Designing Interactive Multi-User Learning Laboratories

David W. Packer, GKA Incorporated (dpacker@gka.com)
William Glass-Husain, Powersim Corporation (wilgl@powersim.com)

Introduction

Experiential activities have long been recognized as a powerful way to demonstrate the significance of a systemic view to learning. Simulations in which participants become part of the feedback structure create an environment where people can encounter many of the challenges and frustrations of life in a complex system. The "Beer Game," "Fish Banks," and "People Express," have become effective, popular ways of enhancing learning, through active participation in a system less mysterious than the real world but with enough of its characteristics to provide a rich experience. Such participation typically involves both playing a simulation and debriefing the experience to expose the role of underlying structure. The whole activity is often called a Learning Laboratory.

This paper deals with design and development of multi-user learning laboratories, consisting of a simulator (system dynamics model) that accommodates multiple decision-makers, an interface that creates a "realistic experience," and workshop facilitation that aids the debriefing activity.

This paper is largely experiential as opposed to theoretical. It stems from a number of projects we have done in this area, largely at GKA Incorporated, and also from our growing recognition of a set of recurring fundamental design issues. In the paper we attempt to organize and articulate our thoughts about the design of learning laboratories and the factors that lead to learning effectiveness.

A Real Example

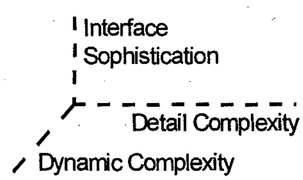
In the Spring of 1996, GKA worked with a U.S.-based manufacturing firm that, although over a century old, had in the last decade undergone significant expansion. A new CEO had recently been hired who had a strong vision of turning the company from a manufacturing to a global market driven firm. To communicate that vision to his company he invited his top managers from each division to participate in a weeklong conference focusing on company strategy and performance.

The conference began with an introduction to a custom-designed simulation of the firm's industry and its major global markets. The hundred managers were soon split into ten cross-divisional teams and sent into separate rooms that held nothing but a flip chart and a computer with a tiny monitor. Each team represented a competing company and each meal period represented a year. During the week the teams pored over computer printouts giving current information on sales, customer satisfaction, product quality, and finances. They eagerly crowded around posted bulletins of newspapers with light-hearted articles on company successes, failures, and industry trends. The teams created their own decision-making processes, filling the walls with posters showing data and business plans that they studied before they typed in their decisions on investments in capacity, staffing, and marketing. And each day at 8 a.m., 1 p.m., and 8 p.m. they clicked the "Send Decisions" button on their computer in order to have their decisions counted before the year advanced.

Although the simulation was a key part of the learning lab experience, it did not exist by itself. The conference included a number of presentations given by corporate management on company issues. GKA also ran workshops on systems thinking issues, including the beer game and some work with causal loops. Most importantly, the week ended with a series of debriefing activities that involved teams making presentations on company strategies as well as some causal loop analysis of important competitive issues. The grand finale included a banquet and prizes.

Design Trade-offs

In creating a learning lab such as this one, there are many decisions that must be made. These decisions include both bigger ones (what type of issues should the simulation address) and smaller ones (what type of computer equipment to use). Three choices that drive many of these design decisions are the levels of *detail complexity*, *dynamic complexity*, and simulator



interface sophistication. These can be summarized on a three dimensional axis as shown. These choices apply to all simulations and learning labs, but are particularly significant in a multi-user simulation.

A high degree of detail complexity is characterized by the presence of a significant amount of dis-aggregation and a large amount of detail. High detail complexity significantly adds to the challenges of managing a project as it adds to the time spent on design, development, data collection and testing while developing a learning lab. A very important factor is the likelihood of pressure from clients to include large amounts of detail under the often mistaken assumptions that more detail automatically leads to more realism and more realism leads to more learning.

On a different axis, a simulation or learning lab with high dynamic complexity contains a model with a robust underlying structure with a significant amount of feedback. These models are usually of high quality and are based on extensive research and testing with regard to similar companies and industries. There is a wide range of possible behaviors that may emerge from the simulation. Consequently how to design the workshop to enable participants to experience and learn about those behaviors is an important consideration of using high levels of dynamic complexity.

The level of interface sophistication involves the visible aspect of the simulation. It includes the type and manner of input by the user and also of the presentation of simulation results. Increased sophistication in the interface can lead to a higher degree of ease of use (for example with on-line help) as well as make the simulator more appealing (for example, with multi-media and other technological glitz). Note that developing elaborate interfaces requires different skill sets than traditional system dynamics efforts. A strong focus on interface sophistication can significantly add to the cost, and may in fact get in the way of the learning if the interface becomes too video game-like or overwhelming. Our experience has been that there are significant diminishing returns on investment in the interface sophistication. A simulator with a compelling story and a number of interesting dynamics can often add to the engagement of the participants as much as an elaborate multi-media simulator interface, yet provides a much greater learning experience.

There are many different trade-offs between these design drivers, Note that the learning lab that is "Ideal for Systemic Learning" has just enough detail complexity to make the simulation tangible, just enough interface sophistication to make it easy to use, interesting, and fun, and has a significant amount of investment in dynamic complexity (helping to create those dynamic "ah-ha's").

Design Process

The process of designing a learning lab is an iterative one in which each step generates the information needed for the next step but also feeds back and helps to refine the previous one.

Typically, the design proceeds through these five steps:

1. Articulating the objectives of the learning laboratory
2. Identifying the systemic and dynamic issues
3. Developing a model
4. Designing a simulator
5. Designing the learning laboratory workshop

Articulating the Objectives

The first step in designing a learning laboratory is to articulate the objectives for the participants. The ultimate design of the simulator and workshop will vary considerably depending on the purpose of the learning laboratory. Some possible objectives are to:

1. Learn how to operate in the business. The simulation is then used to develop familiarity with terms, processes, decision factors, and information sources used by employees in the real organization.
2. Learn dynamic lessons such as the impact of feedback, delays, and other systemic issues on the business.

3. Provide a forum for development and testing of new strategies on all or part of the business.
4. Help employees gain holistic view of the business system by acting as "President for a Day."

These objectives have considerable interplay with the level of detail in the simulation, the sophistication of the interface, the duration of the experience, and the content and manner of other workshop experiences.

Identifying the Issues

Producing a useful, relevant learning lab requires that the simulation and workshop address on the core concerns of the client organization. In particular, issues of a systemic or dynamic nature that involve long time delays, feedback, and connections across multiple parts of the business environment are particularly well suited to be examined in learning labs. Conceptualization techniques such as FASTBreak™ can be used to assist a cross-functional group of managers in the client organization in the process of generating important issues, identifying areas in which to focus, and coming up with variables that can then be used to develop causal loop diagrams and system dynamics models.

Multi-user learning laboratories are particularly effective at highlighting issues involving competitive strategy. While single-user microworlds such as *People Express Management Flight Simulator* have long included a competitive sector, interactions in these simulators between participants' decisions and competitor reactions occur on a highly abstract level. On the other hand, multi-user simulations offer highly visible, often emotionally strong lessons of the interplay between company, competitor, and market.

A recent example involved a multi-user simulation of the fast-food restaurant industry. In the third year, team "Charlie Chicken" made a bid to gain market share by offering a steep discount to customers with great fanfare (expressed both verbally and by choosing from a list of pre-set promotions available in the simulation). Over the next two years, each of the other four teams also offered similar discounts. During that time "Charlie

Chicken" not only lost the market share it had gained, but all the teams involved suffered significant drops in profit. At the mid-day debriefing we discussed what had happened and brought out "Escalation" systems archetype. Seeing this dynamic play out back and forth across a classroom during the course of a few hours not only dramatized the relevance of this competitive issue but also provided a context in which we could teach the more general issues that were involved.

Developing the Model

The models that underlie the simulations used in our learning laboratories are developed with the system dynamics methodology using one of the standard SD modeling software packages. Developing a dynamic model of the business environment that is separate from the simulation interface makes the model more visible and hence easier to create, modify and test.

Typically we begin the model by combining generic system dynamic structures (such as inventory, capacity, and market stock-flow sectors) and customize them to match the objectives and issues identified previously. We then work with a small group in the client organization who have a broad understanding of their business and market to further refine and validate these assumptions. Often, the development of the model and the design of the simulator interface will overlap, allowing for the progressive stepwise refinement of the overall simulation.

Designing the Simulator

In designing a simulator, it is helpful to think of it as being composed of four modules:

- *User Interface*: An attractive, convenient software that can be used to enter decisions and see simulation results. May include multiple windows, notebooks, on-line help, pop-up messages, and multi-media displays.
- *Numerical Information*: The set of current/historical data representing the state of the business system.
- *Textual Information*: On-line help, pop-up messages and other textual descriptions that provide context for the simulation.

- *System Dynamics Model*: Contains the set of mathematical relationships that make up the business, competitive, and market system. Calculates the new simulation results each time period, based on user decisions and the old results.

Elaborate simulators may use separate tools in developing each of these modules. For example, Powersim may be used to build the model; Visual Basic may used to develop the user interface; Microsoft Access may be used to develop databases for the numerical and textual information. (When distributing such a simulation the end user does not actually need all these tools; run-time versions for each of these are available free and can be bundled with the simulation software.)

Simpler simulations may combine these modules together. For example, many single-user simulations have the numerical and textual information integrated into the model and user interface. In addition, for ease of distribution, the system dynamics model may be translated from its native format into mathematical equations that are embedded directly in the user interface software. Taking the opposite approach, most of the current modeling software programs contain some interface developing capability that can be used to make prototype simulators or even simple interfaces for final versions.

Creating a Workshop that Enhances Learning

The workshop encompasses both experiencing the simulator and stepping back to reflect on the experience and its meaning. The role of facilitation is, we believe, a critical factor in learning. Facilitation should, for example, encourage (even demand) theory building and testing that provides direction for experimenting with coherent strategies, assessing outcomes, and discussing perceptions jointly among participants. It moves the experience away from a cut-and-try video game approach with dubious learning potential toward one that develops understanding at the systemic level.

On a final note, we believe that to create a successful learning laboratory, designers must help participants to move their mental models from *Winning* to *Learning*. This includes encouraging far-out approaches that test the limits of the situation creating an exciting atmosphere where players w*ant* to make mistakes in order to truly learn!

References

Diehl, Ernst. 1990. Participatory Simulation Software for Managers: The Design Philosophy behind MicroWorlds Creator. *European Journal of Operations Research* 59 (1): 203-209.

Kim, Daniel H. 1992. Learning Laboratories: Practicing Between Performances. *Systems Thinker* 8 (3).

Kreutzer, W. Brian. Building Learning Laboratories to Create More Effective Distributed Decision Making. 1995. In *Learning Organizations*, ed. Sarita Chawla and John Renesch, 216-227. Portland, OR: Productivity Press.

Kreutzer, David. FASTBreak™: A Facilitation Approach to Systems Thinking Breakthroughs. 1995. In *Learning Organizations*, ed. Sarita Chawla and John Renesch, 228-241. Portland, OR: Productivity Press.

Meadows, Dennis. Fish Banks, LTD Game Kit. Available from Laboratory for Interactive Learning, Institute for Policy and Social Science Research, Hood House—UNH, Durham, NH 03824.

Senge, Peter and William Isaacs. Overcoming Limits to Learning in Computer-Based Learning Environments. 1990. System Dynamics Group Working Paper D-4185. Sloan School of Management, MIT, Cambridge, MA 02139

Simons, Ken. 1993. New Technologies in Simulation Games. *System Dynamics Review* 9 (2): 135-152.

Sterman, John. 1992. The Beer Distribution Game: An Annotated Bibliography Covering its History and Use in Education and Research. System Dynamics Group Working Paper D-4281-1. Sloan School of Management, MIT, Cambridge, MA 02139

People Express Management Flight Simulator™. 1990. Available from MicroWorlds, 125 CambridgePark Drive, Cambridge, MA 02139. Software.

Powersim®. 1995. Available from Powersim Corporation, 1175 Herndon Parkway, Suite 600, Herndon, VA, 20170. Software.