

# Developments in Business Simulation and Experiential Learning, Volume 26, 1999

## UNDERSTANDING YOUR BUSINESS THROUGH HOME-MADE SIMULATOR DEVELOPMENT

Takao Terano \*1, Hisatoshi Suzuki \*1, Yasushi Kuno \*1, Hiroshi Fujimori \*2, Hiroaki Shirai \*3;  
Chizuru Nishio \*1, Noboru Ogura \*1, Mitsuo Takahashi \*2;  
\*1 GSSM, University of Tsukuba, Tokyo; \*2 Reitaku University;  
\*3 Fujitsu Information Network Systems Ltd.

### ABSTRACT

This paper discusses a novel approach to a business simulator course. The course we are developing consists of (i) Simple gaming experiment among multiple students using Alexander Islands, a tiny business simulator on the WWW; (ii) Lectures to let students to understand the core concepts of systems management through the simulation; and (iii) Home-made simulation model development by the students themselves using a business model description language (BMDL) and a business model development system (BMDS). Our course is unique in the sense that, through the business simulation, we aim to develop students' skills (1) to implement their own specific models of business firms, (2) to develop information systems for the firms, and (3) to understand business processes among companies. This paper describes the background and motivation, basic principles, the architecture and implementation of BMDL/BMDS, and experimental results.

### INTRODUCTION

This paper reports a novel approach to a business simulator course at Graduate School of Systems Management (GSSM) of Tsukuba University. The goals of the course are to develop students' skills (1) to implement their own specific models of business firms, (2) to develop information systems for the firms, and (3) to understand business processes among companies.

In order to achieve the goals, the most unique point of the course is to let the students develop their own business simulators using a simple Business Model Description Language (BMDL)

and its Business Model Development System (BMDS). The developed simulators are run and evaluated by the other members including lecturers on the WWW environment. Through the experience, the students will understand the concepts and skills of business management.

This paper describes the background and motivation, basic principles, the architecture and implementation of BMDL/BMDS, some results of three year course experience, and future issues.

### BACKGROUND AND MOTIVATION

Business simulator is a common vehicle to study business and management principles under controlled virtual situations. The conventional approach to business simulation courses is, at least in Japan, to educate naive students to understand the concepts of management, accounting, business processes, and/or the basic techniques for business analysis. There are many conventional gaming simulators in the literature in order to attain the goals (for example, refer to Elgood (1993), Richardson (1982), Morecroft (1984), and Rye (1994)).

However, at GSSM, such approaches are not enough. The students we have are all business people from various industries. They have their own jobs in daytime, different expertise, and different backgrounds in their experience. Therefore, although the academic levels of the students are so diverged, they will not be satisfied by playing-only simulators. They want to know how to make good management decisions by developing business models, decision support tools, and business information systems Henshaw (1984).

## Developments in Business Simulation and Experiential Learning, Volume 26, 1999

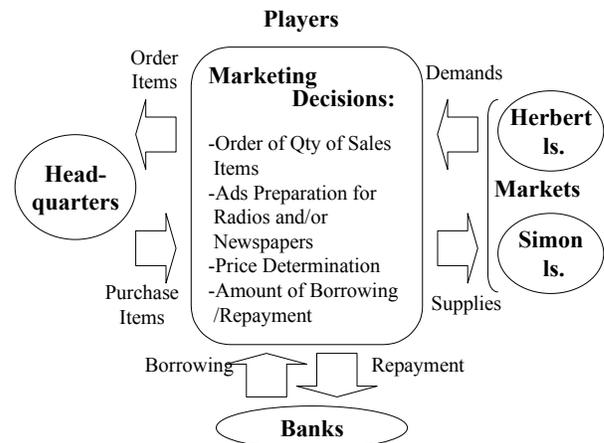
To meet the requirements and based on our previous experience Fujimori (1993a), Fujimori (1993b), Shirai (1994), Shirai (1996), Takahashi(1986), we set the following goals to design the business simulator course:

1. The game we will use is so simple for business people with various background, especially for those who have few accounting knowledge, that they can understand the basic process of business simulations.
2. However, it is enough complex for those who have real and practical business experience to play the simulation to understand the advanced concepts of decision making and business processes.
3. Using the simulators, they will be highly motivated to further study advanced courses at GSSM including operations research, information systems, decision theory, accounting, marketing, computer programming, artificial intelligence, and/or computer networks.
4. A dozen of students can execute the simulators at the same time and different places, therefore, it is desirable that the simulator will run on a computer network or on the World Wide Web.
5. To let the students to easily develop their own business models, a new BMDL and BMDS should be designed and implemented. BMDL should be so simple that the students with few skills on computer programming can understand it and write their own models.
6. To guide the students, a typical business model and simulator should be developed. The simulator should be both executable as the introductory tool for the course and readable for students to understand how the model is built, and how the simulation is executed. The simulator should be used as an example in the introductory course.

Based on the above, as a result, the course we are developing consists of (i) Simple gaming experiment among multiple students using Alexander Islands, a tiny business simulator on the WWW; (ii) Lectures to let students to understand the core concepts of systems management through the simulation Knotts (1998), Wolfe (1998); and (iii) Home-made simulation model development by the students themselves using BMDL and BMDS.

### FRAMEWORK OF ALEXANDER ISLANDS: A TINY BUSINESS SIMULATOR

Alexander Islands is an introductory gaming simulator developed to meet items 1, 2, and 6 of the requirements in the previous section (please refer to Fujimori (1999)). The simulator models a business process of (1) purchasing consumer items (e.g., personal computers) from the head-quarter, (2) selling them to two different markets (Herbert Island and Simon Island)<sup>1</sup> and (3) among ten competitors or ten players, making marketing decisions on ordering, advertising, pricing, and accounting.



**FIGURE 1: BUSINESS MODEL OF  
ALEXANDER ISLANDS**

The business model of Alexander Islands is summarized in Figure 1. At every turn (monthly)

<sup>1</sup> The name of the simulator is taken from the name of Professor H. A. Simon.

## Developments in Business Simulation and Experiential Learning, Volume 26, 1999

of the game, each user can order any amounts of a sales item from the head quarter, prepare advertises for radio and/or newspapers, determine sales prices for the two markets, make accounting decisions on borrowing and/or repaying money. The demands of the two markets are given from the environment.

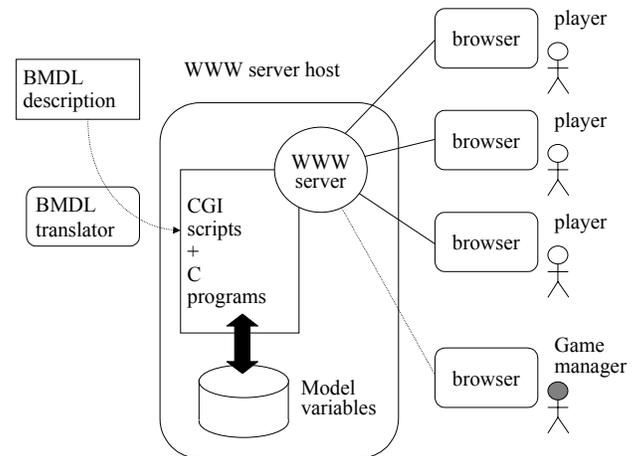
The model implicitly includes a stock management problem in operations research, demand forecasting in decision making, and advertise strategy in marketing. Although the simulator does not include explicit decision support functions (e.g., Gray (1986)), it is desirable for the students to aware the existence of such practical problems in the simple gaming environment. Therefore, to properly make the decisions during the game, the players should have some decision aids on a PC, for example, spread sheet programs. As the simulator is simple enough, to make decisions, it takes within 10 minutes even for naive users, thus, the time to complete one game round is about 70 minutes. It is enough short for the students with their own businesses.

Alexander Islands consists of basic mechanisms of the business process and user interfaces for ten players and one manager. The user interfaces run on a web browser. The first version of the simulator was implemented in the C language, and re-implemented in BMDL in 1997. The source codes of Alexander Islands currently consists of about 450 steps of BMDL instructions including detailed comments. The length is enough short that the students can read the contents and understand how it works.

### FRAMEWORK OF BMDL/BMDS

This section describes the architecture of Business Model Description Language and Business Model Development System. BMDL/BMDS was designed to meet the items 3, 4, and 5 of the requirements in Section 2. Figure 2 shows the system configuration.

A model developer describe his or her business model in BMDL. Sample codes of BMDL is shown in Figure 3. The example in Figure 3 is a simulator designed for three players and one manager with ten game rounds. The game is executed as follows: At beginning, each player inputs the sales price; then the cheaper the price is, the more he or she can sell the goods; all ordered goods are sold at every round; new goods and a decision is made in order to supply the goods to keep the same level of the stock.



**FIGURE 2: ARCHITECTURE OF BUSINESS MODEL DEVELOPMENT SYSTEM**

The interfaces for players to give a price and the ones for a manager to browse the conditions of all players are also included in the description. In the original codes, the variables of the model are described in Japanese characters, however, in Figure 3, they are translated capital ASCII characters. The mechanism enables the user to easily develop home-made simulators.

A business simulator written in BMDL is first translated into corresponding CGI scripts and C programs by BMDL translator. The programs are then run on a host computer with a WWW server and the model variable data in the form of spreadsheets. Finally, players execute the simulation through browsers on the WWW environment. Model variables are managed in a model database with the configuration shown in Figure 4.

# Developments in Business Simulation and Experiential Learning, Volume 26, 1999

Simulation is executed with the architecture as shown in Figure 5. A game manager have a task

```

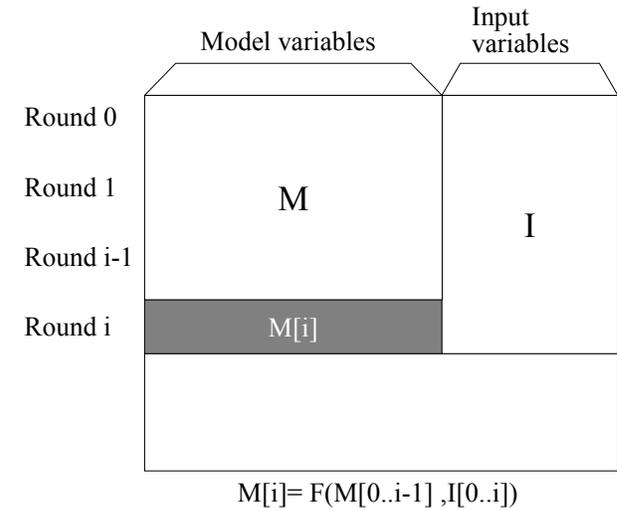
#
# NOTE: Original codes includes KANJI characters to denote variables.
# Size of the Game
#
def game-name Price Only
def max-team 3
def max-round 10
password ctr t1 t2 t3
# Series constants definition
scon DEMANDS 497 1195 2447 4037 5406 6626 8177 9451 9945 10713
# Global constants definition
gcon ORDER_PRICE 90
gcon MINIMUM_PRICE 50
# Input Variables and Input Window definition
ipage price INPUT_PRICES
  <H1>Input Price</H1>
  <P>Input Sales Price</P>
ivar SALES_PRICE range 0 1000 120
# Model variables and their initial values of each team.
tvar NUMBER_OF_SALES
tvar PRICE_OF_PROCEED
tvar PRICE_OF_ORDER
tvar AMOUNT_OF_PROFIT
tvar AMOUNT_OF_DEPOSIT 150000
# Computation Model Description
pinv NUMBER_OF_SALES = DEMANDS by SALES_PRICE -
MINIMUM_PRICE;
tlet NUMBER_OF_SALES = rint(NUMBER_OF_SALES);
tlet PRICE_OF_PROCEED = NUMBER_OF_SALES * SALES_PRICE;
tlet PRICE_OF_ORDER = NUMBER_OF_SALES * ORDER_PRICE;
tlet AMOUNT_OF_PROFIT = PRICE_OF_PROCEED -
PRICE_OF_ORDER;
tlet AMOUNT_OF_DEPOSIT = AMOUNT_OF_DEPOSIT@1 +
AMOUNT_OF_PROFIT;
# Output description
ooption fmt %1.0lf
opage sales SALES STATUS public
  <H1>SALES STATUS REPORT</H1>
  <P> $ ROUND-th: Demands: $ DEMANDS</PY>
begintable
out teams
out teams-vars SALES_PRICE::%5.3lf NUMBER_OF_SALES
PRICE_OF_PROCEED PRICE_OF_ORDER AMOUNT_OF_PROFIT
endtable
#
opage balance PROFIT STATUS teamspec
  <H1>PROFIT STATUS REPORT</H1>
  <P> $ ROUND-th, TEAM: $ TEAM, TOTAL_DEMANDS:
$ DEMANDS</P>
begintable
out values 'ITEM 'INCOME 'OUTGO
out values 'LAST_TERM_DEPOSIT AMOUNT_OF_DEPOSIT@1 -
out values 'AMOUNT_OF_INCOME PRICE_OF_PROCEED -
out values 'AMOUNT_OF_OUTGO - PRICE_OF_ORDER
out values 'AMOUNT_OF_PROFIT - AMOUNT_OF_PROFIT
out values 'THIS_TERM_DEPOSIT - AMOUNT_OF_DEPOSIT
endtable
#
opage allteam ALL_VARIABLES_THROUGH_TEAMS control
  <H1>$-ROUND ROUND: ALL_VARIABLES_THROUGH_TEAMS
</H1>
begintable
out teams
out teams-allvars
endtable
#
opage allteam ALL_VARIABLES_THROUGH_TEAMS control
  <H1>TEAMS$-TEAM: ALL_VARIABLES_THROUGH_TEAMS
</H1>
begintable
out rounds
out rounds-allvars
endtable
#

```

# end  
#

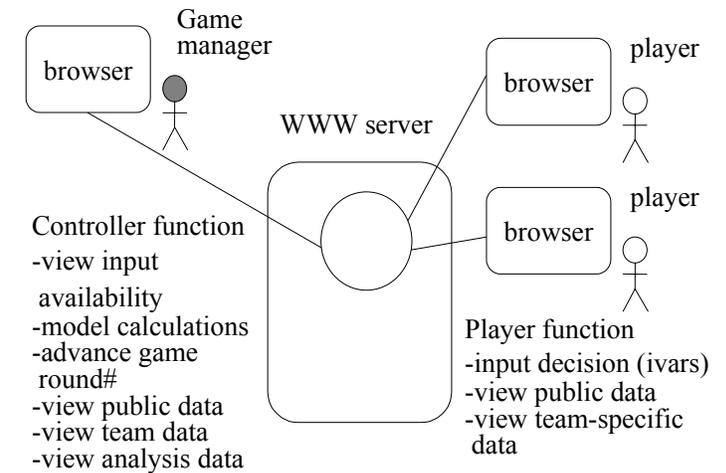
**FIGURE 3: SAMPLE CODES OF BUSINESS MODEL DESCRIPTION LANGUAGE**

of controlling the input information availability, simulation calculations, simulation rounds, views of public, team, and analysis data. The other game players can input and modify the input variables based on public and team-specific information and their decisions. Figure 6 shows a sample of the manager's interface. Figure 7 shows a sample of players' input screen .



**FIGURE 4: MEMORY MANAGEMENT OF BUSINESS MODEL DEVELOPMENT SYSTEM**

**FIGURE 5: FUNCTIONS OF MANAGER**



# Developments in Business Simulation and Experiential Learning, Volume 26, 1999

## AND PLAYERS OF BMDS/BMDL SIMULATION



FIGURE 6: SAMPLE WINDOW OF SIMULATION ENTRY

### EXPERIENCE AND DISCUSSION

#### Outline of the Course Experience

The course was started in 1996, when we had no specific environments. In 1997, Alexander Islands in the C language was used in the introductory simulator (sub-)course, and BMDL version was introduced for advanced course to develop their own business models. The 1996 program was not welcome by the students because the supplementary tasks were too heavy to understand the business management principles.

The 1997 program was so remarkably improved that the students could understand the model of Alexander Islands and could develop the home-made simulators. Questionnaire data on the course were gathered. Amongst 23 respondents of the questionnaire, (1) 22 students replied the course using Alexander Islands was interesting, (2) 17 students thought the level of the course

was moderate, and (3) 18 students were comfortable in the WWW environment.



FIGURE 7: SAMPLE OF SIMULATION DISPLAY FOR A MANAGER

The summary of the models they developed is shown in Table 1. They cover vary wide task domains in practical business situations, although our BMDL/BMDS toolkit mainly fit the style of assembly type production and sales companies.

TABLE 1: HOME-MADE SIMULATORS DEVELOPED IN THE 1997 PROGRAM

- |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>(1) Model of production line improvement via research &amp; development decision making</li> <li>(2) Model of equipment replacement for Production line improvement</li> <li>(3) Model of resource purchasing for Production company</li> <li>(4) Model of Research and development investment for new products</li> <li>(5) Model of model changes of products</li> <li>(6) Placement of logistic bases<br/>BS/PL/Cash flow Model</li> </ul> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

**1998 Program Plan and Tiny-P Model**

In the 1998 program, we provides students with one much more simple business model: Tiny-P which runs on our environment in order to let students use it as a prototype or a sample source codes for their own projects. The model is originally designed to be used as a small case study of our course which simulates a production firm. Although it is simple, it can be extended to meet student' complex requirement.

The specifications of Tiny-P are summarized in Table 2. The corresponding source codes in BMDL contains about 100 lines of codes including comments on the case.

**TABLE 2: SPECIFICATIONS OF TINY-P MODEL**

- |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>(1) Kind of Products: Only one Product <i>A</i></li> <li>(2) Kind of Material Parts: Only one Part <i>a</i></li> <li>(3) Decision Variables:<br/>Sales View: One: Price of Product <i>A</i><br/>Production View: Two:<br/>                    Number of Product <i>A</i><br/>                    Number of Order <i>a</i></li> <li>(4) How to Order Parts:<br/>Parts Price: Constant<br/>Number of Parts:<br/>    Provided the number exactly required<br/>Lead Time: One Term</li> <li>(5) How to Make a Product:<br/>The Product consists of 50 parts<br/>Lead Time: One Term</li> </ul> |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

**Evaluation**

In the 1998 program, we think we have attained most design goals described in Section 2. From the questionnaire data among 15 respondents, we have got the following implications:

- (1) all of them replied that the course with Alexander Islands was interesting and that recommended to the new comers;
- (2) 11 students thought the level of the course was moderate, and
- (3) most of them requested more intensive lectures and discussions among students.

The plan of developing home-made simulators in 1999 includes the candidates in Table 3.

**TABLE 3: PROJECT CANDIDATES FOR SIMULATOR DEVELOPMENT IN THE 1998 PROGRAM**

- |                                                                                                                                                                                                                                                                                                                         |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>(1) Marketing competition model</li> <li>(2) Model of production industries</li> <li>(3) Model of accounting systems</li> <li>(4) Model of finance systems</li> <li>(5) Model of players of business simulations</li> <li>(6) Scenario making for business simulators</li> </ul> |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

From these observations, we believe that our novel course is of success for those students with various background and expertise. The important implication is that using business simulation approach and the BMDL/BMDS toolkit, we can approach to the business processes we would like to model and analyze.

**CONCLUSION AND FUTURE WORK**

This paper have described our experience of developing a novel course on business simulator. Unlike conventional gaming simulation courses, which aim at studying basic principles of simulated business processes, accounting, or, data analyses techniques, the objectives of our course is to develop skills (1) to implement their own

## Developments in Business Simulation and Experiential Learning, Volume 26, 1999

specific models of business firms, (2) to develop information systems for the firms, and (3) to understand business processes among companies.

To attain the objective, the most remarkable point is that the course contains (1) Alexander Island: tiny business simulate on the www, and (2) Development of home-made models via BMDL and BMDS. The approach is promising for business simulator courses to develop more advanced systems and concepts.

Future work includes (1) to improve the functions of BMDL/BMDS by providing agent-based technology Bradshaw(1997), Russel 1995), Terano(1998) in (Distributed) Artificial Intelligence, which will enable the user to execute multi-player simulations although (human) users are not multiple, And (2) to develop corresponding textbooks to guide the courses.

### ACKNOWLEDGEMENT

The research is supported in part by the Grant-in-Aid for Scientific Research of the Ministry of Education, Science, Sports, and Culture of Japan, the contract number is 09558044.

### REFERENCES

- Bradshaw, J. M., ed. (1997). *Software Agents*. AAAI/MIT Press.
- Elgood, Chris.(1993). *Handbook of Management Games*. Gower Press.
- Fujimori, H.(1993a): Design and Operation of Business Games on a Network Environment. *Journal of Japan Association of Simulation and Gaming*, Vol. 3, No. 1, pp. 15-24 (in Japanese).
- Fujimori, H.(1993b): Application of Business Games in Japanese Companies. *PASOKON LITERACY*, Vol. 18, No. 12, pp. 17-24, (in Japanese).
- Greenblat, C. S.(1989): *Designing Games and Simulations*. Sage Publications.
- Gray,P., Borovits, I.(1986): The Contrasting Roles of Monte Carlo Simulation and Gaming in Decision Support Systems. *Simulation*, Vol.47, No.6, pp.223-239.
- Fujimori, H., Kuno, Y., Shirai, H., Suzuki, H., Terano, T. (1999): Alexander Islands: GSSM Tiny Business Simulator on the WWW. *Proc., ABSEL 1999*.
- Henshaw, R. C., Jackson, J. R.(1984): *The Executive Game*. Richard D. Irwin, Inc.
- Knotts, U. S.(1998): Teaching Strategic Management With a Business Game. *Simulation & Gaming*, Vol. 28 , No. 4, pp.377-394.
- Morecroft, J. D. W.(1984): Strategy Support Models. *Strategic Management Journal*, Vol.5 ,pp.215-229.
- Richardson, G. P., Pugh, A. L.(1982): *Introduction to System Dynamics Modeling with DYNAMO*. Productivity Press.
- Russel.S, and Norvig.P. (1995): *Artificial Intelligence A Modern Approach*. Prentice Hall.
- Rye, David E.(1994): *The Corporate Game: a Computer Adventure for Developing Business Decision-Making Skill*. McGraw-Hill.
- Shirai, H.(1994): Gaming Simulation for Management Consulting. *Journal of Japan Association of Simulation and Gaming*, Vol. 4, No. 1, pp.129-137 (in Japanese).
- Shirai, H.(1996): Gaming Simulation for Problem Setting. *Journal of Japan Association of Simulation and Gaming*, Vol. 4, No. 1, pp.85-92 (in Japanese).
- Takahashi, M., Fujimori, H.(1986): *Introduction to Business Games Using PCs*. NIHON-KEIZAI-SHINBUN-SHA.
- Terano, T., Kurahashi, S., Minami, U. (1998). TRURL: Artificial World for Social Interaction Studies. *Proc. 6th Int. Conf. on Artificial Life (ALIFE VI)*, pp. 326-335.
- Wolfe, Joseph., Fruttsche, D. J.(1998): Teaching Business Ethics With Management and Marketing Games. *Simulation & Gaming*, Vol. 29 , No. 1, pp.44-59.