

System Dynamics as a Tool to Advance Organizational Learning

Martin R Ochs
Industrieseminar der Universität Mannheim
University of Mannheim, Schloss
D-68131 Mannheim
Federal Republic of Germany
Tel: +49 621 292-3140
Fax: +49 621 292-5259
E-mail: marox@mailrum.uni-mannheim.de

Abstract

Today it can be seen that management of change has become a management of "surprise", in which an enterprise can only survive by recognizing future events in the environment and by acting on that information with appropriate business moves. The ability to learn about these changes requires a kind of organization that never stands still; moreover, enterprises have to develop their own strengths according to their environmental conditions.

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INFLUENCE OF ENVIRONMENTAL CHANGES ON STRATEGIC PLANNING

The economic environment is changing constantly. Competition, suppliers, customers, substitute products or potential new rivals alter the conditions in rapid succession, so that very little time remains for an enterprise to react with appropriate business moves. Traditional planning concepts do not provide better information, because mostly they extrapolate past events and do not take into consideration structural breaks. They can be classified in long-term breaks, e.g. the die out of the combustion motor due to the environmental pollution or decreasing product life cycles. Medium-term breaks however, often show symptoms, so that they can be expected but not surely foreseen. Through this difference organizational learning must contain two characteristics: *Adaptability* is the capacity to expand niches or to find new niches that are adequate for survival in the long-run. Nevertheless profits are achieved in the present and future profits are heavily influenced by decisions of today. For that reason it is necessary that organizational learning also takes into account enhancing *adaptation* (Boulding 1978).

As Arie de Geus points out, "the ability to learn faster than your competitors may be the only sustainable competitive advantage" (de Geus 1988). This learning depends on experiences that people have drawn from past actions. Thus, the feedback of their decisions is the initiation of a learning process.

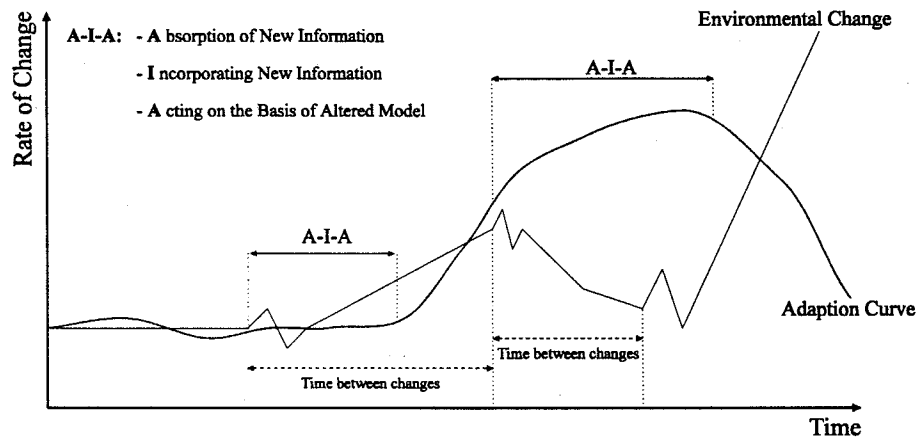


Figure 1: Adaptation to environmental changes

The problem in this situation is that the answer of the system is delayed and that the feedback-loop contains too many elements to recognize and understand the interactions with the environment – as a consequence, the learning process develops too slowly. Figure 1 illustrates the adaptation of an enterprise: If the phases of absorption, incorporation, and acting are shorter than the time between structural breaks in the environment, the behavior can be changed in sufficient time. But, by shortening the time of change, even the time to react can lengthen. The reason for that are frozen mental models for lack of communication. Furthermore, past experiences contain past conditions. This requires not only cognitive performance, but also the ability to unlearn.

To achieve those objectives mentioned above, System Dynamics will be discussed as a tool to advance organizational learning. The following comments show that it is not possible to reach all goals in connection to this process. Nevertheless it indicates the chance of System Dynamics as an initiator and catalyst.

CONSTRUCTS AND PROCESSES ASSOCIATED TO ORGANIZATIONAL LEARNING

The paper deals with four learning-related constructs (Figure 2).

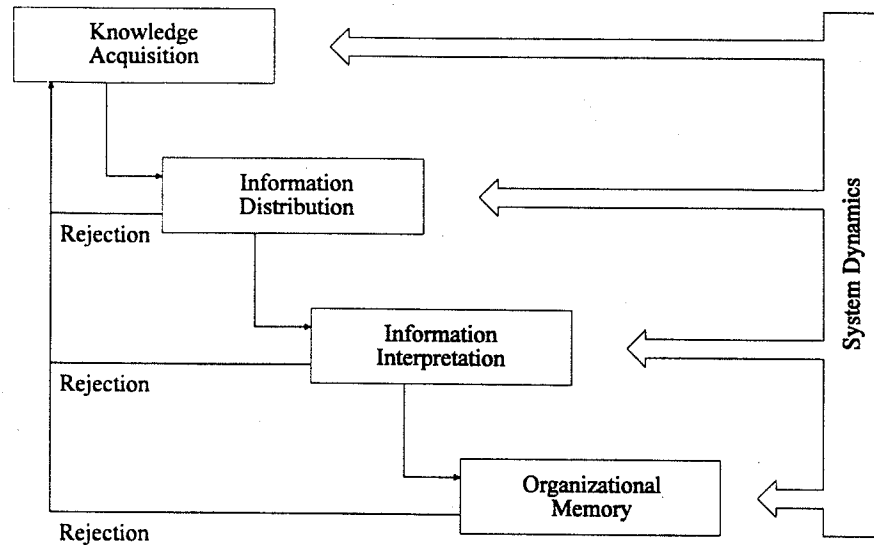


Figure 2: Learning-related constructs

Each construct is treated in a subsequent section of the paper. *Knowledge acquisition* is the process by which knowledge is obtained. *Information distribution* is the process by which information from different sources is shared and thereby leads to new information and understanding. *Information interpretation* is the process by which distributed information is given one or more commonly understood interpretation. *Organizational memory* is the means by which knowledge is stored for future use.

APPLICABILITY OF SYSTEM DYNAMICS TO CONSTRUCTS AND PROCESSES OF ORGANIZATIONAL LEARNING

KNOWLEDGE ACQUISITION

A lot of organizational activities are intended to acquire information or knowledge. Examples are customer surveys, research and development activities, performance reviews, and analysis of competitors' products. Collecting this information very often is unintentionally and unsystematically. Several functional areas of an enterprise obtain different knowledge which is not stored or analyzed altogether. Figure 3 shows subprocesses of knowledge acquisition:

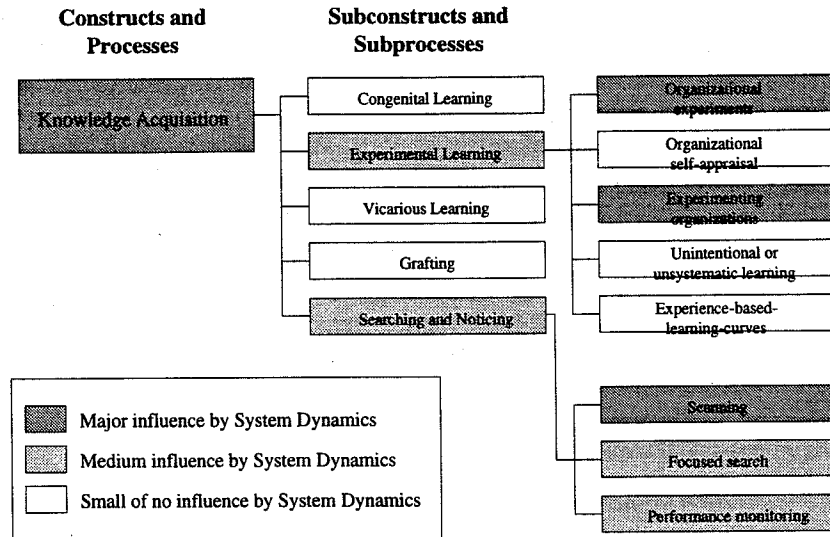


Figure 3: Subprocesses of knowledge acquisition

Therefore *organizational experiments* become one of the most important tasks for knowledge acquisition. Experimental learning is enhanced by the availability and analysis of feedbacks. Two approaches are mentioned how System Dynamics can facilitate a intentional learning process:

- (1) The accuracy of feedbacks about cause-effect relationships between organizational actions and outcomes can be increased. By modeling the problem and experimenting, sensitive parameters and feedbacks can be identified.
- (2) The combination of cause-effect relationships to feedback-loops allows a structured collection and analysis of the behavior.

Portraying the decision structure and their impacts on profits in the daily managerial routine is not possible and most of the time not admitted. The fear of dissemination of any but positive findings inhibits reflections about present conditions. An external consultant in connection with computer simulation serves as a medium to uncover the hidden opinions and expectations, because the formal model is detached from personal responsibility. Furthermore the curiosity about the structure and results provides an encouraged cooperation of the team members.

Experimenting organizations are suggested to maintain adaptability. Organizational experiments and self-appraisals are generally directed towards enhanced adaptation, while maintaining organizational experiments are generally directed towards enhancing adaptability. One group of researchers (Nystrom, Hedberg, and Starbuck 1976) has suggested that organizations should operate as „experimenting“ or „self-defining“ organizations. They should maintain in a state of frequent, nearly-continuous change in structures, processes, domains, and goals. The researchers argue that operating in this mode is efficacious, perhaps even required, for surviving in fast changing and unpredictable environments. Experimenting organizations would thus be less resistant to adopting unfamiliar features or engaging unfamiliar environments, i.e., they would be adaptable. But the will to break up old structures and rules is both a risky and feared act. Though nobody likes rules, they are extremely important in a corporation, because they serve as the glue of the organization. Changing or removing those rules feeds the fear of chaos and instability. If this fear is seen as a discrepancy between recognized need for change and missing skills and information, the application of System-Dynamic-models can provide a better understanding and thus a reduction of fear (Stata 1989). The simulation of organizational structures with their interactions to the environment brings up hidden opinions and estimations and shows the „critical path“.

The last brick for knowledge acquisition is *searching and noticing*. If the lack of fit between an organization and its environment becomes too big, the organization either fails to survive or undergoes a costly transformation. In order to avoid this lack of fit, organizations *scan* their environment for information about changes. This behavior relies on the assumption that scanning contributes to performance – an assumption that has been validated in a variety of studies (e.g. Daft, Sormunen, and Parks 1988). While *focused search* such as market studies raises expenses, the database for a System-Dynamics-model is almost available in the enterprise.

Yet, it has to be considered that facts stored in subunits and at lower organization levels are largely reactive to problems. The duty of the consultant or the model builder is not to collect the relevant information by visiting selected functional areas, rather he has to gather the heads of department to a round-table conference, where they bring in their information into the model – and with it their mental models. Presenting a model that is only constructed by an external is condemned to failure, because the acceptance of managers cannot be achieved. The process of the model building is perhaps as important as the working with the model.

Performance monitoring is one of the clearest and most pervasive forms of organizational control. Organizations formally and routinely assess how well they are meeting both their own standards, such as inventory levels or revenues, and the expectations of external constituencies and stakeholders. In order to improve performance most of the measuring instruments look at amounts of the management accounting. These, however, reflect only results of operative management that are countable. The fitness to adaptation or qualitative facts are not included.

By way of contrast the System-Dynamics-model is full of qualitative data. A lot of parameters can only be quantified ordinally or cardinally. This forces the model builders to bear in mind soft facts, e.g. organizational self-appraisals or the organizational culture. The model is more realistic, though it is more abstract. Consequently, the model is suitable not only to measure past performance, but also to reflect on the conditions of past success and to simulate potential further success.

INFORMATION DISTRIBUTION

Information distribution is a determinant of both the occurrence and breadth for organizational learning. With regard to occurrence of organizational learning, one has to consider that organizational components develop "new" information by piecing together items of information that they obtain from other organizational units, as the shipping department learns that a shortage problems exists by comparing information from the warehouse with information from the sales department.

Except for their systems that routinely index and store hard information, organizations tend to have only weak systems for finding where a certain item of information is known to the organization. But when information is widely distributed in an organization, so that more and more varied sources for it exist, retrieval efforts are more likely to succeed and individuals and units are more likely to be able to learn.

System Dynamics can be such a source. Once the model is constructed, it is a collection of assumptions and isolated mental models. By means of being a formal mathematical model it is easy to communicate among the team members. During the model construction the comprehension of a unit or a member in the organization for the information's relevance of another member or unit increases. The costs of routing are very small. It is to be expected that the communication flow raises in the future.

Organizational units with potentially synergistic information are often not aware of where such information could serve, and so do not route it to these destinations. Also, units which might be able to use information synergistically often do not know of its existence or whereabouts. How those who possess nonroutine information and those who need information find each other is relatively unexplored (Huber 1991).

A better understanding of subunits and their problems can be improved by the modeling process. The insights into relationships and interactions between subunits, the organization, and the relevant environment raises the sensitiveness for the need of information. Another advantage of System-Dynamics-models is the kind of information transmission. In the daily routine the communication chain is prescribed. The employees have to use an established way to distribute their information. This leads to slow transmission speed and the loss of information. Furthermore, each unit obtains its own jargon that contains specific informations about their mental models. In order to understand actions of other subunits a direct communication is demanded. The computer-based model serves again as a medium that forces people to communicate with each other without interfering elements in the communication chain. Too many receivers and senders in a chain can forge information.

INFORMATION INTERPRETATION

Daft and Weick (1984) define interpretation as "the process through which information is given meaning ... [and also as] ... the process of translating events and developing shared understandings and conceptual schemes". Do these definitions imply that more organizational learning occurs, if all organizational units develop a common interpretation about an item of information? Or does more learning occur if all units interpret the information differently? It seems reasonable that the last question provides better progress. The microworld that is created in the modeling process serves only to discover the hidden, isolated mental models (de Geus 1988). It is not necessary to achieve common sense, because this mostly represents only the lowest common denominator of the management team. It is important that the model contains the current mental models. The insights into the nature of the various interpretations held by other units changes the range of the organization's potential behaviors, and this is congruent with the definition of learning.

The information interpretation can be subdivided in four parts (see Fig. 4).

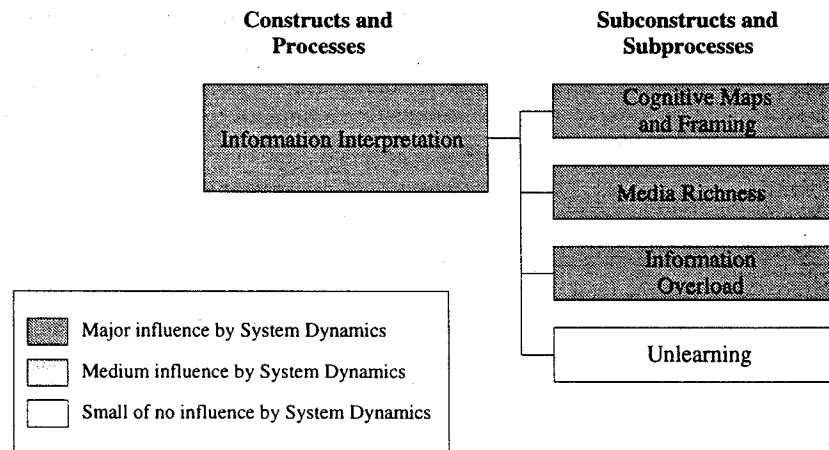


Figure 4: Subprocesses of information interpretation

A person's prior *cognitive map* will shape his or her interpretation of information, and these cognitive maps vary across organizational units which have different responsibilities. If information is not uniformly framed when distributed to different units, uniform interpretations are less likely to be achieved. The System-Dynamics-model is able to communicate the assumptions and premises, because the acceptance of the built model is high by the involvement of the decision makers. This provides an idiosyncratic message that can be used to create uniform framings.

System Dynamics is also a tool to enlarge *media richness*. Media richness is a determinant of the extent to which information is given common meaning by the sender and receiver of a message. It is defined as the communication medium's capacity to change mental presentations within a specific

time interval (Daft and Lengel 1984). System Dynamics as a medium contains two benefits: It can convey a great variety of cues and therefore a lot of qualitative and quantitative information. Furthermore, the simulation of the model guarantees a fast feedback that effects the development of common understanding.

Interfering in the organizational learning process is *informational overload*. Interpretation within or across organizational units is less effective if the information to be interpreted exceeds the units' capacity to process the information adequately. Working with computer-based models helps in three ways:

- (1) The model builders learn what constitutes relevant information. They are forced to separate relevant from non-relevant information that provides a reduction of complexity.
- (2) A great number of variables can be processed. By means of the human mind, most people can only deal with three or four variables.
- (3) Mental models do not allow a precise analysis of cause-effect-relationships. Considering the time delays between action and results the impacts of decision once taken are not conceivable without a simulation model.

The process of *unlearning* is not further discussed. In the opinion of the author unlearning is a subprocess of learning. Unlearning, defined as a process of discarding knowledge, requires the existing of new, substituting knowledge.

ORGANIZATIONAL MEMORY

Everyday experience and research makes clear that the human components of organizational memories are often less than satisfactory. The problem of poor organizational memory is much more complex than simple considerations of the deficiencies of humans as repositories of organizational information and knowledge. Personnel turnover creates great loss for the human components of an organization's memory. Furthermore, nonanticipation of future needs for certain information causes great amounts of information, that are not stored or stored in a way that it is not easy to retrieve them. Finally organizational members with need of information frequently do not know of the existence or whereabouts of information possessed or stored by other members.

Storing and retrieving information. A great deal of organizational knowledge about how to do things is stored in the form of standard operating procedures, routines, and scripts. What is not well understood is the intent to which nonroutine information is deliberately stored to be used as a basis for future decision making. This behavior could involve anticipating future needs for the information. Perhaps System-Dynamics-based models show their strongest point here. Though the predictability of the future is uncertain, experimenting with the model can generate a number of possible futures. The question "What will happen?" can be substituted for the question "What will we do if it happens?". The scope of future needs can be enlarged by modifying the model. With each change of the basic model structure, the managers can analyze and store it for future use. If elder models are used for performance monitoring they initiate again a learning process. The comparison of the simulation results with real developments provides a critical reflection about the assumptions in the models – mental models can be investigated and changed.

Much of what an organization learns is stored in the minds of the members. In many cases organizations grow their experts. These people are expert not in the whole discipline or broad category of problems, but rather they have gained organizational experience. Using the knowledge of these home-grown experts, organizations create computer-based expert systems to achieve accessibility, reliability, and "own-ability", and they are a component of organizational memories. Expert systems, however, obtain the danger of being a brake for organizational learning. The knowledge stored in such a system is not always accessible, and very often it is abused for decision making in a black box. Moreover, expert systems contain static views, so that the dynamic problem

structure remains hidden. Consequently, they perpetuate old mental models and do not take into account a holistic view.

CONSEQUENCES FOR THE MODEL BUILDER AND CONCLUSIONS

The objectives mentioned above show that the most productive source of organizational learning is identifying the hidden mental models. The phases of knowledge acquisition, information distribution, information interpretation, and storing organizational knowledge have to be passed even in the daily business. Obtaining adaptability and adaptation requires a permanent iteration of these phases. For that reason the System-Dynamics-model has to be modified frequently to understand and to store newly gained information about interactions to the environment and possible futures.

The demand of reflection of patterns of behavior raises the question of whether an employee or a manager of an enterprise is able to discover mental models and to create shared visions. As Arie de Geus (1988) points out the leader of a model creating team has to serve as a transitional object and therefore as a medium. This requires a neutral position and also no established patterns of behavior. In case of identity of team leader and member of the organization, the danger is that the mental models are gradually adjusted to the mental model of the team leader, and that this contributes only to common sense but not to organizational learning.

A lot of consultations show that System Dynamics works as a communication tool. It helps to collect relevant information in the enterprise and in the environment. The defined procedure of model construction forces members or units to communicate to each other at different level than in the everyday life. Frequent meetings of the group establish a flowing reflection on possible futures, but it has to be indicated again and again that simulation with System Dynamics is not one more tool to forecast the future.

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