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SIMULATING COMPLEX SYSTEMS AS SUSTAINABLE ORGANIZATION BY TRANSPARENT SENSITIVITY MODELS

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ABSTRACT

By visualizing simulation processes additional qualities of the sensitivity approach appear as a new kind of dialogue instrument which leads interactively through a holistic illustration on the system level to a lasting consensus. The newly designed instrumentarium will be presented at the congress by means of a typical system model for decision making processes including qualitative parameters and their simulation.

KEYWORDS

Sensitivity model, complex systems, biocybernetics, transparent simulation

THE LACK OF ATTRACTIVENESS OF USUAL SIMULATIONS

Simulation is part of every learning process. It is useful only - and avoids pitfalls - if the reality you want to simulate is adequately picturized. This is not always the case. The weaknesses of most methods of system analysis are:

First: lack instruments to check the entirety of the system in question so that the choice of the components investigated in their interrelations is arbitrarly.

Second, that the focus lies often an the mere quantitative aspect of these components leading to an enormous number of variables instead of focussing on the relations between the key elements thus achieving an understanding of the systems dynamics with a handful structuring parameters.

Third: The same tendency of quantifying avoids to introduce qualitative variables like attractiveness, image, motivation, flexibility thus neglecting our important parts of the system and their mutual influence. The introduction of fuzzy logic and fuzzy sets right from the beginning has helped a lot to solve this third problem as well as the forth one.

Forth: The algorythms used for simulation are often hidden behind mathematical functions and differential equations that look sophisticated but do not exist in reality - where - as in open complex systems the case - most relations are non-linear with breaks and threshold values, that cannot be described by a neat curve of the general function like for example $y = f(x)$.

Apart of these inherent weaknesses of many simulations another reason for not using them to solve complex problems is their hermeneutical character producing in the non-experts a sort of mistrust - be it well-founded or not. Those who are supposed to understand and handle the complexity of a system (laymen, planners, CEO's, politicians) will thus avoid systems analyses due to the lack of transparency.

In developing a holistic procedure to a better understanding of complexity - especially in view of the growing need for sustainable development in all sectors of our civilisation and its environment, we tried from the beginning to firmly connect the instrumental development and the programming of adequate tools to practical tasks, thus detaching it from mere theoretical academic considerations. Our crucial checkup for every methodological step was always its easy handling and usability, visualization and its transparency also for non-EDP-experts.

The essence of the biocybernetic approach is the living cell. As one of the most complex systems, it turned out to be the model of a highly sophisticated factory with self-circulating production, a most efficient use of energy, and a flexibility of its management that we may never be able to achieve in our artificial systems without changing our view towards complexity. Until now we have hardly developed a feeling for the links and feedback-loops that connect our world. Every interference in complex structures, however, results in complex consequences – time delays, feed-backs, late sequellae. The usual “linear” intervention, itself carefully planned, can cause interactions that provoke further disturbances or even lead into chaos. Unfortunately we are even not protected by the huge amount of information that we can access today. On the contrary: they create a deceptive security. One of the main reasons form the crisis of our industrial society lies in the lack of awareness of the closely interwoven factors, which are involved in the process of our civilization. Although we know that our world is a large interwoven system, the realization of this knowledge in economic, political, industrial and planning practices has still not taken place.

This situation requires a new systemic way of thinking that explains how even complex systems can be understood without detailed precision but nevertheless correctly with only a few ordering parameters. This can be done by visualizing structures of effects. The point is then not so much to combat problems but to use (or maybe alter) constellations.

Thus, during the last 20 years, the experience and benefits of its wide practical application (from regional planning, transportation management and technological assessment to corporate strategy, risk management and organization development) are flown into this project, which after multiple updates and adaptations can now be presented as a general instrumentarium to deal with complex systems by visualizing their cybernetic dynamics as a transparent pattern and learning by policy tests how to handle them in a way that they will obey general biocybernetic rules for their survival.

The special system-tools of the Sensitivity Model develop these tasks for planning practice and fulfill the system-relevant requirements for practicable aids to deal with complexity. It can be illustrated how to master the usual difficulties in political and commercial mediation, having mostly resulted in a failure to correct, detect and interprete complex systems. It is shown by multimedia presentation of a concrete example in communal decision making how to build up transparency in simulation by a new kind of table-function algorythms and visualizing the complete input at any time of the simulation process including interacting with special areas of the system due to the situation seen on the screen and storing such policy-tests for repetition and comparison.

The user is conducted by nine structured steps through the process of information gathering and data reduction to the few systemrelevant key parameters that will model the system. Throughout specially developed tools allow to build up, visualize and analyze the cybernetic dynamics in a feedback diagram of the whole system. To focus on particular issues "subsystems" of specially interesting "clusters" of the overall effect system are developed. These partial scenarios are simulated to explain the dynamics and significance of the feedback cycles which have been defined in the previous steps.

A relational database supports continuous modifications in the whole process. The final verification of the policy tests and the validation of the proposed measures is based on the application of a set of biocybernetic rules for the sustainable and longterm viability of the system under consideration.

These nine steps (System-Description, Variable Set, Criteria Matrix, Influence Matrix, Cybernetic Role, Effect System, Partial Scenarios, Simulation and Systemevaluation) are recursivly leading to a permanently interactive working tool which by visualization and self explanation is easily understood also by non-experts.

By visualizing simulation processes additional qualities of the sensitivity approach appear as a new kind of dialogue instrument which leads interactively through a holistic illustration on the system level to a lasting consensus.

HOW DOES THE MODEL LEAD TO A COMPREHENSIVE CAPTURE?

The system-tools of the Sensitivity Model make the capture and assessment of complex systems accessible for the human brain by visualizing and using the linguistic approach of Fuzzy Logic. It puts the user in the position of capturing the examined system and its socio-economic-ecological environment in plain English, as a biocybernetic unity without getting lost in a countless number of mathematical factors and variables.

Argument Aid

With its new simulations-, interpretation- and assessment programme, it provides the political and material decision aids, for the future development of the system under consideration. At the same time, the model also provides the neccessary reasonable arguments by multimedia presentation, a must for decision-makers.

New Types of Solutions

It always interprets the behaviour of the system with regard to its sensitivity or its robustness in the whole system and offers under the main criterium of increased survival capability new types of solution possibilities and opportunities.

No Data Flood

Instead of drowning in data, as is usually the case in the capturing of complexity, in the sensitivity model it occurs by means of a programmed screening of the variables, which are to be included with a clear number of representative influential dimensions with the fuzzy logic approach. At the same time, another problem was solved by the fact that not only quantitative inputs but also qualitative connections gain access and can be processed together in the instrument.

Fuzzy logic as a Basis

The type of representation which is related to Petri-networks and the use of the mathematics of Fuzzy Logic, makes it possible, already from little relevant data, to draw conclusions regarding the function of the examined system. The background consists of the concept of the survival capability my means of self regulation and flexibility, which is ensured by the strictest possible adherence to the basic rules of biocybernetics.

Interactive Way of Working

Last but not least, the instrument is deliberately designed, so that the user is in a continuous open dialogue between the computerised and manual parts of the method.

As the dialogue takes place at all stages of the processing and is included in the interactive course of simulations and priority tests, it allows the recursive type of working which is important for complex systems. So, every stage of the process remains open until the end, is always realizable, so that every system model which has once been developed, laters serves as a permanent work instrument.

No nonsense Predictions

The result of examinations does not consist of the usual type of predictions. It refrains from developing future scenarios by means of calculation of trends or the prediction of the occurrence of events which is obsolete in complex systems anyway. It is far more helpful to recognize the characteristics and developmental possibilities of such a system and by using if – then predictions regarding the behaviour of the system, applying them in such a way, so that the system will also better be able to cope with unexpected events.

Thinking Aid, no Thinking Replacement

Individual mental effort is neccessary, as before. However, it is noticeable eased, as all mechanic, organising, documenting activities are automized in such a way that the cybernetics of the system is revealed and the parallel procedures of dynamic occurrencies which are no longer impossible for the brain, can be followed up.

Support for integrated Thinking

Furthermore, the method, as a result of its instrumental guidance of projects of various types and levels of difficulty, gives the support of consequently providing integrated thinking and thereby avoiding sliding back into linear thinking which is hardly avoidable without the help of appropriate instruments. Nonetheless, by whom and wherever it is used, the use of the sensitivity model will doubtless offer new insights into otherwise obstructed connections.

THE AREA OF USE

Through the open structure of the instrument, the areas of use of the advisory package are practically unlimited and are useful everywhere where the complexity of the problem can no longer be tackled by customary methods:

1. Corporate strategic planning
2. Technology assessment
3. Developmental aid projects
4. Examination of economic sectors
5. City, regional and environmental planning
6. Traffic planning
7. Insurance and risk management
8. Financial services
9. Research and training.

In addition to an environmental suitability test, the instrument can - on the basis of a biocybernetic assessment - also be used for the most diverse projects, in the sense of a systems' suitability test.

“SENSITIVITY MODEL PROF.VESTER ” - THE COMPUTER PROGRAMME

This compact EDP programme which needs little storage place was newly developed without purchaseable tools with - in part - self-designed drivers, in order to be able to carry out all the processes on the screen. All that is neccessary for the installation of the programme is an IBM-compatible PC with a VGA screen and an MS-compatible mouse. The user is supported by a user interface, whose development is also based on the discoveries of modern biology of learning. It is presented clearly and attractively. The proceedings on the screen are easy to understand and allow efficient work without any knowledge of programming. The operation itself is as simple and self-explanatory as possible, so that a manual is dispensible.

Permanent Orientation

By means of the integrated relational data bank, the user always has access to an overview of the state of the entire process, e.g. at which manual or computer supported work stage he is, which work stages he has already concluded and which work stages he should tackle next. Even incompletet stages are not in an codified form, but are always represented by tableaus.

Secured Parallel Processing

As is already evident, the programme has been designed in such a way that it allows the simultaneous processing of practically as many system models as one wants. These are secured by each other through the relational data bank, so that they can be simultaneously processed from the same menu without the risk of confusion.

Copy and Print Functions

Again, directly from the user interface, entire system models which are being worked on as well as only parts of them can be copied onto other models, which greatly simplifies the processing of similar systems analysis. The same applies for the functions for the background print as well as the colour print of the respective screen (for prepresantation purposes also on film) which are accessible from the user interface.

CONCLUSION

Supported by practical experiences I am convinced that we have opened a new way of making simulation of complex systems accessible to the man on the street even to politicians by visualizing the cybernetics behind the many systemic processes in our daily life and thus create motivation and interest in the relations and effects between things so long discarded by the overweight of the description of things themselves. The simulation and the shown example of communal decision were build up in interaction with simple workers of a slaughterhouse, gastronomers, farmers, communal clerks, doctors and laymen. They all admitted that they have gained a new view to reality.

PRESENTATION

The newly designed instrumentarium "Sensitivity Model Prof. Vester " will be presented at the congress by means of a typical system model for decision making processes including qualitative parameters and their simulation. A derivate of this professional Sensitivity Model consists of a strategy game called "ecopolicy " - using the same transparent interactive simulation part. This game, just awarded with the European Comenius medal for its outstanding pedagogic value, serves as

a first introduction in the art of network thinking and could also be presented at the congress in a short workshop to relax its scientific atmosphere if desired.

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BIOGRAPHY

Frederic Vester, born 1925 in Saarbrücken, biochemist. Prof. Dr.rer.nat. habil.Dr.oec.h.c. Main area of work until 1970 was molecular biology in cancer research. 1970 establishment and up to now management of the private Study Group for Biology and Environment Frederic Vester GmbH. From 1981 until 1988 Professor for “Interdependence of Technical and Social Change" at the Bundeswehr University, Munich. From 1989 until 1991 Permanent Guest Professor for Business Management at St.Gallen University. Since 1993 member of the Club of Rome. Author of bestsellers, e.g. “Thinking, Learning, Forgetting”, “Phenomen Stress”, “Neuland des Denkens”, “Ausfahrt Zukunft”, “Crashtest Mobilität” as well as his newest book "Die Kunst, vernetzt zu denken" (The Art of Interlinked Thinking) chosen as business bestseller in January 2000. Extensive lecture activity. Scientific television films and radio broadcasts. Several exhibitions, including “Our World - an Interlinked System”, “Man and Nature - Joint Future”. Numerous prizes and awards. His environmental simulation game "ecopolicy" on CD-ROM was honored with the Comenius-medal 2000 as outstanding educational medium. The first application of the sensitivity model was awarded with the Phillip Morris Research Prize.