SYSTEMS THINKING and LEARNING ORGANIZATIONS

Systems Thinking and Organizations: An Initial Inquiry into the Subject

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In the years 1987-1991, more than eighty-five percent of the Fortune 1000 companies downsized their white collar staffs (Cameron & Freeman, 1993). During the first seven months of 1993, 350,000 workers faced terminations due to reductions in force (Richman, 1993). January, 1994 had even higher rates of terminations. These have all been intentional reductions in the size of staffs undertaken with the goals of achieving cost reduction, increased productivity, and greater profitability. The evidence suggests that those goals have not been met. Studies have suggested that although the first year may show increased profitability, this is short-lived, as the following year does not produce the same results. Performance never matches the pre-downsizing efforts. Rather, companies have been faced with such negative consequences as decresed morale, commitment and work effort of the survivors (McKinley, Sanchez, & Schick, 1995). The authors propose that the reason companies continue this practice in spite of contrary evidence is "institutional rules". These rules serve as myths which perpetrate and perpetuate common practices. They warn that managers be aware that downsizing may be partly driven by social forces rather than predictable financial results, and that the long-term health of the corporation may be sacrificed for short-term gains. Certainly there is an aspect of companies following others' examples. The practice of benchmarking for "best practices" has become a common one; however, the degree with which these "best practices" are adopted are probably quite variable. Every organization has unique qualities that require unique actions. Yet, when these "adoptions" fail to meet expectations, managers wonder why (Day, 1994).

The numbers are staggering. Upon projecting the associated costs, human combined with such expenses as extended termination pay and benefits, outsourcing, litigation and union arbitration, one may ask the paramount question: "Did management plan it this way?" The answer comes quickly, "Surely not; so, why is this happening? How could we have arrived at this point?"

To understand this situation, one may first examine models of management, and, consequently, how management history proposes people have organized during the past century. In a cross-cultural analysis of adoption of these models, Guillen (1994) identifies three separate lines of development in management history: technical (scientific management), social (human relations), and structural models. Guillen's table is included to illustrate the features and techniques of these organizational paradigms (Figure 1). He believes that the leaders in organizations have historically assessed and utilized these models depending on the prevailing modes of thought in the society. Even though similar situations were present in different countries at various times, similar models were not adopted, even in such countries as the United States and Great Britain. However, Guillen sees adoption of the models and subsequent changes within countries as cyclical: shifting from rational (scientific management) to natural (human relations) perhaps in answer to "unresolved tension" between mechanistic and organic solidarity. Until now. Until Japan. Until "lean production" and Total Quality Management, etc.

Remember the practice of benchmarking? But, if one set of practices cannot translate from one firm to another in the same industry in the same country, how can they translate cross-culturally? As Guillen points out, when ideas travel from one country to another, they do not translate exactly. There are many factors that influence the transfer process. Although the lean production and TQM methods may be identified as eclectic management models, Swedish and German researchers have concluded that Japanese production models are merely "relentless, intensive, and effective implementation of the basic Fordist principles of simplified tasks, accelerated work pace, and reduced waste" (Guillen, p. 81). They are predicated upon conditions in which management prerogatives are unlimited and worker dependence is maximized through firm-specific skills and paternalistic corporate welfare programs. One only has to perform a perfunctory analysis to realize that if TQM and lean production have proliferated in Japan because of the above conditions, they will probably not be successful in a firm which has been recently (or ever!) downsized. Yet, management probably implements these actions side by side and then wonders why TQM doesn't work. This is just one example of how we got this way.

Perhaps one should begin by questioning our basic tools and methodologies for any inquiry. King (1994) proposes that our tools shape our intentions and that our values shape what we even investigate when we look at paradigms because we look at what "matters". Our usual modes of scientific inquiry are inductive and deductive logic. Both are linear. Senge (1990) states we are limited by our language. English is linear. Certainly management models seemed to have followed a bipolar continuum from mechanistic to humanistic. But do we live in a linear world? King points out that linear logics are inadequate because they do not consider that most phenomena exhibit "recursiveness"; (i.e., cause alters effect which alters cause which alters effect). This may be too linear an argument, but an elegant one.

Bemoning the Blight of Civilization or: So we Left the Farm and Went to Gay Paree, but can we get back?

Peter Senge relates the story of one of his colleagues who grew up on a farm (Senge, 1994, p. 87). This man tells of farm children learning naturally about the cycles of cause and effect that make up systems. These systems are not just farm-related, but they occur in every aspect of our lives, including organizational ones. Perhaps the price of civilization has been the loss of the very information that can save our lives. By breaking work into ever smaller tasks, we have dissolved the obvious interconnectedness of the processes of our lives. The management models discussed previously are missing this cyclical pattern of processes which is characteristic of our very existence.

Are these models the only ones available to organizational development? Although structural analysis does consider the open environment, it does not seem adequate to describe the complexities of organizational life. In 1950, Eric Trist presented a paper titled "The Relations of Social and Technical Systems in Coal-Mining" to the British Psychological Society after having a revelation of a new paradigm of work. This revelation occurred while performing research at a coal mine (1951). In this vision, he imagined the effective blending of the requirements of both the technical and social systems. Since that time there has been considerable development of theory and practice of sociotechnical systems (STS). The goal of STS is the integration of the social requirements of workers with the technical requirements with regard to their (open) environments (Fox, 1995). Table 2 provides Fox' comparison of hallmarks of the Sociotechnical Model with the Traditional Model. An historical limitation of STS has been its focus on the linear model, (i.e., input to output); however, recent work has led to new analytical tools for non-linear work processes. STS may be the first management model to incorporate the idea of systems theory.

Recent management trends such as TQM and lean production (JIT) have been mentioned previously. Other possible trends for the 90's include re-engineering (Hammer and Champy, 1993), time-based competition (Meyer, 1993; Schaffer, 1988), the learning organization (Senge, 1990, 1994) and what has been called "world class" manufacturing/organizations (Hodgetts, Luthans, & Lee, 1994). The common thread running through all of these practices is that they involve addressing processes, not "things". Reengineering, seen by some as much "higher" on the evolutionary scale requires mastery in systems thinking and systems tools along with solid grounding in the sociotechnical school (Allee, 1995).

In the forward to Meyer's book, Fast Cycle Time, Peter Senge admits having a love-hate relationship with the concept of time-based competition. He just did not understand how "running around like chickens with our heads cut off" could possibly be the answer to long-term competitive advantage. Senge further admits to being relieved that Meyer's work addresses such issues as the formation of teams and removal of barriers to performance. Meyer's concepts are more based upon the simple precept:

"Every result a business achieves is the output of a process. In order to change substantially the timeliness, cost, or quality of any output, one must change the process that creates it. Simply increasing the speed of an existing process will usually cause damage to quality or cost." (Meyer, p. 161)

Similarly, reengineering is defined as "the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service, and speed." (Champy and Hammer, p. 32). As the authors state, most business people are not process-oriented, but rather are focused on tasks, jobs, people, structures, (i.e., "things"). Thus, recent management models are moving from what was essentially a false (unnatural?) model of the world. Certainly the literature refers to organizational processes in living, even anthropomorphic, terms (Settembrino, 1994). The social aspects of organizations has perhaps remained largely untapped.

In 1990, Peter Senge published The Fifth Discipline. Much to his surprise, the book became a best seller. The ideas were intriguing (indeed, somewhat mystical by Western standards), but the readers did not know how to implement these ideas in their organizations. With the publication of The Fifth Discipline Fieldbook, Senge (1994) has attempted to communicate the practice of the disciplines. The conernerstone of this book, the fifth discipline, is what he refers to as systems thinking. I think the way Senge presents this model or paradigm for viewing, experiencing, and ordering the environment is broader than anything promulgated before in the management disciplines. It is also, simultaneously, the most accessible and least concrete of any of the other models. However, this may be the natural evolutionary model whose time has come.

Systems Thinking: How does it Relate to Organizational Function?

Senge (1990, p. 73) defines the essence of systems thinking as a shift of mind to: (a) seeing interrelationships rather than linear cause-effect chains, and (b) seeing processes of change rather than snapshots. According to him, most systems analysis focuses on detail, not dynamic complexity. This may be a very pivotal point in organizational analysis and planning. If, as mentioned above, most organizations are concerned with only things - details, they may very well be operating with a very limited vision of the world. Senge defines detail complexity as merely one of many variables. This type of complexity does not capture the dynamic complexity that is at work in complex social systems. Daniel Kim (1993) relates a very basic hypothesis proposed by H. A. Simon in Science of the Artificial (1981),

"A man, viewed as a behaving system, is quite simple. The apparent complexity of his behavior over time is largely a reflection of the complexity of the environment in which he finds himself."

Systems thinking "plops" the organization and all of its individual players into the context of their environment(s), then sets them moving. Kim's types of organizational interpretation systems relates the richness and complexity of just the interpretive aspects of an organization alone (Figure 3). Within these multiple dynamic systems, one can even view the organization as a "learning system" (Nevis, DiBella, & Gould, 1995). Their proposed model with definitions is Figure 4.

How can Systems Thinking save the Planet?

To not engage in systems thinking will probably dictate organizational failure, and may explain quite a few (failures) that went before. Systems thinking in and of itself is probably a case of "necessary but not sufficient". Even Senge recently shared the attitude that if it (his learning organization principles) isn't working, we need to do something differently (Dumaine, 1994). He estimates that this entire system is probably in its infancy and is about on the evolutionary scale of TQM in the 40's when Deming was calling in the wilderness.

One way of assessing the value of a systems approach is in the broader context of Senge's learning organization. What happens if a company adopts the approach? Janet Gould, Director of MIT Organizational Learning Center's Organizations as Learning Sysems Projects, categorizes by their perspectives the companies that have tried to develop learning organizations (Bencivenga, 1995). Companies with a normative perspective incorporate the disciplines as a massive change of the organization. Companies with a developmental perspective view the disciplines as one aspect of their development. A growing third group, with a capability perspective, adopts the five disciplines, but also incorporates the appropriate tools into their organization such that they retain the unique things that they do very well.

At any rate, unless an organization is a very unusual one, these practices will require a massive change of culture, particularly in older companies. Then that organization will generate very basic questions such as how are we going to institute it? How are we going to evaluate our progress? How long are we gonna give it to work?

Underpinnings for "Deep Thought" when Applying Systems Thinking

This course and the reading I have undertaken in writing this paper have lead me down many knowledge paths. I know there are many more things I want to know. The following additional items to my "lifetime reading list" are some areas into which I could not delve due to time constraints and because they were outside the purview of this paper. They are, however, germaine to the topic and, I believe, necessary for my deeper understanding. Some are subjects that "came before and you would understand this if only...." such as process dynamics. Others are subjects which are probably now becoming hot topics such as how do we research this? Yet others delve deeper into the greater meaning of such issues as the method of inquiry and tools, which lead back to the old philosophy days.

Process Dynamics and Systems Theory: What Systems Engineers Always Knew

Systems thinking as described and developed by Senge for organizations is derived from process dynamics. Other authors also borrow heavily from the physical sciences (natural world?) to describe how organizations function. One I found particularly useful was from laws of thermodynamics which proposes that systems inevitably reach a state of static equilibrium. Then, entropy sets in and the system disintegrates unless something adds energy to the system again (i.e., a spinning top). Broesma (1995) compares this to organizations which gravitate to a state of equilibrium. As entropy develops, the organization must expend increasing amounts of energy to

maintain the status quo, leaving less for productive work. But, the author notes, living systems do not experience entropy while mechanistic, non-living systems do. Why? Novel laureate Ilya Prigogine discovered that living systems continuously renew themselves through a process of "spontaneous structuration" which occurs when they are jarred out of a state of equilibrium. Of course, Psychology 5050, Fall 1995, has already termed this process the "frying pan in the face phenomena". The analogy to organizations is very compelling.

A natural course of study in process dynamics will lead to the work of Jay Forrester. There are also a number of authors associated with MIT and Peter Senge who have peaked my interest greatly. Their works are often found in the Sloan Management Review, an excellent journal to peruse in spare time.

Causal Links: Have you Really Done Good "Research"?
This area can be approached from both a practitioner and researcher level. I do think, however, that the two may come much closer in practice when studying systems thinking than they have in the past. The practitioner may very well be concerned with the operating "system" in much the same way as the researcher. Research sometimes is so narrow and divorced from reality that it looses practical value. However, in systems thinking, the "stuff" of the research will remain imbedded in the system. The tendency for both may be to become too concrete, too early.

Strategic Alignment: Hoping for a While Practicing/Rewarding B?
"Unfortunately, the primary institutions of our society are oriented predominantly toward controlling rather than learning, and for rewarding individuals for performing for others rather than cultivating their natural curiositiy and impulse to learn." (Senge, 1990).

I chose not to jump into the strategic planning agenda in this paper. That strategic planning must be aligned with these disciplines is obvious. It is also quite obvious that in many contemporary organizations, strategy, practice, structure, rewards, are not aligned (maybe a bad word?). They do not coexist in a system that serves the purposes of the organization. Systems thinking is a very good start for analyzing an organization's strategy. The technique called scenario planning ("forecasting" into the future) depends heavily on a wide-angle, systems view of the dynamic complexities and interrelationships to define future business operating environments (Thomas, 1994). Thomas notes that this can be a powerful tool for any organization and seems to be particularly embraced by companies in crises because the old ways haven't worked. (Another example of "frying pan in the face" or spontaneous structuration.

Applications in the Real Work of Management Modest Proposal: A Caveat for Practitioners
"The key is to teach the entire subject, but from different angles, and relate it to things people already know." (Bencivenga, 1995). This may be a very good thing to remember. One warning offered by Cavaleri (1994) should probably be kept in mind, also. He proposes that there are several dominant forms of systems thinking: 1. hard, 2. soft, 3. cybernetic, 4. servo-mechanistic, and 5. integrative. He believes that the soft form of systems thinking is the necessary form for a learning organization and yet most Western organizations conduct their business using hard systems thinking such as operational research and systems analysis. With the advent of systems modelling and simulation (Wolstenholme & Stevenson, 1994), an organization may believe they are truly utilizing systems thinking. They may be, but they may be only capturing the detail complexity of which Senge spoke.

I believe one of the most disheartening stories I read came from Ford Motor Company operations (Bencivenga, 1995 and Dumaine, 1994). Fred Simons, the program manager for the Lincoln Continental team who embraced learning organization principles in the entire design and

production process of the latest model. Although the initial phases were far below average, (i.e., 500 versus the normal 150 engineering errors), the final product was astounding. They finished under budget and ahead of schedule. They also returned $65 million they did not need in engineering design. The results? Ford asked Simon to take early retirement in a company downsizing. Simon admitted he could have educated upper management more in the learning organization principles. However, this remarkable story is being read by many people and the next large scale attempt within an established beauracratic organization is probably taking place now.

Byond Systems Thinking

Where would I like to go with this? I have already stated fields of inquiry that may prove fruitful. I will also pursue your suggestion to look at Ron Purser's work and configuration theory. But there are other ways of knowing.

The field of research into this discipline seems to be rather sparse. There are some other streams of research which may prove a useful analogy. Recent work in network effectiveness may provide very useful methodology for research into utilization of systems theory in organizations (Provan & Milward, 1995).

The subject of systems thinking is also suggestive of anything interdisciplinary to encourage the recognition of interconnectedness. An interdisciplinary course offering which would include business, education, public administration and the physical & social sciences could be terrific. The Texas Conference on Organizations (last year's notice is Appendix B) is such an interdisciplinary forum. This is an excellent annual conference I discovered and attended last year. It is an informal gathering of research and practitioner talent from many disciplines. Next year will be the eleventh gathering and I recommend it highly.

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Systems Thinking:

The flapping of a single butterfly's wing today produces a tiny change in the state of the atmosphere. Over a period of time, what the atmosphere actually does diverges from what it would have done. So, in a months time, a tornado that would have devastated the Indonesian coast doesn't happen. Or maybe one that wasn't going to happen, does. (I. Stewart)

What is it?

Systemic thinking means considering cause-effect relationships of decisions.

What is the benefit?

Systemic thinking facilitates the creation of alternative scenarios for the future. Be prepared for the unexpectable!

Key questions

What is the underlying cause for our problem? What are the positive aspects of doing things in an old-fashioned way? What effects do we expect from reaching our goals? How does the anticipation of effects influence the status quo? What question would I like to ask an oracle?

Although our brain certainly is on of the most complex devices ever invented by God, human beings strive to simplify their perception of the world - we create our individual mental maps. In fact, without simplistic models that help us navigating through the world, we would be lost, and in most cases our models do work. Generally, it is not necessary to know how microchips and hard-disks work to use a computer. Even we don't need to know all features of a complex text processing programme to write and print a letter. But many of us know the Friday afternoon horror: we have to have some work done over the weekend, and our desk-top breaks down exactly a 6 p.m., leaving us lonely with a blank screen and the message.

Of course, if it works at all, only it tells us all the things we already know. In this situation, our model is clearly limited. The complexity of the world and of social and technological systems is increasing at indescribable speed. For an example, a person who utilizes an electrical device like a drill *"does this not in the way one uses a simple tool like a hammer, which one can either hold in the hand or put aside"* (W. Bierter, 1992). Rather, he is connected to a worldwide system of electricity production and supply. Maybe the best current model of complexity is the medium you just tuned in, the Internet, which developed structures by itself. If you want to know more about complexity, search the internet for the key word "chaos". Since 1984, researchers at the Santa Fé Institute try to find common principles of chaos and order, which can be applied to economical, biological and social systems. (Waldrup, M.M., 1992: Complexity: The Emerging Science at the Edge of Order and Chaos).

Most projects of Technical or Financial Assistance have reached a level of complexity which hardly can be understood or managed by traditional means. This becomes particularly evident in so-called integrated rural development projects. These are programmes that tend to influence the entire social and economic setting of the project region. They often concentrate on increasing productivity of agriculture, and by the same time provide inputs to create off-farm employment generation, improve health and social systems, education, environment, women's groups, etc. They try to consider every aspect of the rural life. But they are hardly prepared for the systemic effects of external and internal influences. To invent a few examples:

Eventually, the world price of the main agricultural commodity (let's say

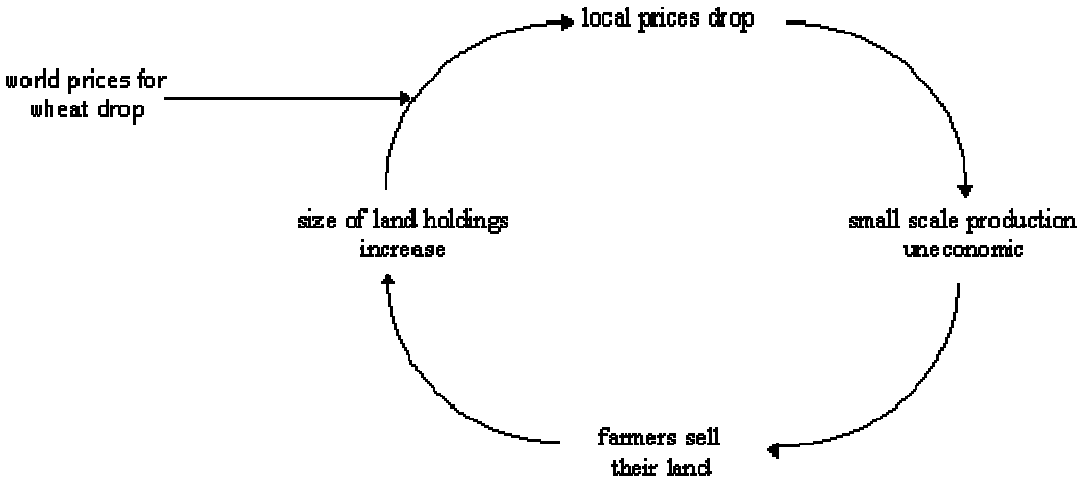
wheat) of a project region drops by 40%. Cheap wheat is imported.

Then, production becomes uneconomic for small-scale farmers.

Then, farmers sell their land.

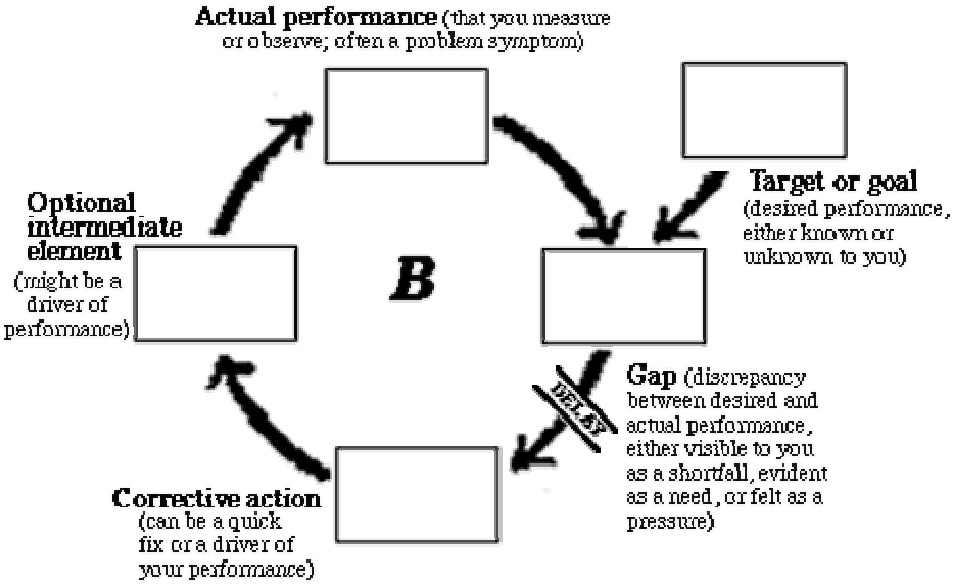
Then, size of land holdings increase.

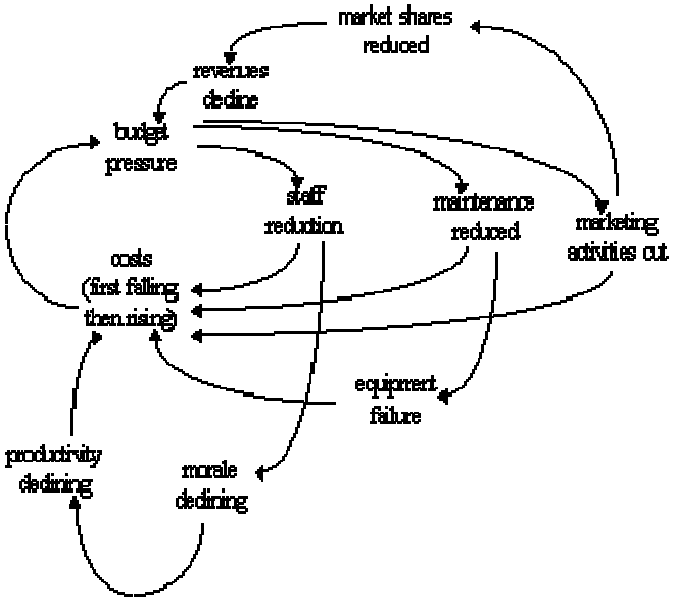
Then, because of the effects of production of scale, local medium and large-scale farmers produce wheat a lower price. This increases the pressure on small-scale farmers.



An other example that deals with a private manufacturing company has been described by M. Goodman and R. Karash in P. Senge's The Fifth Discipline Fieldbook:

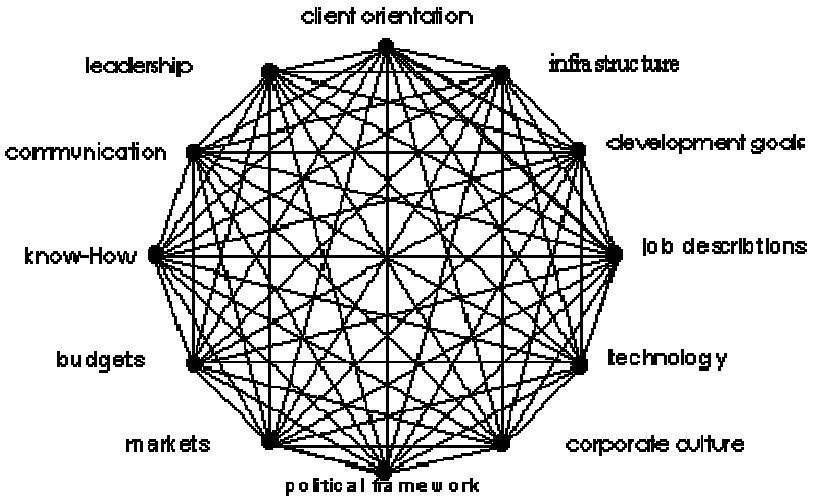
The General Manager of a Manufacturing division faces a series of budget crises. She is told to shrink her facility, to make it run "lean and mean". So she reluctantly decides to reduce her staff, sacks some employees, reduces also maintenance and cuts back marketing activities. her costs go down for a while, but than rise again. So she continues to cut down everything. The reduction of marketing activities has a depressing impact on her market share, the reduced maintenance leads to equipment failure (and increasing costs), and the motivation of staff declines. Eventually, everything collapses.





The success of a project or an organization is influenced by a magnitude of factors. In each case, it is possible to identify at least a dozen of such factors, but there are many others of subordinate and partially not identifiable variables, which influence each other. All processes of a system (like an organization, group, project, society, etc.) are principally dynamic and can only be influenced in a systemic context. It is not possible to foresee all effects and relations between the factors. For example, 12 variables result in 66 linear and 220

triangular relations. To elaborate a planning base that facilitates sustainable growth the most important factors must be identified and arranged in a context that considers systemic effects. In such a complex environment, linear planning tools loose their effectiveness.



> *Of course, it is quite possible that we could fully account for the properties of each whole if we could know the characteristics of all the parts and know in addition all existing relationships among them. The we could reduce the characteristics of all the parts and know in addition all existing relationships among them. Then we could reduce the characteristics of the whole to the sum of the characteristics of the parts in interaction. But this involves integrating the data not merely for three bodies, but for three thousands, three million, three billion, or more, depending on the whole we are considering. And since science cannot perform this feat even for a set of three parts, it is quite hopeless to think it can do it for any of the more complex phenomena it comes across in nature, man, and society. Hence, to all practical purposes, the characteristics of complex wholes remain irreducible to the characteristics of the parts. (E. Lazlo)*

In the eighties, planning tools for projects were introduced that tried to structure the complexity through a series of consecutive steps of linear analysis. In Germany, it was called ZOPP (Zielorientierte Projektplanung - Objectives Oriented Project Planning). A variation of this method is now widely used under the name PCM (Project Cycle Management) and widely applied in the projects of European Union. For more explanations on PCM, see the articles: Project Cycle Management, and: Applying Chaos Theory to Planning Workshops.

Introduction to Peter Senge's work

In a way those who work in a learning organization are "fully awakened" people. They are engaged in their work, striving to reach their potential, by sharing the vision of a worthy goal with team colleagues. They have mental models to guide them in the pursuit of personal mastery, and their personal goals are in alignment with the mission of the organization. Working in a learning organization is far from being a slave to a job that is unsatisfying; rather, it is seeing one's work as part of a whole, a system where there are interrelationships and processes that depend on each other. Consequently, awakened workers take risks in order to learn, and they understand how to seek enduring solutions to problems instead of quick fixes. Lifelong commitment to high quality work can result when teams work together to capitalize on the synergy of the continuous group learning for optimal performance. Those in learning organizations are not slaves to living beings, but they can serve others in effective ways because they are well-prepared for change and working with others.

Organizational learning involves individual learning, and those who make the shift from traditional organization thinking to learning organizations develop the ability to think critically and creatively. These skills transfer nicely to the values and assumptions inherent in Organization Development (OD). Organization Development is a "long-term effort at continuous improvement supported at all levels of the organization, using interdisciplinary approaches and modern technologies."[1] Organization Development is the mother field that encompasses interventions, such as organization learning. OD is about people and how they work with others to achieve personal and organizational goals. Many times achieving goals means making changes that require creative thinking and problem solving. French and Bell report that the values held by OD practitioners include "wanting to create change, to positively impact people and organizations, enhance the effectiveness and profitability of organizations, [to] learn and grow, and exercise power and influence." (1995, p. 77) Although values do shift over time, the values held by OD practitioners mesh well with the characteristics of learning organizations as outlined in this paper.

The paper is organized according to the five disciplines that Peter Senge (1990) says are the core disciplines in building the learning organization: personal mastery, mental models, team learning, shared vision, and systems thinking.[2] Even though the paper makes liberal use of Senge's pervasive ideas, it also refers to OD practitioners such as Chris Argyris, Juanita Brown, Charles Handy, and others. What these writers have in common is a belief in the ability of people and organizations to change and become more effective, and that change requires open communication and empowerment of community members as well as a culture of collaboration. Those also happen to be the characteristics of a learning organization. The paper is influenced by team meetings in which the five authors prepared a class presentation on the topic of learning organizations. The team worked to emulate a learning community within the group. The paper reflects the learning, reflection, and discussion that accompanied the process.

Personal Mastery

Personal mastery is what Peter Senge describes as one of the core disciplines needed to build a learning organization. Personal mastery applies to individual learning, and Senge says that organizations cannot learn until their members begin to learn. Personal Mastery has two

components. First, one must define what one is trying to achieve (a goal). Second, one must have a true measure of how close one is to the goal. (Senge, 1990)

It should be noted that the word 'goal', in this context, is not used the same way it normally is in management. Managers have been conditioned to think in terms of short-term and long-term goals. Long-term goals for the American manager are often something to be achieved in the next three to five years. In personal mastery, the goal, or what one is trying to achieve, is much further away in distance. It may take a lifetime to reach it, if one ever does. (Senge, 1990) Vision is a more accurate word for it. Senge worked with Chart House International to prepare a videotape on Personal Mastery. In the videotape, the idea of lifelong learning is represented by the story of Antonio Stradivari whose quest was a particular musical sound that could be produced by a violin. Stradivari spent his entire life in the pursuit of that sound. He made constant refinements to the violins he crafted and produced instruments that are considered outstanding to this day. No one will ever know if Stradivari was fully satisfied with his last violin. Senge would say that Stradivari was not satisfied because of his obsession with continually trying to improve on the sound. (Senge, *Self-Mastery*, 1995) Senge refers to the process of continual improvement as 'generative learning.' (Senge, 1990)

The gap that exists between where one is currently functioning and where one wants to be is referred to as 'creative tension.' Senge illustrates this with the image of a rubber band pulled between two hands. The hand on the top represents where one wants to be and the hand on the bottom represents where one currently is. The tension on the rubber band as it is pulled between the two hands is what gives the creative drive. Creativity results when one is so unsatisfied with the current situation that one is driven to change it. (Senge, 1990) Another aspect of personal mastery is that one has a clear concept of current reality. Emphasis is placed on the word 'clear' here. One must be able to see reality as it truly is without biases or misconceptions. If one has an accurate view of reality, one will see constraints that are present. The creative individual knows that life involves working within constraints and will not waver in trying to achieve the vision. Creativity may involve using the constraints to one's advantage. (Senge, 1990)

Handy has a similar concept in his 'wheel of learning.' The wheel consists of four quadrants: questions, ideas, tests, and reflection. The metaphor of the wheel makes one think of something moving. What keeps the wheel moving is:

- Subsidiarity: Giving away power to those closest to the action,
- Clubs and Congresses: Places and opportunities for meeting and talking,
- Horizontal Fast-Tracks: Horizontal Career-Tracks that rotate people through a variety of different jobs in the new, flattened organization,
- Self-enlightenment: Individual responsibility for his own learning,
- Incidental Learning: Treat every incident as a case study from which learning can occur.
- The driver of the wheel should be the leader of the organization who sets the example for others to follow. (Handy, 1995.)

Individuals who practice personal mastery experience other changes in their thinking. They learn to use both reason and intuition to create. They become systems thinkers who see the interconnectedness of everything around them and, as a result, they feel more connected to the whole. It is exactly this type of individual that one needs at every level of an organization for the organization to learn. (Senge, 1990) Traditional managers have always thought that they had to have all the answers for their organization. The managers of the learning organization know that their staff has the answers. The job of the manager in the learning organization is to be the teacher or coach who helps unleash the creative energy in each individual. Organizations learn through the synergy of the individual learners. (Senge, "The Leader's New Work," 1990)

Mental Models

Mental models are the second of Senge's five disciplines for the learning organization.(Senge, The Leader's New Work, 1990) Much of the work involving mental models comes from Chris Argyris and his colleagues at Harvard University. A mental model is one's way of looking at the world. It is a framework for the cognitive processes of our mind. In other words, it determines how we think and act. A simple example of a mental model comes from an exercise described in *The Fifth Discipline Fieldbook*. In this exercise, pairs of conference participants are asked to arm wrestle. They are told that winning in arm wrestling means the act of lowering their partner's arm to the table. Most people struggle against their partner to win. Their mental model is that there can be only one winner in arm wrestling and that this is done by lowering their partner's arm more times than their partner can do the same thing to them. Argyris contends that these people have a flawed mental model.

An alternative model would present a framework where both partners could win. If they stop resisting each other, they can work together flipping their arms back and forth. The end result is that they can both win and they can win many more times than if they were working against each other. (Senge, 1994) Argyris says that most of our mental models are flawed. He says that everyone has 'theories of action' which are a set of rules that we use for our own behaviors as well as to understand the behaviors of others. However, people don't usually follow their stated action theories. The way they really behave can be called their 'theory-in-use.' It is usual:

1. To remain in unilateral control,
2. To maximize winning and minimize losing,
3. To suppress negative feelings, and
4. To be as rational as possible by which people mean defining clear objectives and evaluating their behavior in terms of whether or not they have achieved them. (Argyris, 1991)

People act this way to avoid embarrassment or threat. (Argyris, 1991) Argyris says that most people practice defensive reasoning, and because people make up organizations, those organizations also do the same thing. So at the same time the organization is avoiding embarrassment or threat, it is also avoiding learning. Learning only comes from seeing the world the way it really is. (Argyris, 1993) Argyris believes that we arrive at our actions through what he calls the 'ladder of inference.' First, one observes something i.e., a behavior, a conversation, etc., and that becomes the bottom rung of a ladder. One then applies his or her own theories to the observation. That results in the next rung on the ladder. Subsequent rungs on the ladder are assumptions we make, conclusions we draw, beliefs we come to have about the world, and finally the action we decide to take. As we climb farther up the ladder, we are becoming more abstract in our thoughts. Unfortunately, our flawed mental models usually cause us to make mistakes in this process of abstraction, and we end up with inappropriate actions. This entire process becomes a loop. We generalize our beliefs and assumptions to the next situation we encounter and use them to filter the data we are willing to consider. Hence, every time we start up the ladder for a new situation, we are handicapped from the beginning. (Argyris, 1993; Senge, *Fieldbook*, 1994)

Argyris believes that people can be taught to see the flaws in their mental models. One way to do this is to practice the left-hand column technique. In this exercise, one takes some dialogue that occurred during a conversation and writes it in the form of a play script on the right-hand side of

a sheet of paper. In the corresponding left-hand column, one records what he or she was really thinking during the conversation. An example is as follows:

Left-hand column (What I'm thinking)	Right-hand colum (What was said.)
Everyone says the presentation was a bomb.	Me: How did the presenation go?
Does he really not know how bad it was?	Bill: Well, I don't know. It's really too early to tell. Besides, we're breaking new ground here. Me: Well, what do you think we should do? I believe that the issues you were raising are important.
He really is afraid to see the truth. If he only had more confidence, he could probably learn from a situation like this. I can't believe he doesn't realize how disastrous that presentation was to our moving ahead.	Bill: I'm not so sure. Let's just wait and see what happens.
I've got to find some way to light a fire the guy.	Me: You may be right, but I think we may need to do more than just wait. (Senge, 1990, pp. 196)

Professor Sue Faerman at the University at Albany suggests that there could be two left-hand columns: one for what each partner to the conversation might be thinking: (Faerman, 1996)

Left-hand column #1 *(What I think she was thinking.)*	Left-hand column #2 *(What I was thinking)*	Right-hand column *(What was said.)*

Argyris maintains that true learning occurs when the left-hand and right-hand columns begin to match. Once one has been trained in this technique, one can do it mentally during a conversation to assess what is being said. As a culture, we have to learn to say what we think and to take criticism without being on the defensive. People and organizations learn by recognizing mistakes and correcting them. No progress can be made if we pretend that the mistakes never happened.

What an organization needs is ‘actionable knowledge.’ This is Argyris‘ phrase for a new set of mental models. These models would be validated through research and would be a series of if-then statements that would say something like: “..if you act in such and such a way, the following will likely occur.” (Argyris, 1993, p. 2-3) These models are also referred to as system archetypes and will be discussed later in this paper.

Teams

What is a Team and Why are They Important?

A team, say Robbins and Finley, is "people doing something together." It could be a baseball team or a research team or a rescue team. It isn't what a team does that makes it a team; it is a fact that they do it "together." (Robbins and Finley, 1995, p. 10) "Teams and teamwork are the 'hottest' thing happening in organizations today..." according to French and Bell. (1995, p. 97) A workplace team is more than a work group, "a number of persons, usually reporting to a common superior and having some facetoface interaction, who have some degree of interdependence in carrying out tasks for the purpose of achieving organizational goals." (French and Bell, 1995, p. 169)

A workplace team is closer to what is called a selfdirected work team or SDWT, which can be defined as follows: "A selfdirected work team is a natural work group of interdependent employees who share most, if not all, the roles of a traditional supervisor." (Hitchcock and Willard, 1995, p. 4) Since teams usually have team leaders, sometimes called coaches, the definition used by Katzenbach and Smith in French and Bell seems the most widely applicable: "A team is a small number of people with complementary skills who are committed to a common purpose, set of performance goals, and approach for which they hold themselves mutually accountable." (1995, p. 112)

Organization development (OD) focuses on the human side of organizations. It is believed that individuals who have some control over how their work is done will be more satisfied and perform better. This is called empowerment in OD. Put these empowered individuals together into teams and the results will be extraordinary, we are told. French and Bell put it this way:

> A fundamental belief in organization development is that work teams are the building blocks of organizations. A second fundamental belief is that teams must manage their culture, processes, systems, and relationships, if they are to be effective. Theory, research, and practice attest to the central role teams play in organizational success. Teams and teamwork are part of the foundation of organization development. (French and Bell, 1995, p. 87)

Characteristics of Successful Teams

OD interventions are divided into two basic groups: diagnosis and action or process. Team building is one type of process intervention. In fact, French and Bell consider teams and work groups to be the "fundamental unitsof organizations" and the "key leverage points for improving the functioning of the organization." (1995, p. 171)

A number of writers have studied teams, looking for the characteristics that make some successful. Larson and LaFasto looked at highperformance groups as diverse as a championship football team and a heart transplant team and found eight characteristics that are always present. They are listed below:

1. A clear, elevating goal
2. A resultsdriven structure
3. Competent team members

4. Unified commitment
5. A collaborative climate
6. Standards of excellence
7. External support and recognition
8. Principled leadership (Larson and LaFasto, 1989, in French and Bell, 1995, p. 98)

How does a group become a highperformance team? Lippitt maintains that groups operate on four levels: organizational expectations, group tasks, group maintenance, and individual needs. Maintenancelevel activities include encouraging by showing regard for others, expressing and exploring group feelings, compromising and admitting error, gatekeeping to facilitate the participation of others, and setting standards for evaluating group functioning and production. (Lippett, 1982, p. 9)

Lippitt defines teamwork as the way a group is able to solve its problems. Teamwork is demonstrated in groups by: (a)"...the group's ability to examine its process to constantly improve itself as a team," and (b) "the requirement for trust and openness in communication and relationships." The former is characterized by group interaction, interpersonal relations, group goals, and communication. The latter is characterized by a high tolerance for differing opinions and personalities. (Lippett, 1982, p. 207-208)

TEAM BUILDING AND TEAM LEARNING

A recent concept in OD is that of the learning organization. Peter Senge considers the team to be a key learning unit in the organization. According to Senge, the definition of team learning is:

> ...the process of aligning and developing the capacity of a team to create the results its members truly desire. It builds on the discipline of developing shared vision. It also builds on personal mastery, for talented teams are made up of talented individuals. (1990, p. 236)

Senge describes a number of components of team learning. The first is dialogue. Drawing on conversations with physicist, David Bohm, he identifies three conditions that are necessary for dialogue to occur: All participants must "suspend their assumptions;" all participants must "regard one another as colleagues;" and there must be a facilitator (at least until teams develop these skills) "who holds the context of the dialogue." Bohm asserts that "hierarchy is antithetical to dialogue, and it is difficult to escape hierarchy in organizations." (Senge, 1990, p. 245) Suspending all assumptions is also difficult, but is necessary to reshape thinking about reality.

Before a team can learn, it must become a team. In the 1970s, psychologist B. W. Tuckman identified four stages that teams had to go through to be successful. They are:

1. **Forming**: When a group is just learning to deal with one another; a time when minimal work gets accomplished.
2. **Storming**: A time of stressful negotiation of the terms under which the team will work together; a trial by fire.
3. **Norming**: A time in which roles are accepted, team feeling develops, and information is freely shared.
4. **Performing**: When optimal levels are finally realized—in productivity, quality, decision making, allocation of resources, and interpersonal interdependence.

Tuckman asserts that no team goes straight from forming to performing."Struggle and adaptation are critical, difficult, but very necessary parts of team development." (Robbins and Finley, 1995, p. 187)

Senge's characterization of dealing with conflict draws on Chris Argyris. Argyris writes about how even professionals avoid learning, using entrenched habits to protect themselves from the embarrassment and threat that comes with exposing their thinking. The act of encouraging more open discussion is seen as intimidating, and they feel vulnerable. (Argyris, 1994, p. 346-7)) The missing link for Senge is practice. Team learning is a team skill that can be learned. Practice is gained through dialogue sessions, learning laboratories, and microworlds. (Senge, 1990, p. 245) Microworlds are computerbased microcosms of reality, in which one learns by experimentation . Examples are Logo, in which children learn the principles of geometry, and SimCity, in which one literally builds a city, making all the decisions and learning the consequences of those decisions. Simulation, Senge believes, is a tool for learning "How do things work?" and just as important, "How might they work differently?" (Senge, 1990, p. 338)

TEAM PRACTICES

Contributors to *The Fifth Discipline Fieldbook* declare that team learning is not team building, describing the latter as creating courteous behaviors, improving communication, becoming better able to perform work tasks together, and building strong relationships. (Senge, 1990, p. 355) Just as teams pool their knowledge and then examine it from many different angles, so have the practitioners of OD shared their different perspectives and experiences. One such OD "strategist" is Juanita Brown, who has coached organizations toward innovative ways to involve employees. Looking back on groups with which she has worked, she recounts those experiences where team building turned into team learning. She draws inspiration from the community development movement and from the study of voluntary organizations. Roots of this are found in the work of Miles Horton, Paulo Freire, the Scandinavian study circles, Saul Alinsky, M. Scott Peck, and Marvin Weisbord. (Senge, *Fieldbook*, p. 508-9)

Of particular interest is her description of the San Francisco Foundation, a funder of worthy causes throughout the Bay area, which she counseled through a period of extraordinary growth, change, and pressure. Foundations may promote innovative projects, yet they are seldom organized progressively themselves. The executive director, Martin Paley, wanted to shift the role of the Distribution Committee from administrative decisions to policy making, involve the community in a dialogue on project directions, and then for the first time publish explicit grant guidelines in a newsletter. He also faced the delightful problem of an extremely large bequest. Approaching it as an adventure, he hired Juanita Brown as a long range planning consultant. In addition, he attended a systems dynamics training session led by Peter Senge at M.I.T. (Sibbert and Brown, 1986)

Six 'Commitment to the Community' input sessions were held to open the foundation to new ideas. What they heard was that this foundation didn't belong to the Distribution Committee or to the staff; it belonged to the community and community members wanted "damn good care" taken of it. They came to think of the foundation as a kind of community development bank. They learned that every meeting agenda is subject to change; that they had too much structure; and that people can learn from each other. (Sibbert and Brown, 1986)

Brown expressed her belief in the importance of dialogue as follows: "Strategic dialogue is built on the operating principle that the stakeholders in any system already have within them the wisdom and creativity to confront even the most difficult challenges." The 'community of inquiry' can extend beyond employees to include unions, customers, suppliers, and other

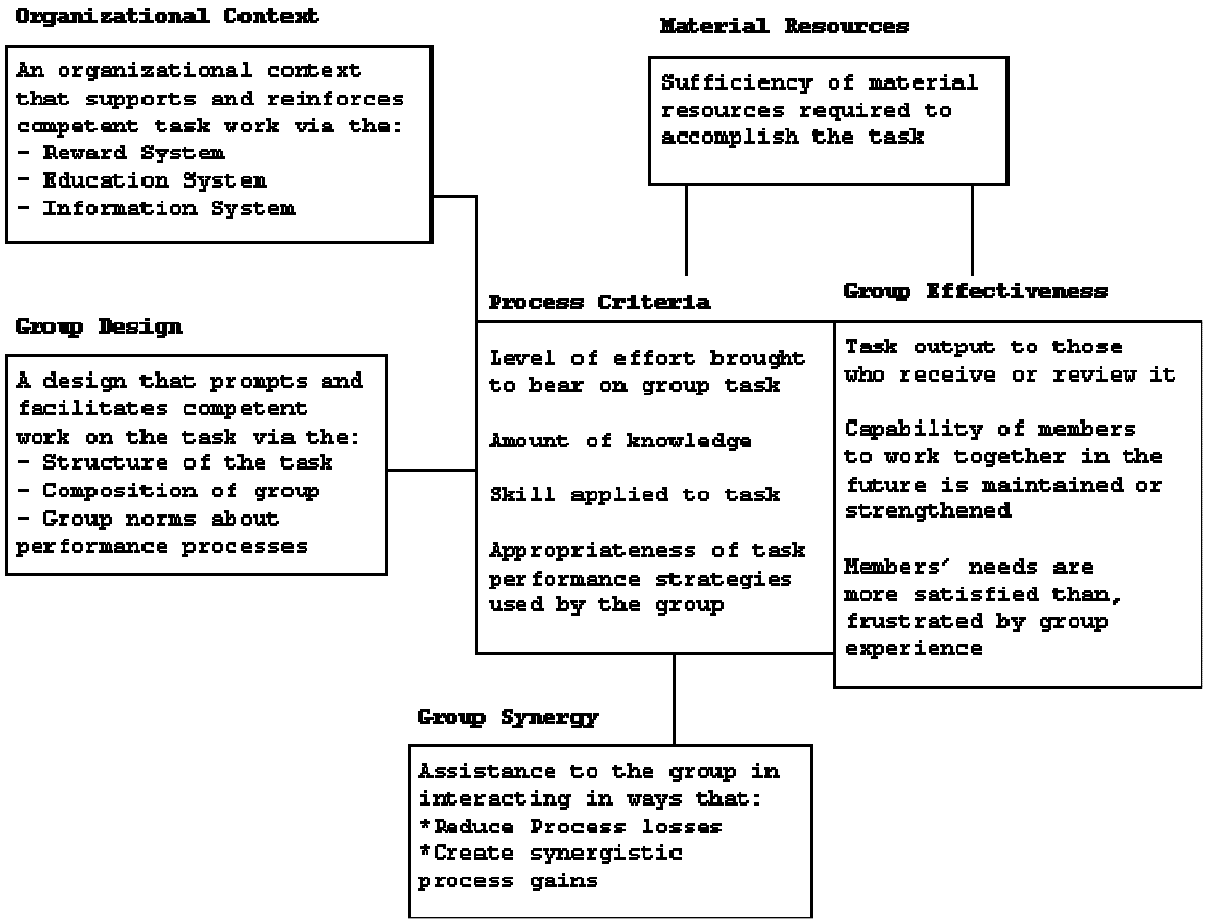
stakeholders, becoming a “dynamic and reinforcing process which helps create and strengthen the ‘communities of commitment’ which Fred Kofman and Peter Senge emphasize lie at the heart of learning organizations capable of leading the way towarda sustainable future.” (Bennet and Brown, 1995, p. 167)

EVALUATION

While much anecdotal evidence exists, there remains a lack of a clear understanding of how to really describe and measure team learning. As Senge stated:

> Until we can describe the phenomenon better, it [team learning] will remain mysterious. Until we have some theory of what happens when teams learn (as opposed to individuals in teams learning), we will be unable to distinguish group intelligence from ‘group think,’ when individuals succumb to group pressures for conformity. Until there are reliable methods for building teams that can learn together, its occurrence will remain a product of happenstance. (1990, p. 228)

What usually is measured is productivity, because high or low productivity has a direct effect on wages, the cost of products, the consumption of resources to produce goods, the quality of work life, and the survival and competitiveness of industries and of individual firms. However, these studies only evaluate productivity at the individual level. (Pritchard, 1990, p. 254) Goodman et al suggest that "if we want to understand how to design more productive groups, we need to move to finer-grained models that link group design and productivity changes." They suggest that the Hackman model (below) provides a good start. (Goodman et al., 1988, p. 317)



Shared Vision

What does it mean to have a shared vision? A shared vision begins with the individual, and an individual vision is something that one person holds as a truth. Throughout history there are many examples of people who have had a strong vision, some of these people are remembered even today. One example is John Brown with his *vision* of a holy war to free the slaves, which culminated in his attack on Harpers Ferry, Virginia, in 1859. According to Carl Jung, "Your vision will become clear only when you can look into your own heart.... Who looks outside, dreams; who looks inside, awakes." (Mindscape, 1995)

What is this vision that is found within our hearts? According to WordNet,[3] a vision is a vivid mental image. In this context, vivid means graphic and lifelike. Based on this, it can be concluded that a vision is a graphic and lifelike mental image that is very important to us, i.e., held within our hearts. The vision is often a goal that the individual wants to reach. In systems thinking that goal is most often a long term goal, something that can be a leading star for the individual.

The shared vision of an organization must be built of the individual visions of its members. What this means for the leader in the Learning Organization is that the organizational vision must not be created by the leader, rather, the vision must be created through interaction with the individuals in the organization. Only by compromising between the individual visions and the development of these visions in a common direction can the shared vision be created. The leader's role in creating a shared vision is to share her own vision with the employees. This should not be done to force that vision on others, but rather to encourage others to share their vision too. Based on these visions, the organization's vision should evolve.

It would be naive to expect that the organization can change overnight from having a vision that is communicated from the top to an organization where the vision evolves from the visions of all the people in the organization. The organization will have to go through major change for this to happen, and this is where OD can play a role. In the development of a learning organization, the OD-consultant would use the same tools as before, just on a much broader scale.

What is a shared vision? To come up with a classification for shared visions would be close to impossible. Going back to the definition of a vision as a graphic and lifelike mental image that is very important to us, Melinda Dekker's drawing [see p. 2] is as good as any other representation of shared vision. The drawing will probably be interpreted differently by people, but still there is something powerful about the imagery that most people can see.

Reflection on shared vision brings the question of whether each individual in the organization must share the rest of the organization's vision. The answer is no, but the individuals who do not share the vision might not contribute as much to the organization. How can someone start to share the rest of the organization's vision? Senge (1990) stresses that visions can not be sold. For a shared vision to develop, members of the organization must enroll in the vision. The difference between these two is that through enrollment the members of the organization choose to participate.

When an organization has a shared vision, the driving force for change comes from what Senge calls "creative tension." Creative tension is the difference between the shared vision and the current reality. With truly committed members the creative tension will drive the organization toward its goals.

John Brown, mentioned earlier, had a vision of freeing the slaves. Obviously, this was not a vision that came out of his own mind. He must have taken the slaves' vision and shared it with them. Clearly, if the slaves had truly preferred to stay enslaved, John Brown's vision could not have existed. The slaves' sense of shared vision made it possible for them to die by Brown's side, but they did not die *for* Brown, they died for a shared vision.

Systems Thinking

In the October 17, 1994 issue of *Fortune* magazine, Brian Dumaine named Peter M. Senge: "MR. LEARNING ORGANIZATION." (Dumaine, 1992) Why is it that in a field with so many distinguished contributors, Peter Senge was referred to as the "intellectual and spiritual champion?" (Dumaine, 1992, p. 147) The reason is probably because Senge injected into this field an original and powerful paradigm called 'systems thinking,' a paradigm premised upon the primacy of the whole --the antithesis of the traditional evolution of the concept of learning in western cultures.

Humankind has succeeded over time in conquering the physical world and in developing scientific knowledge by adopting an analytical method to understand problems. This method involves breaking a problem into components, studying each part in isolation, and then drawing conclusions about the whole. According to Senge, this sort of linear and mechanistic thinking is becoming increasingly ineffective to address modern problems. (Kofman and Senge, 1993, p. 18) This is because, today, most important issues are interrelated in ways that defy linear causation.

Alternatively, circular causation—where a variable is both the cause and effect of another—has become the norm, rather than the exception. Truly exogenous forces are rare. For example, the state of the economy affects unemployment, which in turn affects the economy. The world has become increasingly interconnected, and endogenous feedback causal loops now dominate the behavior of the important variables in our social and economic systems.

Thus, fragmentation is now a distinctive cultural dysfunction of society.[4] (Kofman and Senge, p. 17) In order to understand the source and the solutions to modern problems, linear and mechanistic thinking must give way to non-linear and organic thinking, more commonly referred to as systems thinking—a way of thinking where the primacy of the whole is acknowledged.

The Primacy of the Whole

David Bohm compares the attempt to understand the whole by putting the pieces together with trying to assemble the fragments of a shattered mirror. It is simply not possible. Kofman & Senge add:

> The defining characteristic of a system is that it cannot be understood as a function of its isolated components. First, the behavior of the system doesn't depend on what each part is doing but on how each part is interacting with the rest ... Second, to understand a system we need to understand how it fits into the larger system of which it is a part ... Third, and most important, what we call the parts need not be taken as primary. In fact, how we define the parts is fundamentally a matter of perspective and purpose, not intrinsic in the nature of the 'real thing' we are looking at. (Kofman and Senge, 1993, p. 27)

In his prominent book, *The Fifth Discipline*, Senge identified some learning disabilities associated with the failure to think systemically. He classified them under the following headings:

- "I am my position"
- "The enemy is out there"
- "The illusion of taking charge"
- "The fixation on events"
- "The parable of the boiled frog"
- "The delusion of learning from experience" (1990, pp. 17 - 26)

Although each of these contains a distinct message, illustrated how traditional thinking can undermine real learning by following up on one example: "the fixation on events."

According to Senge, fragmentation has forced people to focus on snapshots to distinguish patterns of behavior in order to explain past phenomena or to predict future behavior. This is essentially the treatment used in statistical analysis and econometrics, when trying to decipher patterns of relationship and behavior. However, this is not how the world really works: events do not dictate behavior; instead, they are the product of behavior. What really causes behavior are the interactions between the elements of the system. In diagrammatic form:

systems (patterns of relationships) ---> patterns of behavior ---> events (snapshots)

It is commonly recognized that the power of statistical models is limited to explaining past behavior, or to predict future trends (as long as there is no significant change in the pattern of behavior observed in the past). These models have little to say about changes made in a system until new data can be collected and a new model is constructed. Thus, basing problem-solving upon past events is, at best, a reactive effort.

On the other hand, systems modeling is fundamentally different. Oncethe behavior of a system is understood to be a function of the structure and of the relationships between the elements of the system, the system can be artificially modified and, through simulation, we can observe whether the changes made result in the desired behaviors. Therefore, systems thinking, coupled with modeling, constitutes a generative --rather than adaptive-- learning instrument.[5]

Thus, according to Senge:

> Generative learning cannot be sustained in an organization if people's thinking is dominated by short-term events. If we focus on events, the best we can ever do is predict an event before it happens so that we can react optimally. *But we cannot learn to create*. (1990, p. 22) [emphasis added]

LEARNING IN ORGANIZATIONS

Once we embrace the idea that systems thinking can improve *individual* learning by inducing people to focus on the whole system, and by providing individuals with skills and tools to enable them to derive observable patterns of behavior from the systems they see at work, the next step is to justify why systems thinking is even more important to *organizations* of people. Here, the discipline of systems thinking is most clearly interrelated with the other disciplines, especially with mental models, shared vision, and team learning.

Patterns of relationships (or systems) are derived from people's *mental models* --their perceptions about how the relevant parts of a system interact with one another. Naturally, different people have different perceptions about what the relevant parts of any one system are, and how they interact with one another. In order for organizational learning to occur, individuals in the organization must be willing and prepared to reveal their individual mental models, contrast them to one another, discuss the differences, and come to a unified perception of what that system really is.

This alignment of mental models can be referred to as developing a shared vision, as is discussed in the first part of this paper. It is possible that mere discussion among individuals may lead them to a shared vision but, because problems are often too complex, usually this exercise requires the aid of some skills and tools developed by systems thinkers. Whether simple or complex frameworks are used (such as word-and-arrow diagrams or computer simulation), they are essential instruments to developing a shared vision.

When groups of individuals who share a system also share a vision about how the components of that system interact with one another, then team learning (or organizational learning) is possible. First, they learn from one another in the process of sharing their different perspectives. There are many organizational problems that can be solved simply by creating alignment. For example, cooperation is a lesson that is often learned by people who recognize that they belong to different interdependent parts of the same system.

Second, people learn together by submitting their shared vision to testing. When complex dynamics exist, a robust shared vision allows organizational members to examine assumptions, search for leverage points, and test different policy alternatives. This level of learning often requires simulation, which is a much more specialized systems technique. However, if the problems faced by the organization are among commonly observed patterns which have been previously studied, archetypal solutions may be available to deal with them. Later in this paper, we will discuss an example using an archetype commonly referred to as "growth and under-investment."

THE FIFTH DISCIPLINE, A METANOIA

Systems thinking represents a major leap in the way people are used to thinking. It requires the adoption of a new paradigm. Although there is no such a thing as a learning organization, we can articulate a view of what it would stand for. In this sense, a learning organization would be an entity which individuals "would truly like to work within and which can thrive in a world of increasing interdependency and change." (Kofman and Senge, 1993, p. 32)

And according to Senge, systems thinking is critical to the learning organization, because it represents a new perception of the individual and his/her world:

> At the heart of a learning organization is a shift of mind --from seeing ourselves as separate from the world to connected to the world, from seeing problems as caused by someone or something 'out there' to seeing how our own actions create the problems we experience. A learning organization is a place where people are continually discovering how they create their reality. And how they can change it. (1990, pp. 12-13)

But, as we shall see next, systems thinking requires skills and tools which can only be developed through lifelong commitment. Plus, it requires that not just one, but many organizational members acquire them. Thus, some of the authors refer to learning organizations as ‘communities of commitment.’

SYSTEMS THINKING SKILLS AND TOOLS

At the foundation of systems thinking is the identification of circles of causality or feedback loops. These can be reinforcing or balancing, and they may contain delays. But before we "close" the loops to distinguish among these terms, let's examine two examples of flawed (or incomplete) thinking which take into account only partial relationships between elements of systems.

The first example is an unilateral perception of the arms race. The word-and-arrow diagram below illustrates, from the point of view of an American, the logic behind building U.S. armaments:

Foreign arms ---> Threat to the U.S. ---> Need to build U.S. arms[6]

The diagram can be read as follows: The more foreign arms, the greater the threat to the United States and, thus, the greater the need to build U.S. arms to defend the country from these potential aggressors. This non-systemic view suggests that U.S. arms are a defensive response to the threat posed by other nations: "If only the other nations would reduce their armaments, then so would the United States."

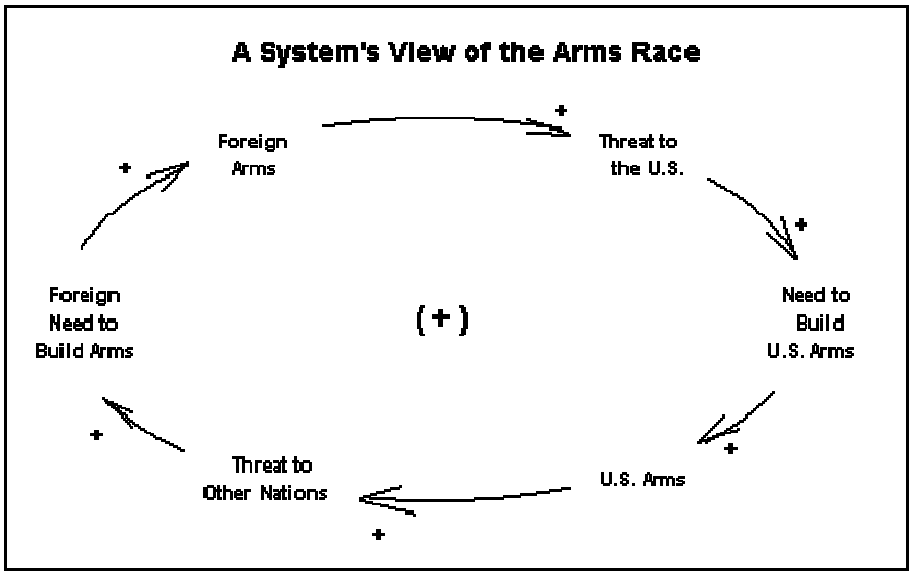
The second example illustrates a simple view of the mechanism involved with adjusting the temperature in a room during a hot summer:

Current temp. too hot ---> Turning on the air-conditioner ---> Results in lower temperature

For all of us who know about the developments of the cold war, or who have experienced first-hand the extremely cold temperatures inside movie theaters in mid-July, it is no surprise that these two diagrams tell only part of the story. Yet, if asked to tell the whole story, many of us would draw alternative diagrams, instead of complementing these. Over time, systems thinkers developed conventions to illustrate relationships, and to capture the whole story in just one diagram. Moreover, they found it useful to distinguish between stories such as the ones told above.

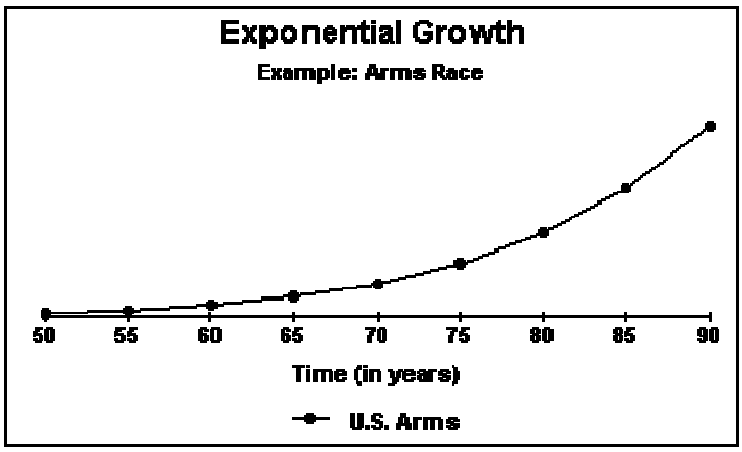
REINFORCING FEEDBACK

The arms race is an example of reinforcing (or positive or amplifying) feedback. Not only do more foreign arms increase U.S. arms, but more U.S. arms also tend to provoke increases in foreign arms. One reinforces the other:



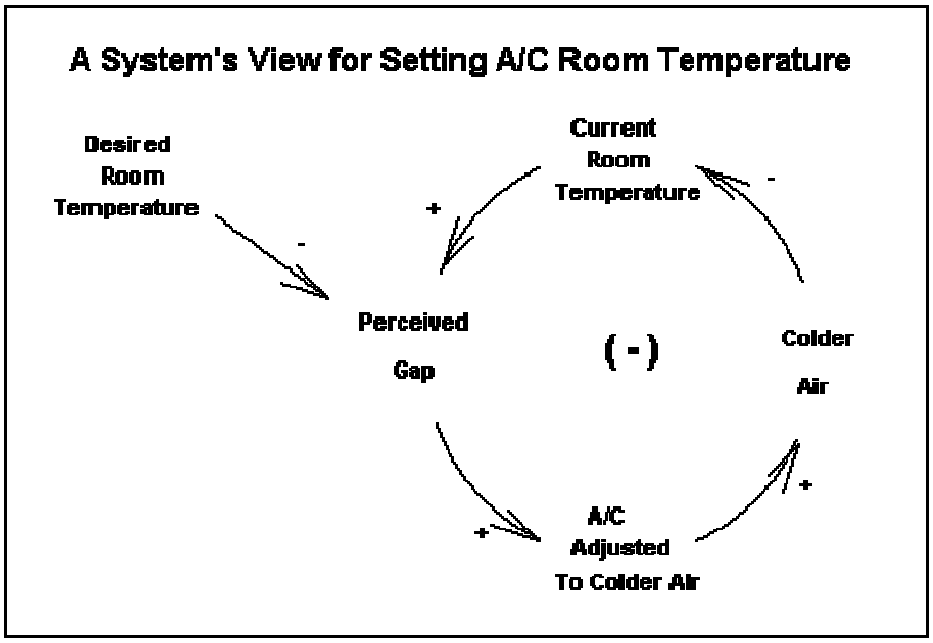
Although reinforcing feedback is commonly labeled as "positive" or "amplifying," this does not carry any value judgment. It simply means that a change in one part of the system causes a change in another part of the system which, in turn, amplifies the change in the first. Things do not always have to grow either. For example, a reduction in foreign arms will reduce the threat to Americans, which will probably cause a reduction in U.S. arms, which is likely to lead to further reductions in foreign arms (since U.S. threat to foreign nations is reduced.)

By itself, reinforcing feedback leads to either exponential growth or decay.



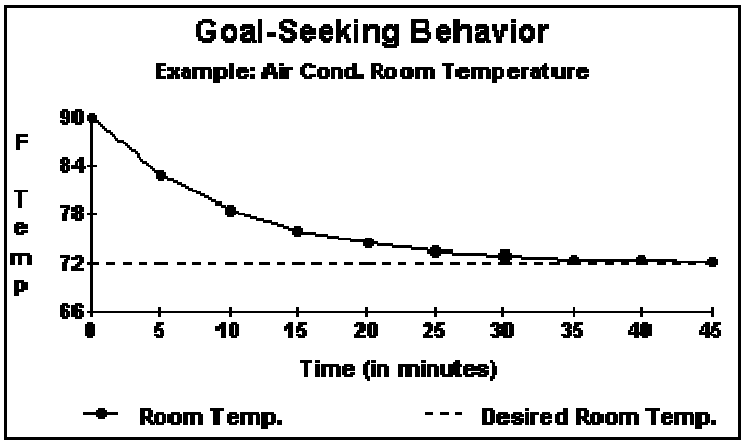
BALANCING FEEDBACK

Controlling room temperature is an example of balancing (or negative or controlling) feedback. In this case, a change in one part of the system causes a change in another part of the system which, in turn, counteracts the change in the first:



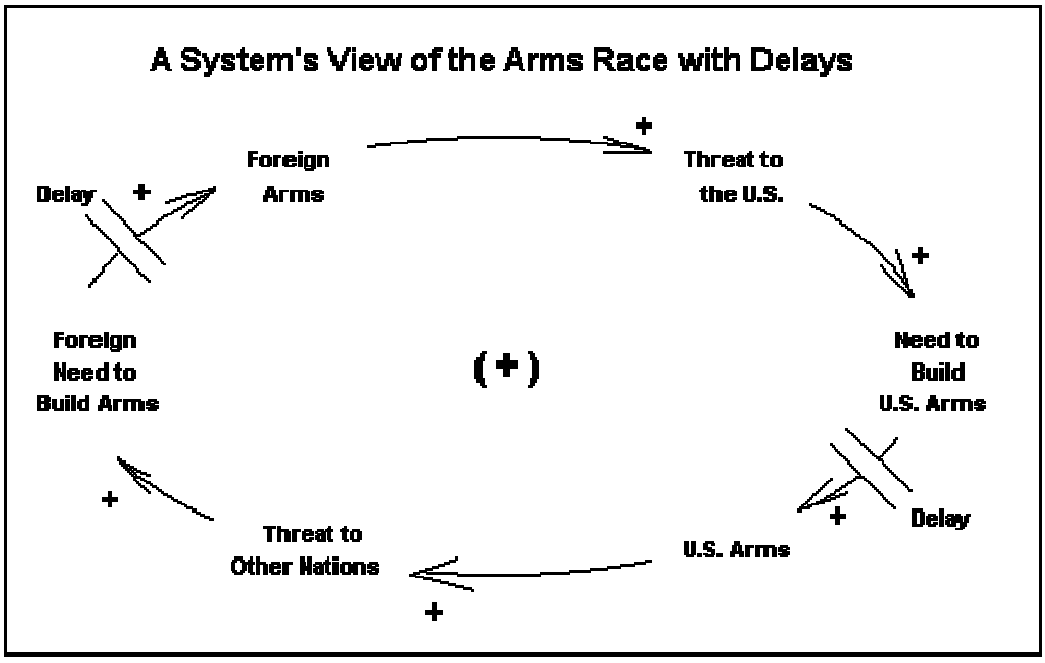
If the *Perceived Gap* is positive, *i.e., Current Room Temperature* is greater than *Desired Room Temperature*, the A/C is adjusted upwards increasing the flow of colder air, thus reducing the gap. This is a balancing system because more adjustment means less gap, not more (unless, obviously, the adjustment is made in the wrong direction!). The leverage point in this system is desired room temperature. If it is set too low, as seems to be the case in shopping malls and movie theaters, the resulting room temperature may be too low for the casual wear people tend to use during the summer.

By itself, balancing feedback leads to goal-seeking behavior.



DELAYS

The time dimension is another factor which tricks people who fail to think systemically. For example, because it takes time to build up foreign arms, an American may not perceive that action as resulting from a response to increases in U.S. arms, but rather as an independent aggressive initiative. Thus a more accurate representation of the arms race would be:



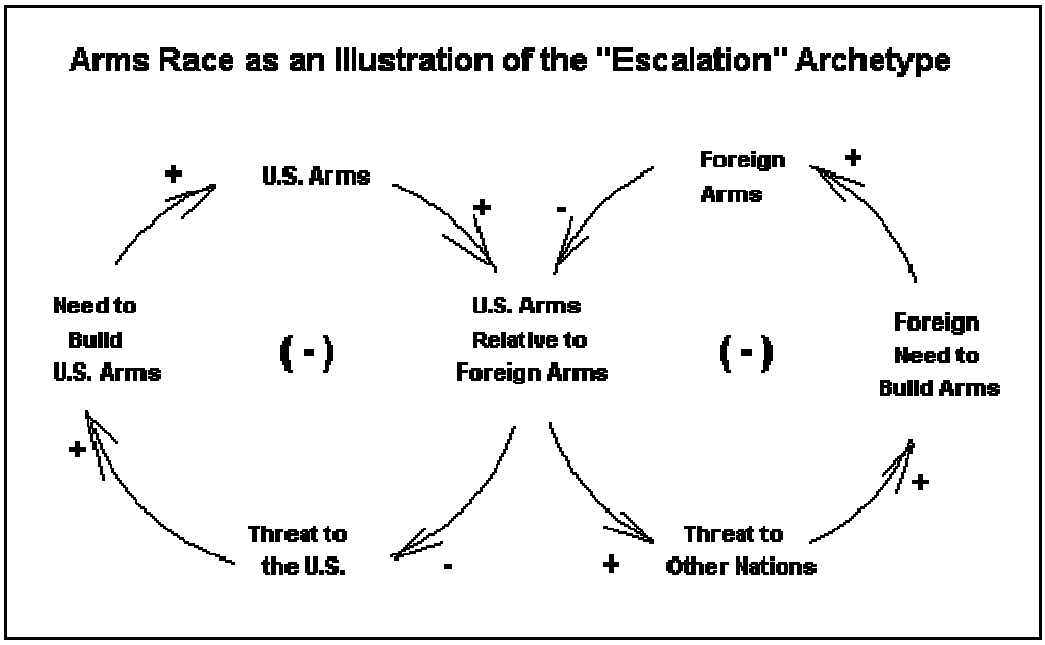
Sound systems thinking requires the utilization of a combination of reinforcing and balancing feedback loops, and the accurate identification of delays. Complex systems are composed of multiple feedback loops laid upon one another. Often, the behavior of the variables in these systems can only be understood through simulation. But, before we discuss simulation, let's recognize the existence of certain archetypal structures which are commonly found, and for which behaviors are already well understood.

SYSTEM ARCHETYPES

A number of system structures or patterns of relationships are commonly found in a variety of settings. Some of these have been carefully studied, and their patterns of behavior and leverage points have been identified. Senge discusses them in *The Fifth Discipline,* Appendix 2 (pp. 378-390):

- "Balancing process with delay"
- "Limits to growth"
- "Shifting the burden"
- "Eroding goals"
- "Escalation"
- "Success to the successful"
- "Tragedy of the commons"
- "Fixes that fail"
- "Growth and under-investment"

The arms race discussed previously could be used as an example of the "Escalation" archetype if we told the story using two balancing feedback loops, instead of just one large reinforcing feedback loop:



The management principle derived from it is to look for a way for both sides to win, since their continued competition will lead to great costs and inefficiencies. Cooperation or mutual understanding is called for.

A practical application of a combination of the "Growth and under-investment" and "Eroding goals" archetypes was recently applied in a strategic planning effort for the Office of Disabled Student Services (DSS) of the University at Albany, State University of New York. Appendix A contains a copy of the analysis that was done for DSS. In this study, the authors suggested that the only way to respond effectively to the increased demand for services for disabled students at the University at Albany would be by increasing work capacity. Although this insight was not particularly dazzling by itself, when coupled with an evaluation that in the absence of resources to increase capacity, there would be slow but unequivocal tendencies to allow for the erosion of the quality of services traditionally offered by the Office, DSS' leadership recognized that this process was already in place, but no one had really noticed it. This is because there are delays in the system.

When system archetypes apply, it becomes easy to focus on high leverage points, and to identify and avoid symptomatic solutions to real problems. This is because the analysis which serves as the foundation for the archetypes has already been done. On the other hand, when the systems under study are more complex because they are composed of a combination of structures, it becomes important to build models and to simulate to confirm assumptions about behavior.

MODELING & SIMULATION

Model building involves the conceptual formalization of mental models about the interrelationships between important elements in a complex system, for the purpose of examining the behavior of the variables of interest. Unfortunately, a great deal of modeling training, and experience is required to build good models, even simple ones. For this reason, so far, the literature in systems thinking for learning organizations has only traced a few steps in this arena. Usually, when modeling work is required, professional modelers are involved in the analysis to serve as the interface between those who know the system (the clients), and the mathematical formalization of the model.

The distinction between qualitative and quantitative systems thinking is commonly made by referring to the former as soft and the latter as hard system dynamics. At present, the contribution made by Senge to the field of organizational learning has relied primarily upon soft system dynamics. However, it is important to emphasize that the knowledge available today in the form of general principles, archetypes, etc., is the product of 30 years of hard system dynamics research and development. Thus, in general, the development of knowledge in systems thinking is highly dependent upon the latter, while its application has been very successful in the former.

Yet, system dynamics technology has progressed tremendously in the last few years. The availability of low-priced, user-friendly software for PCs (such as *Stella II*, produced by High Performance Systems) is extending the realm of quantitative analysis to amateur modelers. Moreover, the skills and tools needed are becoming available in a variety of settings, including K-12 education. Still, only a handful of people qualify as professional modelers, a fact which should serve as an alert with respect to the quality of the modeling being done in the field.

MICRO-WORLDS AND GAMES

Where formal models do exist, they serve the function of a learning laboratory for managers. Some of the commonly used micro-worlds are:

- The People Express simulator
- The Boom & Bust game
- The Beer Distribution game
- Fish Banks
- Stratagem

Each of these captures the dynamics of different systems, with different behaviors, leverage points, principles, etc. For example, the Boom & Bust and Beer Distribution games deal with different dynamics of the business cycle. Fish Banks, on the other hand, is modeled after the tragedy of the commons problem. In Stratagem, players make decisions about investment and consumption practices which carry short- versus long-term tradeoffs.

In each of these games, the objective is to understand the nature of the system at hand, and to extract some lessons about how to improve the conditions of the system or how to avoid problems inherently associated with the systems because of the nature of their structures. The underlying message is that structure determines behavior, and people can generally learn to identify what has to be done to deal with problematic behavior by "playing" with the system until they "understand" how it behaves.

Conclusion

The concept of the learning organization arises out of ideas long held by leaders in organizational development and systems dynamics. One of the specific contributions of organizational development is its focus on the humanistic side of organizations. The disciplines described in this paper “differ from more familiar management disciplines in that they are ‘personal’ disciplines. Each has to do with how we think, what we truly want, and how we interact and learn with one another.” (Senge, 1990, p. 11) The authors of this paper see learning organizations as part of the evolving field of OD. To our knowledge, there are no true learning

organizations at this point. However, some of today's most successful organizations are embracing these ideas to meet the demands of a global economy where the value of the individual is increasingly recognized as our most important resource.

Endnotes

Click on numbers to get back.

[1] This definition is an adaptation of the definition offered by French and Bell (1995, p. 28). It was developed by the Spring 1996 section of PAD633 Organization Development and Analysis course at the University at Albany, taught by Dr. Sue Faerman.

[2] Because Peter Senge is so influential in the field of learning organnizations, his book The Fifth Discipline is cited here freqently. All references to The Fifth Discipline are indicated in parentheses as his 1990 work. All other references to works by Peter Senge in this paper are listed by title in parentheses.

[3] On-line Lexical Database by researchers at Princeton, builds on the Oxford English Dictionary (1928).

[4] Kofman and Senge argue that fragmentation is a cultural dysfunction of society because it is a byproduct of its past success.

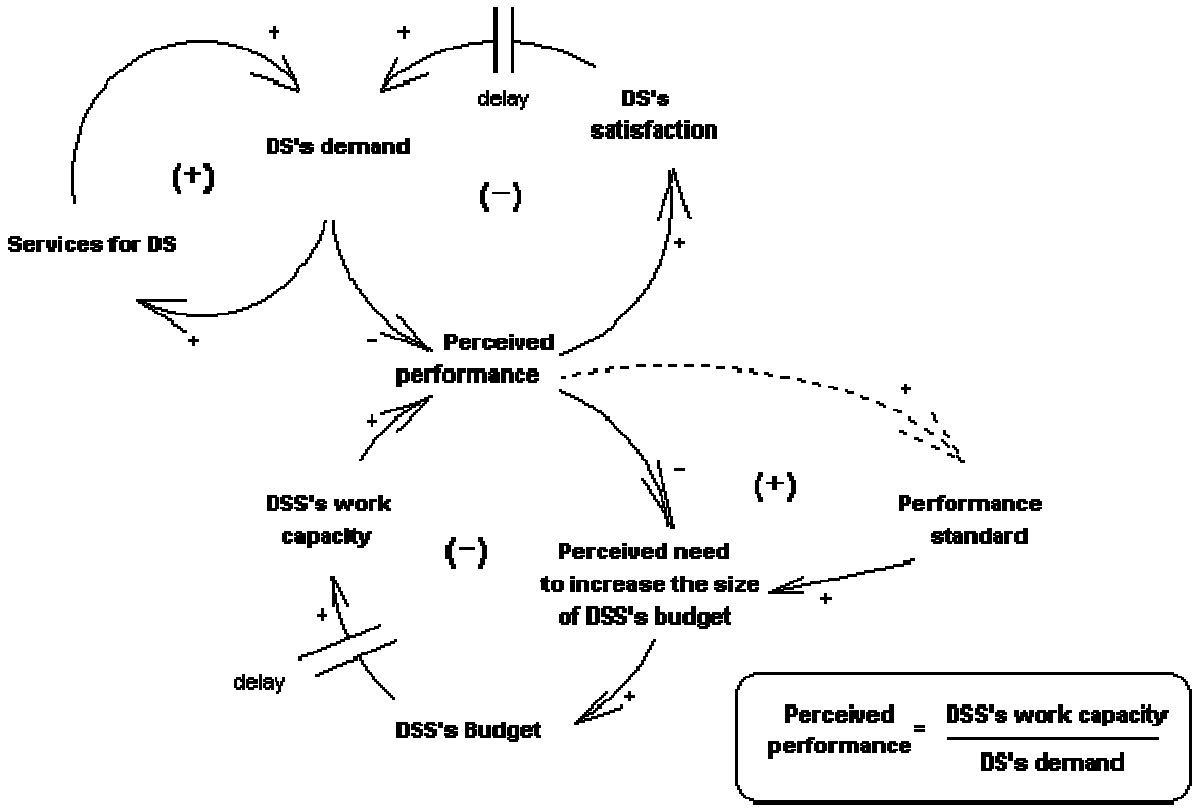
[5] Systems modeling and simulation are the foundation of systems thinking. This larger field is known as 'System Dynamics,' founded by Jay Forrester of MIT in the 1960s.

[6] Example extracted from Senge, 1990, pp. 69-73.

Appendix A

A Systems Thinking Analysis Using a combination of archetypes for the Office of Disabled Student Services DSS), University at Albany, State University of New York

We draw upon Senge's systemic theory of what happened at *People Express* to help highlight the consequences of failure to address the issues identified in this strategic planning effort for DSS. (*The Fifth Discipline*, pp. 130-135) The word and arrow diagram below is an adaptation from the one on p. 133. In it we will find three systems *archetypes*: (1) growth and under-investment (2) balancing process with delay, and (3) eroding goals. In the analysis, we highlight "the size of DSS' budget," but any other measure intended to improve the work capacity of the organization would also be appropriate, such as for example "using DSS' resources more efficiently" (by spending resources according to pre-defined priorities).



Word-and-Arrow Diagram for DSS' Budget Problem

The positive feedback loop on the top-left of the diagram represents the growth in demand for services for disabled students (DS). This loop indicates that *demand for and availability of services reinforce each other*: the greater the demand, the more services are provided, which satisfies the needs of disabled students and leads to new demands. The growth in demand which triggered this process was caused by the passage of the Americans with Disabilities Act (ADA) of 1990. As previously mentioned, ADA defined disability more broadly and opened the doors of higher education to a much larger group.

The negative feedback loop on the top-right is a balancing loop which prevents the growth in services for disabled students to continue forever. It causes this growth to level-off when the

work capacity of DSS has been met. Thus, the limiting factor in this system is the organization's work capacity. This is how it works: As demand grows, perceived performance (measured in terms of work capacity divided by demand) begins to fall. The reduced performance (in a given task) causes the quality of the work of the organization to fall, which consequently drives disabled students' satisfaction down. *Eventually*, reduced satisfaction will also cause demand to fall.

The work capacity of the organization does not stay fixed, however. This is captured in the third feedback loop, in the bottom of the diagram. This is also a balancing loop (negative), and it serves to balance the organization's perceived performance with its performance standard. This is how it works: Suppose DSS has a performance standard of one (*i.e.,* it wants its work capacity always to meet --or be equal to-- DS' demand). Then, as performance falls because of higher demand, this causes a perceived need to invest in the organization's capacity. If this investment occurs, *eventually,* it will serve to increase DSS' work capacity until perceived performance is finally equal to one. In other words, *DSS' work capacity will be adjusted up or down depending upon its perceived performance and its performance standard.*

So far, we have discussed (1) growth and under-investment and (2) balancing process with delay. The following observations should serve to underscore the conclusions from this exercise in modeling:

- once demand for services for disabled students is triggered, there is a "snow-ball" effect which causes it to grow even more as a result of an increased level of availability of services;
- demand grows until the work capacity of the organization has been met;
- this causes performance to fall, raises DS' dissatisfaction, and, eventually, reduces demand;
- the organization can respond by increasing investments to raise work capacity, however, there is a delay between making the investments and collecting payoffs from them;
- in the mean time, DSS'performance and DS' satisfaction will fall;
- the organization may over *or* under-estimate the amount of investment needed to meet demand;
- if it overestimates demand, work capacity will build up beyond necessary causing performance to rise above the standard;
- if it underestimates demand, work capacity will fall short of demand and performance will remain below standard;
- the delay between making the investment and attaining a higher work capacity causes work capacity to *always* fall short of demand *if demand is continuously growing*; and
- the delay between increasing DSS' dissatisfaction and a fall in demand causes demand to grow much above what the organization's work capacity can handle.

The last two observations lead us into the last archetype in the diagram: eroding goals. *There is reason to believe that under a scenario of increasing demand* --because of the delay involved in building up the organization's work capacity and because of the gap in time between growing DS' dissatisfaction and fall in demand-- *there will be a permanent gap in the organization's performance* (between perceived and standard). If the organization allows its performance standard to slip because of this *on-going* experience with a lower performance level (positive link between perceived performance and performance standard), then the problems the organization is experiencing will be magnified. This is because performance standard will be allowed to fall below one, relieving the pressure to invest, lowering actual investment levels, and, ultimately and definitely, keeping work capacity from growing sufficiently to meet demand --indeed, helping increase the gap between DS' demand and DSS' work capacity.

This is probably the most important insight offered by this model. It says that an organization which has been suffering for some time with falling performance may never be able to return to previous performance levels *simply because it lowered its standards*. If this happens, the organization locks itself in a situation of low performance and high dissatisfaction. Naturally, the long-term result will be lowered motivation and morale within the organization. *The solution to this problem is to bring the performance standard back up to adequate levels, and making sure that it stays fixed up there.*

The above exercise underscores the significance of establishing and keeping track of performance measurements. It also clarifies why it is so important to focus services and establish priorities. Under a condition of increasing demand, it is very easy for one to fall into the trap of trying to do everything and *unwillingly* allow quality standards to fall. Keeping standards fixed and monitoring performance closely are key concepts not only to identifying much needed increases in work capacity, but also to help advocate increased budget allocations.

The model also suggests that the only way DSS will be able to meet its increasing demand is with increased investments in work capacity. Whether those resources should be raised internally, through federal, state and local agencies, through grant-writing and/or fund-raising initiatives will depend upon the evolving characteristics of the environment. Right now, grant-writing and fund-raising initiatives appear to be the most viable alternatives. *If DSS wants to maintain its proactive standing in the region, then it must find ways to implement those alternatives*.

Appendix B - Definitions

ADAPTIVE v. GENERATIVE LEARNING (PROACTIVE v. REACTIVE)
According to *Fortune* magazine, "the most successful corporation ... will be something called a *learning organization*, a consummately *adaptive* enterprise." [emphasis added] But Senge argues that increasing adaptiveness is only the first stage in moving toward learning organizations. **The impulse to learn in children goes deeper than desires to respond and adapt more effectively to environmental change. The impulse to learn, at its heart, is an impulse to be generative, to expand our capability.** This is why leading corporations are focusing on *generative* learning, which is about *creating*, as well as *adaptive* learning, which is about *coping*.

But generative learning, unlike adaptive learning, requires new ways of looking at the world. **Generative learning requires seeing the systems that control *events*.** When we fail to grasp the systemic source of problems, we are left to "push on" symptoms rather than eliminate underlying causes. Without systemic thinking, the best we can ever do is adaptive learning.

COMMUNITY DEVELOPMENT
Those who believe in the need for shared vision have looked to groups that have this quality, and found them to be best characterized as communities. Companies redifined as communities see all employees as citizens, sharing in the decision-making and dedicated to a higher purpose.

CREATIVE TENSION
The difference between where we are now and where we want to be results in a feeling that we need to change. This feeling is known as creative tension.

DEFENSIVE REASONING
This is a barrier to learning for both the individual and the organization. We are afraid of embarrassment or perceived threats and that prevents us from having an open mind.

DETAIL v. DYNAMIC COMPLEXITY
Detail complexity is simply when a problem involves several variables. D*ynamic* complexity are situations where cause and effect are subtle, and where the effects over time of interventions are not obvious.

Senge highlights that when the same action has dramatically different effects in the short-run and in the long-run, there is dynamic complexity. When an action has one set of consequences locally and a very different set of consequences in another part of the system, there is dynamic complexity. When obvious interventions produce non-obvious consequences, there is dynamic complexity.

Senge also argues that conventional forecasting, planning, and analysis methods are not equipped to deal with dynamic complexity.

FEEDBACK
Any reciprocal flow of influence. In systems thinking it is an axiom that every influence is both cause and effect. Nothing is ever influenced in just one direction.

LEARNING LABS
Computer simulations of "microworlds" that allow us to speed up time and see the results of actions that might be taken by an organization.

LEVERAGE
Rather than use of a tool, it is through creative ideas, often from unexpected sources, applied to our work activities that gives leverage. A team working with a shared vision can through experimentation develop that extra edge, leverage.

METANOIA - A SHIFT OF MIND
Systems thinking needs the disciplines of building shared vision, mental models, team learning, and personal mastery to realize its potential. Building a shared vision fosters commitment to the long-term. Mental models focus on the openness needed to unearth shortcomings in our present ways of seeing the world. Team learning develops the skills of groups of people to look for the larger picture that lies beyond individual perspectives. And personal mastery fosters the personal motivation to continually learn how our actions affect our world.

But systems thinking makes understandable the subtlest aspect of the learning organization --the new way individuals perceive themselves and their world. At the heart of a learning organization is a *shift of mind* --from seeing ourselves as separate from the world to connected to the world, from seeing problems as caused by someone or something "out there" to seeing how our own actions create the problems we experience. A learning organization is a place where people are continually discovering how they create their reality. And how they can change it.

SINGLE LOOP VS DOUBLE LOOP LEARNING
Single loop learning is linear. It is trying to find a better way to do a process. It is comparable to continuous quality improvement. Double loop learning goes a step further and asks why we are doing the process in the first place. Should we be doing something else?

SYSTEM ARCHETYPES
Systems Archetypes are generic structures which embody the key to learning to see structures in our personal and organizational lives. They are types of systemic structures that recur again and again. Their knowledge helps us to identify and understand the underlying causes of problems, possible leverage points, and so forth. Some examples of systems archetypes are:

- balancing process with delay
- limits to growth
- shifting the burden
- eroding goals
- escalation
- tragedy of the commons
- growth and under-investment

The archetype template is a specific tool that is helping managers identify archetypes operating in their own strategic areas. The template shows the basic structural form of the archetype but lets managers fill in the variables of their own situation.

SYSTEMS ---> PATTERNS OF BEHAVIOR ---> EVENTS
There are three distinct levels to view reality: *events*, *patterns of behavior*, and *systemic structure*. According to Senge, contemporary society focuses predominantly on events, less so in patterns of behavior, and very rarely on systemic structure. Leaders in learning organizations must reverse this trend, and focus their organization's attention on systemic structure. This is because *event* explanations --who did what to whom-- doom their holders to a reactive stance toward change; *pattern-of-behavior* explanations are limited to identifying long-term trends and assessing their implications --they suggest how, over time, we can respond to shifting conditions (adaptive learning); *structural* explanations are the most powerful --only they address the underlying causes of behavior at a level such that patterns of behavior can be changed (generative learning).

TEAM LEARNING
A discipline that starts with "dialogue," the capacity of members of a team to suspend assumptions and enter into a genuine "thinking together." Team learning is vital because teams, not individuals, are the fundamental learning unit in modern organizations.

TRIPLE LOOP LEARNING
Learning about learning. Understanding why we make the choices we do. What predisposes us to act in certain ways?

WHEEL OF LEARNING
This model of learning is based upon observation of animals functioning in the wild. They wait, they focus, they strike, and then they wait again. People also alternate between activity and repose; to make effective change, this pattern must be tapped. The "wheel of learning" has four parts of its cycle--reflecting (thinking and feeling), connecting (looking for links or hypotheses), deciding (choosing an action), and doing. There are both individual and team versions of the cycle. David Kolb and Charles Handy are associated with this concept and Stephanie Spear developed a team variation.

Daniel Aronson

Systems thinking has its foundation in the field of system dynamics, founded in 1956 by MIT professor Jay Forrester. Professor Forrester recognized the need for a better way of testing new ideas about social systems, in the same way we can test ideas in engineering. Systems thinking allows people to make their understanding of social systems explicit and improve them in the same way that people can use engineering principles to make explicit and improve their understanding of mechanical systems.

The Systems Thinking Approach

The approach of systems thinking is fundamentally different from that of traditional forms of analysis. Traditional analysis focuses on the separating the individual pieces of what is being studied; in fact, the word "analysis" actually comes from the root meaning "to break into constituent parts." Systems thinking, in contrast, focuses on how the thing being studied interacts with the other constituents of the system—a set of elements that interact to produce behavior—of which it is a part. This means that instead of isolating smaller and smaller parts of the system being studied, systems thinking works by expanding its view to take into account larger and larger numbers of interactions as an issue is being studied. This results in sometimes strikingly different conclusions than those generated by traditional forms of analysis, especially when what is being studied is dynamically complex or has a great deal of feedback from other sources, internal or external.

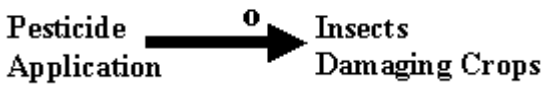
The character of systems thinking makes it extremely effective on the most difficult types of problems to solve: those involving complex issues, those that depend a great deal dependence on the past or on the actions of others, and those stemming from ineffective coordination among those involved. Examples of areas in which systems thinking has proven its value include:

- Complex problems that involve helping many actors see the "big picture" and not just their part of it
- Recurring problems or those that have been made worse by past attempts to fix them
- Issues where an action affects (or is affected by) the environment surrounding the issue, either the natural environment or the competitive environment
- Problems whose solutions are not obvious

Use of Systems Thinking

An example that illustrates the difference between the systems thinking perspective and the perspective taken by traditional forms of analysis is the action taken to reduce crop damage by insects. When an insect is eating a crop, the conventional response is to spray the crop with a pesticide designed to kill that insect. Putting aside the limited effectiveness of some pesticides and the water and soil pollution they can cause, imagine a perfect pesticide that kills all of the insects against which it is used and which has no side effects on air, water, or soil. Is using this pesticide likely to make the farmer or company whose crops are being eaten better off?

If we represent the thinking used by those applying the pesticides, it would look like this:



(*Reading the Diagram*: The arrow indicates the direction of causation - that is, a change in the amount of pesticide applied causes a change in the numbers of insects damaging crops. The letter indicates how the two variables are related: an "**s**" means they change in the same direction - if one goes up then the other goes up, and an "**o**" means they change in the opposite direction - if one goes up then the other goes down (or vice versa). This diagram is read "a change in the amount of pesticide applied causes the number of insects damaging crops to change in the opposite direction." The belief being represented here is that "as the amount of pesticide applied increases, the number of insects damaging crops decreases.")

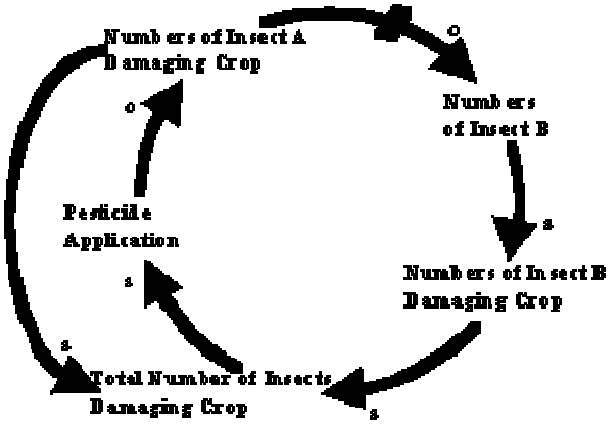
According to this way of thinking, the more pesticide is applied, the fewer insects there will be damaging crops, and the less total crop damage.

The temptation is to say that eliminating the insects eating the crops will solve the problem; however that often turns out to not be the case. The problem of crop damage due to insects often does get better - in the short term. Unfortunately, the view diagrammed above represents only part of the picture. What frequently happens is that in following years the problem of crop damage gets worse and worse and the pesticide that formerly seemed so effective does not seem to help anymore.

This is because the insect that was eating the crops was controlling the population of another insect, either by preying on it or by competing with it. When the pesticide kills the insects that were eating the crops, it eliminates the control that those insects were applying on the population of the other insects. Then the population of the insects that were being controlled explodes and they cause more damage than the insects killed by the pesticide used to.

In other words, the action intended to solve the problem actually makes it worse because the way its unintended side effects change the system ends up exacerbating the problem.

In fact, some studies suggest that a majority of the 25 insects that cause the most crop damage each year became problems to begin with because of exactly this cycle. Graphically, the way this happens can be represented as:



According to this understanding, the greater the pesticide application, the smaller the numbers of Insect A (the original pest) that will eat the crop. This leads to an immediate decrease in the numbers of insects eating the crop (note that this is the effect those applying the pesticides are intending). However, the smaller numbers of insect A eventually lead to greater numbers of Insect B (the hash marks on the arrow indicate a delay), because insect A is no longer controlling the numbers of insect B to the same extent. This leads to a population explosion of insect B, to greater numbers of insect B damaging crops, and to greater numbers of insects damaging the

crop, exactly the opposite of what was intended. Thus, although the short-term effects of applying the pesticide were exactly what was intended, the long-term effects were quite different.

With this picture of the system in mind, other actions with better long-term results have been developed, such as Integrated Pest Management, which includes controlling the insect eating the crops by introducing more of its predators into the area. These methods have been proven effective in studies conducted by MIT, the National Academy of Sciences, and others, and they also avoid running the risk of soil and water pollution.

The way that the broader perspective of systems thinking creates the understanding necessary for better long-term solutions was also evident in work I did with a company whose industry was being deregulated. They seemed to be doing everything right in working on a customer-relations problem they were experiencing: they had a team of capable people working on it, they were using a process that had been successful many times in the past, and they even had affected customers giving them feedback on proposals to rectify the situation.

However, they were having difficulty seeing the big picture of how the way they historically did things was contributing to the problem. Working together over two days, I was able to help them see how the problem was being exacerbated and the most powerful actions they could take to solve it. The session ended with the creation of a strategy for addressing the problem that was unanimously supported by the team and the customers.

By seeing the whole picture, the team was able to think of new possibilities that they had not come up with previously, in spite of their best efforts. Systems thinking has the power to help teams create insights like these, when applied well to a suitable problem.

(Other examples of positive results obtained by systems thinking in service, human resources, and high-technology industries can be found in Peter Senge's classic *The Fifth Discipline* and in The Systems Thinker newsletter, published by Pegasus Communications.[1])

A Better Way to Deal with Our Most Difficult Problems

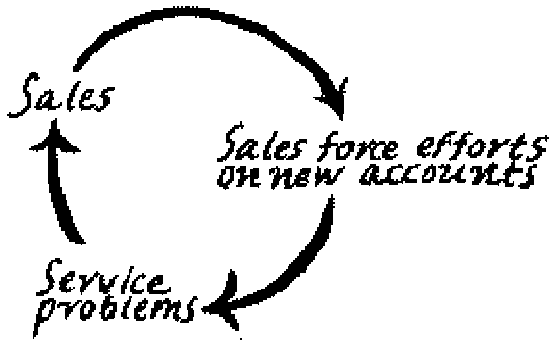
So many important problems that plague us today are complex, involve multiple actors, and are at least partly the result of past actions that were taken to alleviate them. Dealing with such problems is notoriously difficult and the results of conventional solutions are often poor enough to create discouragement about the prospects of ever effectively addressing them. One of the key benefits of systems thinking is its ability to deal effectively with just these types of problems and to raise our thinking to the level at which we create the results we want as individuals and organizations even in those difficult situations marked by complexity, great numbers of interactions, and the absence or ineffectiveness of immediately apparent solutions.

Daniel Aronson is the host of the *Thinking Page* (http://www.thinking.net)

The Language of Systems Thinking: "Links" and "Loops"

Michael Goodman, Jennifer Kemeny, Charlotte Roberts

In systems thinking, every picture tells a story. From any element in a situation (or "variable"), you can trace arrows ("links") that represent influence on another element. These, in turn, reveal cycles that repeat themselves, time after time, making situations better or worse.



This image, for instance, from the Acme Company, shows the level of service influencing sales. Everv time service grows poorer (when billing and delivery problems increase), sales will also decrease. Conversely, if the level of service improves, we can expect (eventually, at least) more sales.

But links never exist in isolation. They always comprise a circle of causality, a feedback "loop," in which every element is both "cause" and "effect" C-influenced by some, and influencing others, so that every one of its effects, sooner or later, comes back to roost.

How to Tell the Story from a Loop

1. Start anywhere. Pick the element, for instance, of most immediate concern. *Our sales are dropping . . .* Resist the temptation to explain why this is happening -- yet.
2. Any element may go up or down at various points in time. What has the element been doing at this moment? Try out language which describes the movement: *As Acme's sales level goes up . . . goes down . . . improves . . . deteriorates. . . increases. . . decreases. . . rises. . . falls . . . soars . . . drops. . . waxes . . . wanes . . .*
3. Describe the impact this movement produces on the next element *As Acme's sales level goes down, the number of efforts to sell new accounts goes up.*
4. Continue the story back to your starting place. Use phrases that show causal interrelationship: "This in turn, causes . . ." or ". . . which influences . . ." or ". . . then adversely affects . . ." *As Acme's sales level goes down, the number of efforts to sell new accounts goes up. This means the level of service drops, which in turn influences sales to continue falling . . .*

5. Try not to tell the story in cut-and-dried, mechanistic fashion. *When service problems rise, sales fall. As sales fall, sales force efforts rise.* Instead, make it come alive. Add illustrations and short anecdotes so others know exactly what you mean.... *This means the level of service drops. We just can't keep to the delivery schedules we promised. Loyal customers, in turn, become upset. Some stop doing business with us . . .*

Note that linear languages, like English, permit us to talk about the loop only one step at a time, as if we were following a train in a toy railroad around a track. In reality, however, all of these events occur at once. Seeing their simultaneity *(. . . sales continue to fall, while we spur even more efforts to sell new accounts . . .)* helps you recognize system behavior and develop a sense of timing.

Reinforcing Loops: when small changes become big changes

There are basically two building blocks of all systems representations: reinforcing and balancing loops.

Reinforcing loops generate exponential growth and collapse, in which the growth or collapse continues at an ever-increasing rate. To grasp the often-surprising ramifications of exponential growth, consider an interest-bearing bank account. Your money grows much faster than it would if you merely put $100 each year into a piggy bank. At first, the difference seems small, interest would generate only a few extra dollars per year. But if you left the interest in the bank, the money would grow at an ever-faster rate. After fifty years (at 7 percent interest), you'd have more than $40,000, more than eight times as much as the piggy bank would generate by growing at the same rate, year after year.

If you were unprepared for it, you'd reach a moment of surprise after perhaps fifteen years, when you saw how the growth of your money was building on itself-a truly virtuous spiral.

But you'd be caught in a vicious spiral if, instead of investing money, you went into debt for a long time. At first it would seem as if you were paying only small sums in interest. But over time, the balance you owed would grow with increasing speed.

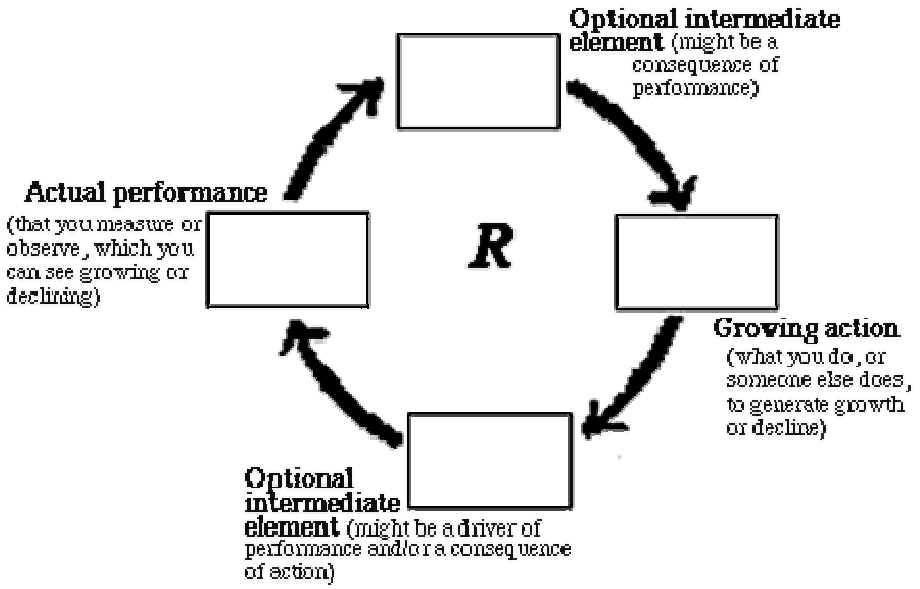
In all reinforcing processes, as in the bank account, a small change builds on itself. High birth rates lead to higher birth rates; industrial growth begets more industrial growth. Don't underestimate the explosive power of these processes; in their presence, linear thinking can always get us into trouble. For example, organizations often assume that they will face steady, incremental growth in demand. They are startled to discover that when their new facilities come on line (be they factories, distribution systems, utility grids, jails, highways, or city services) the demand has already overshot the relief effort.

When someone remarks that, "The sky's the limit," or "we're on a roll," or "This is our ticket to heaven," you can bet there's a reinforcing loop nearby, headed in the "virtuous" direction they prefer.

When people say, "we're going to hell in a handbasket," or "we're taking a bobsled ride down the chute," or "we're spiraling to oblivion," you know they're caught in the other kind of reinforcing loop -- the vicious cycle.

DRAWING THE REINFORCING LOOP
There can be any number of elements in a reinforcing loopC-all in a circle, all propelling each others' growth. Reinforcing loop situations generally "snowball" into highly amplified growth or decline. If you wish, use the letter *R* to mark a reinforcing loop.

A reinforcing loop, by definition, is incomplete. You never have a vicious or virtuous cycle by itself. Somewhere, sometime, it will run up against at least one balancing mechanism that limits it. The limit may not appear in our lifetime, but you can assume it will appear. Most of the time, there are multiple limits.
REINFORCING LOOP TEMPLATE (FOR PLOTTING YOUR OWN SITUATION):



Balancing loops: pushing stability, resistance, and limits

Balancing processes generate the forces of resistance, which eventually limit growth. But they are also the mechanisms, found in nature and all systems, that fix problems, maintain stability, and achieve equilibrium. They ensure that every system never strays far from its "natural" operating range -- a human body's homeostatic state, an ecosystem's balance of predator and prey, or a company's "natural" expenses, which, whenever you cut them, seem to balloon up somewhere else.

Balancing loops are often found in situations which seem to be self-correcting and self-regulating, whether the participants like it or not. If people talk about "being on a roller coaster," or "being flung up and down like a yo-yo," then they are caught in one type of balancing structure. If caught in another type, they may say, "We're running into walls," or "We can't break through the barrier," or "No matter what we try, we can't change the system." Despite the frustration they often engender, balancing loops aren't innately bad: they ensure, for example, that there

is usually some way to stop a runaway vicious spiral. Our survival depends on the many balancing processes which regulate the earth, the climate, and our bodies.

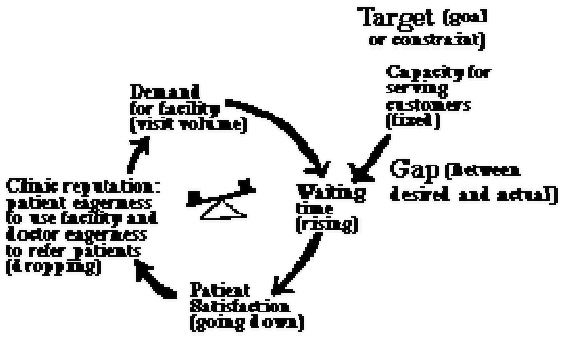
Balancing processes are always bound to a target -- a constraint or goal which is often implicitly set by the forces of the system. Whenever current reality doesn't match the balancing loop's target, the resulting gap (between the target and the system's actual performance) generates a kind of pressure which the system cannot ignore. The greater the gap, the greater the pressure. It's as if the system itself has a single-minded awareness of "how things ought to be," and will do everything in its power to return to that state. Until you recognize the gap, and identify the goal or constraint which drives it, you won't understand the behavior of the balancing loop.

The North Millerfield Community Hospital (a pseudonym) in Connecticut opened a very attractive outpatient clinic in the late 1980s. The administrators knew that it was meeting a real need, and they assumed it would always be filled with patients, almost up to its capacity. That would make it a constant revenue generator. However, a few months after it opened, the number of patient visits (and thus revenues) leveled off, below the hospital's forecasts. The hospital started a community marketing campaign, and patient visits rose for a time, but soon dropped off again.

Finally, the administrators took a close look at their patient volume statistics. They spent time in the waiting room and surveyed staff at the front desk and patients. It turned out that when traffic was low, people were served quickly. Word got around, doctors and paramedics referred people, and North Millerfield's clinic became crowded. But people have an innate distaste for sitting in busy waiting rooms. Since they had a choice, they went elsewhere. The general lesson for all businesses is: if you don't adjust your service satisfaction to the level expected by your customers, the system will do it for you!

Sometimes, the target is clearly articulated and shared. Everyone in a sales force knows their sales targets. Other times, it is obscure, ill-defined, implicit, or assumed. The level of quality which customers would accept has driven the changes in the auto industry for the past twenty years, but no one has been able to agree on, or measure, that level of quality. A vision may drive the behavior of a team but never be articulated. Sometimes the target moves or changes, because it too is subject to influences from the system. In fact, discovering or creating new targets is often the key to overcoming the resistance that confronts you.

DRAWING THE BALANCNG LOOP



Here is how you might represent North Millerfield's patient demand system in a balancing loop. Note that the comments in parentheses (Waiting time is "rising," while patient satisfaction is "going down") represent a snapshot of only one moment of the system. At other times during the clinic's more unpopular peliods, waiting time will fall, while patient satisfaction goes up.

We use a "balance beam" at the center of the loop, because it shows one common type of balancing loop behavior: "teeter-tottering" around a desired level, first overshooting a bit, then compensating in the other direction, and finally coming to rest at the target. If you prefer, label your balancing loops with the letter B.

Delays: when things happen . . . eventually

Delays occur often in both reinforcing and balancing loops. These are points where the link (the chain of influence) takes a particularly long time to play out. We represent delays with a pair of parallel lines.

Delay can have enormous influence in a system, frequently accentuating the impact of other forces. This happens because delays are subtle: usually taken for granted, often ignored altogether, always under-estimated. In reinforcing loops, delays can shake our confidence, because growth doesn't come as quickly as expected. In balancing loops, delays can dramatically change the behavior of the system. When unacknowedged delays occur, people tend to react impatiently, usually redoubling their efforts to get what they want. This results in unnecessarily violent oscillations. One of the purposes of drawing systems diagrams is to flag the delays which you might otherwise miss. In addition, delays are often a source of waste; removing delays is a key method for speeding up cycle time.

When drawing systems archetypes, you may choose to mark more than one delay. But it is most helpful to identify the most significant delays -- particularly the longest delays, relative to the other links.

For example, in the Nolth Millerfield Hospital story, there are at least two significant delays:

- The delay before customer satisfaction goes down. ("The first time I visited the clinic, I assumed the long waits were just a fluke. The second time I visited, I wanted to go somewhere else, but my spouse insisted.")
- The delay before the impact is felt of the clinic's lost reputation. ("That was the end for us. We haven't been back in months. I drove by last week and noticed that they've started advertising for patients.")

The underlying dynamic, of course, applies not just to hospital emergency rooms, but to restaurants, fast-food windows, stores, supermarkets, banks, gas stations, government agencies, and anvone who drives away customers by missing a key component of good service.