Providing Simulation Models on the Internet

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Shared Mental Models in International Firms

That managing organizations and mastering their environment has become a complex (sometimes chaotic) task is generally accepted.[1] Also well known is the insufficiency of the human mind in dealing with such complexity (which has a variety of reasons, for instance the limited capacity of our short time memory, Miller 1956, or misperceptions of feedback structures, Sterman 1989). One prominent way to let people improve their skills to act successfully under these circumstances is to be busy with computer models (Dörner 1992, pp. 307-309). Through the simulation of organizations and playing management games individual decision makers and groups are able to gain insights in the dynamic and chaotic aspects of reality. These so called Microworlds are supposed to be efficient means to improve the mastering of complex business systems (Senge 1990, pp. 313-316).

In order to accelerate Organizational Learning these tools have to be used in management teams to „change their shared mental models of their company, their markets, and their competitors" (deGeus 1988, p. 70). This happens in two steps: firstly, by constructing the underlying formal model which describes the common view of reality of the involved individuals. This formal model is used to run actual simulations. Secondly, teams build a shared mental model by playing with the formal model. In this case, the team members feed-in their hypothetic decisions, run the simulation, and have a look what is happening in the „virtual reality" (Milling 1995, p. 106).

For international organizations both steps of this procedure can be a problem: although System Dynamics provides an international „language" for building models and simulations[2], technical means are needed to realize the chances for people from different parts of the world to truly work with one model. I. e. a „place" is needed where people can bring in their mental models to build a common formal model and where they can test their mental models by comparing their assumptions with results from a simulation run.

Through the widespread use of computer networks the possibility to create „virtual places" to allow people building shared mental models seems obvious. In doing so, new communication technology not only makes it possible to access static data all over the world, but also enables collaborative working with dynamic and qualitative information, which mainly constitutes the policy of an organization (Forrester 1994, p. 58). This technology could be used for internal training as well as to provide models with the organizations view of the world to external people. Working with the same models all over the world supports similar mental models of decision makers in international enterprises. This allows a coherent transformation of strategy to action all over the world.

[1]This statement is so widely in use that you can find it as the starting point for nearly every book about management both popular and scientific.

[2]In a way, that causal diagrams and other graphical explanations of systems can be understood without advanced knowledge of - for example - the English language. Of course, for the description of the diagram a „natural" language has to be used.

Basics of Working with Models on the Internet

The rest of the paper only deals with the second step of building shared mental models in an international organization, i. e. the possibility to provide simulation models in a global scope. In an earlier step collaborative building of a formal model - which is the base for any simulation experiment - can be supported by video conferencing systems, electronic mail, electronic whiteboards, etc. In a broader sense, communication technology can support every of Senge's „disciplines" (Senge 1990), in particular - but not only - if people have to work together who are geographically separated.

The aim is that people can test their assumptions about effects of their decisions against the results of a simulation run with the same decisions. The simulation model constitutes the present corporate view of reality. If they discover substantial differences they either should adapt their mental models (they learn) or should suggest to change the simulation model (the organization learns). Both are a kind of Double Loop Learning (Argyris and Schön 1978, pp. 20-26).

The Internet provides a technical infrastructure and in particular the World Wide Web (WWW) gives opportunities to work on a simulation model in a global scope (Lux and Choi 1995, for a general description of System Dynamics activities on the Internet). The WWW is built in client/server fashion: the client (WWW browser at user's computer) displays data which it gets as HTML pages from a remote (WWW) server over the Internet. The corresponding transportation protocol is called HTTP[1]. This mechanism not only allows to access static data but also makes it possible to access models. Through Common Gateway Interfaces (CGI) input from users can be passed to the core model (implemented with common simulation languages or tools) somewhere in the world (Ford 1995, for a description of the WWW and the CGI mechanism). The simulation runs and returns the results (via WWW server) to the user, who works in the same way as – for instance – with a local „Management Flight Simulator" (Bakken, Gould and Kim 1995, p. 245, for a short definition of Management Flight Simulators). The basic logical structure of simulating a remote model therefore looks like this:

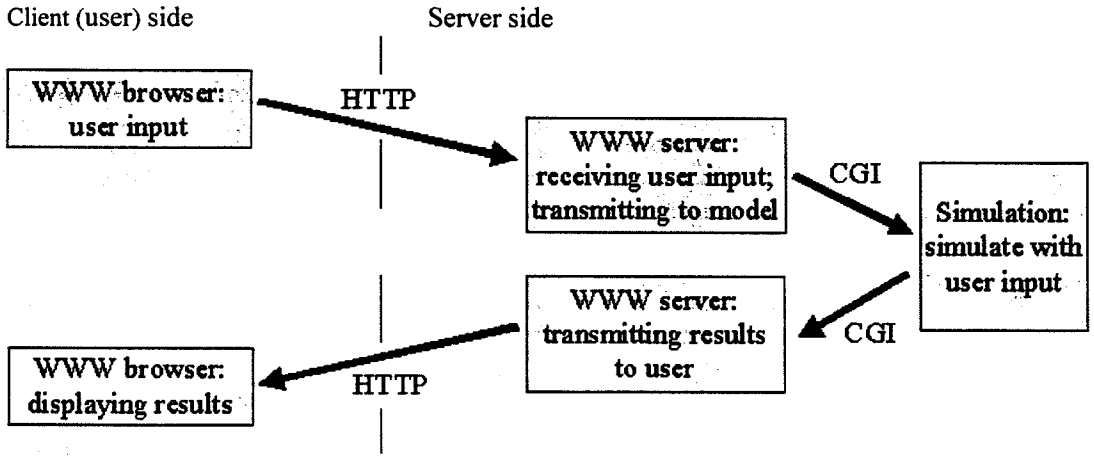


Figure 1: Structure of interactive simulations on the WWW

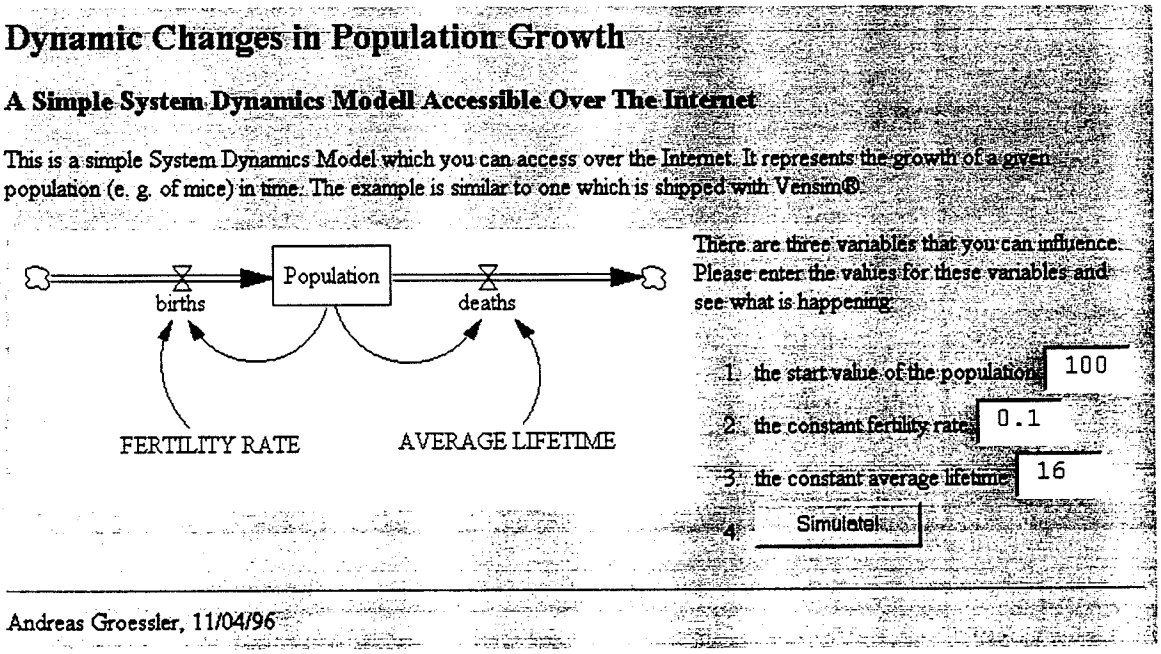
Furthermore, users can also play together: people from different nations can constitute a team and try to manage a certain game situation. If different teams are able to play, the result is an international „Corporate Planning Game".

[1]HTML means Hypertext Markup Lanugage; HTTP stands for Hypertext Transfer Protocol..

An Example Simulation Model Provided on the Internet

As an example we can consider a very simple simulation model: the growth of a given population of mice dependent on their fertility rate and their average lifetime.[1] There is no difference– in terms of the needed action to provide it on the WWW – between this simple model and a more sophisticated one, like a Management Flight Simulator. How can this model be accessed and be influenced via WWW?

When somebody wants to run a simulation he or she needs to know the address of a WWW page which offers this service. The user runs a Web browser with this address and gets a screen, which offers possibilities to enter needed data. The following screenshot shows this data-entry screen for the used example:



Screenshot 1: Input form for simulation data

The screen allows to type in the values for those variables which can be influenced. After pushing the „Simulate!"-button this data is sent back to the server that provides the simulation model somewhere in the world. There, the actual simulation takes place. Some moments later the user gets the results back on his or her screen as another WWW page. The results could be in graphical or numerical form, like it is shown for the example in Screenshot 2.

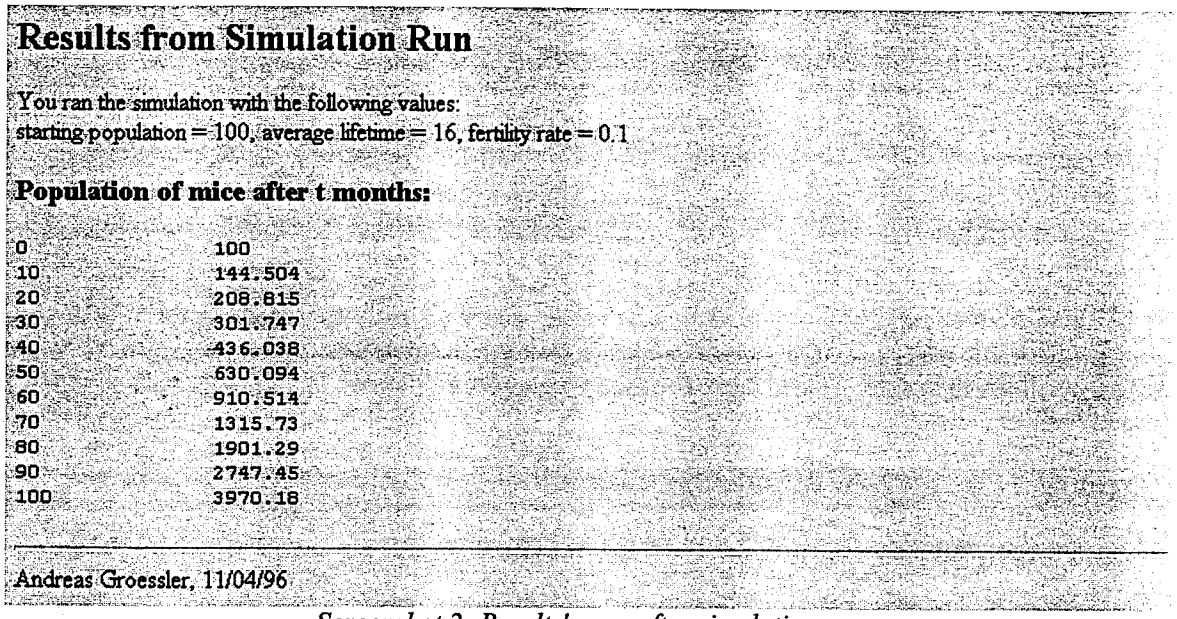
Providers of models must follow a three step schedule to accomplish this task. They have to:

develop the simulation model itself;

create an HTML page explaining the model and possibilities for user input (see Screenshot 1);

write a CGI application which passes the transfered user input from the WWW server to the simulation program (which uses the developed model) and generates another HTML page with the results of the simulation (see Screenshot 2).

[1]The example model is similar to one which is shipped with Vensim® simulation software, which I use to do the simulation.



Results from Simulation Run

You ran the simulation with the following values:
starting population = 100, average lifetime = 16, fertility rate = 0.1

Population of mice after t months:

0	100
10	144.504
20	208.815
30	301.747
40	436.038
50	630.094
60	910.514
70	1315.73
80	1901.29
90	2747.45
100	3970.18

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Screenshot 2: Results' page after simulation run

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