A DYNEX-BASED LEARNING LABORATORY FOR ECONOMIC DEVELOPMENT PLANNING

Khalid Saeed
Asian Institute of Technology
Bangkok, Thailand

ABSTRACT

This paper describes a user-friendly learning medium that revisits the problem of economic development with a behavioral perspective. Formal modelling and computer simulation create a laboratory which makes it possible to experiment with ideas without incurring the costs and risks of action research. Besides sharing the insights gained by the author in his experiments, the package also invites further experimentation by the readers through the use of the accompanying software.

INTRODUCTION

Laboratories and studios are an integral part of the curricula in engineering, physical science and fine arts. These allow students to learn to organize their thinking through experimentation. Laboratories for facilitating learning in the fields of management and planning are, however, almost non-existent. There have been some attempts made at developing such laboratories, presented as games or "flight simulators" designed for specific contexts.

The oldest of the system dynamics games is the so-called Beer-Game, which has been in use for more than a decade for teaching system dynamics. Its originator is unknown.[1] Other well-known games include Stratagem-1, developed by Dennis Meadows in 1984, and Stratagem-2, developed by John Sterman in 1985.[2] A Management Flight Simulator concerning the main operations of a firm, developed by High Performance Systems in 1987 is a relatively recent addition to the inventory of such games.[3]

The bundling of STELLA software with extensive text materials is one of the few attempt to create an experimental learning facility related to a professional field [Richmond, et. al. 1987a, 1987b]. Few other serious attempts have been made to create learning media combining the discussion of theory and empirical evidence with a facility to experiment with the theoretical constructs in a particular professional field.

This paper describes a learning laboratory developed by the author consisting of a book addressing the issues of design and implementation of economic development agenda using system dynamics modelling and a DYNEX-based computer program which allows interactive experimentation with the models

of the book. Although currently considered an interesting but maverick product by the book publishers, such products should become increasingly available in the future for self-study and for use as text or supplementary text for teaching.

DESIGN CONSIDERATIONS

Donald Schon suggests that education in professions should aim at cultivating "reflective practice," which should allow the practitioner to engage in a meaningful discourse with the demonstrations of his or her own ideas while preparing a design. In some professions outside of engineering and physical sciences, such as architecture and music, this might be possible to accomplish by learning to critically examine the outcomes of the initial designs since these can be quickly translated into visual or aural media for demonstration [Schon 1983,1987].

However, any reflective practice in the professions of planning and management would require experimenting with the perceived behavioral relationships forming part of a design, which has not been possible except in a limited way. This is due to the inadequacy of the traditional methods available for such experimentation, namely qualitative reasoning and formal mathematical logic. The former, being inexact, is unable to assist the reflective process in a reliable way. The later can handle only very limited complexity while its application requires specialized skills; hence its scope is limited.

System dynamics overcomes some of the limitations of the traditional methods by providing well defined organizing principles to model the designs of complex social processes, existing as well as new, and affect improvements in these designs through experimentation. The study of organizing principles of systems, together with the possibility to simulate on a computer the outcomes of the hypothesized system relationships, provides an easy-to-use means for such experimentation [Forrester 1968, Simon 1969]. Most experienced system dynamists would also agree that the process of modeling is of great value as a reflective exercise; sometimes, even of greater value than the model it may create in the end [Forrester 1985]. Thus, system dynamics seems ideally suited to introducing the concept of reflective practice in the teaching of management and planning, but this would require redesigning teaching formats and preparing textbooks and materials to facilitate teaching and learning in the new formats.

These were the considerations leading to the development of the learning laboratory discussed in this paper.

ORGANIZATION OF THE LEARNING LABORATORY

The contents of the laboratory have been organized into three parts: 1) the main text of the book containing discussions of the structure of the models provided for experimentation, the related empirical evidence and the key experiments performed by the author; 2) the technical appendices containing mathematical details and operating instructions for the computer program; 3)two floppy diskettes containing the software. The software can be implemented on any IBM personal computer, or compatible, operated with MS-DOS version 3.2 or higher.

The software accompanying the book is based on the DYNEX utility of Profession DYNAMO Plus package.[4] Menus in this program have been prepared in plain English and these allow one to select between the various models [for example, see Figure 1], recognize and modify model assumptions [for example, see Figure 2], recognize and select policy choices [for example, see Figure 3], simulate models [for example, see Figure 4], and display results [for example, see Figure 5]. Some of the relatively lengthy menus are only for providing theoretical premises [for example, see Figure 6].

By following these menus, one can assemble a model with the assumptions of one's choice and also make policy runs with any number of policies selected from the menus. No programming or other computer related experience is needed to experiment with this program, although it is helpful. Knowledge of DYNAMO simulation language is also helpful but not required.

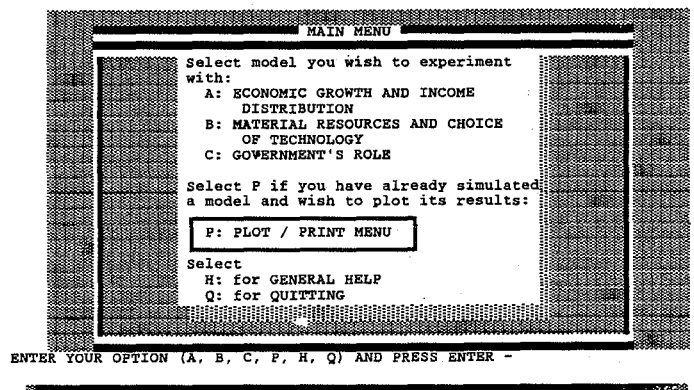

Figure 1: The Main Menu for Selecting a Model and Going to Plot Options.

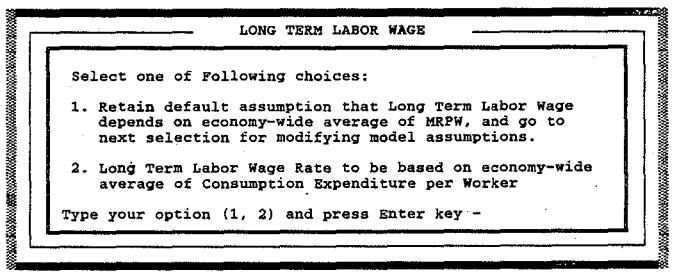

Figure 2: Example of a Menu for Modifying Model Assumptions

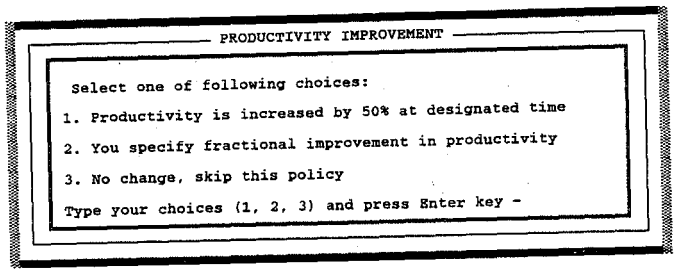

Figure 3: Example of a Menu for Specifying Policy Options

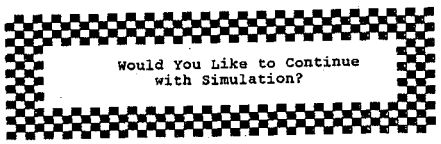

Figure 4: Menu for Ordering Simulation

Select Your Choice (Y, N) and press Enter -

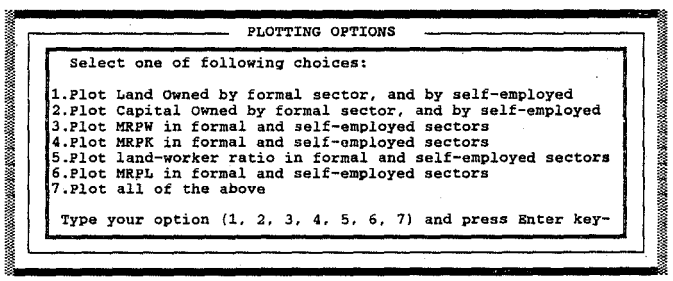

Figure 5: Example of a Menu for Specifying Plots

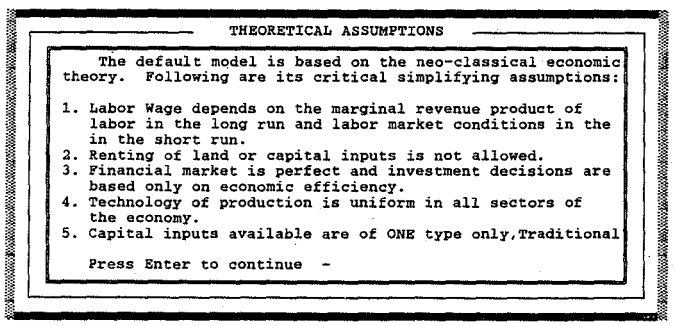

Figure 6: Example of a Menu for Providing Theoretical Premises

AUDIENCE

The learning laboratory addresses the issue of design of change for economic development. It would not only be a good reading and experimental facility for the serious practitioner, it would also make a suitable text or supplementary text for an advanced course or a professional development workshop on the subject of the package.

An effort has been made to keep the three parts of the package as self-contained as possible, so the audience could pursue these independently of one another, depending on its interests. A casual subject may like only to go through the main text of the book which qualitatively describes the models of the package and discusses their behavior and empirical evidence concerning these models. A scientist interested in knowing the mathematical structure of the models may like also to study the technical Appendices. A professional considering application of the concepts discussed in the book may wish to further experiment with the models using the software provided. All three parts would be used if this book is applied as part of a text for a course.

COVERAGE

The process of the design of change requires a deep understanding of the dynamics of the existing system, which is greatly facilitated by computer simulation and the heuristical protocol of the system dynamics method. Without the attempt to understand the social organization in which development is to occur, planning is reduced only to wishful thinking or moral statement making, although such uncontextualized thinking has been widely practiced in preparing development plans, and has been taught in the universities.

Formal modelling of the organizational processes involved in economic development should, however, be viewed only as a vehicle to facilitate understanding of the development agenda, not as a source of design. To reduce the complexity of formal modelling, the problem should be partitioned into smaller components, provided that this does not disconnect important symbiotic processes subsuming the variety of experience over time and geographic location.

Guidelines for partitioning complex problems into multiple models are discussed in the main text. Models containing conservative systems capable of generating a large number of time variant patterns, which in reality are separated by time and location, appear to be sound instruments for facilitating the design of change. Following these guidelines, the developing country system is partitioned in into three sub-systems: 1) social relationships of production and income distribution, 2) ecological and technological factors governing the utilization of natural resources, and 3) political relationships

affecting the ability of government to support public welfare. Policy experiments with the models are addressed to the following issues.

a) Changing Income Distribution

The analysis provided in the main text identifies two types of instruments for changing wage and income distribution patterns -- those creating fundamental forces of change and those facilitating change. The fundamental instruments of change identified are to discourage absentee ownership and promote artisan ownership. This may be operationalized through fiscal policies that increase the cost of owning capital resources in absentee form, for example by imposing a tax on income accrued from such ownership. The facilitators include the well-known technological and financial development policies and community assistance programs which have been the main fare of the past development effort.

Experimentation with the model of social relationships creates the recognition that mere implementation of the facilitating factors may not cause any change in wage and income distribution patterns; this is borne out by the experience of the developing countries. The facilitators may, however, speed up the process of change, if the primary engine of change suggested above has been provided.

The experimentation also allows combining the fundamental and the facilitating policies in designing an appropriate path of change depending on the government's ability to intervene, and to cope with change.

b) Achieving Food Security And Eradicating Poverty

Experimentation with the model of social relationships also establishes that policies, which directly address the symptoms of the problems of poverty and hunger, such as agricultural development, financial and technical assistance for the poor and population control, may be defeated in the long run since socio-technical arrangements of the system favor persistence of poverty and vulnerability to food shortage.

The solutions to the problems of poverty and hunger appear to lie in attempting to influence the internal goals of the system by introducing indirect instruments that encourage transfer of ownership of resources to the self-employed workers possibly through taxing rent income, and building up a food slack possibly through adopting staples which require substantial quantities of cereals to be produced.

c) Managing Natural Resource System

Experimentation with the model of the resource system addresses the

controversy arising from the comparison of the criteria of the neoclassical and the environmentalist models. They are internally consistent, but otherwise have little overlap.

Experimentation leads to the recognition that a sensible resource use policy must incorporate considerations of both the throughput and the boundary interaction of human society with its resource environment. These considerations call for gathering more geological information about resources. This information should then form the basis for influencing the prices and the course of technological development so that a tendency to select appropriate materials for use is encouraged by the market itself instead of being imposed directly by a government.

d) Managing Technology

The adoption of technologies in the developing countries has generated a wide variety of performance patterns and this has confused the issue of what might be an appropriate choice. Experimentation with the various models of the package allows the problem of choice of technology to be examined keeping in view the dynamic systems representing the political and social organizations and the resource environment in which a selected technology must function.

e) Understanding Government's Role

A design of change for economic development cannot ignore the government's role since it would be impossible to implement development agenda without government support. Experimentation with the model of the political system allows to identify critical organizational mechanisms that may assure that a government is able and willing to support development agenda.

The experimentation creates the recognition that contrary to the many truisms about economic development being aided by the presence of a "strong" government that exercises a high level of control, limiting the power of the government so that it is unable to suppress civil rights appears to be the key organizational factor for sustaining its support of the development process.

CONCLUSION

The experimental procedure adopted in the package distinguishes it from the purely conceptual edifices on economic development abundantly found in the literature. The numerical simulation technique used has been in existence for about half a century, while the heuristical method of system dynamics was developed some 35 years ago. These approaches could not be used productively to address a wide range of problems due to the high cost and the limited availability of computing hardware and software. A significant technology introduced over the eighties has been personal computing and the

concept of software user-friendliness. These developments have been integrated with empirical evidence, social theory and behavioral science principles in the creation of the learning laboratory.

Such a framework would also be valuable for designing learning laboratories in other areas of policy design in the social and ecological systems.

NOTES

1. One of the versions of the beer game can be obtained from the author on request.

2. Available respectively from Dennis Meadows, University of New Hampshire; and John Sterman, MIT, Cambridge, MA 02139, USA.

3. Available from High Performance Systems, 13 Dartmouth College Highway, Lyme NH 03768, USA

4. Available from Pugh-Roberts Associates, Five Lee Street, Cambridge, MA 02139, USA

REFERENCES

Forrester, Jay W. 1985. A Model Versus a Modeling Process. System Dynamics Review. 1(1): 1985.

Forrester, Jay W. 1968. Principles of Systems. Cambridge, MA: Wright-Allen Press

Richmond, Barry., et. al. 1987a. An Academic User's Guide to STELLA. Hanover, NH: High Performance Systems Inc.

Richmond, Barry., et. al. 1987b. STELLA for Business. Hanover, NH: High Performance Systems Inc.

Schon, Donald A. 1983. The Reflective Practitioner. New York: Basic Books

Schon, Donald A. 1987. Educating The Reflective Practitioner. San Francisco: Jossey-Bass Publishers

Simon, Herbert. 1969. The Sciences of the Artificial. Cambridge, MA: MIT Press