A brief and incomplete history of operational gaming in system dynamics

by

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I remember vividly the first time I played a game in connection with system dynamics. It was the opening day of my first course in industrial dynamics during the first semester of my graduate program at MIT - September 1964. L. Fillmore McPherson, III was our instructor. I was sitting in the front row of seats in a classroom of the Sloan building desperately trying to understand and follow Professor McPherson's rules for passing pennies to the student on my left and sending orders to the student on my right. We were playing a crude version of what is now called The Beer Game. There was no paper flow sheet and no standard order forms. It was confusing. Mainly the exercise taught me that a facilitator needs to be extraordinarily clear about objectives and rules, if a quick game is to give its participants any useful and lasting insights.

Since that first class, over four decades have passed. During most of that period I have applied, taught, or written about system dynamics and its many applications. And gaming has gradually become more and more important to me as a tool for learning and teaching. In this brief essay I'll summarize some of my memories about the early days of gaming. My goal is not to provide a definitive summary. Instead I will recognize some of the pioneers in this niche of our field. I hope to inspire readers to increase their reliance on gaming. And I'll cite a few important resources they can use, if I succeed.

This is a personal reflection. Please be aware that there are undoubtedly still errors and omissions in this text - probably important ones.

It was clear to the first teachers in the field that active learning is important for mastery of system dynamics. "The underlying philosophy does not become a part of a student's thinking when experienced only through reading and listening. The problems in this book should help guide him into the learning that derives from personal experience." [1]

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[1] Jarmain, W. Edwin (Ed.), "Problems in Industrial Dynamics," The M.I.T. Press, Cambridge, MA 1963, page v.

Jarmain described three exercises at the beginning of his brief text. One dealt with the simple determinants of production and distribution; it was the precursor of The Beer Game. The other two dealt with apartment construction cycles and personnel decisions in a factory. But the latter two were not operational games; they simply gave the student a chance to study a set of equations and then calculate manually the values of key variables at each increment of time. Significantly, the game became widely adopted; the manual calculation exercises were quickly forgotten.

Jarmain never used the term “game” and, of course, the field was called “Industrial Dynamics” until the early 1970s. But already the focus was on what is now generally called “operational gaming.” Not game theory.

The “Production-Distribution System Classroom Simulation” at the beginning of Chapter 2 in Jarmain’s book lays out the goals and the rules of a game identical to The Beer Game we all know today, except that there was no long flow sheet to help participants keep track of flows and steps of play. I added that in 1968 when I started using the game as part of the Principles of Systems course whose teaching I took over from Forrester.

There is an ancient saying, “When I hear, I forget. When I see, I remember. When I do, I understand.” Operational games are tools for learning by doing. They are structured exercises in which participants have goals, rules, roles, paraphernalia, steps of play, an accounting system, and, often, a referee. They can facilitate learning through discovery - where participants make mistakes while engaged in the exercise. Failure in the game leads to reflection on the causes of the mistakes, and, hopefully, on strategies for avoiding those mistakes in the real system. Or games can facilitate learning through confirmation - where participants develop a strategy based on their prior learning. Success in the game confirms that they have mastered the lessons.

Games can be used in many different ways to facilitate learning. They can be a fun way to diffuse energy and help students come into an informal relation with others in the course. They can be used to give participants a shared vocabulary or common experience of some dynamic problem. They can illustrate the dynamics of specific systems and show the importance of particular causal mechanisms. They give participants a chance to practice communicating with each other and working together, developing more effective team skills. They can, under very special circumstances, even be used to predict the future behavior of essentially closed systems or to

predict the results of different decisions. John Sterman has used them in research, studying the capacity (and incapacity) of people to interpret and control the behavior of complex systems.

I have used games in all these ways.

Despite their power and versatility, games got off to a relatively slow start in the field. Into the early 1980s The Beer Game was still the only widely used exercise. But it had become almost a mandatory part of any introductory course. The game is still widely used, and it is sold by the System Dynamics Society.

In 1983 a recently graduated Dartmouth student of mine contacted me to ask if I could develop “something like The Beer Game” that he could use in a course he was developing for use by the US Agency for International Development.

With the great incentive and the small amount of money provided by his request, I chose to focus my 1983-84 sabbatical at IIASA in Austria on developing a game about the interaction of energy and environment in the process of long-term regional economic development. I was assisted in this by Norman Marshall and Donella Meadows who joined me at the Austrian institute.

I constituted an advisory committee of users at the United Nations Development Program in Vienna, and its members graciously played their way through early versions of the game. It was enormous great fortune that Michigan University Professor Dick Duke, one of the world’s great game designers, passed through IIASA and helped us solve many problems in the game’s design. The final product was introduced to others in the field at the 1984 system dynamics conference organized by Jorgen Randers in Geilo, Norway. I think that game session was the stimulus for the diverse developments that soon followed.

John Sterman recognized the value of games. He came to IIASA for a month of work with me. From that experience emerged STRATAGEM2, a nifty exercise that illustrates Jay Forrester’s basic theories about the causes of the Kondratiev long wave.

At first we had to write our games in some standard computer programming language, typically BASIC. But system dynamics software soon started to

incorporate features that facilitated gaming. First was Ernst Diehl's Microworlds simulation package. That permitted an analyst to import a working STELLA model into a computer program shell that greatly facilitated the design of user interfaces for entering decisions and displaying data.

Microworlds gave impetus to a number of gaming projects. Most successful was the People Express Management Flight Simulator created by John Sterman. But there were many other games created for the Microworld shell. Beefeaters (a game about managing a restaurant chain), Boom and Bust (on a product's market growth), and Professional Services. All these games are still available from Pegasus Communications.

By this time DYNAMO was largely eclipsed by STELLA and Vensim. Both of those languages began to incorporate features to facilitate gaming.

STRATAGEM attracted a half million dollar grant from the Canadian government, which wanted to produce the game for nation-wide distribution. The success of the Canadian effort prompted similar projects in Hungary, the Soviet Union, and other nations. Eventually the game was available in at least 10 languages. It is still used widely today.

My experience with STRATAGEM led me in 1986 to create a game about renewable resources, FishBanks, which was certified by the US Department of Education. With a $500,000 grant from that organization we produced the game professionally and ran teacher training workshops across the nation. I have personally conducted sessions of the game in at least 20 countries. Thousands of STRATAGEM copies are used now by teachers in at least 15 countries.

In the early 1990s John Sterman began to use games to conduct research on cognitive processes of those confronted with complex dynamic systems. His work gave important new insights into society's failure to deal with many important environmental, economic, and social systems.

Students who have experienced games in their courses often try developing new exercises. It is a demanding discipline to create a fun, playable game that conveys useful insights. Many people fail. But there have been some notable successes. For example, from a project at Monsanto there emerged "The Manufacturing Game," which has become the basis of a small firm that does training and consulting.

While they were at Innovation Associates, Gary Hirsch and Jenny Kemeney adapted their consulting work for insurance companies into “The Capitation Game.” With Linda Booth Sweeney I created the *Systems Thinking Playbook*, which offers 30 simple exercises that illustrate ideas about paradigms, causal structure, behavior, and leverage.

I now routinely convert my system dynamics models into games. It is challenging to place your model into direct contact with players, but it forces you to understand a dynamic structure thoroughly. And the result is extremely effective at educating clients and helping them to understand their policy options. Among many games I have created was one about HIV for the World Health Organization and another about pharmaceutical use for the Italian Foreign Ministry. I am working now on a game about incarceration in New Hampshire.

I have cited the advantages of this approach. In closing this brief reminiscence I will remind readers of three dangers associated with gaming.

First, note that the game experience needs to be followed by thorough debriefing in order to emphasize important lessons from the play. Since participants much prefer playing games to talking about them, there are subtle pressures on the game operator to expand the time for play and reduce the time for reflection. Don’t succumb to those pressures!

Second is the caveat given to us by a proverb, “When your only tool is a hammer, everything looks like a nail.” For those who have mastered just one game, there is a tendency to imagine that every training situation calls for it. Participants prefer playing almost any game to sitting for one of your lectures. But don’t confuse preference for learning. Be very clear about the functions for which a game is suited, and then do not use it outside its zone of relevance.

Third is the old gamer’s rule of thumb. “It takes ten sessions with a game, before you can call yourself a master.” I have played FishBanks hundreds of times, and I still get new insights about the game and the learning process each time I run it. If you are going to use a game in your teaching, consulting, or research, practice it several times with friends, before you sit down to a serious session.