The Role of System Theory in Scenario Planning

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Abstract

This paper describes system theory as one of several potential foundational theories in scenario planning. Further, this paper intends to clarify hints of the importance of system theory in scenario planning literature through a more detailed and comprehensive examination of how these two concepts may be linked. A discussion of how core system theory concepts are prevalent in scenario planning is provided after detailed descriptions of each. Based on the review presented, it seems that system theory may provide a foundational theory that could serve as a philosophical frame for scenario planning practice.

Keywords: *scenario planning, system theory, uncertainty*

It is no surprise that as our world increases in complexity and uncertainty, business leaders look for ways of anticipating change to help their organizations survive. In efforts to do so, business leaders are relying more heavily on strategic tools. One such tool has been scenario planning. Scenario planning has gained increased attention during the last 20 years as an effective method for identifying critical future uncertainties and investigating blind spots in the organization (Kahane 1999). By focusing on several *plausible* alternative futures and giving up the notion of predicting the future, scenario planning has avoided many of the pitfalls and criticisms of strategic planning (May 1996, Mintzberg 1994). As a result of popular use, there are multiple methods for conducting scenario planning, and due to proprietary methods, the ability to examine the theoretical foundations has been severely limited.

Definition and Purpose of Scenario Planning

In an analysis of scenario planning definitions and outcome variables, Chermack & Lynham (2002) defined scenario planning as "a process of positing several informed, plausible and imagined alternative future environments in which decisions about the future may be played out, for the purpose of changing current thinking, improving decision making, enhancing human and organization learning and improving performance" (p. 343). Scenarios and scenario planning do not aim to forecast or predict a single future, rather the intended outcomes are those described in the definition: changed thinking, improved decision making, enhanced human learning, and improved organizational performance. While each individual scenario does contain a forecast of a potential future, the use of multiple scenarios allows the consideration of many plausible futures that are all relevant to the project at hand, each containing forecasted events based on rigorous analysis. The point is to encourage divergent thinking about what could plausibly happen in the future.

Problem Statement and Structure of the Paper

Scenario planning has developed mainly in practice (Wack 1985, Ringland 1995, Van der Heijden 1997), and has not yet established strong theoretical roots (Gergantzas & Acar 1995). The alternative to having foundational theories is a field or process in which practitioners may include any theories they choose. Such a situation becomes problematic when focusing on a deep understanding, or long-term, replicable results (Swanson 1999). Further, Warfield (1995) suggested that the articulation of theoretical foundations is central to the progress and development of a discipline. The fact that scenario planning practices have not been subjected to rigorous examination leads to questions about the effectiveness of the process itself. Thus the core *problem* is that:

> *Many established authors in the scenario planning literature imply that theory is important in the application of scenario planning (Wack 1985, Schwartz 1991, van der Heijden 1997, Ringland 1998; 2002) however, these claims are rarely clarified.*

It may seem that this is a call for strictly academic examination of scenario planning practices. While the use of academic tools can aid in the understanding of a phenomenon, those tools are most effective when aimed at real world problems such that the results will be useful to practitioners. A starting point, however, is realized in the identification of theory domains that are important in the application of scenario planning. Chermack, Lynham & Ruona (2001), Ringland, (1998; 2002), Schwartz, (1991), van der Heijden, (1997) and Wack, (1985), have all suggested that some potential theory bases for informing scenario planning include learning theory, cognitive development theory, decision theory, system theory and performance improvement theory. This paper aims to tackle one such theory domain in a more detailed examination than current literature offers. Thus, the core purpose of this paper is to:

> *Explore system theory as a foundational theory of scenario planning and attempt to outline the ways in which system theory informs scenario planning.*

While there is extensive literature regarding other potential foundational theories of scenario planning such as learning, mental models, decision-making and performance, the intent of this paper is to address only one – system theory – as the others may be addressed in forthcoming investigations.

Methodology and Research Question

Harkins & Kubic (2000; 2001) proposed three modes of systems, namely (1) mechanistic (2) organic and (3) teleogenic. Their framework was selected on the basis that it is able to integrate and categorize the vast system theory literature in a relatively simple and easily comprehendible manner (Harkins & Kubic 2000; 2001). Given the preliminary nature of this exploration, an extensive review, analysis and synthesis of both scenario planning and system theory literature was used to answer the following question:

- How does system theory inform the process of scenario planning?

It is important to clarify at this point that this paper explores system theory applied to the systems in which scenario planning is used and, where appropriate, the scenarios themselves. That is, some system theory concepts apply to the general organization, and some concepts apply to the individual scenario stories.

Literature was selected based on 2 searches conducted through journal search engines including ABI Inform, ERIC, PsychInfo, as well as electronic journals Interscience/Wiley, Catchword, ScienceDirect, and JSTOR. The first search was conducted using search criteria of "scenario planning" contained in the "keywords" field. The second search was conducted using search criteria of "system theory" contained in the "keywords" field.

Key sources were also selected by examining the reference sections of search results for keywords "scenario planning" for the term "system theory" and vice versa. The intent was to find the original sources used in scenario planning literature to cite the importance of system theory to the process. Further, the intent was to make the argument that system theory is an important theory base in scenario planning.

The methodology was complimented by the initial reviews of this article. Reviewers with clear knowledge and expertise concerning system theory provided numerous further resources that speak directly to the interplay between system theory and scenario planning which were not found as a result of the keyword search. Thus, in order to provide as comprehensive a review of the relevant literature as possible to answer the research question, these additional sources were included to enhance the original methodology.

A key limitation of the methodology can be noted in its mechanistic approach. This approach was meant to capture the literature currently contained in electronic databases that could be used to answer the research question. While this paper operates at an abstract level, it must be noted that alternative approaches to answering this research question can and should be taken in the future. Some of those alternative approaches include: Inayatullah's (2000a; 2000b) Causal Layered Analysis method, case studies, or interviews with practitioners (Russo 2003, Inayatullah & Wildman 1998).

Examining Complex Systems

Kubic & Harkins (2000; 2001) submit three modes or forms of system: (1) mechanistic (2) organic and (3) teleogenic. Mechanistic systems are generally very simple systems. These simple systems are usually non-human systems and are rigidly controlled. Organic systems operate at higher levels of complexity and are found in artificial intelligence, computer programs, and biological system, among others. Organic systems can be human systems, however, the core point of differentiation between organic systems and human systems is the notion of purpose. Organic systems may serve a purpose, but teleogenic systems create purpose. Teleogenic systems are systems that develop, and are responsive to, intent, or purpose (Powers 1989). Because of the ability of teleogenic systems to cope with purposefulness, this third mode or classification of systems is most appropriately applied to human systems and is where this paper will focus most of the majority of its examination. While the teleogenic mode of systems is most pertinent to the realm of human systems, the mechanistic and organic modes require some explanation as work in these areas has given rise to the notion of teleogenic systems (Kubic & Harkins 2001, Banathy 1993, Martuana 1975).

Mechanistic Systems

Mechanistic systems are rigidly controlled systems. These systems are human-machine interface systems that are limited in their interaction with their environments, have minimal components, minimal freedom, singleness of purpose, and exhibit mechanistic behavior (Banathy 1993). Examples of mechanistic systems include: aircraft landing gears, a drill press, simple lever systems, or single outcome mechanical systems. A key factor for mechanistic systems is that they are non-human system.

Organic Systems

Organic systems are systems with properties of self-regulation. Organic systems are found in the development of artificial intelligence, cybernetics, computer simulation system and simple living systems. Simple living systems can be classified as organic systems, but the key characteristic is the complexity of the system in terms of inputs, processes, and outputs. These systems have defined goals (often simply to reproduce system parts, structures, and the system itself) but exhibit some degree of flexibility in operation. Human systems can be classified as organic systems based on the notion that they *serve* some purpose, however, if they *generate* purpose, such human systems may more appropriately be classified as teleogenic systems.

Central to the mode of organic systems are the notions of autopoiesis, feedback and dissipative structure (Capra 1996). Autopoieis describes the self-generative behavior of complex systems and is responsible for the pattern and organization of the system (Capra 1996). Feedback influences the state of the system by supporting growth, shutting the system down, maintaining equilibrium, or giving rise to innovation in a state that has become known as "bounded instability" (Stacey 1996: 74). Dissipative structure refers to the notion that a system can be structurally open but organizationally closed, or that it can have form, but allow materials and/or resources to flow through it. These three concepts are described in particular as they apply in scenario planning.

Autopoiesis

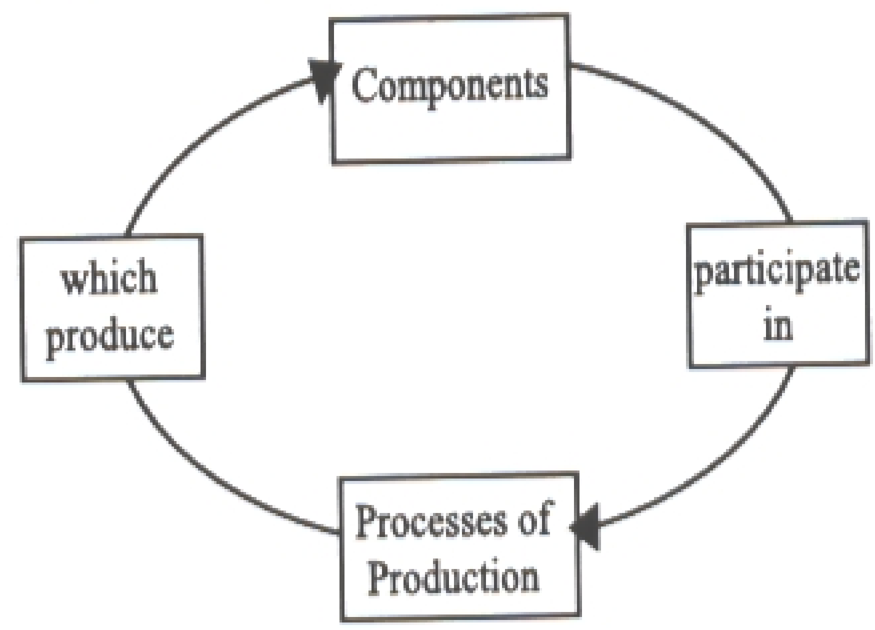
Maturana & Varela (1973) base their work on 4 fundamental assumptions about the nature of organic systems, namely, (1) that organic system are autonomous (2) the behavior of the whole is generated by the components and their interactions with neighboring elements (3) observers can perceive both the system and its environment and how they interact and (4) the observation of function can only be made by an observer who can interact with both the components and the whole. Maturana & Varela consider two key questions in the analysis of what differentiates organic system from mechanistic system:

What is it that a system produces?

What is it that produces the system?

Maturana & Varela use a cell as an example of an organic system. Consider for a moment what it is that a cell produces. Cells produce their own components, which therefore produce the cell itself in a cyclical and ongoing process. "A cell produces, and is produced by, nothing other than itself" (Mingers 1995: 11). This is the core of autopoiesis. The word means, literally, self-producing, which is exactly what a cell does. (Figure 1 displays the circular processes of production).

Figure 1 Circular processes of production (Mingers 1995)



The organization of a system demonstrates the properties of the system as a whole and occurs on a conceptual and abstract level. Organization is found in concrete examples in reality, while structure often refers to the generality lying behind such examples (Mingers 1995). The distinction between organization and structure is, therefore, in the distinction between the whole and its parts. In these terms, organization refers to the events (often empirically detectable) and structure refers to the underlying assumptions.

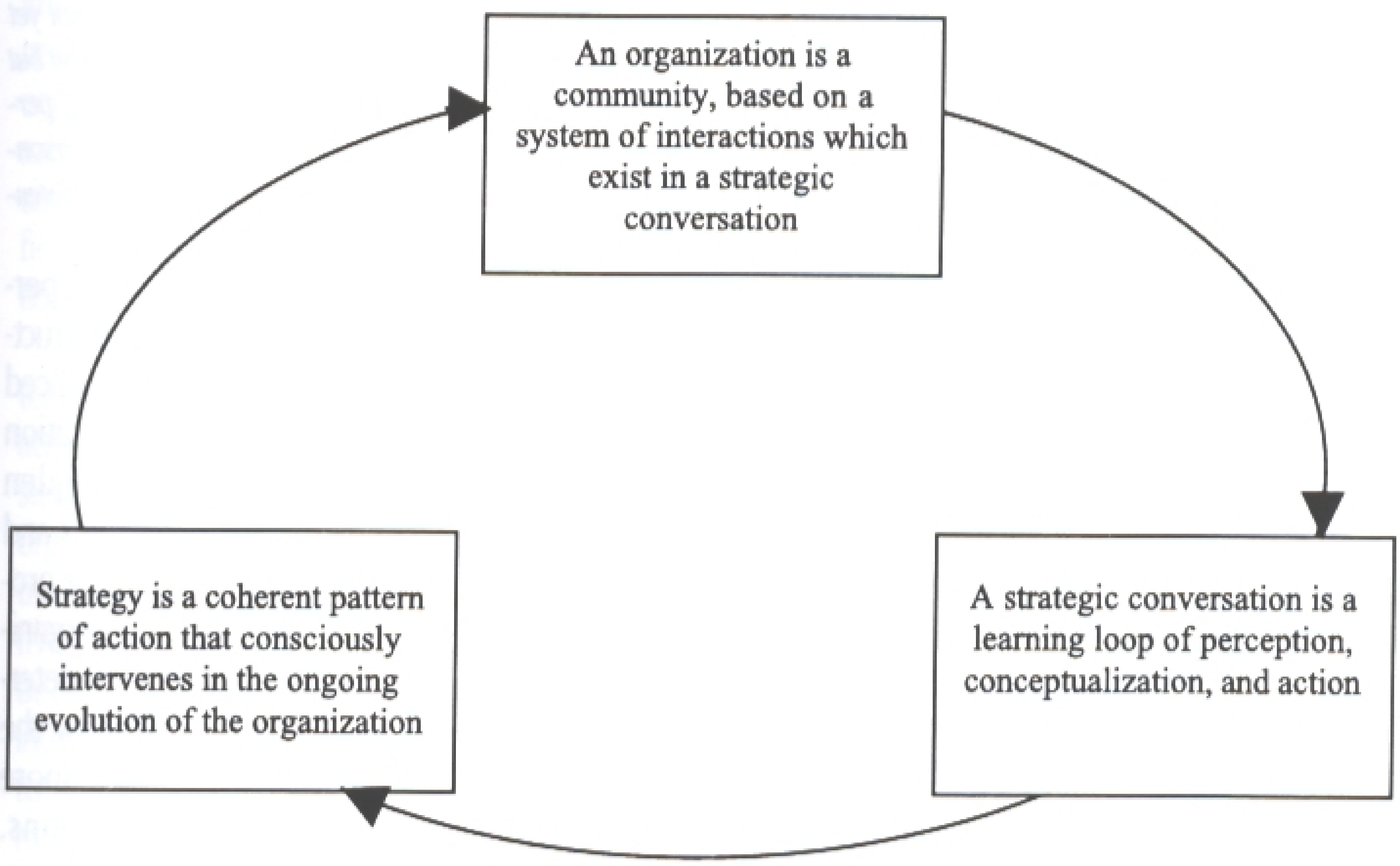
In other words, autopoetic networks must continually regenerate themselves in order to maintain organization. Autopoiesis is not confined to the physical world (Mingers 1995, Martuana & Varela 1973) thus leaving open the possibility for communication, social systems, or a set of concepts to also be defined as autopoietic systems. A concern around the concept of autopoiesis is in its application to other systems. Human-influenced systems become extremely complex, which makes the origins of autopoiesis within them, something mysterious. Human-influenced systems become more abstract because of their complexity. For example, one cannot observe a business organization in the same way that one can observe a cell under a microscope. Thus, a common problem in the application of system concepts is a failure to make the switch in perspective. Looking for characteristics of autopoiesis in human system from the mechanistic perspective will not yield very powerful results. The key to autopoiesis in human-influenced system is in the relationships among components.

Autopoiesis is evident in human-influenced systems and organizations and can be considered by first asking the same questions posed by Martuana & Varela, which are both critical questions in scenario planning (Schwartz 1991, van der Heijden 1997).

The use of heuristics often provides an answer to the first question. For example, the business idea (van der Heijden 1997) is designed to articulate the key products and processes without which the organization would not exist. The second question is more difficult to answer. The organization system is sustained by the continuous input and output of resources. In today's world, the primary resource of concern is a financial one. If an organization is not financially viable, it will not be in business for long. Thus, business organization systems can be described as autopoietic because they naturally strive to regenerate themselves through the perpetual flow of inputs, processes and outputs and because they must regenerate their resources to sustain themselves.

Scenarios as Autopoietic Systems. The actual stories generated in the scenario planning process can also be viewed as autopoietic systems. van der Heijden (1997) referred to the notion of the "strategic conversation" (p. 46) which is an example of autopoiesis in the scenario itself. A strategic conversation occurs when individuals participate together, share ideas about patterns, reflect together, build a common course of action, and act together. The strategic conversation is the collective consideration, deliberation, planning, and action of members of an organization. In this context "the learning loop works as a positive feedback loop" (van der Heijden 1997: 47). The assumptions of the strategic conversation are that organization structure exists in action and interaction, and that action and interaction take place through conversation or dialogue. van der Heijden provided a heuristic for understanding the strategic conversation (See Figure 2).

Figure 2 The art of strategic conversation (van der Heijden 1997)



Feedback Networks and System States

Maruyama's (1963) work on feedback has had a delayed, although profound impact on the development of the systems view. Maruyama's work has been simplified as the application of system theory to other disciplines has increased. Using complex cybernetic terminology, Maruyama investigated "deviation-counteracting" (balancing) and "deviation-amplifying" (reinforcing) feedback. In general, there are four types of feedback based on the work of Maruyama, and thus four general system states, namely (1) negative feedback which leads to system failure (2) positive feedback which leads to system growth (3) a balance of positive and negative feedback which pushes the system to equilibrium and (4) non-linear feedback which occurs randomly but within limits.

Negative feedback often begins when a system finds itself in an environment to which it cannot adapt and simply shuts down. In organizations, and example of negative feedback would be an organization that is experiencing a negative cash flow. Given enough time, the system will fail because it is not generating the resources it needs for survival. Positive feedback refers to feedback that supports system growth. An example would be positive financial growth. A balance of feedback is the most common system state and most organization leaders strive for equilibrium and the predictability that accompanies it. Non-linear feedback occurs when a system has enough self-direction that it does not have to be controlled, but there are limits to the changes that can occur within the system.

Because feedback determines the state of the system, it is an important aspect when considering business organizations as systems. Stacey's (1992) early argument was that the equilibrium model, which is predictable and stable over time, is no longer the model that organizational leaders should be striving for. Instead, Stacey stressed that organization systems will fluctuate among all of these states; however, the most productive and innovative state is a state he called bounded instability, caused by non-linear feedback. This is the state in which innovation leads to a competitive advantage. The equilibrium model simply does not allow leaders of the organization to break out of a state in which they react to changes in the environment. Innovative organizations design and determine their own futures and it is argued here that one way of doing so is by using scenarios.

Stacey's thinking has evolved to the point of separating humans from systems. According to Stacey's more recent work (2003; 2001), humans cannot be considered system components because this implies that they are performing some required function as a process in a larger system. The problem inherent here is that humans are required to interact with multiple systems and have influence on systems, but cannot be considered system components themselves.

> *Stacey's approach to complexity science suggests that such a complex network of agents cannot lend itself to a single purpose, control, or design of any given single system. The situation is emergent. That is, human agents acting in complex networks consisting of different purposes, goals and notions of the future create their own futures through emergent interaction. Stacey (2003) explained: "I experience a process of learning occurring through conversations taking place in the context of personal relationships. The experience is one of dialogue that slips in and out of debate, in which people are trying to surface what they do not yet know, as well as articulating what they know but cannot yet express. It is though conversing, persuading and exerting influence in a highly personal network of relationships that the shape of potential change emerges." (p. 17)*

Feedback in Scenarios. Feedback is perhaps the most important reason for constructing scenarios. The feedback that is produced regarding the capabilities of the organization when it is "windtunneled" (van der Heijden 1997: 57) will show precisely the strengths and weaknesses of the organization. Planning professionals can also alter the state of the organization system in an imaginary capacity to determine if a different system state will allow the organization to respond differently or more successfully in similar future situations. Additional research in this area could prove useful, particularly research concerning the most successful applications or activities of each system state.

Dissipative Structures

Prigogine (1977) described dissipative structures and placed emphasis on the openness of the structure and its ability to allow energy and matter to flow through it. Capra (1996) used the vortex in a bathtub as the water funnels down the drain as a simple example of a dissipative structure. The vortex is self-organizing (although the irregularities in the movement of the water and in the drainpipe are environmental factors that influence the developing structure) and it allows the water to flow through it continually. "Thus a living system is both open and closed-it is structurally open, but organizationally closed. Matter continuously flows through it, but the system maintains a stable form and it does so autonomously." (Capra 1996: 169)

Dissipative structures emerge when a system moves away from equilibrium to a point of bifurcation. (Prigogene 1997) The general expectation is that the system becomes unstable at this point. Beyond this point, however, systems take on new phenomena, for example, alternate chemical reactions in biological systems, or alternate structures in others. The importance of this point is that systems spontaneously organize at points that are far from equilibrium, and while this spontaneous organization can be clearly observed in natural systems, (Prigogine 1997) they are much more difficult to identify and observe in social and human systems.

The significance of equilibrium in any system is that it is an indicator of non-changing activity. However, this is increasingly an undesirable characteristic as the rate of change organizations are facing is pausing for equilibrium for short enough periods of time that it is irrelevant. Organizations themselves are becoming more and more innovative and increasing their internal change processes due to the complexity and uncertainty in the environments they are facing. Thus, Stacey's (1992) early work becomes informative.

Stacey (1992) pointed out that most organizations are perceived as systems striving for equilibrium. However, he noted that organizations with a competitive advantage are innovative, and by definition, "innovative strategic directions take an organization into uncharted waters, away from the norm or equilibrium." (Stacey 1992: 4) Stacey suggested that innovative organizations, by embracing uncertainty and letting go of linear management and prediction thinking, are systems operating as dissipative structures (like the vortex in the bathtub), far from equilibrium. "In this state, the system generates behavior that is unstable, but because it is unstable within limits that behavior is called bounded instability." (Stacey 1992: 11) Bounded instability is Stacey's description of the behavior that occurs in a dissipative structure. Accordingly, what may be required is a new set of perceptions about the nature of and purposes ascribed to organizations as system and their intended states of operation.

The utility in viewing an organization as a dissipative structure far from equilibrium helps inform scenario planning professionals and practitioners about the nature of a system that is inherently unstable, yet within limits. This shift in thinking is precisely what Stacey (1992) called for. An organization that is pushed by its leaders toward comfortable equilibrium will never be innovative and thus, never develop a competitive advantage. In an environment of considerable change at increasingly rapid rates, the equilibrium model is contrary to the nature of the system view and leads to system failure. (Stacey 1992) However, Stacey's (2002) later work on complexity and its role in strategic management suggested that attempts to study human organizations with the tools of engineering and scientific approaches to management were likely candidates for failure. Thus, Stacey's (2003) thesis has been that understanding complexity in human organizations requires tools involving dialogue, debate and the ability to let go completely of the idea that anyone or anything can control such an organization.

Scenarios as Dissipative Structures. Scenario stories themselves, can be viewed as dissipative structures. The utility in taking this view is demonstrated by considering the characteristics of dissipative structures and comparing them to the characteristics of scenarios. Linked to van der Heijden's (1997) notion of the strategic conversation, scenarios will follow a plot line and structure, but are conceptually open in terms of imagined events in the story. The authors of the scenario are not limited in the events that they may create in the story; however, the plot, or structure of the story is held in place. The scenario stories also act as dissipative structures when they are used as "windtunnels" (van der Heijden 1997: 57) to test the adaptability of the organization, allowing the current organization to "flow" through them in an imaginary capacity.

To clarify, scenarios are used to create alternative pictures of the environment and assess organizational resources and options in each of them. Thus, scenarios allow experimentation with multiple futures that are inherently complex and uncertain, yet they do not force organization decision-makers to select a preferred future such as is the case with other strategic approaches.

Teleogenic Systems

A *teleogenic* or purpose generating system is a system that seeks a set of related goals for which it was created. (Banathy 1993) Mechanistic and organic systems can be purposeful, meaning that they serve some purpose but they do not generate purpose. Teleogenic systems incorporate and build upon the concepts of autopoiesis, requisite variety, and dissipative structure. Scenarios and scenario planning incorporate these concepts and are attempts to develop purpose-seeking systems by providing and constructing multiple plausible visions for the future. These visions are used to challenge the status quo and current thinking about the strategic agenda of the organization and other potential options.

Teleogenic systems can incorporate all three modes of systems: mechanistic, organic and teleogenic. (Banathy 1993) For example, the pilot of a sailboat is dealing with several mechanistic systems in the operation of the sailboat, several organic systems in computer navigation and weather systems, and is functioning as the integrative teleogenic system that brings the others together and provides purpose and intent. Teleogenic systems are most effectively and appropriately applied to human systems, because, as Von Bertalanffy (1969) stated, "True purposiveness is characteristic of human behavior, and it is connected with the evolution of the symbolism of language and concepts." (p. 79) An exciting idea in teleogenic systems is the notion that there are too many options to plan for any one set of circumstances and the implication is that instead of choosing, and understanding of teleogenic systems will allow humans to create their own futures. (Banathy 1993) Humans create their own futures in ideal circumstances, and they do so by making decisions and taking action. Scenarios, as part of teleogenic system enable humans to make better decisions as a result of developing a better understanding of the choices they may face and the potential consequences of those choices.

Thus, scenarios and scenario planning allow decision makers within human systems to design custom systems that devise and constantly revise their own purposes and seek new areas of advantage within their own environments. To this end, teleogenic systems develop and generate requisite variety, future memory, and ultimately, self-organization. These three concepts will be explained and described as they apply to organizations and also as they apply in the scenario stories.

Requisite Variety

Key to the notion of teleogenic systems is the concept of system anticipation or preparedness. In systems, this is accomplished through the development of requisite variety. The law of requisite variety states that "the larger the variety of actions available to a control system, the larger the variety of perturbations it is able to compensate." (Ashby 1956: 206) Where requisite refers to "required" (Webster's New World Dictionary p. 529), this type of variety is that which is required in the environment.

Ashby (1956) used the simple example of a press photographer to demonstrate the concept of requisite variety: "A press photographer would deal with twenty subjects that are (for exposure and distance) distinct, then his camera must obviously be capable of at least twenty distinct settings if all the negatives are to be brought to a uniform density and sharpness." (p. 212-213) This example is simple but the law of requisite variety can also be applied to large, more complex systems.

Requisite Variety in Scenarios. One function of scenario planning is to provide organizations with the required or requisite variety to cope with the external forces of the business environment. These forces can be multiple and from differing domains, for example, societal, technological, economic, environmental, and political are all environmental domains that contain interrelated forces influencing organizations. (Mintzberg 1994) Scenarios can then be used to "windtunnel" (van der Heijden 1997: 57) the organization itself, and consider possible actions in a considerable number of plausible yet challenging situations. An organization with requisite variety is an organization that has considered many plausible futures and how it might adapt and change to cope with each different environment. (May 1996) An organization with requisite variety is an organization that is relatively prepared for a number of plausible options.

Scenarios allow organization decision makers to think through decisions they might make in the future and consider their possible implications. Because of the imaginary capacity of the stories themselves, an aim of the stories is to provoke managers and executives to think what is considered unthinkable, and to explore the events thought not possible. (Wack 1985) In short, scenario stories help organizations develop preparedness for a variety of plausible future environments, thus expanding the adaptability of the organization.

Anticipatory Memory

An intriguing phenomenon has occurred with the use of scenario planning called "anticipatory memory". As Schwartz (1991) noted in the final step of his methodology, the selection of leading indicators and signposts, is critical to the realization that a given scenario may be unfolding. Sometimes the direction is obvious, but it can also be very subtle. Indicators and signposts are selected to monitor, in an ongoing sense, the progress of the organization along the lines of a given scenario. (Schwartz 1991) The advantage created by having previously considered critical circumstances when they actually present themselves is termed anticipatory memory. (Schwartz 1991)

The phenomenon of anticipatory memory is closely linked to the concept of requisite variety. Anticipatory memory occurs when a system, or organization, encounters a situation that it has considered previously in a scenario. In a study conducted by De Geus (1998), Shell Oil considered the $15 barrel of oil when prices were $28 per barrel and a $10 barrel was viewed as the collapse of the industry. Shell acted based on multiple scenarios that were circulated throughout the organization and when the price suddenly fell to $5 per barrel, Shell's reaction time was much shorter than that of any of the competition. This is anticipatory memory – the advantage created by having previously considered critical circumstances when they actually present themselves. (Schwartz 1991)

Anticipatory Memory in Scenarios. In essence, individuals create this kind of memory constantly. It unfolds along the lines of logic, for example, if X happens, then I will do Y. When this concept is applied to an entire organization through the use of scenarios, the implications become very powerful. Anticipatory memory can decrease the response time of an organization to external changes in the environment because the situations have already been considered. (De Geus 1998, Schwartz 1991, van der Heijden 1997) Scenario stories help organization decision makers consider a wide variety of plausible future changes.

Self-Organization

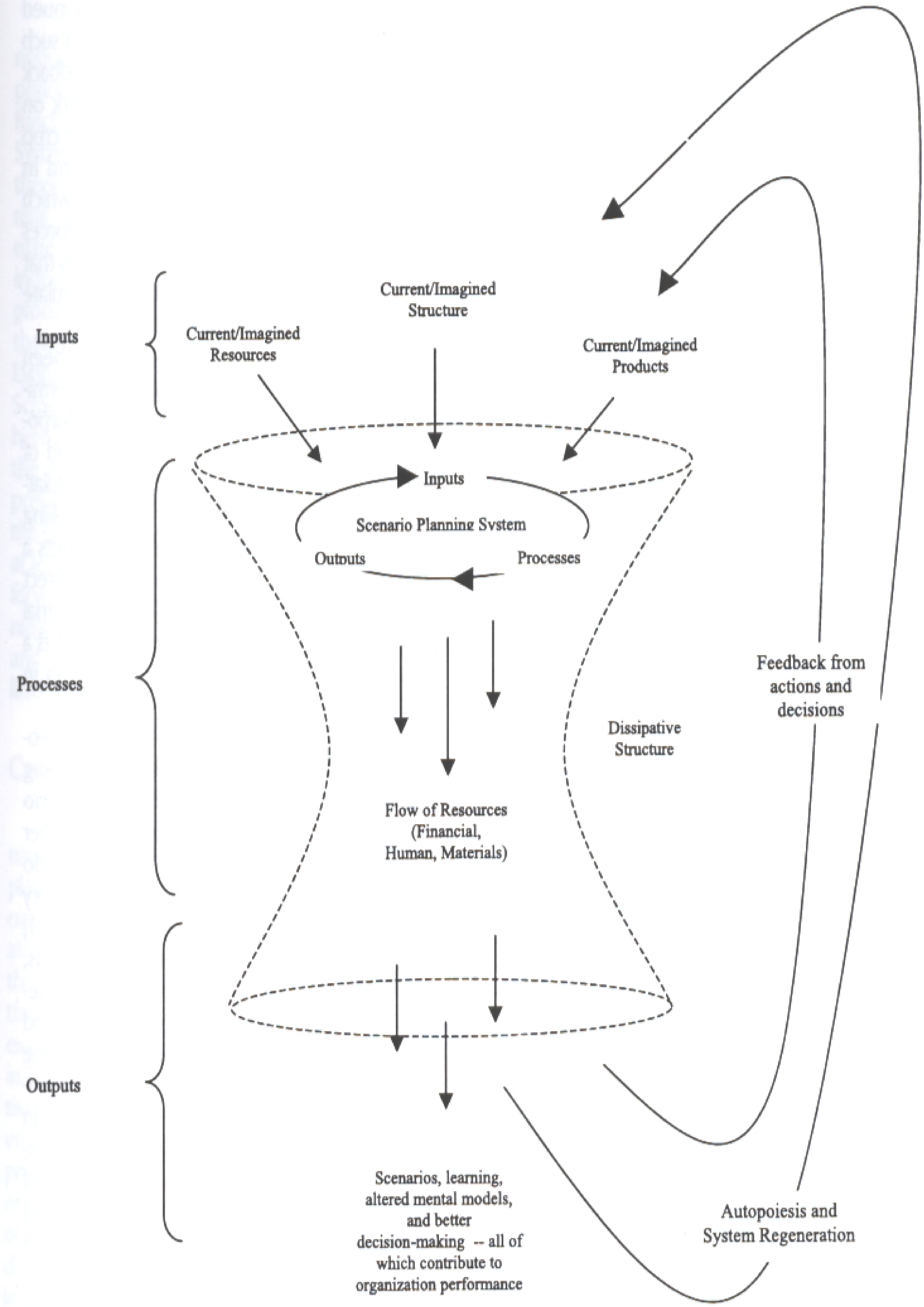
Self-organization has been defined as "the spontaneous emergence of macroscopic nonequilibrium organization structures due to the collective interactions among a large assemblage of simple microscopic objects." (Prigogene 1997a) In simpler terms, self-organization is the spontaneous emergence of a large system via the collective innovations of several simple and smaller systems. Self-organizing systems incorporate all of the system concepts discussed thus far. Self-organizing systems demonstrate the ability of all living things to self-organize into networks of relationships that change and adapt as the environment fluctuates. (Prigogene 1997a) Self-organizing systems reject equilibrium so that they can stay *off-balance* and grow. These systems incorporate feedback to monitor the state of the environment, and can react, or act independently. The key to these systems is their capacity for choice and change. (Wheatley 1999) These systems also have dissipative structures that recreate themselves into new forms, and thus, these systems are extremely adaptable. Wheatley (1999) described self-organizing systems; "The viability and resiliency of a self-organizing system comes from its great capacity to adapt as needed, to create structures that interface with the moment with the environment. Neither from nor function alone dictates how the system is organized. Instead, self-organizing systems are *process structures,* reorganizing into different forms in order to maintain their identity." (p. 82)

Self-organizing systems also endlessly search for the information they use to keep themselves off-balance and alert to potential change. (Prigogene 1977) Self-organizing systems, however, can cope with being constantly off-balance because they have a well-defined mission and goals. A system is much like a human being in that it can cope more effectively with its environment if it has a deep center and develops self-knowledge. (Harkins & Kubic 2001) Because of self-knowledge and anticipatory memory, self-organizing systems use a secondary process called self-reference as an adaptive mechanism. (Wheatley 1999) When the environment changes and the system notices a need for change, the system will change in a manner that is consistent with itself. "This is autopoiesis in action, a system focused on maintaining itself, producing itself." (Wheatley 1999: 85) Thus, the importance of articulating organizational purpose, vision, goals, mission, and identifying other strategic objectives is becoming more and more important.

Self-Organizing in Scenarios. Many organizations are beginning to use the powerful concepts of self-organization to become more adaptable and effective. These organizations have eliminated the rigidity in structure that was once so prevalent. For example, Sony credits its success with the Walkman, and the Discman, among other electronic devices to the hands off policy of its managers. Sony executives do not examine new products until they are nearly completed, and offer their workers a great deal of autonomy and independence as they develop new products. (Stacey 1996) Wheatley (1999) described self-organizing characteristics at Oticon, a Scandanavian manufacturing company: "employees were given the freedom to redesign their physical space...they created maximum flexibility for themselves ...employees created nomadic offices; each person received a cell phone, a laptop computer, and a file cart on wheels." (p. 83) Self-organization can be provided through the use scenarios incorporating all of the aspects covered in this paper. In this manner, self-organization and the properties of self-organization can be used as criteria for effective and comprehensive scenarios.

Scenarios can be used to explore more than the external environment of the organization. Referring to the Sony and Oticon examples, organizations can use scenarios to explore new ways of structuring work and the implications of such interventions. Additionally, organizations that constantly create scenarios to monitor internal assumptions about the business environment and explore potential external forces are indeed acting as self-organizing systems. (May 1996) To clarify, the use of scenarios promotes self-organization at the organization level. Self-organization via scenario planning can also be thought of as what has been termed "Anticipatory Action Learning". (Inayahtullah, 2000) In this approach, scenarios are used to explore alternative futures and also to create a culture in which that future can actually occur. Requisite variety, anticipatory memory, and self-organization are useful concepts in scenario planning because they can help scenario planning professionals and practitioners understand the requirements for organizations to be innovative in a constantly changing environment.

Figure 3 An organization operating with self-organization through scenario planning



It is clear that scenario planning is a powerful means by which to develop organizational purpose. When viewing organizations as teleogenic systems, it is appropriate to consider scenario planning as a critical tool in further developing, examining, testing, and altering such purposes. The power of scenario planning is seen when an organization can more effectively interface with multiple environments, as the business environment changes with increasing pace. The complex system concepts explored in this paper have been combined in Figure 3 as a model of scenario planning as a self-organizing system. It is the key argument presented here that scenario planning, highly informed by system theory, can enable an organization to operate in such a state.

Figure 3 captures scenario planning as a process within organizations. The essence of this conceptualization includes the notion that organizational planners can choose to consider scenario planning as a self-organizing system intended to provide autopoeisis, feedback, requisite variety, and anticipatory memory to organizations. Further, scenario planning works as a dissipative structure in that it provides a platform for considering different configurations of resources flowing through organizational processes. The benefits of taking such an approach are expected to be:

1) Better long-term fit with the environment
2) Shorter reaction time to massive changes in the environment
3) More efficient use of resources
4) Improved long-term financial performance, and
5) The adjustment and refinement of organization mission, processes and goals

Implications for Further Research

Senge (1990) identified system "archetypes", which he describes as events that reoccur, or are common among many systems, for example Limits to Growth. The Limits to Growth archetype is a positive feedback loop that creates a secondary negative feedback loop, which in turn, eventually slows the growth. For example, a farmer increases crop yield with fertilizer only to the point at which there is enough rainfall to support continued growth. Senge offered that the solution in such a situation is to remove the negative feedback rather than to push the growth - to work on adding other means of watering the larger crop area. Another example of this is found in Lewin's "force field analysis" (1948: 73) in which the concentration is on the removal of forces working against the desired goal. It seems that in essence, these are both attempts to regulate the feedback that affects the system.

Although such attempts have not been named or examined in detail in system terminology, it is tempting to offer the title "purposive feedback". This might be one method of shaping the purpose of the system – by regulating the feedback that affects it. By controlling the type and amount of feedback that affects a system, one could feasibly intentionally direct the state of the system. While there is minimal evidence or application of this in practice, it is a concept that warrants further examination in considering teleogenic systems.

Also of further interest are the other theoretical foundations of the scenario planning process. An important question in scenario planning is: if system theory integrates other theory domains that are core to the scenario planning process, what are these other theory domains? Chermack, Lynham, & Ruona (2001) have suggested that learning, mental models, decision-making and performance improvement theories all apply in scenario planning and are important domains to consider in furthering establishing the theory base of scenario planning. It is proposed that a critical next step in exploring and validating the application of system theory to scenario planning is a series of case studies involving strategic problems and issues of theory integration. For example, such case studies might emphasize:

1) The role of scenario planning in organization change interventions
2) Further documentation of scenario planning aiding in crisis avoidance
3) The influence of scenario planning

on research and development efforts over time, and
4) The impact of scenario planning on firm performance

An important further consideration is the notion that system theory may best serve as a philosophical orientation in considering the function of scenarios and scenario planning. System theory may also serve to integrate other theory domains with regard to scenario planning. Scenario planning literature suggests that other theory domains worth investigating include learning theory, decision theory, group process theory and performance improvement theory (Ringland 2002a, 2002b, Chermack, Lynham & Ruona 2001, van der Heijden 1997, Schwartz 1991). While the review presented here intends to present a frame for considering the nature of scenario planning, it does not present a detailed set of studies for "proving" the use of system theory in scenario planning – at least, not yet. Therefore, key steps in moving forward with the theory base of scenario planning are to identify the other theory domains, and then revisit the role of system theory in linking and integrating them.

Conclusions

The importance of system theory in scenario planning has been argued in several examples. The use of heuristics in conceptualizing organizations as system has led to the consideration of several complex system concepts as they might be applied to organizations. While this application requires a shift in frame, for example, the conceptualization of autopoiesis in organizations from the mechanistic perspective is certainly a struggle; the concepts presented here seem to inform the scenario planning process. From the use of heuristics to posit an organization as a system to the notion of self-organization, these concepts provide the foundation for thinking differently about the problems of uncertainty and change in the business world. Two logical conclusions given this examination of system theory are that (1) *scenarios and scenario planning can be viewed as systems and therefore they incorporate the characteristics and properties of systems,* and (2) *system theory is an important and foundational theory in scenarios and scenario planning.*

The ultimate contribution of system theory to scenario planning seems to be the concept of self-organization (spontaneous emergence of macroscopic non-equilibrium organization structures due to the collective interactions among a large assemblage of simple microscopic objects). An organization or business unit that can continuously regenerate itself, use feedback networks to assess its environment, can spontaneously alternate among a series of structures that are organizationally formed, yet allow resources to flow through them, and that uses scenarios to establish requisite variety and anticipatory memory is an organization or business unit that can cope with today's demanding and ever-changing business environment. (Capra 1996, Wheatley 1998, van der Heijden 1997, Schwartz 1991)

> *Scenarios have been advocated here as a means for preparing organizations for an uncertain future, but without sound theory in place to support replication, consistent results, and progress for the process of scenario planning, the process will likely suffer failure through atheoretical and random or inappropriate application. (Swanson 1999, Micklethwait & Woolridge 1997)*

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References

Ashby, W.R. 1956. Part Two : Variety. *An Introduction to Cybernetics.* London.

Banathy, B.H. 1993. "System Design: A Creative Response to the Current Educational Predicament." In Reigeluth, C.M., Banathy, B.H. & Olson, J.R. (eds.), *Comprehensive System Design: A New Educational Technology.* Berlin: Springer-Verlag.

Bateson, G. 1972. *Steps to an Ecology of Mind.* New York: Ballantine.

Capra, F. 1996. *The Web of Life: A New Sci-*

entific Understanding of Living System. New York: Doubleday.

Chermack, T. J., & S.A. Lynham. 2002. "Definitions and Outcome Variables of Scenario Planning." *Human Resource Development Review 1* (3): 366-383.

Chermack, T. J., S.A. Lynham & W. E. A. Ruona. 2001. " A Review of Scenario Planning Literature." *Futures Research Quarterly 17* (2): 7-31.

De Geus, A. 1988. "Planning as Learning." *Harvard Business Review 66* (2): 70-74. England: Methuen.

Fahey, L. & R. M. Randall. 1998. "What Is Scenario Learning?" In L. Fahey & R. Randall, (Eds.), *Learning From the Future: Competitive Foresight Scenarios.* New York: John Wiley & Sons, Inc.

Georgantzas, N. C. & W. Acar. 1995. *Scenario-driven Planning: Learning to Manage Strategic Uncertainty.* Westport, CT: Quorum.

Jacobs, R. L. 1989. "System Theory Applied to Human Resource Development." In D. Gradous (Ed.), *System Theory Applied to Human Resource Development.* (p. 27-60). Alexandria, VA: American Society for Training and Development.

Kahane, A. 1999. "Scenarios for Changing the World." In P. Senge, A. Kliener, C. Roberts, R. Ross, G. Roth, & B. Smith. (Eds.), *The Dance of Change: The Challenges to Sustaining Momentum in Learning Organizations.* New York: Doubleday.

Harkins, A., & G. Kubic. 2000. "The Future of Distributed Competence: Constructing a Post-Education Paradigm." *On the Horizon, 8* (6): 6-9.

Harkins, A. & G. Kubic. 2001. "Legacy-based Thinking II: Resisting New Tools and Competencies." *On the Horizon 9* (5): 6-9.

Inayatullah, S., & P. Wildman. 1998. *Futures Studies: Methods, Emerging Issues, and Civilizational Wisdoms - a Multimedia Reader.* Brisbane: Prosperity Press.

Inayatullah, S. 2000a. *Questioning the Future: Futures Studies, Action Learning and Organizational Transformation.* Taipei: Tamkang University Press.

______. 2000b. "Possibilities for the Future." *Development* (43): 4, 17-21.

Lewin, K. 1948. *Resolving Social Conflicts; Selected Papers on Group Dynamics.* Gertrude W. Lewin (ed.). New York: Harper & Row.

Martuana, H. 1975. "The Organization of the Living: A Theory of the Living Organization." *Int. J. Man-Machine Stud. 7, 313-332.*

Maturana, H. & F. Varela. 1973. "Autopoiesis: The Organization of the Living." In H. Martuana & F. Varela(ed.) *Autopoiesis and Cognition: The Realization of the Living.* Reidel, Dordrech Pp. 63-134.

Maruyama, M. 1963. "The Second Cybernetics: Deviation-amplifying Mutual Causal Processes." *American Scientist 51:* 164-179.

May, G. 1996. "The Future Is Ours: Foreseeing, Managing and Creating the Future." Greenwood Publishing Group, Incorporated.

Micklethwait, J., & A. Woolridge. 1997. *The Witch Doctors: What the Management Gurus Are Saying, Why it Matters, and How to Make Sense of it.* New York: Times Books.

Miller, R. F. et al. 1997. "Examination of the Use of Scenarios as Learning and Decision-making Tools for Human Resource Development." In E. F. Holton III (ed.) *Academy of Human Resource Development 1997 Conference Proceedings,* Atlanta, GA: Academy of Human Resource Development, Pp. 80-86.

Mingers, J. 1995. *Self-producing System: Implications and Applications of Autopoiesis.* New York: Platinum Press.

Mintzberg, H. 1994. *The Rise and Fall of Strategic Planning.* London: Prentice-Hall.

Powers, W. T. 1989. *Living Control System.* San Francisco: CSG.

Prigogine, I. 1997a. *The End of Certainty: Time, Chaos, and the New Laws of Nature.* New York: The Free Press.

Prigogine, I. 1997b. "Non-linear Science and the Laws of Nature." *Journal of the Franklin Institute, 334B* (5/6): 745-758.

Ringland, G. 2002a. *Scenarios in Business.* New York: John Wiley.

Ringland, G. 2002b. *Scenarios in Public Policy.* New York: John Wiley.

Ringland, G. 1998. *Scenario Planning: Managing for the Future.* New York: John

Wiley.

Ruona, W. E. A. 1998. "System Theory as a Foundation for HRD." In R. Torraco (Ed.), *Proceedings of the 1998 Academy of Human Resource Development Conference.* Baton Rouge, LA: Academy of Human Resource Development.

Russo, C. 2003. "The CLA Questioning Methodology." *Journal of Futures Studies* 7 (4): 73-82.

Schwartz, P. 1991. *The Art of the Long View.* New York: Doubleday.

Senge, P. 1990. *The Fifth Discipline.* New York: Doubleday.

Stacey, R. D. 1992. *Managing the Unknowable: Strategic Boundaries between Order and Chaos in Organizations.* San Francisco: Jossey-Bass, Inc.

_____. 2002. "Strategic Management and Organization Dynamics: The Challenge of Complexity." London: Prentice Hall.

Swanson, R. A. 1994. *Analysis for Improving Performance: Tools for Diagnosing Organizations and Documenting Workplace Expertise.* San Francisco: Berrett-Koehler.

_____. "The Foundation of Performance Improvement and Implications for Practice." *Advances in Developing Human Resources 1,* 1-25.

_____. 2001. "Origins of Contemporary Human Resource Development." *Advances in Developing Human Resources 3* (2). Thousand Oaks, CA: Sage.

_____. "The Discipline of Human Resource Development." In R. Swanson and E. Holton, *Foundations of Human Resource Development.* San Francisco: Berrett-Koehler. P. 88-100.

Swanson, R. A. et al. 1998. "Human Resource Development's Role in Supporting and Shaping Strategic Organizational Planning." In p. Kuchinke (Ed.), *Academy of Human Resource Development Conference Proceedings.* Baton Rouge, LA: Academy of Human Resource Development Pp. 119-124.

van der Heijden, K. 1997. *Scenarios: The Art of Strategic Conversation.* New York: John Wiley.

Von Bertalanffy, L. 1969. *General System Theory: Foundations, Development, Applications.* New York: George Braziller, Inc.

Wack, P. 1985. "Scenarios: The Gentle Art of Re-perceiving." Unpublished manuscript. *Harvard Business School.*

Warfield, J. N. 1995. "Demands Imposed on System Science by Complexity." In K. Ellis, A Gregory, B. R. Mears-Young, & G. Ragsdell (Eds.), *Critical Issues in System Theory and Practice* (Pp. 81-88). New York: Plenum.

Webster's New World Dictionary.

Wheatley, M. J. 1999. *Leadership and the New Science: Discovering Order in a Chaotic World.* San Francisco, CA: Berrett-Koehler.