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Back to the Future: A Critique of Demetis and Lee's "Crafting Theory to Satisfy the Requirements of Systems Science"

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1. Introduction

The idea of taking a major research approach such as positivism or interpretivism and then asking what implications does this approach have for crafting theory is a good one (Lee, Briggs, & Dennis, 2014; Lee & Hovorka, 2015) and can yield insightful and useful papers. The current paper attempts this task for systems theory but is too narrow and rather old-fashioned for it to successfully do justice to such a rich and vibrant field

The first problem is that the field of systems is so broad as to defy any sort of succinct definition or description as this paper attempts. We immediately face this in the title which refers to "systems science". This already points to a particular, and one-sided, view of systems as opposed to "systems thinking", "the systems approach" or "systems theory". This is confirmed in Section 2 where it is stated that "Systems science is also known as 'General Systems Theory' (GST)" (page ?) so, in reality, the paper is actually only about one fairly small and arguably outdated facet of the very rich world of systems thinking.

The second problem is that even this area is dealt with in a rather cursory manner. In terms of any detail, it covers only a single theorist – Niklas Luhmann -who is rather marginal, highly abstract and complex, and is not really a representative of GST as it was originally defined by the likes of von Bertalanffy (1971), Boulding (1956) and (Rapoport, 1986).

2. A Partial History of Systems Thinking

To give a more rounded picture, I will give a brief, and rather partial, history of systems thinking – for a detailed overview of the origins of systems ideas right back to the Greeks see Checkland (1981) and for a more recent review of applications of systems thinking across the management field see Mingers and White (2010)

2.1 Stage 1: First order cybernetics/Hard systems thinking

The fundamental concepts of systems thinking were developed (in modern times) in the early part of the 20th century across a range of disciplines, particularly those such as organismic biology, ecology and gestalt psychology (Capra, 1997; Capra & Luisi, 2016). Cybernetics developed as a new discipline concerned with processes of information, communication and feedback control (Ashby, 1952, 1956;

Capra, 1997; Capra & Luisi, 2016; Weiner, 1948, 1950). As a minimum, the basic systems concepts included: parts/wholes/sub-systems, system/boundary/environment, structure/process, emergent properties, hierarchy of systems, positive and negative feedback, information and control, open systems, holism, and the observer[1]. Most of these concepts are discussed by Demetis and Lee (2016) except, interestingly, emergence. They mention holism and hierarchy but it could be argued that in fact emergence is the most fundamental systemic concept since it is the emergence of new properties and behaviours at higher levels of organization which is the essence of holism and the bulwark against reductionism.

The application of these concepts across many disciplines was recognized by von Bertalanffy (1950) and called general systems theory (GST). These ideas were taken up in management and information systems as management cybernetics (Beer, 1967), system dynamics (Forrester, 1961), systems engineering (Hall, 1962) and what we might generally call the systems approach (Churchman, 1968; Klir, 1969; Weinberg, 1975).

2.2 Stage 2: Second Order cybernetics/Soft systems methodology

Cybernetics (meaning the study of self-governing mechanisms) is a particular branch of systems theory developed originally in the 1940s (Heims, 1993; Pickering, 2002) by scientists such as Weiner (1948), Ashby (1956) and Bateson (1973). It studied the way that systems could control themselves autonomously through the transmission of information within error-controlled feedback loops. This enabled cyberneticians to explain both the particular nature of living systems and also explore how the brain and our cognitive processes worked. In studying, for example, the nature of perception it became clear that what we perceive is not a passive reflection of the external world but rather a very active construction of the human nervous system.

Thus we have to recognize that, in principle, the observer is always part of the system being observed. This insight developed into what became known as “second-order cybernetics”. First-order cybernetics studies the mechanisms of the external world while second-order cybernetics studies the process of observing itself. As Von Foerster put it in the titles of two of his major books, it is the *Cybernetics of Cybernetics* (Von Foerster, 1975) or the study of *Observing Systems* (Von Foerster, 1984), where “Observing” is to be read as both a noun and a verb. It reached its most developed form in the work of Maturana and Varela (Maturana & Varela, 1980, 1987) on “autopoietic” systems – systems, primarily living systems, that produce or construct themselves (J. Mingers, 1995). Autopoiesis is the characteristic organization that distinguishes living from non-living systems. The concept of autopoiesis has been influential in a range of disciplines (J. Mingers, 1995) and is invoked by Luhmann in his sociological theory as discussed by D&L. However, what they do not mention is that Luhmann’s use of autopoiesis is very questionable (J. Mingers, 2002) and Maturana himself did not agree with its use beyond the biological level. Stemming from, but separate to, autopoiesis, Maturana and particularly Varela developed a theory of mind that was much more phenomenological than computational, conceptualizing cognition as non-representational and embodied (Varela, 1991).

[1] The seminal point of these early developments were the Macy Conferences on Cybernetics (Pias, 2016) bringing together such luminaries as Weiner, von Neumann, Bateson, Ashby, Lewin, Mead, McCulloch, Shannon and von Foerster

At the same time, similar developments were occurring in another area of systems – applied systems thinking or systems engineering. The systems approach was successfully being used in the design of complex engineering projects such as oil refineries, and methodologies for tackling these problems had emerged (Hall, 1962). However, when these methodologies were applied to problems in human organizations they were not found to work well. The issue is that human beings are significantly different to machines and buildings. People, through self-consciousness and language, have the ability to conceptualize themselves and the systems that they are part of – they exist in a world of meaning and signification. This means that we cannot just take for granted, from the outside, the nature of a particular social system or social interaction but have to engage with the participants and become active observers. This is indeed the essence of the interpretive or phenomenological position.

This led to the development of an alternative systemic approach to problem-solving in organizations – what became known as "soft systems thinking" as opposed to the "hard systems thinking" of traditional systems engineering. This represents a similar paradigm shift to second-order cybernetics – problematizing the role of the observer/participant in systems analysis. It was most fully articulated by Checkland (P. Checkland, 1999; P Checkland & Holwell, 1998; P. Checkland & Poulter, 2006; P. Checkland & Scholes, 1990) in a practical intervention approach called Soft Systems Methodology (SSM) which, he argued, was underpinned by a phenomenological social theory (Husserl, 1964).

2.3 Stage 3: More recent developments

At the present moment, systems thinking has burgeoned in many directions – system dynamics, complexity theory , critical systems thinking, critical realism , and the mechanisms view of causality. All of these are highly relevant for information systems research.[2]

In general terms, system dynamics simply means the changing behavior of systems, but in practice the term has become associated specifically with the work of Jay Forrester from MIT who has developed an approach to simulating the behavior of large complex systems. Forrester was initially interested in the dynamic behavior of whole industries such as supply chains (Forrester, 1961) and of populations of people as in the growth and decay of cities (Forrester, 1969). He identified the major flows of people, materials and money and the ways in which these were controlled through feedback loops. He then modelled these using systems of differential equations which were run on a computer to display the dynamic behavior of the system over time. System dynamics is now also used on a more micro level for exploring the "mental models" that individuals have about how parts of their world work. This approach was popularized by Peter Senge in his book about the "learning organisation" called *The Fifth Discipline* (Senge, 2006), where the fifth discipline is in fact systems thinking, and can be seen as a "soft" version of traditional system dynamics.

Complexity theory (Gell-Mann, 1995; Kauffman, 1993) developed in a range of disciplines – biology (Bawden 2007), chemistry (Prigogine and Stengers 1984), mathematics (Gleick 1988) and economics (Anderson et al. 1988). Traditionally, these "hard" sciences have made a range of assumptions about the behavior of systems in their domains that were increasingly found not to hold true. This led to a crisis which eventually resulted in the emergence of what was first called chaos theory and later

[2] On the IS front, there was a special issue of MIS Quarterly, one of the leading journals in the IS field on critical realism in 2013 (J. Mingers, Mutch, & Willcocks, 2013).

complexity theory. The assumptions were mainly that the types of behavior displayed were generally orderly and fairly predictable. For example, that systems were usually stable and reached equilibrium; that changes tended to be linear or at least smoothly non-linear; that systems exhibited cyclicality and robustness; that simple models would generate simple behavior (and vice versa). Instead, complexity theory explores situations of non-linearity, lack of equibrium, small changes creating large effects (butterfly effect or tipping points), and chaotic and highly complex behavior.

In the same way that social science generally developed a critical movement, so too systems developed critical systems thinking after soft systems. Much of this was developed at Hull (Flood & Jackson, 1991; Jackson, 1985, 1991, 1997) which is ironic since one of the paper's authors is based there but they do not mention it at all in their paper. If interpretive or soft systems recognizes that the observer and processes of interpretation need to be addressed, then critical systems recognizes that the wider social and political contexts need to be addressed and that there are limits to knowledge whether it is positivistic or interpretive (J. Mingers, 1992). This leads to the epistemological insight that we need different research approaches dependent on the domain of enquiry, for example material, personal and social (Habermas, 1978), and ultimately to mixed methods enquiry or multimethodology (J. Mingers & Gill, 1997).

A further important philosophical and theoretical development was critical realism (CR) (Bhaskar, 1978, 1979). Although this developed within philosophy rather than systems thinking, it has been shown that it is actually highly systemic (J. Mingers, 2014). Put simply, CR develops a position between positivism and interpretivism that recognizes the strengths and weaknesses of both, while at the same time holding a critical view of social science. Ontologically, it maintains the existence of an external, causally-efficacious real world while recognizing the cultural and temporal limitations of our access to that world. It draws a distinction between the domain of the Real, where systems and structures with particular powers and tendencies operate and interact to generate events and happenings of the everyday world in the domain of the Actual. Out of all these events we only actually observe and record a very limited number to form the basis of research. These are the domain of the Empirical. It also distinguishes between the intransitive aspects of science – the independent objects of knowledge, and the transitive aspects of human scientific activity. Mingers (2004) applied this to information systems and there are a range of examples in *MIS Quarterly* special issue in 2013.

Developing out of CR and also the philosophy of science is a new approach to causality that stands against the positivist view of constant conjunctions of events and the interpretivist reluctance to engage with external causality at all (Illari & Williamson, 2011; Salmon, 1998). This is known as the "mechanisms" view. Rather than aim for putative universal laws, or for purely intentional human action, it seeks to explain the events that occur (or do not) by hypothesizing underlying mechanisms or systems with causal properties or powers that, through their behavior and interaction, generate the events we experience. These mechanisms may be material, conceptual or social, and may or may not be observable. This is known as abduction or retroduction as opposed to induction or deduction (Peirce, 1992). This "generative causality" encourages us to seek rich causal explanations in terms of multidimensional interacting systems rather than merely modelling patterns in empirical data as does positivism.

3. Towards some criteria for systemic theorizing

The purpose of Demetis and Lee's paper (2016) was to argue for the importance of "systems" within the field of information "systems", and then propose some criteria for sound and rigorous theory based on their view of the systems approach. However, I feel that a richer and more sophisticated discussion of the implications for information systems theorizing is warranted. To that end, I will first point out some limitations of their criteria, and then suggest some very tentative ones of my own.

3.1 Demetis and Lee's criteria

1. *"The whole is more than the sum of its parts*". Well, that is certainly one of the most well-worn catchphrases for systems thinking or holism but is it not too general and vague to be of practical use. In what way is a system more than the sum? Does this not depend on particular forms of structure/relationships and emergent properties? Are not some systems only the sum of their parts (for instance, computer code that does not work is just the sum of the lines of code)? Or even less than the sum of their parts (a work group that argues all the time may be worse than the individuals in it)? One needs to be much more detailed about the components, their relationships, boundaries, environment and behavior.
2. *Goal seeking and equilibrium*. While there are some systems, often designed systems or biological systems, that do seek a goal and maintain equilibrium, many recent developments show that perhaps most systems do not in fact operate like this. Complexity theory emphasizes disorder, constant change and lack of equilibrium, and Maturana (1975) argues that autopoietic systems are purposeless other than maintaining their own circular organization. Soft systems argues that humans pursue many different, often conflicting goals and are "irrational" in classical economic terms.
3. *Input, transformation, output*. This is a very hard systems view. Autopoietic systems are organizationally closed, they do not transform inputs into outputs other than themselves into themselves. Soft systems shows that a system may be characterized in many different ways by different observers. Can we, for example, specify unambiguously the inputs, outputs and goal of a prison, a hospital or a school?
4. *Recognize "self-reference" and "autopoiesis".* These are certainly very important, and rather complex and potentially contradictory concepts. We have already mentioned that there is considerable debate as to whether social systems can be autopoietic at all. Self-reference can easily lead to paradox and contradiction (J Mingers, 1997) – "This sentence is false", for example. It was the downfall of Russell's attempts to systematize mathematics in *Principia Mathematica.*
5. Recognize the system/environment distinction. This is very fundamental to systems but actually a very problematic notion once one leaves the world of hard physical systems (J. Mingers, 2006, Ch 4). In the social and conceptual world the boundary that separates the system from its environment is an observer construction.
6. Requirement to recognize "communication". Communications is very important, especially in psychological and social systems, but it is not clear that Luhmann's approach is the most fruitful. We could consider Habermas (1984 1987; Klein & Huynh, 2004) or indeed semiotics (J. Mingers & Willcocks, 2014, 2017) as alternatives.

3.2 Alternative criteria

With considerable reluctance, I will put forward some very tentative and under-developed guidelines myself that could guide the IS field's approach to systemic theorizing:

1. Recognize the fundamental concepts of systems thinking: (i) system/ boundary/ environment; (ii) behavior depends on the structure (components and particularly their relationships); (iii) emergence of new properties at higher levels, hierarchies of systems; (iv) the importance of information and feedback and circular causal loops rather than simple linear causality; and (v) complex, non-linear behaviors and unpredictability.
2. Recognize the importance of the observer. Whenever we analyze a system we have to remain aware that we become part of the system and that our analysis is, in part, our construction. Reflexivity - to reflect upon the research situation and our relations to it – is a necessity within systems theorizing.
3. Seek to observe interesting and perhaps unexpected patterns of events and then try to explain these in terms of generative causality. What systems or mechanisms, with which properties or powers would, *if they existed*, generate the events we experience? These systems may be of different kinds (material, cognitive, social) and may be stratified into a hierarchy of levels.
4. The real world, unlike the laboratory, is not closed and controlled but open, ever-changing and unpredictable. We should expect divergence rather than convergence; and seek explanation rather than prediction.
5. Behavior depends on structure and context. The same system (e.g., a person) may behave differently in different contexts, and different systems (e.g., people) may behave similarly within the same context. We must always consider information systems within their wider social and political contexts.
6. Recognize that the world is multidimensional with many different kinds of systems and therefore that a range of different research methods or methodologies are required.

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