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Model-Based Management (MBM): A Research Agenda

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- Abstract -

The purpose of this paper is to introduce and conceptualize the topic of Model-Based Management (MBM) in organizations. The importance of qualitative and quantitative models for management is highlighted, and a research agenda for this new topic is proposed. This agenda promises to make a contribution to the use of models for higher managerial effectiveness. The role of models for managerial purposes has been under-researched and often misunderstood. In this paper, an analysis of the concept, role and function of models in the context of management and organization is undertaken. A new understanding of both the concept and role of models in management, grounded in system science, is proposed, which the planned research program will explore. The gain promised by such an innovative scope derives from its high potential: Both theory and practice can benefit from the envisaged research. Theoretically speaking, advances in management and organization science can be achieved, while on the practical side the gained insights will caution managers and leaders against succumbing to the traps of complexity, while radically improving their managerial effectiveness. Ultimately, MBM should enhance the intelligence, adaptiveness and viability of organizations[1] of any kind: private, public, non-profit, large or small.

[1] Terms as defined in Schwaninger, 2008.

1. THE RELEVANCE OF MBM

Over the last years, the complexities confronting organizations have been subject to drastic amplification. As a consequence, the pressure on leaders has markedly increased. Orientation and steering devices have become all the more important, because they enable actors in organizations

a) to find their way in complex settings, and
b) to decide and act more effectively and consciously.

This is where high-quality models can make a powerful contribution[2]. To leverage this potential benefit, a research program dedicated to exploring the topic of models and modeling in organizational realities has been designed, which will be outlined in the following sections.

The term *Model-Based Management* is introduced here to make an important point: The significance of models and modeling to organization and management can hardly be overestimated, a factor that has a deeper reason: The use of models in organizations has by and large been subject to little reflection, evident in the facts, first, that the potential of models for enhancing managerial effectiveness and organizational viability is poorly understood and minimally actualized, and, finally, that the entire issue has been given too little research attention.

This paper introduces and conceptualizes the idea of Model-Based Management (MBM) as an area of pertinent research. Furthermore, it proposes a research agenda for this area, in order to stimulate the study necessary for a deeper understanding of this topic that promises to greatly benefit organizations and their members.

[2] Inadequate models, on the other hand, can inflict great damage on organizations, as has been the case in financial institutions, lately (Mollenkamp et al. 2008).

2. PURPOSE AND GOALS OF THE RESEARCH AGENDA

The purpose of this research agenda is to improve the state-of-the-art of management theory, but also the modeling and model use in organizations, in order to enhance the intelligence, adaptiveness and viability of organizations of any kind: private, public, non-profit, large or small.

The twin goals of the program are to carry out a general exploration of the field of modeling and to find ways of improving the quality of models. Both formal and informal models will be objects of research. In the latter case, for example, the process of eliciting a mental model and making it explicit will be studied.

The program should result in a significant contribution to the state-of-the-art of organization and management science. In the first place, it is a matter of theory-building, mainly in the sense of empirical research and the science of socio-technical design. However, the theoretical knowledge we are striving for should be applicable at the same time in actual organizations.

3. CONCEPTS

By *model* we understand the representation of a *real system*. More exactly, a model is an abstract, conceptual system by which a concrete system is represented.

Models can both reproduce or re-create (→ 'portrait'), and anticipate (→ 'paragon'). They may refer to either actual or potential ('ideal') systems, and they can be either formal or informal. A formal model is cast in a stringently logical and mostly mathematical way, e.g., a simulation model, a balance sheet or an architectural plan. Informal models, if explicit, use fuzzier or abridged modes of expression. Often informal models are implicit, e.g., mental models. The term 'mental model' refers to models in the minds of actors or observers. In this context, shared mental models are of particular relevance. If they are to be shared, they must be made explicit. In the broad sense of the term, mental models refer to the images,

assumptions, theories, concepts, and schemes as well as principles, norms, ‘philosophies’, and world views held by an individual or a collective.

In view of the topic Model-Based Management, we define *management*, with Ulrich[3], as the design, (self-) control and development of social systems, organizations in particular. As we shall see, models are crucial devices for any kind of management, be it general management or specific versions of management in the diverse functional areas of organizations. This holds irrespective of organizational type.

4. THE FUNCTION OF MODELS

The use of models can fulfill different functions, such as description, explanation, design, decision and change. Descriptive Models represent what is the case; they make the issue under study comprehensible. Explanatory models, including these, explain why the real system at hand behaves as it does and not differently. They try to capture interrelationships, e.g. causalities, interactions and dependencies. Models of analysis and diagnosis, which are among the explanatory models, inquire into the implications of system behavior and of the structure underlying it.

Design models are instruments that support the conceptual development of systems. Decision models, which can be considered a kind of design model, support decision-processes. They serve the eliciting of options and their comparative assessment, marking the difference between "better" and "worse" variants, mainly by exploring their consequences and implications.

In general, models can trigger the discovery of new perspectives and insights, support the ascertainment and assessment of options, highlight priorities, illuminate uncertainties, and unveil the dynamic features, propensities, risks and vulnerabilities of a system. They are very helpful in disciplining the organizational discourse. They are also important in fostering

[3] Ulrich, 2001.

education and learning, in solving problems and in changing conditions or transforming organizations.[4] Finally and foremost, "models can surprise us, and lead to new questions."[5]

5. THE IMPORTANCE OF MODELS FOR ORGANIZATIONS AND MANAGEMENT

The argument that models are important for management has a scientific basis, which can be deduced from a fundamental law of cybernetics – the *Conant-Ashby Theorem*. This is a formal, proven law, which in the original says: "Every good regulator of a system must be a model of that system".[6] The implication is that the results of any management process cannot be better than the underlying model except by chance. This law has universal validity, because we always manage on the basis of models, whether we want to or not and whether we know it or not. In light of the Conant-Ashby-Theorem, the quest for high-quality models is a must.

This raises the question about the quality of models on the basis of which one makes decisions. It is not enough to build insightful models; they also must be valid. Hence, the first criterion for the quality of a model is **validity.** A model is valid if it represents what it is supposed or claimed to represent. This applies once the constitutive components of the real system under study and the relationships between them are properly captured; in the case of dynamic models, it holds if the behavior of the model over time reflects the behavior of the real system.[7] Absolute or timeless validity is an unachievable goal. Models are always surrogates, which are more or less accurate. Rather, the quality of a model in the context of an organization must be judged, if it fulfills its purpose, as to whether it is better, more appropriate, and more useful than the ones already available. As has been said previously, all models are wrong, but some of them are useful.[8]

[4] See also Pidd, 1996, Schwaninger, 2004, and Epstein, 2008.
[5] Epstein, 2008: 4.
[6] Conant & Ashby, 1981.
[7] See, e.g., Schwaninger & Groesser, 2008; Schwaninger & Groesser, 2009
[8] Sterman, 2000: 846 (after a famous dictum of George Box).

Models have been called "tools for thinking".[9] A tangible advantage of their use is that they allow experiments in the computer (or in the brain) that are normally much less costly and time-consuming than experiments "in the real world". This is of great importance whenever different options must be examined, which is a constant need in the managerial domain.

From a conventional understanding modeling is a process by which models are produced. In a wider sense however, modeling can be understood as a vehicle for the creation of new realities. Hence, one may assume that models determine the realities of the future to a high degree. If this assumption holds, then progress in the area of management will substantially hinge on the development of better models. Agents in organizations carry a high responsibility for the quality of the models that determine their decisions and actions. If that quality is neglected, Gresham's law will prevail: The important will be driven out by the trivial and the short-term perspective will supersede long-term orientation.

6. TYPES OF MODELS

The diversity of models could be categorized in different ways. In order to avoid a one-dimensional typing, which would be too simplistic, a three-dimensional descriptive scheme is used, in which three ideal-types of models are positioned (Figure 1). The dimensions used are:

- *Depth:* refers to the levels of detail and specificity of a model
- *Breadth:* denotes the scope of the domain modeled, between broad and narrow
- *Acuity:* indicates the accuracy and precision of a model.

The ideal-types of models discerned, without any claim to be exhaustive, are:

[9] Pidd, 1996.

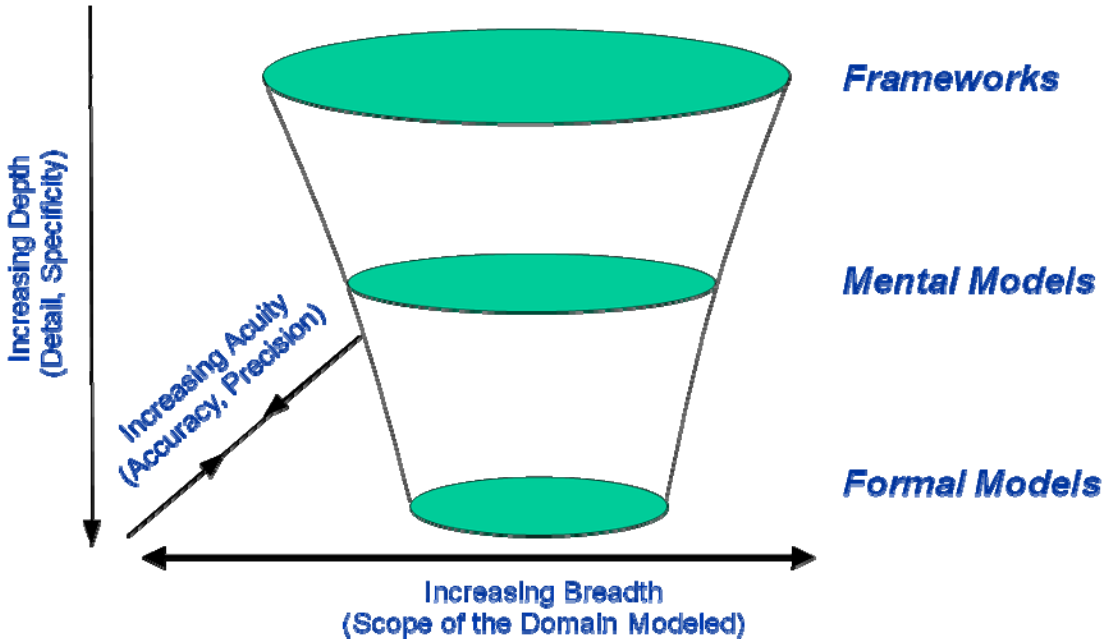


Figure 1: Ideal-types of models

1. *Frameworks:* These are broad schemes which support the orientation within a wide field. A framework offers dimensions and categories, by which a rough overview and a first location, and possibly also a structuring of an issue or problem, can be undertaken. The various generations of the St. Gall Management Model are highly condensed frameworks of that kind.[10]
2. *Mental Models strictu sensu*: As distinct from the broad version of the model concept, we are addressing more specific and accurate models here. These are representations of less ample objects, for example in the context of strategic management or organizational issues. Mental models support the determination and discussion of specific causal factors and relationships.

   Both frameworks and mental models are conceptual heuristic devices. *Conceptual* means that they help in ascertaining and structuring the object under study. *Heuristic* means that they support the finding of solutions, even if the goal has not been defined or if the solution is not precise. If we take mental models in a wider sense, they would figure above frameworks in Figure 1.

[10] Ulrich/Krieg, 1972; Bleicher, 2004; Rüegg-Stürm, 2005.

3. *Formal Models in strictu sensu:* At this level the model is formulated in a stringently logical and mostly mathematical language, and it can be calculated algorithmically, i.e., in a defined, finite sequence of steps, within a specified goal system. In the case of a formal model, specificity and precision are further enhanced. At the same time, however, it is necessary to restrict the boundaries of the model.

7. AXIOM

Much of the debate about strategy has been focused on the competition between firms. But ultimately **the competition is between models**. The organizations that survive are those with the better models. More generally, the evolution of a social system manifests itself in cultural progress. Such progress is grounded in the evolution of models, which conceptually guide the ongoing process by which socio-cultural reality is shaped. Models are not in the first place objective images of a reality out there, but devices which support the dialogue and the (inter-) action by which

- organizations invent and reinvent themselves, and
- desirable futures are designed and brought about.

8. SUGGESTIONS FOR A RESEARCH PROGRAM

In this section, a brief proposal is made concerning aims, research gap, and research questions for a research program in Model-Based Management. Furthermore, some reflections on methodological issues are propounded. Finally, the benefits of such a research program are outlined.

8.1. Aims of the Program

The program's aim is to develop a methodological basis for the design and use of formal and mental models in organizations:

- To explore the **role of models and modeling** in management

- To examine the **impact of models** on the process and the result of management
- To develop principles, rules and procedures for the design **of high-quality models and effective modeling processes**
- **To find ways to foster managers' conceptual understanding** necessary for their own development and their use of high-quality models

In principle, these aims refer to frameworks, mental and formal models or, in other words, to both qualitative and quantitative models. Given resource constraints, early on the focus is on **formal models**. Among the quantitative models, an emphasis will be on simulation models, which address the complex, often messy problems paramount in organizations.

8.2 Research Gap

The research gap to be addressed is threefold:

- **Lack of understanding** of the role of formal and mental models in management
- Knowledge **deficit** concerning how models are developed in organizations
- **Minimal insights** on the use of formal models and the results achieved with them
- **Little research** on how to ensure high-quality models

While this appraisal cannot be "proved", it can be corroborated, however, by some indicative evidence. First of all, the appraisal is based on many albeit unsystematic observations of managerial practice over many years. Second, a database research we have undertaken hints at a lack of academic discussion around the topic of management models.[11] Third, according to a study among German companies, the interviewees consider modern

[11] A research in the JSTOR database, realized on September 18, 2008, bred the following quantities of hits:
- Keywords "Management AND Model" in article titles: 133 hits. These went back as far as 1964 and included such diverse topics as manpower management, balance sheet management, fuel management, decision support, land management, forest management. Only one title referred to an empirical test of model use (Chung et al., 2000). All the other papers were focused on the description of a variety of models, methods and tools.
- Keywords "Management AND Management AND Use" in article titles: 2 hits, both of them not applicable to a general view on management models.
- Keywords "Management AND Management AND Use" in abstracts: 15 hits, of little utility in the context of a general management view on models.

Furthermore, in a search, on September 17, 2008, in the Amazon.com database, with the search criterion "Management AND Model", the first 100 hits only showed seven books having these terms in their titles. Most of these were specialized, e.g., in a product management model, linear programming etc.

simulation methods as the number-one success factor in strategy development, However, only less than five percent of the responding firms use simulation in the formation and evaluation of strategies, and only 20 percent in strategic analysis.[12] In addition, the above assertion about a research gap withstands scientific criteria, as it could, in principle, be refuted on empirical grounds.[13]

8.3 Research Questions

The following list of research questions is non-exhaustive, because further and more specific issues will emerge in the research process:

- How can both management and organizations be **improved by means of models**?
- Do strategy makers use formal models?
- Does the use of formal models make a difference?
- How should formal models be designed for higher managerial effectiveness?
- How can mental models be validated and improved?

8.4 Methodology

The research in this program should be grounded in system theory and cybernetics, because these are the sciences that focus on complexity and holistic system design. Other disciplines, e.g., organization science, psychology, sociology and cognitive science, will contribute as well to the study of Model-Based Management.

Given the complexity and large scope of the topic, different methods will be needed for the realization of the research activities. In the following list (Table 1), a number of more specific research questions than the ones just listed is related to different methods and rules that can be used. This list is offered without any claim to completeness.

[12] Gilbert et al. 2003.
[13] This is a reference to the falsification principle (Popper, 1959).

Table 1: Methods with pertinent research questions (examples)

Method	Research questions
Survey	What kinds of models are used? For what purpose are they used? What are the effects of model use?
Case Study	How are models used? Which features of modeling processes lead to high-quality models? How can models be customized to specific contexts?
Experiment	How do distinct kinds of model differ in their effect on performance? How do distinct kinds of model use differ in their effect on performance? Which factors determine the efficacy of model use?
Design principles and tests	How should models be designed to improve performance? How can models support organizational processes for effective decisions and actions? How should modeling processes be designed for high-quality models to emerge? How can learning with models be enhanced? How should decisional aids (e.g., feedback, decision heuristics, human facilitation) and Human-Computer-Interfaces, both of which complement models, be designed?

Some of the research into these topics can already be related to a substantial body of empirical research. For example, valuable insights concerning the design of model-based decision processes, learning laboratories and simulation environments, along with a wealth

of studies on Interactive Learning Environments and Dynamic Decision-making, has already been accumulated.[14]

8.5 Benefits

The following list relates to the expected ultimate benefits for model-users and their organizations:

- Higher intelligence and **viability of organizations**
- Availability of **design methods** for high-quality (more accurate, valid, fruitful, etc.) models
- Knowledge for more effective and efficient **modeling and model validation** processes
- Clarity about **methodological choices**
- Higher **managerial effectiveness** for model users
- Enhancement of the **quality of organizations** (economic, human-social, socio-technical and ecological)

9. OUTLOOK

The work presented here is meant to contribute to the design, (self-)control and development of organizations so that they can attain higher intelligence, adaptiveness and viability.

A crucial challenge for the proposed research endeavor is to provide ways to design better models - including theories, frameworks,[15] etc. - which are more apt to enhance the capability of organizations to master the paramount and growing complexities (and contingencies) they face, and to cope in adaptive and responsive modes.

The research program laid out here, even in its relatively crude form, can make a substantial contribution to the quality and impact of models in all kinds of enterprises. It will generate

[14] For an overview, see: Karakul & Qudrat-Ullah, 2008, and literature referred therein
[15] A framework for the design and development of intelligent organizations has been proposed in Schwaninger, 2009.

new knowledge that is vital for organizations. Given the demanding goals of the program, cooperations with other institutions will be indicated.

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