RESISTING DYNAMIC STRUCTURES IN SHIFTING TOWARD "SYSTEMS THINKING"

Keyvan Vakili
Graduate School of Management and Economics
Sharif University of Technology
Azadi Ave., Tehran, Iran
keyvanv@gmail.com

Ehsan Fakhar Izadi
Graduate School of Management and Economics
Sharif University of Technology
Azadi Ave., Tehran, Iran
e_izadi@yahoo.com

Shora Moteabbed
Graduate School of Management and Economics
Sharif University of Technology
Azadi Ave., Tehran, Iran
shora.m@gmail.com

ABSTRACT

There is a unanimous agreement that "systems thinking" helps both individuals and organizations make more intelligent and more effective decisions. On the other hand, the unsatisfactory rate of systems thinking evolution among managers, collegians, students and other stratums raises this question that, why such a useful, discriminating and tasteful concept in theory, does not spread with the desirable pace in practice. Where exactly does the problem originate from? The tragedy is more sensible when noting the fact that even those who know the concept methodically do not apply it in action and in their decisions.

Unfortunately, despite relatively numerous literatures on changing beliefs, values and behaviors of individuals, there are comparatively few works regarding dynamics of change in thinking styles and thinking methods. Moreover, there are often different terms used for addressing the thinking process in human individuals such as "thinking style", "thinking process", "thinking strategy" and "cognitive style".

In this paper, an agreed upon definition for the "systems thinking" is extracted and its constituting components from different fields such as systems science, system dynamics and operation research are distinguished. This paper carefully seeks to identify major dynamic structures against the transition from "non-systems thinking" toward holistic "systems thinking" in individuals, moreover, the resisting structures and barriers in applying it. Having identified these resisting dynamic structures, one can better realize the roots of this poor growth rate, and give more insightful and effective solutions to overcome the barriers and limitations.

Barriers to Application of Systems Thinking in Decision Making

Keywords: Systems Thinking, Decision Making Process, Resisting Structure

INTRODUCTION

In his paper "Systems Thinking: critical thinking skills for the 1990s and beyond", Richmond (1993) mentions that "the problems that we currently face have been stubbornly resistant to solution, particularly unilateral solution". Surely, after 14 years, we now face problems even more complex and more stubbornly resistant to solution. The more complex and interdependent the problems we face, the more we need a new way of thinking to deal with them. On the other hand, as Richardson (1991) put it "as our personal relationships, technologies, jobs, institutions and communities continue to grow increasingly complex and interdependent, the occurrence of 'spills' will increase. At the same time, the chances of any spill remaining 'local' diminish. Almost any 'fix' that we implement reverberates through a web of interconnections, producing a wave of counter-reactions that are widely distributed in both space and time".

There is unanimous agreement that "systems thinking" helps both individuals and organizations make more intelligent and more effective decisions. It has a great potential to help managers, practitioners, and academics to deal with such complex interdependent problems of today's modern world. Moreover, "Across the world, there is increasing industrial, government, and academic interest in systems and systems thinking" (Davidz et al, 2004). Systems thinking with its tools and methodologies gives us the ability to see greater structures surrounding us and the possibility to see the their resulting behaviours beforehand. There are numerous articles and extensive research on the benefits of systems thinking at the individual, organizational and societal level. The introduction of more than six major disciplines such as 'System Dynamics', 'Soft Systems Methodology', and 'Critical Systems Thinking' all, having systems thinking at their core, also support this idea.

On the other hand, the unsatisfactory rate of systems thinking evolution among managers, collegians, students and other stratums raises this question that, why such a useful, discriminating and tasteful concept in theory, does not spread with the desirable pace in practice. The tragedy is more sensible when noting the fact that even those who know the concept methodically do not apply it in action and in their decisions. It seems that there are great impediments to learning and adopting systems thinking. Despite the importance of the problem, there is not much literature on the barriers to systems thinking development. Richmond (1991) enumerates "seven major impediments to the rapid and wide-scale assimilation of Systems Thinking". Davidz, Nightingale, and Rhodes (2004) believe that "sufficient data are missing to understand the mechanisms that most effectively and efficiently develop systems thinking". In their article they discuss their primarily findings on enablers, barriers, and precursors to the development of systems thinking. Moreover, despite the relative large number of literature on changing beliefs, values and behaviours of individuals, there are comparatively few works regarding dynamics of change in thinking styles and thinking methods.

Although both articles of Richmond and Davidz and her colleagues give good insights on the matter, but they both lack a structured and dynamic framework. The focus of the current article is on arranging the barriers and impediments to the development

and practice of systems thinking in a more organized framework and introducing a dynamic model which captures them more systematically. In the next section, different definitions of systems thinking are reviewed and a framework to capture these definitions is presented. In the third section, a model for decision-making will be illustrated. Finally, with regard to the depicted framework and the decision making model, a dynamic model for capturing the barriers to shift toward systems thinking will be systematically developed.

WHAT IS SYSTEMS THINKING?

There are different definitions, or as Richardson (1994) used it, different tongues and creeds for "systems thinking" in different fields and bodies of knowledge. "The several tongues and creeds are related, but they are far from identical" (Richardson, 1994). Davidz, Nightingale, and Rhodes (2004) pointed out the "morass of misunderstanding surrounding the phrase systems thinking" and stated that "the phrase 'systems thinking' can have a plethora of definitions and understandings". Moreover, Forrester (1994) indicates that "'systems thinking' has no clear definition or usage". Hardly one can denote a definition of the phrase, which is accepted among different systems thinking communities.

Despite the many definitions of the phrase, almost all of them have a common purpose: they try to prepare a better way to see the complex structures around us, to better understand how these structures work, and so to empower us in providing more efficient and wiser solutions for the complex problems surrounding us. Here, our mission is not to extract an agreed-upon definition for the phrase "systems thinking", but to see the several aspects of those definitions, which can help us better achieve the mentioned common purpose.

Richardson (1994) in a long list, enumerated some major fields which "flag patterns of thought and problem solving that all fall under the generic label systems thinking". Systems analysis, general systems theory, viable systems heuristics, critical systems science, sociotechnical systems, and system dynamics are just those fields in Richardson's list, which carry the term system in their names. Woodward (2005) mentioned that "six distinct bodies of work can be identified that relate to different forms of systems thinking": system dynamics (SD), Viable System Diagnosis (VSD), Strategic Assumption Surfacing and Testing (SAST), Interactive Planning (IP), Soft Systems Methodology (SSM), and Critical Systems Heuristics (CSH). Jackson (2003) presents an insightful categorization for different systems methodologies related to the type of problem contexts, which can be dealt with in each methodology (figure 1).

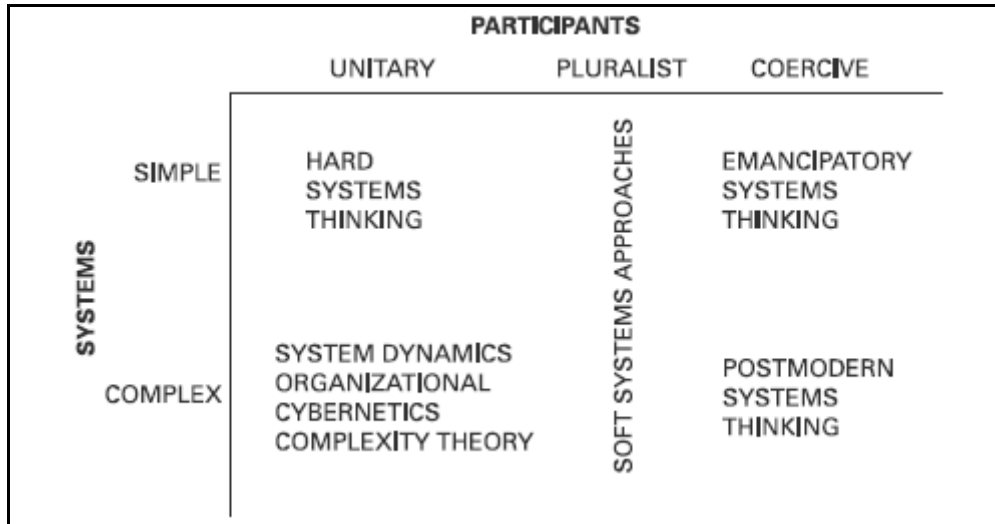# Barriers to Application of Systems Thinking in Decision Making

Figure 1. System approaches related to problem contexts in the System of Systems Methodologies (Jackson, 2003).

Besides categorization of the systems thinking notion based on different fields of study and bodies of knowledge, one can generally categorize these definitions based on what they call systems thinking in terms of whether it's a thinking style, a perspective, a conceptual framework, a group of methodologies and tools, or a collection of them.

Perhaps the first definitions of systems thinking go back 60 years, when Ludwig von Bertalanffy, the father of General Systems Theory, "began to argue that the ideas they had developed [as organismic biologists] could be applied to wholes of any kind, which he referred to as systems" (Checkland 1994; Gray and Rizzo 1973). Probably, at that time, systems thinking, more than being a collection of methodologies and tools, could be assumed as a worldview: to see the wholes instead of the parts and to see the interconnections between the parts. A few years later, the field of Operations Research was introduced as a methodology based on that worldview, which was later, identified as Hard Systems Thinking (HST) methodology.

Reisman and Oral (2003) define systems thinking as "thinking systemically with due attention paid to the dynamic and often nonlinear, stochastic processes of interaction between and across the above mentioned resources as well as the environment within which the system operates." Richmond (1994) defines the term as "the art and science of making reliable inferences about behaviour by developing an increasingly deep understanding of underlying structure". He suggested that 'systems thinking' is "a paradigm and a learning method" which both of them are composed of different pieces such as a vantage point, a set of thinking skills, a process, a language and a technology. He also identifies a set of seven thinking skill which constitutes the thinking paradigm of systems thinking (Richmond 1993, 1994). Senge (1990) in his masterpiece, The Fifth Discipline, offered a similar definition to that of Richmond, as "a conceptual framework, a body of knowledge and tools that has been developed over the past fifty years, to make the full patterns clearer, and to help us see how to change them effectively". Also, he identifies 'systems thinking' as a worldview, a discipline, a conceptual framework, a set of general principles, a set of specific tools and techniques, and finally a sensibility. In the appendix of his book, he gave a

framework to capture the different layers of his definition of the term, which is depicted in figure 2 (Senge, 1990).
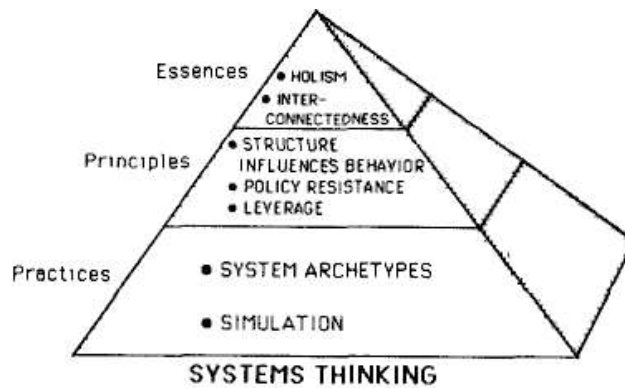

Figure 2. Systems Thinking Hierarchical Definition (Senge, 1990)

Jackson alongside Flood and some other system scientists who were mainly under the influence of Jurgen Habermas, while focusing on the progress of systems thinking and the strength and weaknesses of alternative methodologies (Jackson 2003; Jackson 1994), took one step further to organize and embrace the diverse nature of systems sciences and introduced 'Critical Systems Thinking' (CST) (Flood and Jackson 1991; Jackson 1994; Flood 1994; Jackson 2003). Jackson (1994) mentioned five major commitments embraced by CST: 'critical awareness', 'social awareness', 'pluralism at the methodological level', 'pluralism at the theoretical level', and 'emancipation' which later, by 2000, had been transformed into three: 'critical awareness', 'improvement' and 'pluralism' (Jackson 2003). Recently, he introduced creative holism, as "a new development in systems thinking" which is composed of a "philosophy and theory, Critical Systems Thinking (CST), its metamethodology, called Critical Systems Practice (CSP)", and of course, its methods like Total Systems Intervention (TSI) (Jackson 2003).

There are many other definitions for systems thinking in other systems fields and bodies of knowledge (for more definitions see Forrester 1994, Ulrich 1988, Ackoff 1994, Mason and Mitroff 1981, and Richmond 1991). Despite this wide versatility in views toward 'systems thinking', there is significant similarity among them. Most of these perspectives consider at least three levels of definition for systems thinking: 'worldview', 'methodology', and 'methods and tools'. The worldview is also described by the terms ontology, principles, thinking style, mental model and paradigm, stands at the base, and explains how a systems thinker looks at the world outside, recognizes the causes of the behaviours, articulates the problems in his mind, and what and how one methodology he decides to use to solve the problem. The methodology, built upon the worldview, defines what theories to use, what data to collect, how to interpret the data, how to articulate them, how to evaluate different policies and what tools and methods to use to solve the problems. Above all lays the methods and tools, which can be employed to interpret and actualize the methodology. It should be noticed that these components are strongly interrelated and interdependent. To show this interrelatedness we use the framework depicted in figure 3 to grasp all the aspects of systems thinking. Hereafter, we call this framework the "Systems Thinking Set". It is supposed that any other thinking method has some

worldview, one or more methodologies, and some tools and methods in its definition. In fact, a thinking method without these components has little use in practice.

Methods and Tools

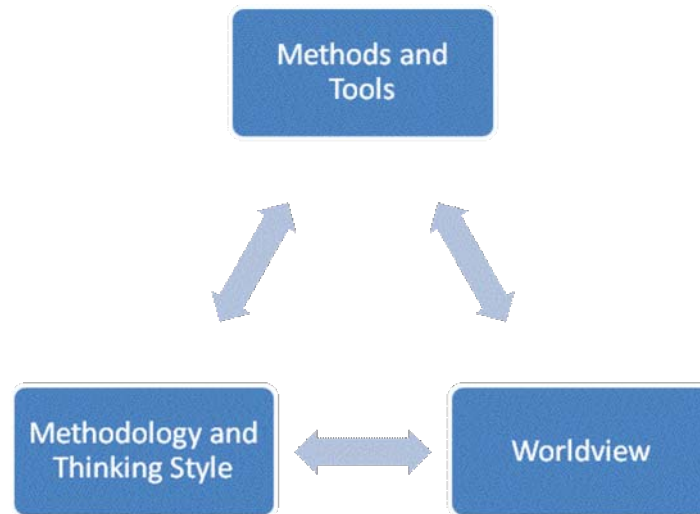Methodology and Thinking Style   Worldview

Figure 3. The Systems Thinking Set

This framework guides us to understand how systems thinking can help us make better decisions. In each step of decision-making cycle, we use some kind of worldview to interpret the environment around us, we take advantage of some kind of methodology and we use some tools and methods to model and decide. So, the introductory question now can be construed in a different fashion: how does one decide to use a particular worldview, a methodology and necessary methods and tools in each step of a decision making cycle? What causes one to prefer and use a particular worldview, methodology and set of tools and methods to another? And finally, what are the barriers and enablers at each step of decision making cycle related to each level of systems thinking definition? In the next section, we first take a more accurate look at the decision-making cycle, and then we try to envision a holistic framework to better identify and understand the barriers to shift toward systems thinking.

DECISION MAKING MODEL

Decision-making is regarded as one of the most central mental activities. This process, as defined in cognitive studies, is making a choice from a set of alternatives. However, many academics, when describing this process, take into account some preliminary and finale steps, such as information gathering, alternative generation and reasoning. Including these stages may be insightful since some ineffective decisions can be traced back to shortcomings in initial steps of decision-making process.

Before studying these shortcomings, a comprehensive model for decision-making process should be introduced. In order to provide such a model some previous literature is reviewed and summarized. Although each of these models emphasizes a specific part of the process, almost all of them share some common features. Moreover, most of these models describe the process in a serial staged manner including information gathering, problem articulation, alternatives generation, outcome estimation, analysis, and decision selection (Gobel, 1999; Lawson, 1981; Wohl, 1981; Simon, 1977). Nevertheless, despite their similarities, these models have

some differences too. That is why each of these models is best applicable to some specific situations.

As shown in figure-1, the first step in the decision-making process is attention. During this step, one will search for and gather required information around the issued subject. Though it is often a conscious act, sometimes attention is performed automatically. Moreover, it should be pointed out that attention serves as an important bottleneck in human information processing (Newell & Simon, 1972).
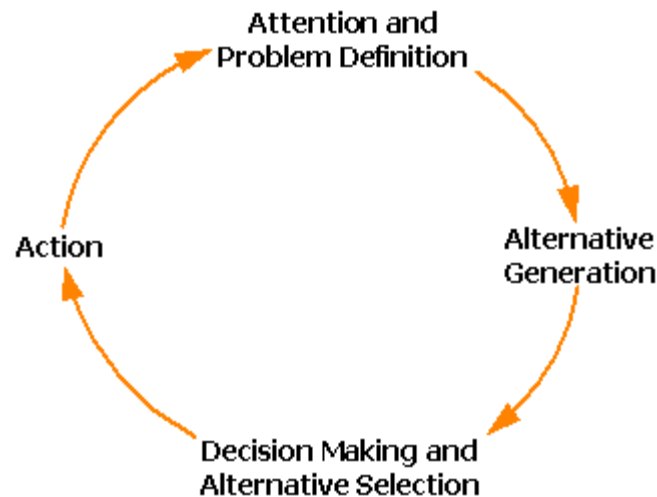
Figure 4. The Decision Making Process

The acquired information during the first step is then stored in the memory, which is defined as the capacity to encode, store, and retrieve information (Azuma et al, 2005). Acquisition phase is followed by interpreting received information into cognitive maps, which explains the problem by decision maker's mental model. We call this step problem articulation. Only after this articulation, alternative solutions can be generated by one's reasoning and information processing. We will argue later that a variety of techniques such as analogy, facilitate the alternative generation stage; for example, novel problems may be treated via analogy in comparison with previously experienced situations.

Subsequently, among different alternatives the one, which best satisfies the needed criteria is selected. Simon argues that in most cases due to the complexity of the problem all the possible solutions cannot be identified. As a result, people will discontinue the process when an alternative meets the minimum requirements (Simon, 1976). After the selection takes place, the corresponding alternative is implemented. The last step of the loop, aside from action itself, includes the controlling measures, which means that the implementer examines the result to enhance the process of subsequent decisions.

It must also be noted that in each step one may move back to previous steps when needed. For example if during the problem articulation one concludes that some more information is needed, he or she may go back to attention stage to gather necessary inputs or if none of the available alternatives are considered suitable, alternative generation may be repeated. Among these feedback loops, we are just emphasizing two of them, which originate from the selection stage. In the selection stage, the

decision-maker may consider available alternatives insufficient and as a result, he or she may get back to previous step and create more options. Furthermore, in the evaluation of different alternatives one may need more information on a specific choice and therefore may return to attention stage.

The decision-making process is a continuous cyclic one. Individuals learn from their previous actions and processes leading to that action for their current decision-makings. During this process, some factors such as time pressure or one's knowledge about different thinking methods regulate the process. For instance, if little time is allocated to the decision-making process, less information is likely to be acquired; or when the decision-maker is unaware of some analytical tools such as systems dynamic, he or she may stick to previous methods of problem solving. In the following part, some factors, which influence individuals' decision-making approach, are discussed. More specifically these factors are studied in the form of barriers to application of systems-thinking approach.

RELATIVE DECISION METHOD SELECTION

Practically decisions are not made on a purely systemic or non-systemic basis. Each individual may intentionally or unintentionally employ either approach and as a result, there would be a combination of different thinking paradigms during the decision process. In order to make this point clear we may consider two different decision loops; one representing decision-making on a systemic basis and one based on any other non-systemic set.

Once again, it should be emphasized that for some problem areas systems thinking methods are not necessary and non-systemic approaches may as well result in effective outcomes. However, in our argument we attend those issues, which are best resolved through effective application of systems-thinking set's worldview, methodologies and tools. Therefore, in the two-cycle model shown in figure 5 the systems-thinking loop of decision-making is more preferable.
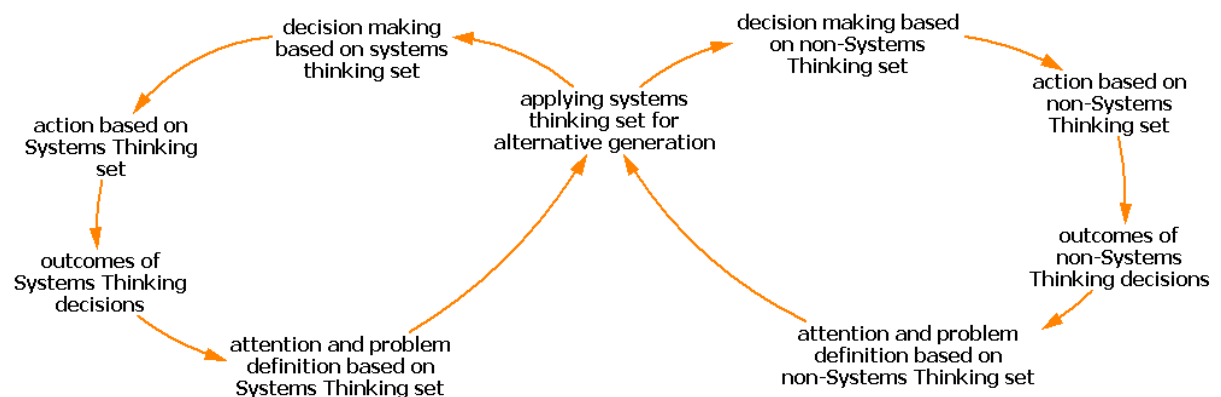

Figure 5. The Double Cycle Decision Process

We have discriminated between attention stages in the two cycles, which is because of the difference in data collection, problem articulation and time horizon in systems-thinking and non-systems-thinking sets. Moreover, these different decision cycles result in different outcomes; which makes more discrimination in the dynamics of

applying either thinking set. In the following sections these dynamics structures are gradually injected into the process.

Decision makers are free to choose whether to apply systems or non-systems thinking set, but there are some prerequisites to this selection. One of these conditions, as mentioned before, is the way in which previous stages of decision-making are handled. In generating the alternative solutions and selecting the best alternative on a systems or non-systems basis, one is constrained by available information gathered in the attention stage and by how the problem is defined in the problem articulation stage.

Other prerequisites for applying systems-thinking set, as shown in figure 6, are the motivation to and the possibility of using this set. Motivation or the willingness of the decision-maker to use systems-thinking set is influenced by his or her perception about the effectiveness of systems-thinking approach as well as the perception about the ineffectiveness of the non-systems-thinking set. While the perception about the effectiveness of each approach depends on its meeting the expectations in previous applications, the role of training and education, in introducing the benefits and disadvantages of each approach, is also to be emphasized. In the next sections, these constituents will be discussed more thoroughly.

Possibility of using the systems-thinking set is determined by having the required abilities and skills and the availability of time. The abilities and skills are either accumulated via experience or taught by outsider experts. Time pressure, on the other hand, constrains the thorough analysis of the problem, prevents comprehensive generation of alternatives and hinders effective alternative evaluation, all of which are necessary in applying systems-thinking set. As a result, availability of time may affect the selection of thinking set in decision-making process. While more time availability allows the application of systems-thinking set, strict time limit promotes the use of non-systems thinking approach.
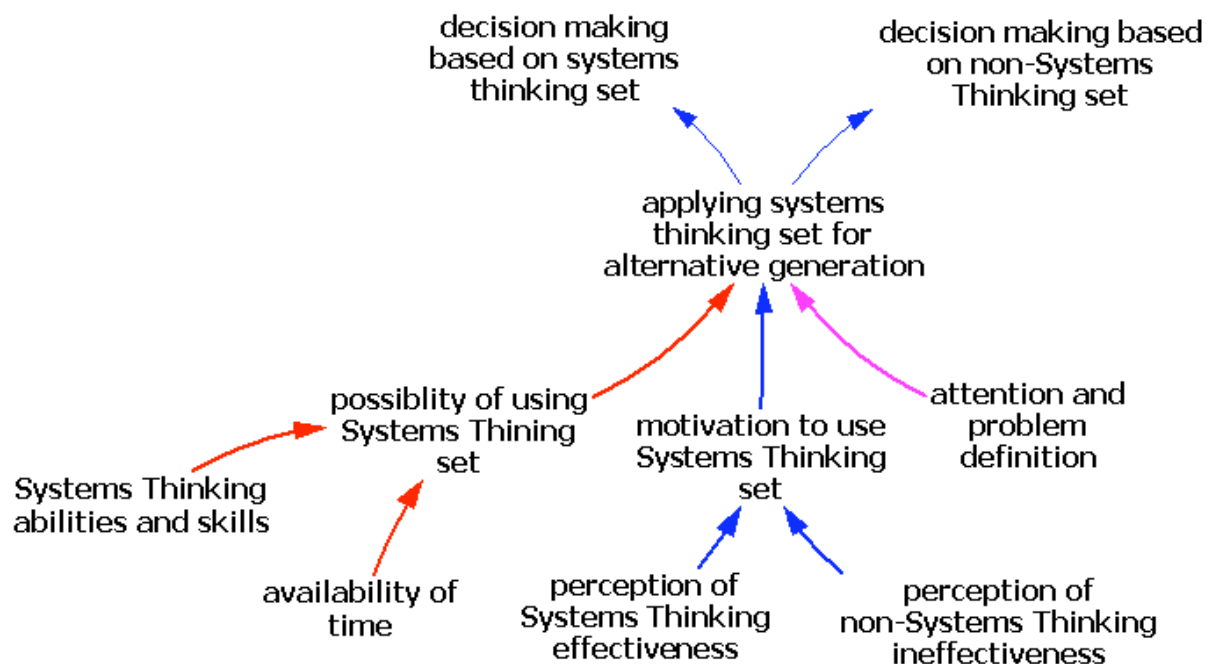

Figure 6. Selecting Between Systems and Non-Systems Thinking Set

EXPECTATION STRUCTURE

It is discussed in the previous section that motivation to use systems thinking comes from two sources: perception of systems thinking effectiveness to solve a special problem, and the perception of non-systems thinking ineffectiveness to deal with the problem. To shift from non-systems thinking methods to systems thinking ones, the first step is to understand the ineffectiveness of the former. Once one concludes that the previous methods cannot help him solve his problem, he/she will give himself the opportunity to use other methods. Both perceptions mainly come from how much we are satisfied with the outcomes of using one methodology. This satisfaction depends on two sets of sources: one's internal expectations of outcomes, and others' expectations of them. These expectations also have different components. There are numerous types of norms, values and beliefs, in the individual, family, organizational and social level that one considers to evaluate the effectiveness of actions and to decide on what measures he/she should take to solve a problem.

One of the major sources of resistance to change is the incongruousness of change outcomes with norms, values, beliefs or expectations of people or groups whom somehow we care for. Watson (1966) mentions "conformity to norms", "the sacrosanct" and "cultural coherence" as some major resistances to change in social systems. "Deep rooted values" and "emotional loyalty" are also referred to as one of the "sources of resistance and inertia" during the change implementation (Del Val et al, 2003; Nemeth, 1997). Del Val and Fuentes (2003) also point out the organization values as one of the barriers to change when there is a conflict between these values and the change outcomes. Klein and Sorra (1996) highlight the importance of fit between innovation and change outcome with organization values. "Vested values" or "vested interests" are pointed out as another source of resistance to change mainly in the organization and social level (Rumelt, 1995; Watson, 1966). Furthermore, there are also political barriers rooted in the power structure of the organizations or teams, which can defy the change process because of the fear of loosing power as the result of change.

Therefore, it seems that changing thinking methods needs a change in interpersonal and intrapersonal expectations of the outcomes. As long as the expectations remain unchanged, hardly one can act to change his thinking style. For as long as we expect a specific action to have its effects as soon as possible, we cannot use systems thinking methodologies which most of the time show their results in the long run. In addition, until our superiors expect us to use a previously applied method to solve a special problem, we cannot use an alternative method, which needs more time and more investment to deal with the roots of the problem. Furthermore, the change in the way we solve the problems, needs a change in compensation methods, which value the new methods and outcomes.

When it comes to the shift of one's thinking style from non-systems thinking, either linear thinking or atomic thinking, to systems thinking, this type of resistance plays a major role against the change process. There is not much literature on the incongruence of decisions based on systems thinking and the ones based on non-systems thinking. But considering the fact that most of the times, decisions based on systems thinking target the roots of the problems in a wider time scope in a way different from other thinking methods, it seems logical to assume that it should be

some kind of incongruence in the results of systems thinking decisions and non-systems thinking ones.

So, the basic model can be completed with regard to the expectation structure. The expectation structure is depicted in figure 7.
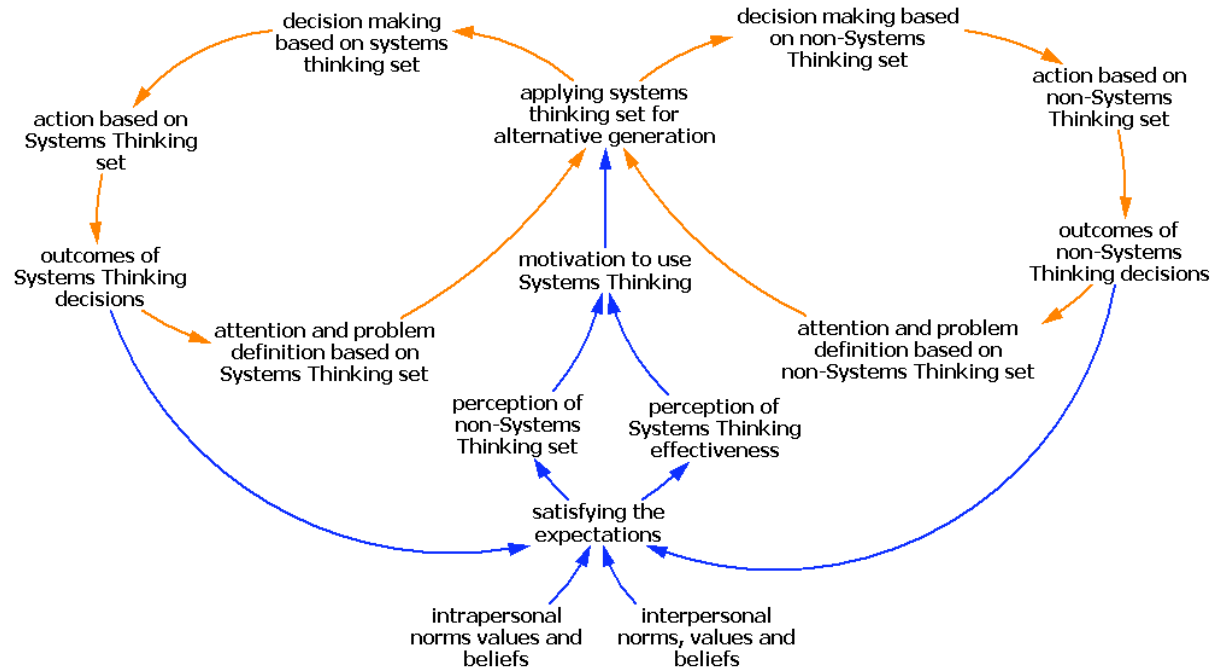

Figure 7. Expectation Structure

TIME STRUCTURE

Non-systems thinking decision-making normally results in temporary and short-term solutions. These solutions only remove the symptoms of the problem, but they do not solve the original problem. The problem can then keep growing with no symptoms and Deteriorate (Senge, 1994). We call this problem recurrence. Two basic elements are needed for making the use of systems thinking possible. The first one is availability of time and the second one is systems thinking abilities and skills.

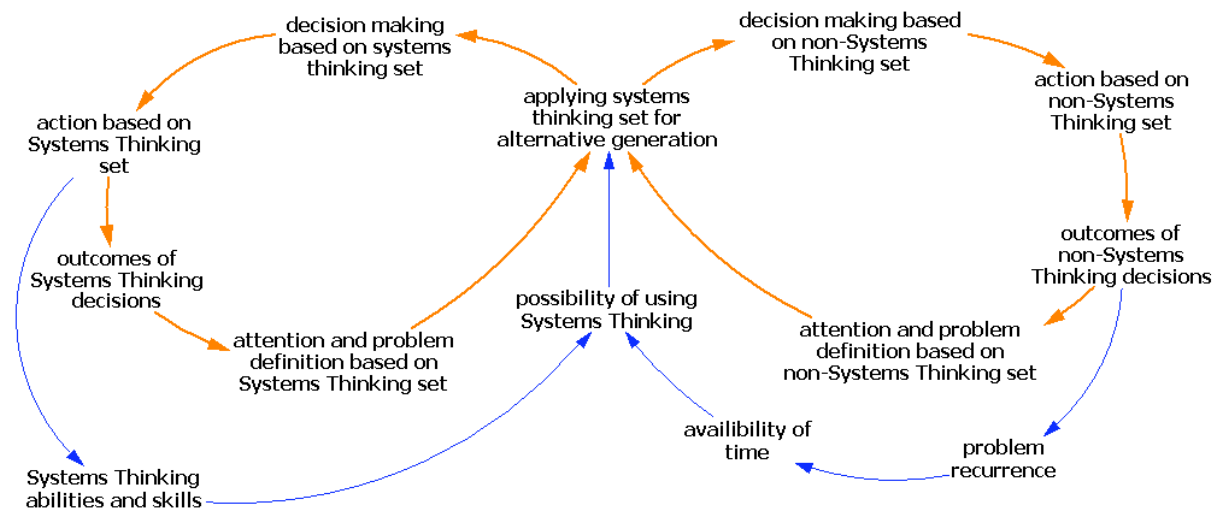# Barriers to Application of Systems Thinking in Decision Making

Figure 8. Structure of time and learning systems thinking

Change plans in general and systems thinking as a change plan in particular, requires people who spend time on new activities like thinking, team work and training. If the needed time is not dedicated, in spite of great enthusiasm for systems thinking, no fundamental change will occur in the organization. Problem recurrence as an outcome of non-systems thinking decision, consumes a lot of time for solving temporary problems, because these solutions are not the basic ones for the problem its symptoms keep showing again and again after a time elapse and time is needed to vanish them again. This time-consuming process influences the variable availability of time and diminishes it. It is clear here that the more decision-making is based on non-systems thinking, less time is available for the use of systems thinking. The problem of time seems important in all steps of decision-making; however, it can become even more important in more time-consuming steps like alternative generation and alternative selection. In this regard, one must pay attention that the main problem about time is not the lack of it, but the wrong priority setting of the activities.

The problem of time is not as simple as it was explained above. Actually, two variables of time can appear in different places and stages of learning. The time to use systems thinking was explained, but time is also needed in learning systems thinking, and acquiring mindset, and learning methodologies and tools (Senge, 1991, 1994, 1999). The availability of time for these activities affects the level of systems thinking abilities and skills.

Another issue about time is that "systems thinking" usually shows its effects in the long run. In contrast to other decision-making methods (especially linear thinking), one cannot expect the results of systems thinking soon after the action. This can lead to a problem because when people are unaware of this mechanism (or lack the required patience) they expect swift results after using systems thinking. Consequently, when nothing happens, they may infer that systems thinking is not useful and become dejected to use it again. It can be concluded then that systems thinking can be more appropriate for problems with a long-run nature, where there is less pressure of time for viewing the results.

USING SYSTEMS THINKING

Experience and Learning Structures

To use systems thinking, two basic conditions are needed: accepting the concept of systems thinking as a mindset and gradually referring to this mindset for decision making; and learning its methodologies and tools. However, accepting the concept of systems thinking as a dominant mindset can crash to some obstacles, the most important of which is the experience.

Experience normally seems useful in the process of decision-making. It is somehow obvious that people with more experience, have more information and this helps them develop more alternatives and also evaluate them better to make a decision. Nevertheless, experience can have another side as well, which might be a source of resistance to change. Richmond (1991) mentions experience as a fundamental impediment and explains: "experiences, color the way we view and interpret subsequent experiences. The prevailing interpretation, combined with the weight of evidence in the storehouse, make it difficult to adopt a systems perspective. "

Another aspect of experience is that almost none of our everyday experiences appear to be the product of ongoing reciprocal processes, as a systems perspective. Conversely, they are gained mostly in an open loop and one-way processes so remembering them also guides us to a one-way process too. So in this process an individual only shoots or responds to whatever that comes related to their experiences.

Experience can also be referred to as a source of resistance to change when there is a sense of insecurity or regression. People may also refer to experience when there is a sense of insecurity or regression. In this case experience can act as a source of resistance to change. One can seek security in the past so he may rely on the past and follow the examined pattern, instead of trying new ones (Watson, 1966).

Habit is another source of resistance to change. Although it acts through the same dynamics of resistance as experience, they are different in their origins. The word "Habit" mainly talks about the special behavior of the organism that unless the situation changes noticeably, organism will continue to respond in their accustomed way (Watson, 1966). An individual (or organization) when accustomed to specific routines may resist any change in their details. This will appear in the process of attention and problem definition. When the person is accustomed to something, it is very probable that he or she will ignore the stimuli against it and is reluctant to collect data about those stimuli. However, if individuals and organizations are aware of this issue, they can deal with the problems constructively by shaping their own habits of attention. In the alternative generation and alternative evaluation, the same pattern of action reoccurs if the problem has similarities with the previous ones.

Primacy is another source of resistance to change, which can be categorized under experience too. The way in which the organism first successfully copes with a situation sets a pattern, which is unusually persistent (Watson, 1966). Primacy shows

up in the steps of alternative generation and selection mostly and causes dominance of particular alternatives, which were tried previously and have been successful. Primacy can appear in choosing the means of decision-making, the way to choose alternatives or ends, and the alternatives themselves (Etzioni, 1988). This barrier can cause the trust to outsiders to diminish and as a result ignore one useful source of learning.

Ability and Skills; the Need for Technical Knowledge

Systems thinking ability and skills are necessary for the use of systems thinking. Ability and skills are normally the result of learning methodologies and tools, which usually need acquiring technical knowledge.

The third layer of systems-thinking set includes the application of specific tools and methods in the individuals' approach to problem articulation and alternative generation. This layer, which is often implemented on a computer technology basis, includes systems dynamics tool and other systems simulation methods. Therefore, the application of these components requires an adequate technical knowledge for the use of computer-based tools.

The general dread from using computer software and tools is already mentioned by scholars; however, less attention is paid to its impact on individuals in applying systems-thinking components. The challenge originates from the unfamiliarity of most decision-making groups with these techniques, which necessitates the outsiders' intervention to introduce required skills and methods. Nevertheless, sometimes these interferences are not much welcomed by insiders, especially when the need for such technical knowledge is not realized. Therefore, lack of necessary technical knowledge combined with unwillingness to accept outsiders' interventions, prevents successful application of systems-thinking components in decision-making.

Mastery experience is one of the sources of self-efficacy (Bandura, 1989), which can change the level of the person's belief of his ability in a defined process (Gist et al., 1992). One of the reasons of sticking to the past experiences and lack of courage and strength for making differences in the way a system works], is lack of self-efficacy because of little or no experience in the new fields (Richmond, 1991). Actually it can show up here, because there have been no or little experiences in working with systems thinking tools. If the process of practicing with tools and techniques is initiated, the mastery experience can be achieved over time and may result in more self-efficacy. Consequently, the lack of courage and strength for changing the way of thinking will disappear. Moreover, mastery experience cannot be defined separated from the worldview, methodologies and tools. With more practicing with tools and experiencing the results, deeper belief in methodologies and worldviews will gradually form.

Barriers to Application of Systems Thinking in Decision Making
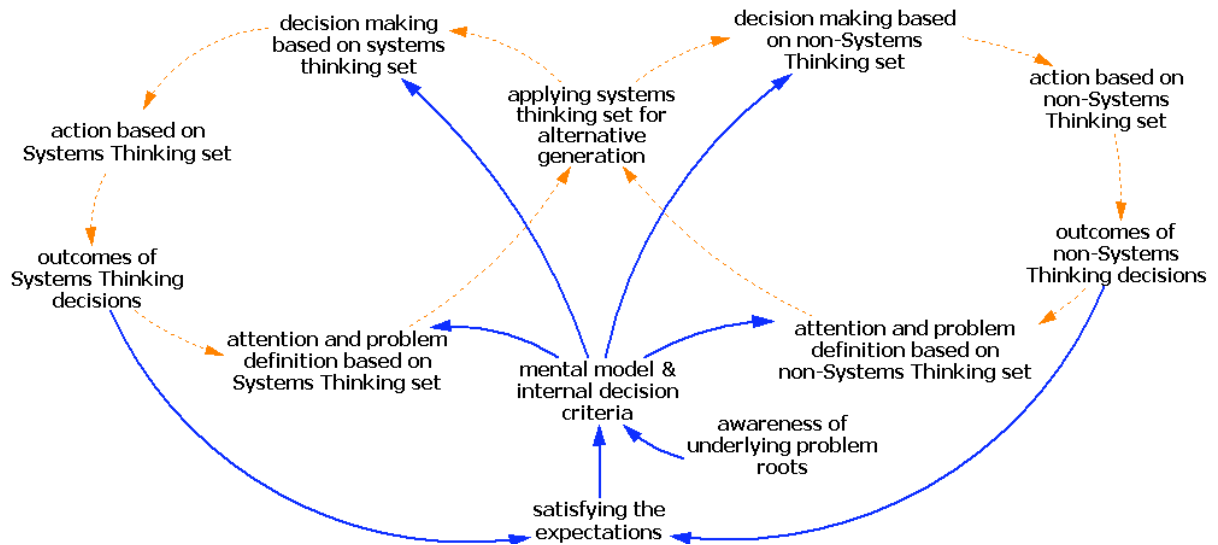
Mental Model

Figure 9. Mental model structure

Argyris and Schon (1996) argued that people are selective in the data acquisition from their environment (attention and problem definition step). Senge et al. (1994) suggested that people's assumptions and mental images, also known as mental models, are important when making decisions and framing actions (decision making). A person may quickly use a "ladder of inference" in her or his mind and create relationships among these structures consistent with their assumptions and beliefs, and finally, exhibit behaviors based on their inferences. Such inferences are usually untested and sometimes incorrect (Senge et al., 1994; Argyris and Schon, 1996). The influence of mental models and internal decision criteria on both attention and problem definition and decision making steps can be viewed in figure 9. Mental models may be flawed or reflect knowledge that no longer applies but as long as a person is unaware of the fact that his mental model is no longer valid or acting upon it can not satisfy his expectations, he or she would not try to change it. As a result, there must be a force to make this change possible.

Let us start from a situation when someone makes most of his decisions based on non-systems thinking set. Non-systems thinking set is not effective for long-run problems and its results do not solve the problems from their origins. Accordingly, in the long-term, outcomes of non-systems thinking will not satisfy the expectation of the person. Satisfying expectation has two forms: satisfying one's own expectations and satisfying others' expectations. For example, a manager's expression of dissatisfaction about an employee's decisions based on non-systems thinking set may motivate the employee in changing toward application of systems thinking. When a person starts learning and using systems thinking and also becomes aware of underlying problem roots, a comparison could be done among this two thinking set and gradually person's mental model and decision criteria start changing from non-systems thinking to systems-thinking. Through this dynamic, the shift happens. The point that should be

taken into consideration here is that the outcomes of using systems thinking will happen after a period of time, which may be long. Therefore, the personal experience on the outcomes of systems thinking will rarely be the reason for changing the mental model but satisfying others expectation may be a stronger stimulus

CONCLUSION

There is undisputed agreement about systems thinking as a new way of thinking, which is more effective than previous ones in solving problems. In spite of this agreement individuals and organizations rarely use this powerful thinking set in the process of decision making. This can occur mainly because of unawareness of the force and process needed to shift from non-systems thinking set to systems-thinking one. For this shift happens change in one's worldview, methodologies and thinking style and tools used for decision making should occur. To acquire the needed awareness for setting of change dynamic in these three areas one should become attentive about the barriers which resist this shift and on the other hand the essentials of applying systems thinking.

In this paper, exploring through literature, a decision making process model was selected and based on the model, a double-loop decision making model which depicts the shift from non-systems thinking set to systems-thinking set was developed. In this model different barriers of this shift were explained. Theses barriers may have static or dynamic natures. Static ones usually are external factors like norms, values, other's people opinion or expectations. Dynamic barriers act through a structure. The most important dynamic structures are time structure, experiences and learning structure and mental models structure.

Time structure is important because systems thinking is a time consuming process and one should be informant of this and also the delay happens for the results of systems thinking to demonstrate. Past experiences are also fundamental impediment for the use of systems thinking set and also methodologies and tools. Habit and primacy in the same structure as experience resist shift to systems thinking set. Mental models must alter also prior to change one's worldview and style of thinking. Nevertheless change of mental model is not enough for applying systems thinking. One should gain abilities and skills for using systems thinking tools.

For further studies experimental research can be done on each of dynamic structures. Moreover the models can be studied more carefully and all the details which influence the dynamics can be found out.

REFERENCES

Argrys, C. and Schon, D.A. (1996). *Organizational Learning 2: Theory, Method and practice*. Addison-Weseley, Reading, MA.

Ackoff, R. L. (1994). *Systems thinking and thinking systems*. System Dynamics Review, Vol. 10, Number 2-3, pp. 175-188.

Bandura, A. (1997). *Self-efficacy. the exercise of Control*. New York: W.H. Freeman.

Chapman et al (2001). *Fatal Flaws, the acquisition of imperfect mental models and their use in hazardous situations*. Journal of intellectual Capital, Vol. 2, No. 4, pp. 398-409.

Checkland, P. B. and Haynes, M. G. (1994). *Varieties of systems thinking: the case of soft systems methodology*. System Dynamics Review, Vol. 10, Number 2-3, pp. 189-198.

Davidz, H. L., Nightingale, D. J. and Rhodes, D. H. (2006). *Enablers, Barriers, and Precursors to systems thinking development: The Urgent Need for More Information*. MIT.

Del Val, M. P., Fuentes, C. M. (2003). *Resistance to change: A literature review and empirical study*. Management Decision, 41/2, pp. 148-155.

Espejo, R. (1994). *What is systemic thinking?*. System Dynamics Review, Vol. 10, Number 2-3, pp. 199-212.

Etzioni, A. (1988). *Normative-Affective Factors: Toward a New Decision-Making Model*. Journal of Economic Psychology, Vol.9, pp. 125-150.

Flood R. L. (1994). *I Keep Six Honest Serving Men: They Taught Me All I Knew*. System Dynamics Review, Vol. 10, Number 2-3, pp. 231-244.

Flood R. L. and Jackson, M. (1991). *Creative Problem Solving*. Wiley, Chichester.

Forrester, J. W. (1994). *System dynamics, systems thinking, and soft OR*. System Dynamics Review, Vol. 10, Number 2-3, pp. 245-256.

Gist, M.E. and Mitchell, T.R., (1992). *Self-efficacy: A theoretical Analysis of Its Determinants and Malleability*. The Academy of Management Review, Vol.17, No.2, pp. 183-221.

Gray, W. and Rizzo, N. D. (1973). *Unity through Diversity: a Festschrift for Ludwig von Bertalanffy*. New York: Gordon and Breach.

Jackson, M. C. (2003). *Systems Thinking: Creative Holism for Managers*. Wiley, Chichester.

Jackson, M. C. (1994). *Critical systems thinking: beyond the fragments*. System Dynamics Review, Vol. 10, Number 2-3, pp. 213-230.

Kim, D. H. and Senge P. M. (1994), *Putting systems thinking into practice*. System Dynamics Review, Vol. 10, Number 2-3, pp. 277-290.

Klein, K. J. and Sorra, J. S. (1996). *The Challenge of Innovation Implementation*. Academy of Management Review, Vol. 21, No. 4, pp. 22-42.

Mason, R. O. and Mitroff, I. I. (1981). *Challenging Strategic Planning Assumptions*. Wiley, New York.

Nemeth, C. J. (1997). *Managing Innovation: When less is more*. California Management Review, Vol. 40, No. 1, pp. 59-74.

Reisman, A. and Oral, M. (2003). *Soft systems methodology: A context within a 50-year retrospective of OR/MS*. 2003

Richardson, G. P. (1994). *Introduction: Systems thinkers, systems thinking*. System Dynamics Review, Vol. 10, Number 2-3, pp. 95-100.

Richmond, B. (1994). *Systems thinking/system dynamics: let's just get on with it*. System Dynamics Review, Vol. 10, Number 2-3, pp. 135-158.

Richmond, B. (1993). *Systems thinking: critical thinking skills for the 1990s and beyond*. System Dynamics Review, Vol. 9, No. 2.

Richmond, R. (1991). *Systems Thinking, Four key questions*. High Performance Systems Inc.

Rumelt, R. P. (1995). *Inertia and Transformation*. in Montgomery, C.A., (Ed.), Resource-based and Evolutionary Theories of the Firm, Kluwer Academic Publishers, MA, pp. 101-132.

Senge, P. (1990). *The Fifth Discipline: The Art and Practice of Learning Organization, strategies and tools for building a learning organization*. Doubleday.

Senge, P. (1994). *The Fifth Discipline Field Book: Strategies and Tools for Building a learning organization*. Doubleday.

Senge, P., Kleiner, A., Roberts, Ch., Roth. G., Ross, R. and Smith, B. (1999). *The Dance of Change: The Challenges to Sustaining Momentum in Learning Organizations*. Currency

Senge, P. Kleiner, A., Roberts, Ch., Roth. G, Ross, R. and Smith, B. (1999). *The Fifth Discipline Fieldbook Strategies and Tools for Building A Learning Organization*. Doubleday/Currency

Barriers to Application of Systems Thinking in Decision Making

Simon, H. (1987). *Making Management Decisions: The role of intuition and emotion.* Academy of Management Executive.

Sterman, J. (2000). *Business Dynamics: Systems Thinking and Modeling for a Complex World.* Boston, MA: McGraw-Hill Companies.

Ulrich, W. (1988). *Systems Thinking, Systems Practice, and Practical Philosophy: A Programme of Research.* Systems Practice 1: pp. 137-163.

Watson, G. (1966). *Resistance to change.* Concepts for social change, Cooperative project for educational development series, Vol.1.

Woodward, B. (2003). *Thinking more systematically about systems thinking.*