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# Structuring managerial problem situations

## Assessing the suitability of different methodologies

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### Introduction

From its origin system dynamics has been employed as a tool to find leverage points to improve the performance of systems. In a meta-analytic study Rouwette *et al.* (1999) found that the number of case descriptions of system dynamics model building studies involving the client in the process of model construction has increased exponentially over the last couple of decades. Clearly, system dynamics is more and more being used not only as a research method, but also as an intervention tool in organizations, and quite successful in a number of cases. Seen from an intervention perspective, system dynamics is not the only methodology that is used to solve managerial problem situations. There is a host of methods and techniques, most notably those from the realm of soft operational research, also known as problem structuring methods. All of these methods have proven that they can be successful in structuring policy problems. However, it is not entirely clear if system dynamics and other problem structuring methods are equally suitable for each type of managerial problem situation.

In the past some researchers have attempted to clarify the similarities and differences between soft OR and system dynamics and indicated how one could benefit from the other (Lane, 1994). Some have even made an attempt to design a typology of problem situations/contexts and accompanying methods (see for example: Geurts *et al.*, 1985; Flood and Jackson, 1991; Mingers and Brocklesby, 1997). Unfortunately, these typologies are too general in nature and at too abstract a level to be helpful as a guide in answering the question when to apply which methodology.

This paper addresses the latter question in more detail. It takes three different, well established methodologies which have been used widely as tools to support strategic decision-making in organizations, i.e. Group Model Building, Soft Systems Methodology, and Strategic Options Development and Analysis. In order to be able to answer the question when to use which methodology, one needs to systematically compare their similarities and differences first. Criteria for comparison include such things as objectives of the method, origination, operating procedure, the role of models, et cetera. In this paper we will deal primarily with this comparison. Our objective in the longer run is to specify criteria to make an appropriate selection of a method in a particular managerial situation as well. We will start with a brief description of the three methodologies.

### Group Model Building

Group Model Building is based on system dynamics. System dynamics was developed by Jay Forrester in the second half of the 1950s as a critique to operations research (also called management science). Forrester regarded the latter paradigm as being too scientific and too mathematically oriented to apply it to managerial problem situations. Moreover, operations research had an open-loop approach towards problem solving and decision making. This

means that the results of decisions are seen as having no effect on new decisions (Forrester, 1990; Lane, 1994; Vennix, 1996). System dynamics has a closed-loop view by assuming that the decision making process consists of information feedback systems. A decision in a social system affects the environment, which, in turn, affects the decision. The feedback structure of a system as a whole (instead of individual parts) determines its behavior (Forrester, 1970; Forrester, 1973; Forrester, 1980; Forrester, 1990; Lane, 1994; Lane and Oliva, 1998; Richardson, 1991; Richardson and Pugh III, 1983; Vennix, 1996). Social systems are in general so complex that it is impossible for the human mind to capture the dynamic consequences of feedback systems and to allow an analytical solution of the model (Forrester, 1973; Forrester, 1980; Forrester, 1990; Lane and Oliva, 1998; Vennix, 1996; Wolstenholme, 1990). Forrester (1970: 9) describes this as the counterintuitive character of social systems: "[...] corrective action [...] will often be ineffective or even adverse in its results. Very often one finds that the policies that have been adopted for correcting a difficulty are actually intensifying it rather than producing a solution. Choosing an ineffective or detrimental policy for coping with a complex system is not a matter of random chance. The intuitive processes will select the wrong solution much more often than not." Because of this complexity of social systems, systems dynamics makes use of simulation (Forrester, 1973; Forrester, 1980; Forrester, 1990; Lane and Oliva, 1998; Vennix, 1996; Wolstenholme, 1990). The goal for building a simulation model of a system is twofold. In the first place, one tries to gain a better understanding of the structure and behavior of the system under study. Secondly, one is looking for robust policies to alleviate problems in the system and to improve its performance (Lane and Oliva, 1998; Vennix, 1996).

A systems dynamics model consists of levels, flows, decision functions, and information channels. Levels are the accumulators within the system. They represent a state or condition of a system. Forrester (1980; 1990) makes a distinction between six kinds of levels: materials, orders, money, personnel, capital equipment, and information. Flows, the second element of a system dynamics model, transport the content of one level to another. They represent an activity, while the levels show the resulting state of this activity. Decision functions are the actual policies taken in order to move the system in a desired direction. Finally, information channels form the link between levels and decisions. They give the decision-maker the necessary information to take a decision (Forrester, 1970; Forrester, 1973; Forrester, 1980; Forrester, 1990; Richardson, 1991; Richardson and Pugh III, 1983).

The model building process starts with the identification of the problem. This problematic behavior of the system is depicted in a so-called reference mode of behavior. Next, the system under study and the problem it contains are transformed into a conceptual model. Depending on the (problem) situation and the wishes of the client organization, this conceptual model can be quantified. The model that results, either qualitative or quantitative, is being tested and validated. The intervention ends with formulating policy measures and their implementation (Forrester, 1980; Lane and Oliva, 1998; Richardson and Pugh III, 1983; Vennix, 1996).

However, it is not always enough to stop at the end of the process of building a model of a system and performing simulations. Practice shows that people in organizations often all have their own view on policy problems. They often disagree if there is a problem at all or not, and if they agree that there is a problem they frequently disagree on what the problem is precisely. People construct their own reality by selecting and interpreting the information they receive. This results in a situation of multiple realities and no viewpoint can be regarded as being the best or most valid. This makes it difficult to talk about 'objective' problems. The problem is that such situations of multiple realities hamper the effective and efficient functioning of an organization seriously. These problem situations are often referred to as messy problems (Vennix, 1996). Involvement of the client in the model building process may overcome, or at least help to deal with these different and antagonistic viewpoints. Then building a system

dynamics model becomes not a goal in itself, but rather a means to enable problem owners to learn about the system and to come to consensus among them and commitment with a proposed policy. These participative variants of systems dynamics have become known as Group Model Building (Andersen, Richardson, and Vennix, 1997; Rouwette *et al.*, 1999; Vennix, 1996). Andersen and Richardson (1997) describe a host of more or less standardized procedures, techniques, and tools that can be helpful in Group Model Building interventions.

A facilitator guides the Group Model Building intervention. His task is twofold. First, as for content, he tries to bring the individual mental models of the team members together in a system dynamics model. Second, as for the group process, he tries to make the individual group members cooperate so as to actually work as a group (Richardson and Andersen, 1995; Vennix, 1996). It is best for the facilitator to be a person from outside the organization. Otherwise, he easily gets involved in the content of the model building process. The danger is that the facilitator becomes a member of the group, which makes it difficult for him to act as a neutral person (Vennix, 1996).

Group Model Building separates fact from value. As Vennix (1996: 3) puts it: "[...] the way team members think a system works is separated from how they would like a system to work". The reason for this separation is that the group process is somehow less politicized.

To keep the group process manageable, Group Model Building implies working with small groups (Vennix, 1996).

### **Soft Systems Methodology**

Soft Systems Methodology (SSM), developed by Peter Checkland, belongs to the realm of soft operations research methodologies. SSM is based on systems engineering. Systems engineering is a problem solving approach for dealing with major and complex technological problems. In this approach one selects an appropriate means to achieve an end which is defined and thereafter taken as given. Systems engineering is similar to approaches such as systems analysis or operations research. These approaches are in general referred to as hard systems thinking approaches, to set them apart from soft systems thinking, which grew out of it (Checkland, 1989; Checkland and Haynes, 1994). The hard approaches, however, turned out to be less suitable for policy problems, which tend to be messy, ill-defined and changing (Checkland, 1989). SSM, like other soft operations research methodologies, leaves from such soft problem situations. This means that SSM has a subjective and interpretive way of looking at social settings. Individuals are said to have their own perception and interpretation of the world around them in general and of the problem situations they encounter in particular. Checkland (1989) calls this the *Weltanschauung* of people. Both what to do about the problem and how to do it are problematical. There is no objective view on the problem. There is no rational, calculable way from goals to means and from means to solutions. People have different interests at stake, which makes goals part of the problem (Checkland, 1989). At the same time, however, people involved have to act together in order to take action to alleviate the problem situation. The multi-perspectiveness makes it a difficult and complex process, though (Checkland, 1989). Therefore, a neutral consultant is introduced into the problem structuring process. His task is to guide the process by helping the group to structure the problem themselves instead of acting as an external expert (Checkland, 1989).

So SSM is not concerned with an objective world, but with the way people try to make sense of the world in which they live (Checkland, 1989; Lane and Oliva, 1998). To prevent individual views from clashing, people are in a constant process of negotiation. The goal is to come to an accommodation (Checkland, 1989; Checkland and Haynes, 1994) between different, and often conflicting, views and interests of participants in a process of debate and learning instead of optimization. It is crucial that actions both lead to improvement of the problem situation and motivate people to implement defined changes. To realize this, learning and ac-

tion need to alternate in a cyclic process. Since it is not the consultant who has to learn but the client and to prevent the development of inappropriate models because of miscommunications between the consultant and the client, SSM should be participative (Checkland, 1989; Checkland and Haynes, 1994; Patching, 1990).

The SSM process is as follows. First, an organized finding out about the problem situation takes place. This contains making a model of every viewpoint on the problem situation and how it should be dealt with. These models are called root definitions. It is important to note that these models are not meant as a representation of the 'real world'. Their function is to structure debate about how reality is perceived by individual participants. In the next stage, the root definitions are transformed into qualitative, conceptual models of human activity systems. The conceptual models are compared with reality or, perhaps more correctly, with reality as people involved perceive it. This comparison provides clues for improving a problematical situation. Changes are then proposed and implemented. However, there are no permanent solutions. So SSM is a process that is in fact never ending (Checkland, 1989; Checkland and Haynes, 1994).

### **Strategic Options Development and Analysis**

Strategic Options Development and Analysis (SODA) is a problem structuring methodology that is focused on structuring complex and messy problems (Eden, 1989). It was developed by Colin Eden. SODA tries to reach consensus and commitment to action. Eden (1989) states that a SODA intervention is successful only when consensus rather than compromise, and commitment rather than agreement have been reached. The client group needs to have the feeling it 'owns' the outcomes. This makes SODA not so much concerned with finding the 'right answer', but reaching a point where those involved feel confident to take action (Eden, 1989).

Like SSM, SODA can be classified as a soft operations research methodology. In SODA there is no such thing as an objective world. SODA takes the individual perspective as its starting point. Every individual problem owner has a personal view on the problem situation. Each view is equally valid and equally necessary to come to consensus and commitment to action. By forming a personal view on a problem situation, people try to make sense of their world in order to manage and control it (Eden, 1989). This process of sensemaking leads to a view of an organization as a changing set of coalitions in which forces of politics and power determine decision-making to a large extent. To use Eden's words: "[...] organizations are a negotiated enterprise whose participants are continuously negotiating and renegotiating their roles within it" (Eden, 1989: 25-27).

The consultant is the instrument for facilitating this negotiation. His task is to bring together the different perspectives that exist among the group of problem owners, analyze the implications of these perspectives, and guide the group in the process of formulating a common action strategy to which all members feel committed. The key notion is that the consultant helps the group work with the problem situations they face, instead of acting as an expert. The consultant has to pay equal attention to the content of the problem and the group process of working on the problem together. To be able to achieve these goals the consultant must feel confident to improvise and to work in a contingent and cyclic way (Eden, 1989). As the client group must be considered a small number of significant people, instead of the organization as a whole. In practice, a 'small number' comes down to three to ten people. With 'significant' people is meant people who are in position to act as an intermediary between the client organization and the consultant and who have the power to bring about proposed changes resulting from the intervention (or at least to make them bring about). Moreover, a social factor is also of great importance. Client and consultant should feel comfortable with each other and with each other's way of working (Eden, 1989; Eden and Simpson, 1989).

SODA is based on the personal construct theory of George Kelly. This theory states that people try to make sense of their world in order to be able to control it better. Kelly formulates his theory around a fundamental postulate, which says that: "A person's processes are psychologically channelized by the ways in which he anticipates events" (Kelly, 1955: 46). The meaning of this postulate is that an individual is not so much an object, which is temporarily in a moving state but is himself a form of continuous motion. This makes it hard to anticipate real events. Nonetheless, individuals seek prediction in order to be prepared for events that may happen in the future. Therefore, an individual 'channels' his thoughts and actions towards his goals. As Kelly (1955: 49) puts it: "Anticipation is both the push and the pull of the psychology of personal constructs".

The individual viewpoints are the crucial input of the problem solving process in SODA. Such a viewpoint is depicted in a model, which is called a cognitive map. This is a network of ideas linked by arrows. The arrows are not causal relationships, but indicate the way in which one idea may lead to, or have implications for, another (Eden, 1989). The SODA process begins with making cognitive maps at an individual level. In this stage a cognitive map is made of the point of view of every individual from the client group. Next, all individual cognitive maps are merged into an aggregated map, called a strategic map. This strategic map is a rich and qualitative description of the way in which the participants see the problem and it gives the group an instrument to move to action. In forming a strategic map the consultant tries to find a joint problem definition and consensus and commitment for an action strategy. The consultant analyzes the strategic map, trying to identify so-called emerging themes and core concepts. In the final stage, the SODA workshop, the goal is to enable the client group to develop a mutual problem definition so that they can move to action (Eden, 1989).

## **Comparison**

One can compare the three problem structuring methods on a whole lot of criteria. In our view, the most important criterion is the general purpose the problem structuring methods pursue. After all, when the methodologies do not strive for the same objective, it seems imaginable that the problem structuring processes resulting from each methodology are not the same either. Other criteria for comparison, with which we deal at this moment, are worldview, origination, and operating procedure.

### *General purpose*

In what respect do the three problem structuring methods correspond to each other with respect to their general purpose and on what point do they differ? A first point that stands out is that the methodologies all have the same general goal. They all aim at structuring managerial problem situations, which should enable the group to take well thought-out decisions. Another important goal of the three problem structuring methods is that they urge participants to actually learn, which gives them more insight into the problem situation. In this way, the aim is to realize a common vision on the problem situation. This, in its turn, enhances the chances that participants commit themselves to decisions taken.

Taking a closer look, however, there seem to be some fundamental differences with regard to the general goals of the various problem structuring methodologies. Group Model Building, for example, seeks for robust strategies. This connotation, typical for the field of system dynamics, entails that policy measures do not break down with the slightest headwind. This often happens with strategies that are not robust, because, for example, they result in different outcomes in different policy contexts, which makes decision-makers draw back the measures in dissatisfaction. SSM and SODA on the other hand, do not strive for robust policies. These two methodologies state that decisions are 'good' when participants in the problem structuring process agree with them. In that sense every policy measure that is supported by the group is a

'good' measure, even though it has little or no practical results. In looking for robust strategies, Group Model Building sets itself somehow apart from SSM and SODA.

As became clear from the description of the methodologies, Group Model Building strives (next to looking for robust policy) for learning, consensus, and commitment. In SSM, the focus is on an accommodation of interests. SODA is oriented towards consensus and commitment. So on this point, the general goals of the three problem structuring methods seem to be more or less similar: to align the points of view of problem owners, which might make it easier to move towards a common action strategy. The question is, however, whether this apparent harmony is false. The crux is that Checkland states that SSM looks for an accommodation of interests. Looking at the meaning of the word accommodation, one could get the impression that it is about a conciliation or adaptation of viewpoints. Participants in the problem structuring process have to adjust their own point of view to that of the group. Participants have to display, more or less, a certain kind of obligingness to make a common point of view for the group possible. The question is whether this is the same or that it is fundamentally different from the notion of consensus within Group Model Building and SODA. After all, consensus encompasses a congruence of feelings, a general analogy of views. An accommodation of interests (SSM) seems to lead to decisions that are compromises, while consensus (Group Model Building and SODA) refers to true common decision-making to which all participants in a group agree. However, things could even be more subtle than the above suggests. Eden states that consensus is a general purpose of SODA. At the same time, however, Eden sees organizations as a changing set of coalitions in which participants are continuously negotiating and renegotiating their roles within it. Is it possible that the end product of such negotiation processes can be labeled as something like consensus? Or is it, like in the case of SSM, a compromise? To put it in other words, decisions in SSM and SODA might in fact be compromises, while Group Model Building seems to strive for consensus in the true meaning of the word.

In conclusion, the three problem structuring methods seem to have the same general goals, but this accordance might not hold when taking a closer look. Group Model Building strives, first, for robust strategies, and second, for learning, consensus, and commitment. Within SSM and SODA the belief is that it is impossible to realize actual consensus. In this view, compromises are the best possible result.

### *Worldview*

The three methods all leave from a world of multiple realities. Each participant in the problem structuring process has his own view on the problem situation and each view is equally valid. This means there is no vision that is 'right' or 'wrong'. Consequently, it is not possible to objectively and indisputably determine what *the* problem is. The three problem structuring methods have this subjectivity towards the problem situation in common.

Group Model Building is, out of these three methodologies, the only one to incorporate the feedback concept. Systems are said to be steered by information feedback and solutions to problem situations should be sought for in this direction. According to Group Model Building, however, the bottleneck in the group process remains that every participant has his own view on the problem situation. In this way, Group Model Building combines the somewhat objective notions of system dynamics with the strong subjective notions of SSM and SODA.

In short, all three problem structuring methods leave from a world of multiple realities. An important difference is that Group Model Building, in contrast to the other two methodologies, describes and analyzes problem situations on the basis of feedback relations.

### *Origination*

The origination of Group Model Building and SSM shows similarities. System dynamics, on which Group Model Building is based, originated as a reaction to hard operations research. Forrester stated that the mathematical and optimizing methods of the hard operations research paradigm were incapable of handling strategic problem situations. SSM is based on systems engineering, which can also be classified as a hard operations research paradigm. It is Checkland's statement that these hard operations research approaches were not suitable for messy, ill-defined, and changing problem situations. So both Group Model Building and SSM originated from a reaction to other methodologies that did not have an effective and convincing answer to messy problem situations. However, the theoretical body of thought that resulted out of these critiques differs fundamentally for Group Model Building and SSM. Group Model Building takes as a point of departure individuals in organizations who can have quite divergent points of view indeed, but in spite of this diversity in viewpoints it is possible to come to consensus among the group of problem owners. The systems in which these individuals find themselves are characterized by feedback relations and can be steered. SSM states that the differences in viewpoints among the problem owners are so divergent and so opposite to each other that consensus is impossible. A compromise is the best one can reach. Kelly's personal construct theory seems to share the subjective notion of individual problem construction with Group Model Building and SSM.

### *Operating procedure*

The operating procedures of the three methodologies have some characteristics in common. In the first place, they are all participative problem structuring methodologies in which the group process in particular is the steering factor. Participation of the client in the problem structuring process is believed to be necessary for a valid representation of the problem situation and for taken the most appropriate decisions, which have the client's support.

A second common characteristic is that Group Model Building, SSM, and SODA are, in general, small group methodologies. Approximately up to ten people can participate in the problem structuring process. If the group gets too large, this may hinder the progress of the group process. One runs the risk then that there is not enough room for individuals to express their own view on the problem situation, which, in turn, can be detrimental to learning and commitment.

Third, the three problem structuring methods all have a neutral person who guides the group process. Neutral in this sense means that the person is from outside the client organization. This is to prevent the guide from becoming a participant in the group process, which makes it difficult or even impossible for him to guide the group process objectively. In Group Model Building this person is called the facilitator. SSM and SODA call this person the consultant. Although the terms are different, the role of the person involved seems to be the same: to try to enable the problem owners to learn and to come to a point where they can take decisions.

However, there are also considerable differences in the processes that lead to making a system dynamics model, root definitions, or a strategic map. SSM and SODA have a strong subjectivist way of working by taking the individual as the point of departure. Models are made of the point of view of each individual (root definitions and cognitive maps respectively). Subsequently, SODA brings the individual models together in a group model, while SSM does not result in a group model. The subjectivity is seen as the strength of the intervention. Group Model Building also starts from looking at the individual as the building stone of the group process. This methodology, however, states that the subjectivity hampers the group process and joint decision-making. Therefore, Group Model Building tries to 'objectivate' the



group process by separating fact from value. In that sense, Group Model Building is diagnostic in essence, while SSM and SODA depict situations how participants would like it to be.

### Summary and concluding remarks

In this paper we have tried to make a systematic comparison between three problem structuring methods: Group Model Building, SSM, and SODA. We have summarized this comparison in the following table:

	<b>Group Model Building</b>	<b>SSM</b>	<b>SODA</b>
<b>General purpose</b>	<ul style="list-style-type: none"> <li>• robust policies</li> <li>• learning, consensus, and commitment</li> </ul>	<ul style="list-style-type: none"> <li>• accommodation of interests, through a cyclic process of learning and action</li> </ul>	<ul style="list-style-type: none"> <li>• consensus and commitment to action</li> </ul>
<b>Worldview</b>	<ul style="list-style-type: none"> <li>• information feedback</li> <li>• multiple realities, subjectivism</li> </ul>	<ul style="list-style-type: none"> <li>• multiple realities, strong subjectivism</li> </ul>	<ul style="list-style-type: none"> <li>• multiple realities, strong subjectivism</li> </ul>
<b>Origination</b>	<ul style="list-style-type: none"> <li>• system dynamics, operations research</li> </ul>	<ul style="list-style-type: none"> <li>• hard systems thinking in general, systems engineering in particular</li> </ul>	<ul style="list-style-type: none"> <li>• personal construct theory</li> </ul>
<b>Operating procedure</b>	<ul style="list-style-type: none"> <li>• building a system dynamics model with the client and implementing resulting policy measures; separation of fact and value</li> <li>• guided by a neutral facilitator</li> </ul>	<ul style="list-style-type: none"> <li>• formulating root definitions and subsequently conceptual models, proposing and implementing measures</li> <li>• guided by a neutral consultant</li> </ul>	<ul style="list-style-type: none"> <li>• making individual cognitive maps and a joint strategic map, enabling the client to move to action</li> <li>• guided by a neutral consultant</li> </ul>

However, the answer to the question in what kind of managerial situation to apply which methods has not been answered yet. We see the quest for this answer as an important challenge for both researchers and policy-makers.

### References

- Andersen, D.F., Richardson, G.P. (1997). Scripts for Group Model Building. *System Dynamics Review*. 13(2): 107-129. Cambridge, MA: System Dynamics Society.
- Andersen, D.F., Richardson, G.P., Vennix, J.A.M. (1997). Group Model Building. Adding more science to the craft. *System Dynamics Review*. 13(2): 187-201. Cambridge, MA: System Dynamics Society.
- Checkland, P. (1989). Soft Systems Methodology. In: Rosenhead, J. (ed.). *Rational analysis for a problematic world. Problem structuring methods for complexity, uncertainty and conflict*, pp. 71-100, Chichester [etc.]: John Wiley & Sons.
- Checkland, P.B., Haynes, M.G. (1994). Varieties of systems thinking. The case of Soft Systems Methodology. *System Dynamics Review*. 10(2-3): 189-197. Cambridge, MA: System Dynamics Society.
- Eden, C. (1989). Using cognitive mapping for strategic options development and analysis (SODA). In: Rosenhead, J. (ed.). *Rational analysis for a problematic world. Problem structuring methods for complexity, uncertainty and conflict*, pp. 21-42, Chichester [etc.]: John Wiley & Sons.

- Eden, C., Simpson, P. (1989). SODA and cognitive mapping in practice. In: Rosenhead, J. (ed.). *Rational analysis for a problematic world. Problem structuring methods for complexity, uncertainty and conflict*, pp. 43-70, Chichester [etc.]: John Wiley & Sons.
- Flood, R.L., Jackson, M.C. (1991). *Creative problem solving. Total systems intervention*, Chichester [etc.]: John Wiley & Sons.
- Forrester, J.W. (1970). *Urban dynamics*. Third printing. Cambridge, Massachusetts: M.I.T. Press. [1969].
- Forrester, J.W. (1973). *World Dynamics*. Second edition. Cambridge, Massachusetts: Wright-Allen Press. [1971].
- Forrester, J.W. (1980). *Industrial dynamics*. Tenth printing. Cambridge, Massachusetts: M.I.T. Press. [1961].
- Forrester, J.W. (1990). *Principles of systems*. Portland: Productivity Press. [1971].
- Geurts, J.L.A., Hart, S.L., Caplan, N.S. (1985). Decision techniques and social research. A contingency framework for problem solving. *Human Systems Management*. 5: 333-347. Amsterdam: Elsevier Science Publishers.
- Kelly, G.A. (1955). *The psychology of personal constructs. Volume one: A theory of personality*. New York: W.W. Norton & Company.
- Lane, D.C. (1994). With a little help from our friends. How system dynamics and soft OR can learn from each other. *System Dynamics Review*. 10(2-3): 101-134. Cambridge, MA: System Dynamics Society.
- Lane, D.C., Oliva, R. (1998). The greater whole. Towards a synthesis of system dynamics and soft systems methodology. *European Journal of Operational Research*. 107: 214-235. Amsterdam [etc.]: Elsevier.
- Mingers, J., Brocklesby, J. (1997). Multimethodology. Towards a framework for mixing methodologies. *Omega. The International Journal of Management Science*. 25(5): 489-509. Oxford [etc.]: Pergamon Press.
- Patching, D. (1990). *Practical Soft Systems Analysis*. London: Pitman.
- Richardson, G.P. (1991). *Feedback thought in social science and systems theory*. Philadelphia: University of Pennsylvania Press.
- Richardson, G.P., Andersen, D.F. (1995). Teamwork in Group Model Building. *System Dynamics Review*. 11(2): 113-137. Cambridge, MA: System Dynamics Society.
- Richardson, G.P., Pugh III, A.L. (1983). *Introduction to system dynamics modeling with DYNAMO*. Second printing. Cambridge, MA [etc.]: M.I.T. Press [1981].
- Rouwette, E.A.J.A., Vennix, J.A.M., Mullekom, T. van. (1999). Group Model Building. A review of assessment studies. In: Cavana, R.Y., Vennix, J.A.M., Rouwette, E.A.J.A., Stevenson-Wright, M., Candlish, J. *Systems thinking for the next millennium. Proceedings of the 17th International Conference of the System Dynamics Society and the 5th Australian & New Zealand Systems Conference*, 20-23 July, Wellington, New Zealand.
- Vennix, J.A.M. (1996). *Group Model Building. Facilitating team learning using system dynamics*. Chichester [etc.]: John Wiley & Sons.
- Wolstenholme, E.F. (1990). *System enquiry. A system dynamics approach*, Chichester [etc.]: John Wiley & Sons.