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THE VALIDATION OF AN SDBILE: THE CASE OF *GREENWORLD M.F.S.*

ABSTRACT

A valid tool for environmental decision making is an important issue for practitioners in business management. In order to help decision makers in integrating an environmental vision into the regular business planning activity, a clear "picture" of the system they are acting in has to be provided. One of the main purposes of The GREENWORLD M.F.S. is to give an answer to these needs, particularly, by providing learners a better understanding on how departmentalized versus holistic management approaches in policy design may differently impact a complex system, generating different behavior patterns of key-variables. Here we report our current experience in the validation process of GREENWORLD. The validation of a SDBILE is much more than validating the SD model itself. A real flight simulator can be as accurate as one wished because the physics of aircraft flight is well known. One can, therefore, learn valid lessons about how to fly in different conditions from such a simulator. There is no such theory of the business firm. An increase in efficacy of the validation process can be provided by involving in this process experts in different professional fields, all related with the problem object of analysis in the GREENWORLD. Several firms are already involved in this project. Our purpose is to build up a virtual corporate system in which the user will see the environmental sector as an integrant part of it, as a peer with the other subsets : finance, marketing, production, and, eventually, to assess the capability of SDBILE to stimulate a learning transfer.

INTRODUCTION

Talking about validation has always been a critical issue in an SD model development. Many solutions have been addressed, however, to give an answer to the problem. At this purpose, we can remember a set of tools which – in order to give a good degree of confidence in the behavior of the model (Balras, 1989) – try to solve the validation issue by using statistical techniques coupled with empirical observation methods. In the ILE field, however, there is not such a defined set of techniques which we can address to, in order to provide validity – not only to the model itself, but to the whole learning process. Several aspects need to be investigated in order to clarify what we would like to learn, how to learn it, but more in general what is the ILE made for. We can use an

ILE for several purposes, such as learning, strategy communication, etc. If learning is the goal we would like to achieve, then we should test whether it delivers the desired 'amount' of learning, so it will 'pass' or 'fail'. We should remember to define indicators of learning achievement. If the purpose is to use it as a strategy communication tool, cascading from top management to lower parts of the organisation structure, then we should use standards for measuring communication quality. In order to build a comprehensive body of knowledge, common methods and research concepts are needed.

The validation of an SD based ILE (SDBILE) is much more than validating the SD model itself (which we all know is a complex task). Attention should be paid to the system. A flight simulator designed to train aircraft pilots can respond to the highest standards of accuracy, as the physics of a plane flight is well known. One can, therefore, learn valid lessons about how to fly in different conditions from such a simulator. Unfortunately, there is not such theory for a business, so that many management flight simulators face the risk of being something like computer games!

Therefore, a critical issue in building and validating an MFS is the *learning transfer process*.

The distance between a real system and the one represented in the simulator gives us the dimension of how powerful this process should be. If the system we are acting in is very close, or even the same, to the one designed into the ILE model, we don’t need to provide a deep learning transfer. However, this is not the typical instance how MFSs are usually developed. More in general, there are many trade-offs in the development of a domain-specific ILE versus one domain-independent (Grossler, 1999). An ILE which is not tailored on a specific firm, or describes a firms at a very high level of inference, is simpler to develop than another one which is, instead, built on a generic case-study whose purpose is to fill a learning gap, rather than also to describe a real business system. Another reason why a domain-independent ILE is more difficult to design and validate is the absence of real reference points we can address to in testing the effectiveness of the learning transfer.

Probably, one can find easy to let learners going through the learning process a MFS provides and observing results in terms of understandings about the general system presented. But, because the acquisition of explicit (or even domain-independent) knowledge could not be proved in many cases, the capability of business simulators to stimulate a learning transfer has not been confirmed yet (Grössler et al., 1999).

It is our intention to submit to a validation process an already developed ILE, the GREENWORLD M.F.S. (Marrone et al., 1999). This environment is supposed to provide a general understanding about the existing trade-offs related to the implementation of different environmental business

strategies. In order to define a proper validation strategy for the GREENWORLD M.F.S., an important starting point is to distinguish the different goal to be pursued (filling a learning gap *vs.* communicating a strategy, etc.), according to the business context where the simulator will be validated.
In this particular case, in addition to classical aspects of the validation process, such as SD model and semantic aspects validity, further knowledge is needed in addressing environment-related aspects, such as waste production process and the related rate, qualitative analysis of waste production, etc.

THE APPROACH

One of the long standing concerns of system dynamics has been the concept of generalizability, i.e., the creation of a common frame of reference to capture the characteristics of a system and make them transferable to other settings (Forrester, 1961). Particularly, in the SD tradition, the validation focus is on construct and internal validity. Anyway some more work has to be done on the dimension of external validity. Although construct validity and internal validity are prerequisites to external validity, without addressing the issues of external validity it is impossible to make the generalizability claim, and, therefore, it is quite difficult for `generic structures' to become part of mainstream management theory (Forrester et al. 1980; Oliva, 1998).
It's comes out by itself that the concept of external validity is strictly related with learning. Though, assessing the capabilities of an ILE represents an attempt to provide external validity.

With this work we would like to give our contribution, considered the difficulty of being exhaustive even on the smaller aspect of the learning field, in answering questions such as: how can we build a learning environment, being sure about the efficacy in order to satisfy the purpose of insight transferring? how can we increase the efficacy and the accuracy of the learning process it should be provided by the GREENWORLD? Or, more in detail, how can we enhance its strategy-communication capabilities by acting on the human-computer interaction?

In order to set the "pathway" of the project, considered that the aim of GREENWORLD is the formulation of a real strategy as a result (learning) of a repetitive process of virtually-implemented strategies, our choice is to follow the way of using the ILE for strategy communication, cascading from higher to lower parts of the firm. It comes along that we are in the domain-specific "arena",

meaning that, in few words, a body of knowledge about an existing system structure is available, upon which tailoring our micro-world.

Above we introduced the concept of external validity. In our context, external validity means an attempt to provide to learners the feeling of being dealing with a virtual system that replicates accurately the real one. External validity of the theory needs to be ascertained through a rigorous exploration of the application domain of the model (Oliva, 1998). At this purpose, again, to provide what is called "face" validity, our suggestion is to involve in the validation process a "task-force" composed by experts in different professional fields, all related with the problem object of analysis in the GREENWORLD. Our belief is that an increase in efficacy of the learning effect can be generated by the contribution brought in the process because of the expertise of technicians in fields such as software engineering, business management, computer graphics, environmental management and analysis, and, of course, system dynamics.

In order to keep in mind the aim, the purpose is to build up a virtual corporate system in which the user will see the environmental sector as an integrant part of whole management system, as a peer with the other subsets : finance, marketing, production (Davidsen, et al. 1994). In order to provide this condition we believe that the potential input coming from our validation process is to provide: user-friendliness (semantic aspects first of all), and reality in the dynamics provided (Gagnè, 1995). The identification of the main characteristics of internal firm processes, and the elicitation of causal relationships with other "system variables" not only allows exploration of the flexibility of the model to capture other important insights of the business itself, but it also permit the identification of the characteristics that define the space where particular policy recommendations are valid. In summary, what is suggested here is a kind of "participative validation", a process within which each participant is required to take care of the aspects about which is qualified. So, for instance, the analysis of the structure of the firm has to be carried out, obviously, in collaboration with the management of the firm itself. Potential solutions to environmental problems experienced by the firm will be provided by an environmental management consultant, and, then, discussed all together. The graphical interface developed by a software engineer in collaboration with the system dynamicist. Those are examples of the kind of interventions planned in the project, and are mentioned in order to give an idea of what we mean for "participative validation." This process, anyway, must be iterative because any modification has to be verified in relation with the complexity of the learning environment. So we think the intervention of each expert is not limited to one section, but it takes several sections, individual and collective, before ending up the process.

A further, and probably final, step scheduled in the project is an empirical test of the learning power of the ILE at the end of the validation process.

DISCUSSION AND CONCLUSIONS

Finally, we feel the need to share some considerations. About the opportunity of measuring in learning, for instance, some doubt arises concerning the final test mentioned above. It is not clear what the end-version of the ILE should be compared to. The logic would tell to compare this version with the starting version of the ILE. Anyway the lack of clear parameters for measuring learning represents a further element of complexity in our task. Again, the lack of scientific definition of learning parameters confirms our difficulty. In other words, it is difficult to estimate the position reached along the validation process and the position we would like to reach. In summary, it is hard to establish a scale that measures the learning power of a learning tool.

Other question may be unsolved at the end of this project, for instance, whether we can use or not the "validated" product in other context. In other words, considered we have been talking about domain-specific body of knowledge as a safe way of providing validity to the ILE, how far should we go in context specification process to make the ILE suitable to other contexts?
In order to facilitate the generalization and transferability of insights, the model, then, should be taken outside the context within which has been developed and validated, to explore and test its usefulness in other settings. It has been argued that, by explicitly examining the application domain of the model structure, it is possible to define a generic framework to link structural characteristics of the firm to the problematic dynamics observed in the industry (Wenger et al., 1998).

In summary, it has been argued in these pages that it would be very effective to start the validation process from building an integrated study group by enabling the participants to start learning about how another one thinks about learning. Although its obviousness, our belief is that by making experts, involved in the validation process, thinking about the learning process, it is possible to create a combination of several perspectives, that focusing all on the same aim, can enhance strengths, and discover weaknesses of an interactive learning environment.

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