Systems Dynamics: A Form of the Integrative Systems Approach

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Abstract

There are many different systems approaches and styles of systems thinking that have developed over the past three decades. There a few conceptual frameworks on which to compare the relative merits of each approach. This paper will propose such a conceptual framework, the "systems paradigms framework". Within the context of this framework new systems approach will be described. It is labelled the "integrative systems approach". It will be argued that the system dynamics perspective is the best existing example of the integrative approach. The integrative approach will be compared to the hard systems, soft systems, and cybernetic systems approaches, in terms of the systems paradigms framework.

Systems Approach, Systems Thinking...System Dynamics

Early descriptions of systems often regarded them as being concrete, discrete entities that existed separately from human experience. The view stemmed from a set of assumptions where the world was considered to inherently possess systemic properties. Consequently, the focus of early systems research was directed toward discovering the 'laws' that controlled actions of these systems (Atkinson and Checkland, 1988). The conceptual paradigm that dominated systems research and debate in the 1950s and 60s was grounded in assumptions based on realism, positivism, and determinism. Attempts to understand systems were often directed to identifying isomorphisms with relatively well-known types of systems such as machines and organisms. Such isomorphisms found expression as analogies, such that if a specific organization was seen as being primarily machine-like, then it was expected to behavior in a clockwork-like fashion; deterministic, sequential etc. Efforts to understand organizations followed the same pattern of logic using metaphors as a primary descriptive tool. Various theorists have attempted to explain the nature of organizations by characterizing them in metaphorical terms such as machines, organisms, brains, and hearts (Morgan, 1986). However, organizations are multi-dimensional entities which defy representation with any single metaphor. The systemic characteristics of organizations result from the interaction of a potpourri of economic, social, technical, and political forces usually escape monolithic depiction. In the 1970s and 1980s the focus of systems research shifted toward a more nominalistic, phenomenological perspective. Researchers visualized systems as the creation of human consciousness and cognition. The research agenda was changed to reflect the newly relevant issues of inquiry, learning, and information processing. Conceptual models became understood as systems for understanding other systems. Systems thinking emerged as an important tool for understanding systemic behavior. At various times, systems thinking and systems approaches have been described in popular literature as though they were singular concepts, when they were a aggregation of a number of loosely related ideas. During the 1960s the "systems approach" became popularized and wrongly equated with system thinking (Churchman, 1968). The proliferation of various systemic approaches and styles of thinking can cause confusion regarding how they are related, and what are their relative merits and limitations. This paper will offer a framework for considering these issues.

Systems Approaches

A systems approach encompasses a single theme which may be expressed in terms of systems theory, systems thinking, and systems applications. There are at least four types of systems approaches that have been identified: 1.the hard systems approach, 2.the soft systems thinking, 3.the cybernetic approach, and 4.integrative systems approach (Cavaleri and Obloj, 1992). The hard systems, soft systems, and cybernetic approaches are all grounded in a limited, specific region of the philosophical spectrum. The narrowness of these paradigms restricts their ability to explain many of the complexities recognized in systems and in organizational intervention (Jackson, 1982). This author proposes that the only systems approach which can adequately serve as both a comprehensive conceptual tool, and a basis for organizational intervention is the integrative systems approach. There are two well-known perspectives within the this approach, system dynamics, and sociotechnical systems. In sociological theory, the integrative paradigm is well-established in the literature (Burrell and Morgan, 1979). To this point an analogous framework has not been established in systems theory. There have been numerous attempts to establish a basis to categorize and differentiate the various systems approaches into various specializations. The initial and arguably most important differentiation was made by Checkland (1981) in which he distinguished "hard" and "soft" systems thinking. Jackson and Keys (1984) have developed an interesting framework for comparing systems approaches for varying types of problem solving. Unfortunately, this model does not address the fundamental paradigms on which each systems approach is based. The ground work laid by these writers has clearly established that the various systems approaches reside in very different philosophical territory in regard to basic assumptions.

Systems dynamics is currently the most integrative form of systems perspective and can serve as a working prototype to validate various hypotheses concerning the integrative systems thinking paradigm. The purpose of this paper to propose a set of tentative criteria for use in defining the integrative systems approach more clearly and to distinguish it from other systems approaches. Secondly, it is to identify the potential value of the integrative systems approach, and finally to demonstrate that system dynamics is the most refined form of the integrative systems approach and offers the greatest potential to yield breakthrough insights in systems theory and practice. Consequently, this author proposes that the merits of the integrative systems framework should be considered as a potential basis for evaluating future contributions in system dynamics research specifically, and in systems theory in general. Each of the

three well-known approaches will be presented and explained in relation to its philosophical underpinning.

The Primary Systems Approaches

Each of the major systems approaches will be considered in terms of its underlying assumptions and traditions. The distinguishing features of each approach will be highlighted. Each of these three approaches, hard, soft, and cybernetic systems, will be considered to be a primary approach, while the integrative approach will be seen as a secondary approach.

In general, the hard systems approach emphasizes the importance of quantifying, and measuring systemic properties. The raison d'etre of this strategy is to reduce the levels of uncertainty associated with the problem solving process. The core assumptions undergirding the hard systems approach is that rationalization, and systematization of problem solving processes will lead to decisions which are superior to alternative processes. This perspective is based on prime assumptions of technical and economic rationality. The basis of technical rationality is the belief that science is the rudimentary framework and knowledge base for all problem solving processes. Technical rationality is driven by concern to achieve preestablished goals with the minimal use of resources. The hard systems approach generally follows a strategy that focuses on analyzing sets of problems, and creating an economic solution to each problem. Consequently, this approach is characterized by the basic paradigm that the problem solving process must commence with a well-defined, clear problem statement. Once a problem situation has been clearly formulated, the decision-making process that follows will primarily be concerned with identification of alternative solutions. Most problems are framed as tasks to judge the efficiency of potential solutions in reaching these predetermined end points. Most solutions are designed following basic scientific principles and engineering an appropriate solution involving processes, technology, or structure. The hard systems approach is based on a specific set of philosophies: realism, positivism, determinism, reductionism, structuralism, economic rationality, technical rationality, objectivity, the primacy of closed-systems, and the importance of achieving final solutions.

The soft systems approach is based on the belief that perceptions are subjective experiences, therefore, there is no single reality which is known to all people. Accordingly, the perceptions and experiences of various people will be interpreted in different ways, by various viewers. Consequently, this makes it extremely difficult for a group to identify a single, well-defined problem, in complex, "ill-defined" dynamic systems. Therefore, there is little impetus

to create single technical solutions to problems. Soft systems thinking addresses organizational improvement through the vehicles of continuous learning, and communication. These are "generative" tools which are intended to build the problem solving capacity of organizations. Through the use of continuous processes which include reiterative cycles of action, reflection, and experimentation and discussion among organization members, problematic areas are "whittled" away, while the amount of insight relating to the issue increases.

There are six principles which underlie soft systems thinking, and distinguish it from other forms of systems thinking:

1. Perceptions and experiences are subjective. All events are subject to various interpretation and meanings.
2. There are no problems, "out there" waiting to be solved, rather problems become enacted through people's conditioning and perceptions.
3. The nature of problematic situations is complex. It is more accurate to identify general "issues" than to define specific problems.
4. There are no permanent solutions only improvements. A continuous series of improvements are known as "accommodations."
5. Systems are projections of the mind, not real objects.
6. System gains are the result of learning and accommodation rather than on engineered and optimized outcomes.

Soft systems thinking is based on the belief that many events that people perceive are not "objective" factual happenings. It acknowledges that organization are the mental projections of its members. Since the soft systems approach holds that troublesome issues cannot be permanently resolved, the emphasis of organizational improvement efforts needs to be shifted towards discovering alternative ways of framing situations to fuel continuous improvement. Continuous learning environments are characterized by an emphasis on teamwork, facilitative peer teaching, active experimentation, and thoughtful periods of reflection. Such organizations place are "process-oriented" and focus on continuous improvement, rather than on achieving solutions. Process-oriented methods are based on the assumption that incremental refinement in the methods used to address issues will eventually generate improved outcomes, as a consequence. The soft systems approach is characterized by belief in the following types of assumptions: nominalism, phenomenology, voluntarism, open-systems, process, emergent structure, continuous improvement, continuous inquiry, learning, interpretation, subjectivity, subtlety.

Norbert Weiner's original definition of cybernetics proposes that it is the science of communication and control in animals and machines. Since that time, 1948, cybernetics has become viewed more broadly as the study of communication and control in any environment. Additionally, significant research within this field has focused on information transmission, storage, and processing (Klir, 1965). Cybernetics has also involved the study of the effects of feedback on systems. The control function of cybernetics has traditionally been regarded as a mechanism in the process of regulation that was "necessary" for a system return to equilibrium. Cybernetic thinking is just one application of the broader study of feedback. Strictly speaking cybernetics deals with regulation of systems through the use of feedback. The study of feedback and is not necessarily cybernetics. Theorists such as Ashby (1956) and Beer (1985) have employed cybernetic principles to make prescriptions for organizations on a variety of topics ranging from organization design to strategic management. The cybernetic approach is based on the following assumptions: equilibrium is considered normal, closed-system, technical rationality, realism, positivism, determinism, and functionalism and information is regarded as being a fixed quantity.

It is proposed that it is no longer appropriate to limit cybernetics to the study of control in equilibrium-oriented environments. Positive feedback loops are very important engines of innovation in organizations, yet are virtually ignored in traditional cybernetic theory. Cybernetics can have greater relevance to the process of managing by expanding its scope to include all types of feedback, not just negative feedback and for purposes other than control. Therefore, for the purposes of this paper, cybernetics will be understood as the study of feedback as it relates to the processes of communication, and change in systems.

The integrative systems approach combines the three primary approaches into varying configurations that can be observed in approaches such as system dynamics, and sociotechnical systems approaches. The integrative perspective has several distinguishing features. Most importantly, it must contains elements of each the three primary approaches, ie hard, soft, and cybernetic. Secondly, technology and people have equal value. Thus, it become necessary to engage members of organization through some form of participation. Third, it employs hard systems, and cybernetic thinking as tools to enhance the productivity of people, rather than to generate "solutions". Fourth, it has a conceptual foundation of continuous improvement based on reiteration and experimentation. Fifth it substitutes linearity with causal loop thinking patterns. Finally, structure and design functions are important as factors to

control experiments in improving productivity rather then for creating solutions.

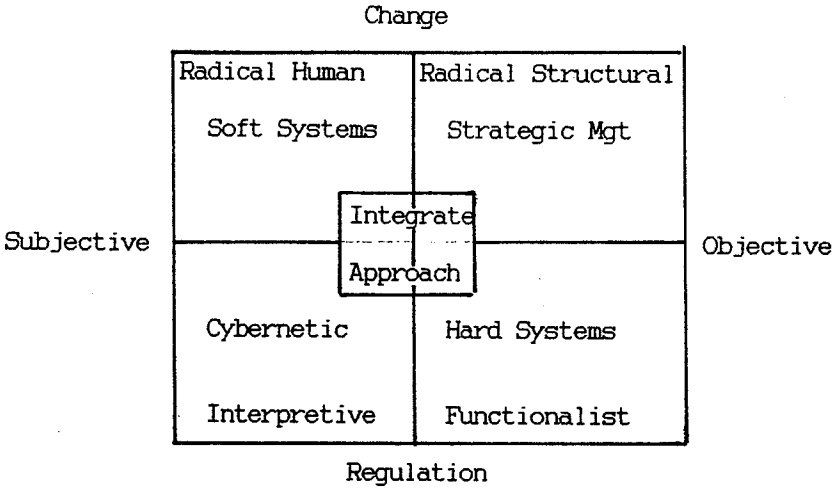
Therefore, the integrative approach may be described as a multi-dimensional systems perspective for creating change, that uses hard system and cybernetic thinking to engage people in a process of continuous organizational improvement. Ultimately, the outcomes that result from the use of the integrative approach are always focused on the optimizing both the human and technical dimensions of system because they are symbiotic co-factors. In the integrative approach information can be used to close or open a system. That is, it can function either as a regulatory role or as a catalyzing force to promote pattern-breaking change. Technical information is used to trigger debate regarding ways that information can be given new meaning. By finding new patterns through the process of reframing information, new meaning is created. Subsequently new meanings creates new information which now serves as the basis for new patterns...and positive feedback loop gathers momentum. The result is that order is found in chaos, and chaos is found in order (Nonanka,1988). The two most common integrative approaches are the sociotechnical systems approach (Trist, 1981) and the system dynamics approach (Forrester, 1961). The sociotechnical approach attempts to optimize human and technical factors through systems design. Until recently, the information feedback dimension has received little attention. Work at various Volvo plants to tie work groups to computer data bases has helped to close some of the informational feedback loops. There are many dimensions of the sociotechnical approach that are still oriented toward linear conceptions of organizations. More recently, work is being done to adapt the sociotechnical concept to embrace the dynamic dimensions of organizations (Pava, 1986). Despite this initiative, this approach is considerably less integrative relative to the system dynamics approach.

System dynamics is the most integrative approach to managing organizations. It maintains deep roots in the hard systems tradition through its applications in system design, modeling, and computer simulation. The work in system dynamics with causal loop, and stock and flow diagramming has roots in cybernetics and control theory. However, it is differentiated from cybernetics by using this information as an educative conceptual tool, rather than as a regulatory mechanism. Sterman's (1989) investigation of the role of feedback in dynamic decision processes has focused attention on the role of emergent feedback, rather than feedback in operational control systems. Senge's (1990) work in coupling system dynamics with systems thinking and organization learning has opened the approach to include the softer dimensions necessary to make it an integrative approach.

The Systems Paradigms Framework

In order to evaluate the potential usefulness of the integrative systems approach, and to establish a working systems typology the sociological paradigms framework of by Burrell and Morgan (1979) has been adapted for this purpose. This typology, the systems paradigms framework, considers two fundamental dimensions that are the foundation for any systems approach: perception and control.

When assumptions are made that information is objective, and the system is concrete, situations are regulated through the use of hard systems approaches, such as operations research and systems analysis. When information is regarded to be subjective and systems are seen as people's mental creations, then the focus shifts to working more directly to increase the capacities of people...and changing the way they think. When adaptation to a uncertain environment is required, regulatory efforts become cybernetically oriented as various reiterating feedback loops seek to lessen the distortion created by subjectivity.



The Systems Paradigms Framework

For example, Beer's (1985) Viable System Model is an interpretative cybernetic system used for promoting organizational adaptation. Finally, when change is required in systemic behavior and information is perceived as being objective, the result is wholesale reorganization of structure. This scenario is commonly observed with corporate mergers, buy-outs, down-sizing etc. In such situations, the value of people declines relative to other factors, and they become subordinate to objective information such as

stock price, market share, and merger premium. In such situations, innovation, the creation of meaning, and other relatively less-tangible factors lose their significance because they are seen as being inconsistent with the objective-regulatory paradigm.

The Integrative Systems Approach and System Dynamics

There are a number of issues that emerge from considering the system dynamics in the context of the Systems Paradigms Framework. These issues may serve as the catalyst for discussion of various ways that system dynamics may be used in the future.

1. Are the means for utilizing the regulatory and change-inducing dimensions of system dynamics sufficiently explicit?
2. Is the organizational learning and systems thinking link to soft systems the best vehicle for creating new meaning?
3. Should there be a meta-model that directs the use of systems dynamics under varying circumstances?
4. Are the social and technical dimensions of system dynamics being effectively optimized?

The concepts of integrative systems and the integrative systems framework are exploratory. They are intended to place reframe system dynamics in terms of a broader meta-model that will provide to new from existing information through forming new patterns of thought.

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