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ARBEITSPAPIERE WISSENSMANAGEMENT
WORKING PAPERS KNOWLEDGE MANAGEMENT

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Knowledge Management in Learning Organizations based on the System Dynamics Approach

Arbeitspapiere Wissensmanagement

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Ziele: Die Arbeitspapiere dieser Reihe sollen einen Überblick zu den Grundlagen des Wissensmanagements geben und sich mit speziellen Themenbereichen tiefergehend befassen. Ziel ist die verständliche Vermittlung theoretischer Grundlagen und deren Transfer in die Praxis.

Zielgruppen: Zielgruppen sind Forschende, Lehrende und Lernende im Fachgebiet Wissensmanagement sowie Praktiker in Unternehmen.

Quellen: Die Arbeitspapiere entstehen aus Forschungsarbeiten, Diplom-, Studien- und Projektarbeiten sowie Begleitmaterialien zur Lehr- und Vortragsveranstaltungen des Studiengangs Informationswirtschaft der Fachhochschule Stuttgart.

Hinweise: Falls Sie Arbeitspapiere in dieser Reihe veröffentlichen wollen, wenden Sie sich bitte an den Herausgeber.
Informationen über die Arbeitspapiere dieser Reihe finden Sie unter http://www.hbi-stuttgart.de/nohr/Km/KmAP/KmAP.htm

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- Degree 1986 in Business Management at University of Stuttgart (Dipl.-Kfm.)
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- Member of the academic staff at the University of Stuttgart (Institute of Industrial Engineering IFF/IAT)
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Knowledge Management: A key Capability of Learning Organizations

> In the middle of the garden were the tree of life and the tree of the knowledge of good and evil.
> Genesis 2:9

Knowledge Management is a key capability of learning organizations. Enterprises have to exist successfully in a world of global business structures and fast changes of the (individualized) customer needs. "In a global economy, knowledge may be a company´s greatest competitive advantage".[1] They have to be „smart“ enterprises which learn very fast to understand the behavior of new customers, new competitors or new markets. These enterprises (cf. figure 1) therefore need an information management which supports the selection of relevant data for business decisions and the transformation of these data to knowledge to get a continuous adaption to the changes in the environment. These „smart“ enterprises need information managers with new capabilities. They have to be project managers & team leaders, information professionals, information system designers, business administration specialists and knowledge engineers. Even the capability of a Chief Knowledge Officer[2] is required.

Individuals and organisations learn to gain knowledge

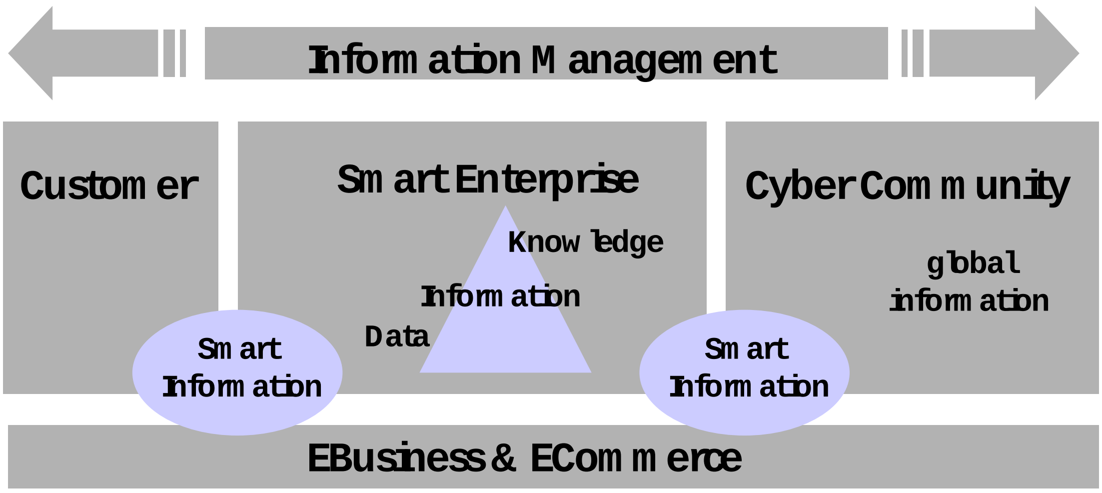

Figure 1: Information Management

Knowledge is a „fuzzy“ term. A definition is: „Knowledge is a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organizations, it often becomes embedded not only in documents or repositories but also in organizational routines, processes, practices, and norms“[3]. With respect to business decisions it can be said that we have to transform data to knowledge which supports a decision process.

Knowledge ist the business key success factor

Two questions therefore have to be answered:

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[1] Davenport, T. H.; Prusak, L. [1998], p.13
[2] cf. Probst, G. et al. [1997], p. 358
[3] Davenport, T. H.; Prusak, L. [1998], p. 5

1. How can we build models to understand the dependencies in such a complex dynamic system like the „smart“ enterprise?
2. Which data do we need for the models and which one are important for our business decisions?

These questions can be answered by following the System Dynamics Approach invented by J.W. Forrester[4]. The approach is based on the „system theory“ using feedback-loop diagrams which can be transformed into computer simulation models. These simulation programs support the understanding of structure and behavior of the real word system. In other words we produce knowledge to learn (cf. figure 2) about structure and behaviour of our business (our organization, our customers, our competitors) as complex dynamic systems. This knowledge supports strategic business decisions and strategy making.

Another important advantage of this approach is that during the development process of the simulation model the approach detects which information is necessary and important for decisions, i.e. it supports the information requirements analysis.

It can be stated that there is a change in information science paradigms. Knowledge was assigned only to artificial intelligence aspects. The „key words“ now are Corporate Memories, Knowledge Repositories and Libraries, Organisational Memories, knowledge navigation, maps and simulation[5].

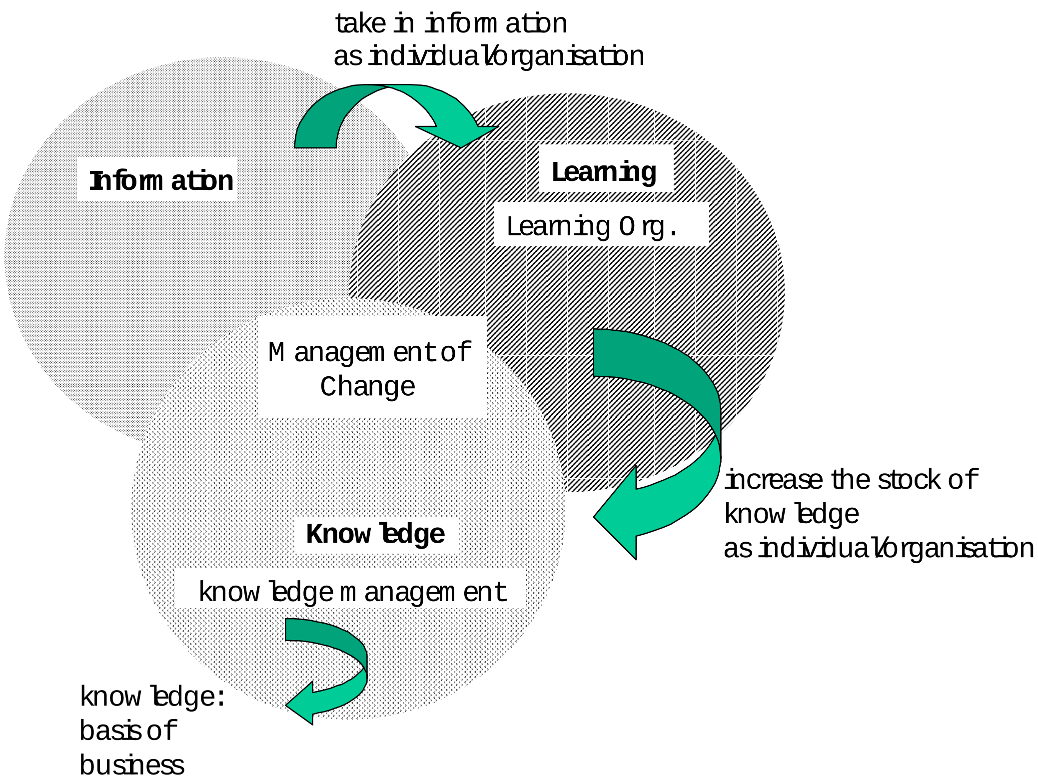

Figure 2: Information - Learning – Knowledge

The System Dynamics Approach

System Dynamics has a long history. J. W. Forrester published

- Industrial Dynamics: industrial organisations modelled as dependent feedback loop systems (studies 1956-1961)

[4] cf. Forrester, J. W. [1995]

[5] cf. Borghoff, U.M.; Pareschi, R. (Eds.) [1998]

- Urban Dynamics 1968
- World Dynamics 1971

This was the basis for the development to a general System Dynamics Approach. This apporach includes ideas of the system theory, cybernetics and of the (dynamic) change of systems during time. The aim of System Dynamics is to understand complex dynamic systems, to understand the behavior of a system and to detect complex dependencies via feedback loops. System Dynamics is not an apporach to make a precise prognosis. In the beginning J.W. Forrester used a language called Dynamo to build the computer models. The modelling language and modelling environment were not very easy to use. Simulation specialists were necessary. Modelling structures of enterprises, markets, competitors was expensive and needed a lot of time. Supporting decisions was limited to important strategic decisions and global important problems („The Limits to Growth“). Meanwhile a wide selection of modelling languages exist which support the System Dynamics Apporach with flexible „easy to use“ environments, e.g. Professional Dynamo, ithink / ithink Authoring, Powersim, Micro Worlds Creator, Vensim and Dynasys.

Using the System Dynamics Approach for the Transformation of Information to Knowledge: An Example

Information Requirements Analysis based on System Dynamics

Information Managers support decision makers by providing information for decsions and tools which help that knowledge origins from information

It has to be analysed how System Dynamics can be used by the Information Managers Point of View. An example is that an industrial decision has to be taken. There are a lot of information sources, i.e. data in databases, written documents etc. The first task for the information manager is to get information out of data. The difference can be explained with the five „c“[6]: contextualized, categorized, calculated, corrected, condensed. This means all the work which has to be done to aggregate data, to select irrelvant data, to draw figures and tables and to do quality assurance. Spreadsheet and database tools support these information management tasks. After this step there are two main questions for the information manager:

- Is there enough information available for the decision making process?
- In case we need more information - which one do we need?

Model Specification

At least if it is an important decision and complex dynamic dependencies have to be taken into account a simulation model has to be specified. This is the step from information to knowledge, the step of the four „c“:[7] comparison (to other situations), consequences (implication for decisions), connections (how does this bit of knowledge relate to others), and conversation (what do other people think about this information).
The model helps to learn by comparing different situations (i.e. different simulation runs), to get know-how about consequences and it is the basis for discussions with other decision makers.
First step to do is to build the feedback-loop diagram.

[6] cf. Davenport, T. H.; Prusak, L. [1998], p. 4
[7] cf. Davenport, T. H.; Prusak, L. [1998], p. 5 f

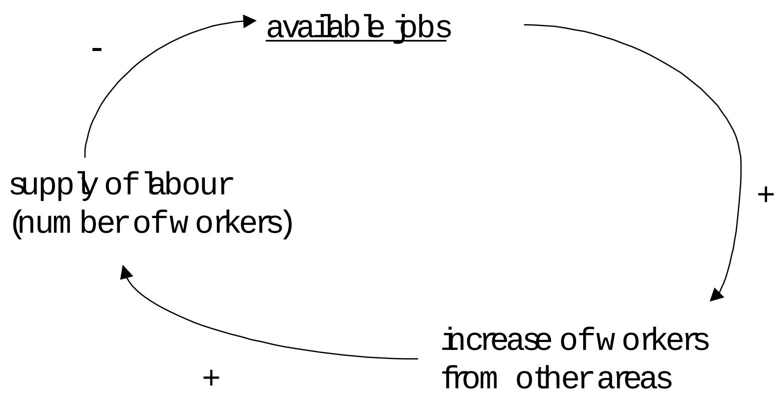

Figure 3: Example of a Feedback-Loop

This diagram (cf. figure 3 for an easy example) shows the qualitative dependencies in the model. The arrows marked with „+“ describe a positive correlation: e.g. if workers are coming from other areas the number of workers in our area is increasing. The arrows marked with „-“ describe a negative correlation: e.g. if the number of persons searching for a job is increasing, the number of available jobs is decreasing.
In this (not necessarily computer supported) phase often the question was rasing: Are we discussing the right problem? Another important problem is to find the system boundaries in order not to build a „world model“.
If the dependencies shown in the feedback-loop diagram exist we need data about all these dependencies to build a simulation model and to make decisions.
There are loops were the initial values are growing, trying to keep a balance, or describing cycles. For easy examples we can decide in our head what will happen, for complex dependent expamples the behavior of the model can not be foreseen. For expample, if the question is: From which parameters does the turnover of an internet-provider depend on? From the number of customers, the price fixing, the service, the number of internet users. The price depends on the service, the service on the training of the employees and so on. A complex model is raising with interesting questions: We can state that service has a strong impact on our turnover. But which figures do we have e.g. to explain the influence of service on the turnover? Often in reality we have no idea of it, nevertheless we decide assuming we have all „relevant information“ for a decision.

Building the computer model using PowerSim

The feedback-loop diagram has to be transferred into a computer simulation program. This is done by modelling graphical-interactive flow diagrams which automatically generate a computer simulation program with the PowerSim tool.
This means equations (with their different variable types: level, rates, auxiliaries, initial values, time stamp parameters), simulation steps, comments and viewing results can be generated and displayed easly working in an MS-Windows environment and using graphical-interactive input possibilities (cf. figure 4). The very simple example in figure 4 gives an idea of the user interface. It shows a model with only an initial value, a level and a rate for the charge of interest. Different views on the model exist (an example is given in figure 5).
The transformation process from the feedback-loop diagram to the computer model shows the information manager, whether there is data available for all relevant dependencies. In this phase the available information is checked with respect to completeness!

Validation

The aim of the validation phase is to get a reliable model. Confidence in the model has to increase. The information manager can test the model using extrem initial values, testing whether the model shows a surprising behavior.
In addition the simulation model has to be tested with colleagues by going through the model step-by-step: are all relevant variables enclosed in the model?
Doing sensitivity analysis it can be detected whether the system behavior is changing by varying a variable. If not, there is no sense for the information manager, to do investigation work to get more data for this variable or correlation. This means the information need will be restricted by using the simulation tool!

Preparing the decision: „The Power of Recognition“

During the work using the model the information manager is working together with people responsible for decisions. Simulation runs were made and compared testing different conditions during simulation time, results were interpreted. The user is able to ask „what happens, if...“.
Knowledge originates from using the model, the user learns to understand complex dynamic dependencies, understanding the causal reasons and effects of alternatives, and can recognize developments. Efficient discussions are made on the common traceable basis of the simulation model.

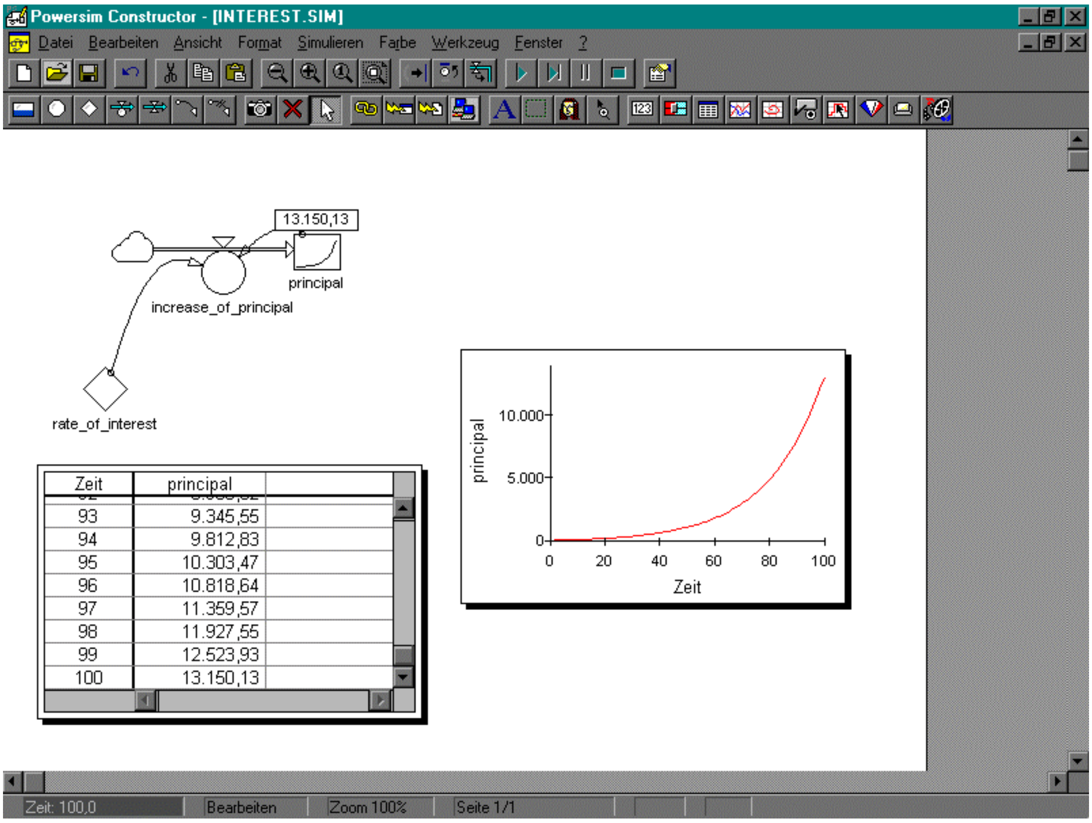

Figure 4: Graphical-interactive Modelling with PowerSim

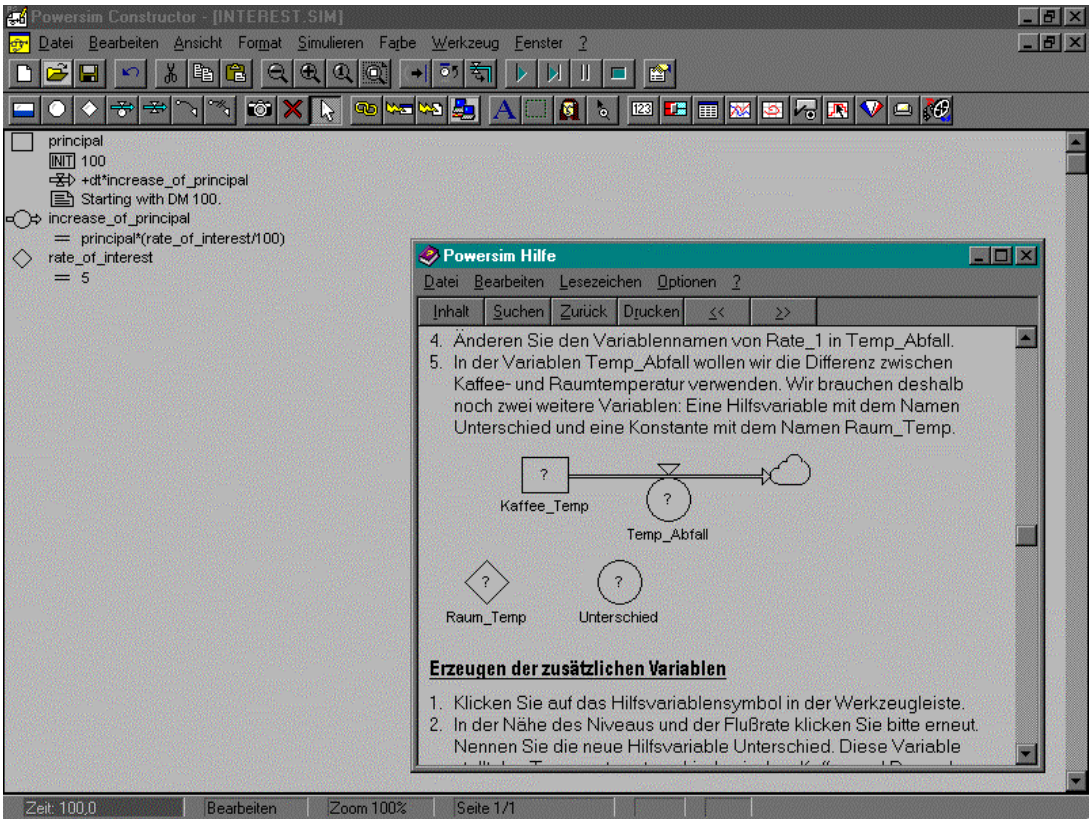

Figure 5: The equation view of PowerSim

The simulation model becomes a component of the enterprise knowledge management for decision and strategy making processes.
During the modelling and testing of different conditions the user gets the „power of recognition“. The user is available to understand the behavior of the system. This supports his decisions.

Conclusions

System Dynamics is a powerful approach for information managers in a learning and knowledge orgnisation. In the past a high effort in terms of time for programming and money, and the necessity of simulation specialists has reduced the usage of this approach on heavy decisons in single branches. This has changed due to the availibity of new easy-to-use and cheap simulation tools and due to the increasing information and knowledge society, which makes learning and knowledge to a key success factor for nearly all kind of enterprises.
First experiences with information management students are encouraging: in one semester (two hours a week training) they were able to understand System Dynamics, and to build a first simulation model going through all the steps discussed before including information requirements anlysis. For example a team of four students built an decison model for an internet-provider. Especially building the feedback-loop diagram brought interesting discussions.
Therefore System Dynamics should be an interesting part of the education of information managers. They have to be able to support the new chalenge of knowlege management in learning organizations.

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