise, a minor premise, and a conclusion. The first formal bit of inference. This prose edifice and its multiple variations lasted virtually untouched for almost 14 centuries. One can say that it dealt primarily with what can be called an “inclusion relationship”.

Then along came **Pierre Abelard**, who is quoted by Bochenski as constructed the following pair of one-sentence bits of inference:

“Whatever implies the antecedent [implies] also the consequent”

and

“Whatever follows from the consequent [follows] also from the antecedent”.

I can tell you for sure that these two statements are equivalent, but I don’t know if anyone understood this at the time. What is important is that each captures in one prose statement what earlier required three statements. Why this is important can be made evident later on.

The relationship of implication is definite in the first statement and implicit in the second statement. Only two members are explicit, the antecedent and the consequent, so I chose the word base to represent the third member.

Notably Abelard still relies totally on prose. There is no hint of a graphic.

Leibniz, The Hint of a Graphic

That it might be helpful to think about using a graphic to help with the logic is apparently first found in the notebook of Leibniz. I suppose most readers have heard of Venn diagrams, but Venn is a figure from the 19th century. Philosophers speak of Euler Circles, and Euler is a figure from the 18th century. But **Leibniz** is primarily a figure from the 17th century, and Bochenski goes to the trouble of showing a plate from Leibniz notebook where he uses circles to study elementary logic relationships. Perhaps Bochenski wants to teach us something about being careful in the way we propagate concepts from the history of scientific or mathematical work. He says some other things to show carelessness in the way the history of logic is presented.

Problems and the Cardinality of Three

If we assume that a problematic situation has a cardinality of three, i.e., that there are three problems to be interrelated, we can see that the Aristotle syllogism would allow for the study of three problems, since the syllogism relates three items. Similarly, Abelard's prose expression deals with three items. Both Aristotle and Abelard accommodate to problematic situations with cardinality of three. What would be required to make a substantial leap from this point forward? This is the next step to be taken with the nineteenth century British scholars.

The British Three

The nineteenth century hosted three British scholars, **Augustus De Morgan**, **George Boole**, and **Arthur Cayley**, who made critical contributions to thought about thought. De Morgan and Boole publishing outstanding results in 1847, De Morgan publishing the theory of relations in which for the first time he symbolized relationship and operations on relations, while Boole symbolized propositions and showed how to carry out logic operations on propositions. Later Cayley developed an algebra of matrices, enabling operations to be carried out on large numbers of variables.

The American Three

Almost alone among philosophers, **Charles Sanders Peirce** recognized the significance of De Morgan's work and announced it publicly. In the middle of the twentieth century, **Frank Harary** integrated the work of De Morgan, Boole, and Cayley along with his own work to produce what he called the "theory of digraphs", and introduced the term "structural models", in which he showed that it is possible to represent consistent models of structure by integrating these various components of mathematics.

Finally I developed a process by which groups of people, operating with assistance from a computer-driven display, could construct consistent structural models, using Harary's theoretical results. I called this process "Interpretive Structural Modeling" or ISM for short.

A Connection to Aristotle

It is now possible to construct structural models and count the number of syllogisms that are linked in such models. I have called the number obtained in this way an Aristotle Index of complexity. It is not unusual to find several hundred linked syllogisms in such a model. There is no way that human beings can be expected to construct such models without computer assistance, but it is relatively easy to do with computer assistance, and there have been hundreds of instances over the past few decades in which this has been done.

A Connection to Leibniz

While the idea of using graphics to portray logic relationships started as a gleam in Leibniz's eye, it is now much more than a gleam. The structural models make it possible for the human eye to scan and the human brain to interpret large logic patterns: ways to absorb major structural patterns that cannot be envisaged in any other way. The common lecture method that is so widely used in higher education relies mostly on the human ear–a very poor organ that is limited to linear absorption, and the blackboard sequencing which constrains the eye largely to linear absorption as well; but the static presentation on a large wall allows the eye to scan repeatedly, much like the flying spot scanner enables the television camera to scan and record large landscapes for transmission to the television display where the eye can absorb large amounts of information.

Consequences of Thought About Thought

If we are now willing to allow what has been developed as a result of more than two millennia of effort and study into thought about thought to become part of our personal repertoire, and part of our higher education, we will find that we can now extend our capability substantially. Abundant empirical evidence exists to show that problematic situations which would not yield to ordinary individual behavior can be brought into the sphere of human insight by taking advantage of the software processes that embody the results that I have described to you.

I hope that some of you will follow the trails that have been blazed in the past few decades by several key practitioners who have elected to take advantage of these results with significant consequences that are now available in the literature and in videotapes and other resources in libraries for your study. Many of these resources can be tracked down by links or references through either of these two sources:

http://www.jnwarfield.com

or

John N. Warfield (2003), "Discovering Systems Science", *International Journal of General Systems* 32(6), 525-563.