

Mass Learning: An Application of System Dynamics

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Large training programs, involving hundreds, and often thousands of people in different countries, often include common basic educational layers (e.g. general management modules) to be delivered to all the population before or besides specific training. While multimedia tools and distance learning are under experimentation, several programs still use human tutors, and the most huge of them still need to make use of a teach-to-teacher approach. In order to make this approach effective, several goals, often conflicting, have to be simultaneously followed. This paper describes how a System Dynamics model, embedded in what is known as a learning laboratory - although with a less common protocol - has been used to support a general management course in a very large re-training project.

The Project

In 1994 the European Union financed a large program aimed to retrain and reintegrate into society as managers and entrepreneurs more than 16,000 Red Army Officers. With a plan of 850 courses, 500,000 hours of lesson, three years of duration, it can be considered one of the most ambitious training projects ever conceived in Western Europe. Because of its size, the work was divided into two phases. In the first stage, 400 Russian teachers, largely University Professors, attended in Western Europe traditional courses of marketing, production & logistics, strategic planning, macroeconomics, quality management, etc. Although some of them were Professors of Economics, globally the level of understanding of capitalist market, and of western principles of management, was virtually zero, so that training had to start from a nearly scratch condition. In the second stage, these same teachers had to train the Officers in several Russian Centers, both using and partially customizing the didactic material received.

Some Peculiar Problems

In addition to the traditional ones, the size and the specific objectives of the project gave rise to some problems that could not be easily faced through a traditional approach:

- as a program aimed to fertilize the growing small enterprise texture in Russia, a special attention was deserved to the possibility of speeding up the understanding of management concepts, and gaining in few months experience that western managers acquire in years in field;
- in the range of few months, the trainees (both professors and officers) had to take up a lot of concepts, coming from different subjects (from strategic marketing to finance), starting from a virtually *tabula rasa* condition. However carefully designed, three months of traditional lessons, divided by subject, and sequentially exposed, are hardly able to provide the participants

with a consistent frame of the interrelationships between concepts, and with a sound sense of proportions in managing a firm;

- in such an international teach-to-teachers project, for each module the information to be transmitted flowed through the following path:

Western author ⇒ Western teacher ⇒ Interpreter ⇒ Russian teacher ⇒ Russian Officer

It happened that concepts thought by the authors in Italian, French or German, were written in English into charts and manuals, which were used by Italian, French or German teachers as a base for lessons given often in their own national languages - throughout a Russian (sometimes inexperienced) interpreter - to inexperienced Russian teachers - who, months later, had to teach the same concepts in Russian to Russian inexperienced trainees using the same teaching materials - in turn translated into Russian and integrated and customized!! If you consider that management glossary itself still exhibits some ambiguities, it is difficult thinking that all the message conceived by the authors could reach the final trainees without distortion, errors or loss of information.

In 1994 our company (that had already used its models for management education in cooperation with the main contractor of the project) was asked whether simulation techniques could help to face this new kind of problems. In a first step, we proposed to develop a new “management flight simulator” around which the whole set of general management courses should be designed, as in a sort of *fil-rouge*. Unfortunately, time available for development was too tight, and the overall course structure and some of the modules had already been designed; so we agreed to customize one of our learning laboratories, “AILA Management Lab[®]”, that had already been used for training of several hundreds of Italian managers.

Learning Laboratories

In the last decade, System Dynamics has significantly shifted its focus towards education in a broad sense (Forrester 1990), (Senge 1990, 1994). In this stream some board games (Sterman 1984), and several “management flight simulators” (Sterman 1988), (Meadows 1989) have been developed. In turn, these games and simulators have been embedded into environments, called learning laboratories, specially designed to support group dynamics and organizational learning (Graham et al. 1990), (Morecroft et al. 1990), (Senge et al. 1991). We refer to the mentioned papers and the bibliography for any discussion of the learning laboratory concept. In the following we will limit ourselves to underline any difference from the most typical use of these environments.

AILA Management Lab[®]

AILA Management Lab[®] is a computer-based learning laboratory based on a System Dynamics model of a typical European manufacturing SME (Small-Medium Enterprise). A “decision shell” - about 30 decisions regarding production, marketing & sales, logistics, quality and finance, corresponding roughly to the competence of a general manager, with some functional additional responsibility - replaces the decision functions of the original model, furthermore providing the user with wide information about the virtual company and the environment, both in structured

(Income Statement, Balance Sheet, Operations Report) and de-structured form. The underlying model includes more than 600 equations, not to provide accurate previsions, or replicate historical series, but to enhance role identification through the introduction of realistic effects, and to give to the gameplayer a mass of information in which he/she has to find by trial and error his/her own strategy of data selection.

The Protocol

While we believe that one of the most important goals for a learning lab is to make people understand how behavior is driven by structure, we decided to adopt an inductive approach to the lessons of complex systems. Any abstract introduction to systems could be overwhelming for the trainees after months of exposition to theories. Moreover, unveiling the underlying structure through causal loop diagrams and graphs in the user manual, or in an introduction before gaming, risked to limit the effectiveness of the method. Our experience suggests, in fact, that anticipating gestalt that could be otherwise elicited from direct experience could clip the role of 'surprise', so important for the process of recognizing and restructuring the trainees mental models (Mass 1991). Instead, we prefer to stake on the workshop development itself, and on a more active involvement of the participants to make them sight and reinforce the structure-behavior connection (Langley 1994).

After briefly introducing the virtual company (AILA), and providing the context of drama (each group of trainees is asked to assume the management of AILA for the next three years, in a sort of Management Committee) and few instructions, the groups receive a set of goals (typically on market share, R.O.I, lead time and equity), the historical data for the last two years, and their own 'copy' of the simulation model - each team manage identical firms, with the same initial conditions and scenario. Then, groups have to organize themselves - without constraints, except for communicating their decisions to the tutor - analyze the mass of data (over 150 variables), define their own strategies - in a formalized way - take decisions for a six-month period and record on paper the expected results - at least as concerns the goals. After the simulation, the players must analyze results, take corrective actions, eventually modifying strategies (again in formalized way), take another set of decisions and simulate again; and so on, according the typical management cycle.

After each year of simulated time (two sub-group session) the groups join into a plenary session. Here the performance of each team as to the goals is displayed on a central PC - this is possible because all teams start from the same initial condition, so that results are comparable, and because no group fights directly against the others. Then, a couple of team - usually those with the most divergent performance - is examined in more detail. The players are asked to expose the strategy followed, and the expected results - this information has been recorded during the sub-group stage. Typically - this result is favored by an intentional design of scenario and initial conditions - the mental models of the players, projected onto a strongly systemic model, produce 'surprising' results, far from the expected ones. This is the moment, we think, in which the mental models become suddenly visible to the trainees: when they *crash* because of their inadequacy in explaining the virtual behavior (that, because of the strong involvement in the game, is in this stage accepted as 'reality'). This is also the best condition to start the construction of a new mental model. The most effective results are obtained when this work is performed by the trainees themselves. The tutor gives reason of the 'surprising' data tracing back the pattern of relevant variables, from the

results to the decisions and the boundary conditions (the model stores on a database the story of all its variables). In doing this, the tutor elicits the model structure directly from the participants, driving a brainstorming-like session, draws causal loop diagrams of the relevant portion of the system, operationally introducing arrows and delays, and fostering the research of cross-functional and not-trivial interconnections; identifies in the map the balancing and reinforcing loops that participants have experimented in facts. This protocol, besides a sort of subliminal familiarization to Systems Thinking, and a deeper knowledge of companies and market, seems to produce in the participants something more similar to a shift in paradigm than an enlargement in knowledge. Many participants report they have felt a sort of discontinuity between their previous and the vision they matured after the workshop.

Results

The first stage (training of the trainers) has been completed in February 1995. The training of the 16,000 officers, started immediately after, is yet ongoing, and completion is scheduled within 1996. AILA Management Lab⁶ has been translated into Russian, and widely adopted by the Training Centers provided by the project. While a quantitative analysis has been impossible, direct observations in the first stage have put in evidence that:

- the learning laboratory has been particularly effective in shaping and give proportion to the mass of concepts received in the traditional part of the training;
- increasingly during the workshop, participants acquired a sort of 'physical mastery' of the enterprise system, mastery that the plenary sessions contributed to fix and rationalize. This was better enhanced when time allowed trainees to play a final reversible session aimed to experiment different strategies to reach the goals;
- as a by-product, participants learned very rapidly to effectively use the standard economical and financial reporting, even if the previous training on the subject was hardly introduced;
- globally, the learning laboratory has proven to be an excellent tool to enhance information selection, time management, conflict and consent management, as well documented in literature;
- last but not least, linking concepts to processes, definitions to behaviors, the lab has given a sort of 'physical' and ostensible support to the process of knowledge transmission, enhancing homogeneity of language and working as a sort of 'living glossary' to give continuity to the different stages of the project.

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