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COMPUTERIZED DECISIONS AIDS FOR INDUSTRIAL MANAGEMENT

UC/GLO/84/197

Technical report: Design of a computer model

Based on the work of
the International Institute for Applied Systems Analysis,
Dartmouth College and
the Factory Establishment and Management Section, UNIDO

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INTRODUCTION

INTRODUCTION

I. PROJECT BACKGROUND (Phase I)

Over the past several years UNIDO and especially the Factory Establishment and Management Section has received many requests for assistance in demonstration, development, and implementation of computerized decision aids for industrial management. These have come for two principal reasons:

- the technology of microcomputers has developed so far that powerful computers are now very cheap and simple to use. They are now realistically available to industrial ministry staff and to factory managers in most of the industrializing nations;

- the advances in management science and in computer software development have provided excellent management aids in a form that is cheap enough and simple enough to be widely available even in the poorer countries.

Microcomputers, when combined with computer programmes that address the common factory management functions (such as inventory control, workforce scheduling, and payroll) can raise the effectiveness and productivity of managers. As a consequence, government/industry officials now see opportunities to compensate for their scarcity of trained personnel. They have been asking UNIDO/FCTY for assistance in selecting and implementing the proper computer systems. UNIDO has been responding to these requests, but developments in the field have been too rapid for any one small group to follow. Further, there is a scarcity of facilities for testing and demonstration of the machines and software that would be most useful to UNIDO's potential clients. Thus, UNIDO initiated the contract with IIASA to supplement its expertise and at the same time acquire the computers and software required to respond to future requests.

The development objective of this project is to increase the expertise of industrial managers and public officials responsible for allocating financial and personnel resources within industry. This will be achieved by:

- assembling a set of computerized training tools that can compensate for the lack of trained industrial management personnel in the developing nations.

- adapting these tools for use on very inexpensive, portable microcomputers suitable for the area.

The UNIDO/IIASA project was originally designed to have two phases.

Immediate Objectives of Phase I

1) Hold the first seminar/workshop to introduce management personnel from the developing world nations to the industrial management programmes prepared by UNIDO/IIASA. The results of the first seminar indicating the range of equipment and software specified by workshop participants. This document will also provide preliminary feedback on the training techniques that have been developed by UNIDO/IIASA to convey management decision aids to clients unfamiliar with the use of computers.

2) Develop and operate within UNIDO a microcomputer software centre that would permit UNIDO to assess and distribute the most effective, computer-based industrial management tools to the developing world.

3) Establish a small, but comprehensive, software library on programmes for management decision-making processes that could be provided to the software centres that are being promoted by UNIDO around the world. IIASA will specify the generic functions to be addressed by these programmes, for example inventory management, payroll, quality control, and so forth. UNIDO will select optimal examples of programmes in each area and IIASA will re-programme one of these packages to demonstrate how software can be implemented on an array of machines in the UNIDO microcomputer centre.

4) Set up a UNIDO/IIASA consulting team that could work on developing and adapting management programmes for use in UNIDO projects.

5) Hold advisory meetings to prepare for Phase II.

Report on the UNIDO/IIASA Seminar Workshop on Microcomputer-based Tools for Management Training and Support

The UNIDO/IIASA seminar was held in two consecutive sessions: September 1-7 in Balaton Fured, Hungary and September 10-14 in Csopak, Hungary. The first meeting involved 39 computer specialists from 15 countries. (The Hungarian Ministry for Industry covered all room, board, and administrative expenses for the conference participants.)

The first session was used to demonstrate a variety of microcomputers and computer-based training tools for use by managers. The second was used to critique the tools used in the first session and to identify future directions for the UNIDO/IIASA project.

Microcomputer Specifications

From discussions of the participants, we finally identified six principal criteria to be used in selecting the microcomputers that should be installed in the UNIDO demonstration facility. To serve the needs of UNIDO the computers must be:

- relatively inexpensive, betweeen $200 and $4,000, including the display screen, printer, and memory.
- manufactured in many different countries,
- widely sold,
- widely serviced and inexpensive to maintain,
- supported by a diverse array of software, and
- available with at least 10K of random access memory.

We identified six computers that meet these criteria.

1. SHARP PC-1261 combined with the CE-125 printer and cassette tape recorder,
2. SINCLAIR Spectrum,
3. COMMODORE 64,
4. NEC PC-82-1A,
5. APPLE IIe, and
6. IBM PC (or suitable PC compatibles).

All six of these machines were demonstrated at the seminar, and these are the microcomputers that will be used as the reference group for the project. Thus they are also the computers that should be included in the UNIDO microcomputer demonstration centre. The combined set of software available for these machines includes well over 20,000 programmes.

Even though the above machines represent the great majority of all microcomputers sold anywhere on the globe over the past three years, there are some countries where none of these machines is available and where some other computer, perhaps one produced domestically, is more prevalent. To make the results of the UNIDO/IIASA project also useful in those countries, we have adopted a set of software standards that will extend the utility of the final programmes beyond the family of six reference machines.

Software Requirements

Participants at the meeting indicated six criteria that should be employed in selecting software adopted for use in the UNIDO/IIASA project. The programmes we use should be:

- easily converted for use on many different computers,

- conceptually straightforward, so that programmers with minimal skills can convert the UNIDO/IIASA programmes to suit local conditions,

- available in the public domain for free or subject to purchase at minimal cost,

- easy to understand, in their essentials, by those with no prior programming experience,

- readily adaptable to a variety of the common industrial management functions, and

- compact enough so that they can be implemented even on the smallest member of the reference computer set, the SHARP PC-1261.

These criteria dictated by the selection of two programming environments, one provided by the family of BASIC interpreters or compilers and the other provided by the spreadsheet machine language programme.

BASIC is the world's most widely used computer language. Virtually every microcomputer is provided with a BASIC interpreter. While there are minor differences among the widely-used versions of BASIC, it is quite straightforward to convert a BASIC programme that runs on one machine into a BASIC programme that is suitable for another BASIC is also conceptually simple to use, and even programmers with modest skills can understand a BASIC listing developed by another programmer and modify it for his or her own purpose.

Spreadsheets are the most widely sold form of microcomputer programme. For example, there are over 50 spreadsheet packages available for the IBM-PC.

The following list of spreadsheet attributes is taken from that chapter by Andrew T. Williams:

> "An electronic spreadsheet is the automated counterpart of an accountant's pad or ledger sheet ... Spreadsheets apply their problem-solving capabilities to the gamut of business situations, from reports and budgets to forecasts and profit-and-loss statements.
>
> Three elements are behind the overwhelming popularity of the electronic spreadsheet as a business tool. First, the screen layout of columns and rows ... present(s) a format familiar to even the most reluctant computer novice. Second, there is a direct connection between the words, number, or formulas you place in the cells (of the spreadsheets) and what appears on the screen ... constructing an electronic spreadsheet is concrete rather than abstract.

Finally, the spreadsheet gives you instant feedback. Because you can see each entry on the screen as it is entered, you can correct it immediately if it is wrong.

In addition, a spreadsheet programme automatically calculates a formula or a function, then displays the results. You can change assumptions as often as you like in order to quickly answer "what if" questions."

I ~~would add that the~~ spreadsheet requires only a logical mind and familiarity with algebra. No elaborate programming languages are required to use it. The basic spreadsheet programme is tailored for use in a specific application by creating a template, a set of numbers, formulas, and labels that fit into the cells of the spreadsheet matrix. Templates have already been developed to deal with a wide variety of factory management tasks. One principal objective of Phase II will be to survey the available spreadhseet templates, identify those that are related to tasks of interest to UNIDO, and then adapt the best of them for use on the six reference microcomputers.

~~Our~~ development work will be done on the IBM-PC. We will use the spreadsheet incorporated in Lotus 1,2,3 to create the basic family of templates. Then each template will be reduced in complexity to fit the progressively smaller computers in the reference set.

The second principal objective of Phase II will be to create the UNIDO facility, the documents, and the training techniques that can permit the selected templates to be widely dissseminated. Microcomputer-based instruction will be used in this connection, and it is with the teaching tools that we will employ the second software standard, BASIC. All the tutorials, games, and models that are developed for use in the training programme will be written in BASIC. Important in the design of these tools will be the feedback received from the first session of the workshop we organized in September 1984.

Preliminary Feedback on the Training Techniques

The second workshop, scheduled for summer 1985, will provide us with much more feedback on the best techniques for use in disseminating the materials developed under the auspices of the UNIDO/IIASA project. However, we did experiment with a variety of different teaching techniques at the September 1984 meeting.

- What is the nature of your work?
- What was the most valuable part of the workshop for you?
- What was the least valuable part?
- What one change or addition would most improve the workshop?
- Please describe in what way, if any, you intend to use the concepts, materials, or techniques of this workshop in your own work.
- In your home country, for what sort of audience do you think a workshop like this is most appropriate?

Appendix I is a summary of the responses to these six questions given at the end of the workshop by the participants.

Sources of Information for the Surveys

An early objective in Phase two will be to conduct two surveys. The first examines literature sources to identify firms that supply suitable templates. From analysis of those sources we will develop a catalogue of available spreadsheets and templates for the six reference microcomputers. The second surveys development professionals to identify the most important functions that should be addressed by the spreadsheet templates we adopt and the most important features we should incorporate in the templates adapted for the UNIDO/IIASA project.

The list of the firms receiving the software survey will be compiled from software catalogues for each of the six computers. This will give a sample of about 100 recipients.

The list of professionals who will receive the questionnaire about priority functions to be addressed within the area of factory management will be drawn from the consultant rosters of UNIDO, UNDP, the World Bank, AID, and the IDRC in Canada. An example of the materials to be used in this part of the study is the book, Consultants Available to Developing Countries. This report, prepared and distributed by UNIDO's Project Personnel Recruitment Section lists about 200 outstanding individuals along with their areas of specialty. Working in close collaboration with UNIDO staff, we will select 100 individuals from this and related publications.

II. INTERIM REPORT ON SURVEY OF PROFESSIONALS DATA SOURCES

The aim of the present project has been defined "to increase the expertise of industrial managers and public officials responsible for allocating financial and personnel resources within industry".

This aim is to be achieved, inter alia, "by assembling a set of computerized training tools that can compensate for the lack of trained industrial management personnel in the developing countries".

In this connection, UNIDO and the contractor agreed that one of the initial steps would be an inquiry to a representative sample of persons in the various developing countries, knowledgeable in economic, and particularly industrial matters, in order to obtain a clear picture of which specific areas of industrial management should receive priority attention. One of the tasks of the project was thus defined:

> A survey conducted by the UNIDO/IIASA staff of professionals in the field to identify the best available microcomputer-based decision making aids.

To carry out the survey one must first identify a substantial number of institutions and individuals living in or knowledgeable about developing countries who can provide guidance to UNIDO in such matters. This is our report on the sources of information to be used in compiling the mailing lists for the surveys of software.

There are currently well over 100 so-called developing countries. In each of them there exist institutions which have as one of their aims the improvement of the economic situation through the introduction of better methods of selecting, establishing and managing industrial enterprises.

These institutions are of various kinds and include governmental subdepartments, universities, chambers of industry, development banks, associations of industrialists, trade groups, research institutes, centres for the improvement of productivity and others.

In order to obtain a properly balanced picture of the problems that may be addressed with the UNIDO/IIASA project, it is desirable to obtain opinions from a good number of these diverse organizations.

Various indexes exist (some produced by UNIDO) that identify such organizations. We have obtained many of them and have selected the following as sources of information for the survey:

1 - MANAGEMENT ADMINISTRATION AND PRODUCTIVITY: AN INTERNATIONAL DIRECTORY OF INSTITUTIONS AND INFORMATION SOURCES

International Labour Office, CH-1211 Geneva, Switzerland

2 - GUIDE TO TRAINING OPPORTUNITIES FOR INDUSTRIAL DEVELOPMENT

Training Branch, UNIDO

3 - DIRECTORY OF INDUSTRIAL AND TECHNOLOGICAL RESEARCH INSTITUTES

Development and Transfer of Technology Branch, UNIDO

4 - DIRECTORY OF ORGANIZATIONS IN DEVELOPING COUNTRIES FOR DEVELOPMENT AND IMPLEMENTATION OF INDUSTRIAL INVESTMENT PROJECTS

Factory Establishment and Management Section, UNIDO

5 - DIRECTORY OF INDUSTRIAL INFORMATION SERVICES AND SYSTEMS IN DEVELOPING COUNTRIES

The Industrial and Technological Information Bank, UNIDO

6 - FINANCIAL RESOURCES FOR INDUSTRIAL PROJECTS IN DEVELOPING COUNTRIES (II)

Published in UNIDO's Industrial Investment and Financing Series

The above directories contain well over 3,000 entries; the difficulty will, therefore, not be to identify addresses; but rather to select a small, yet statistically representative sample from these addresses for the purposes of the intended survey.

This will be a mechanically tedious task, but one that is conceptually easy to do. With concurrence and assistance of UNIDO we will not entirely rely on the existing printed lists, but will also make use of its Senior Industrial Development Field Advisers (where such exist), or else the Offices of the Resident Representatives of the United Nations Development Programme in the following manner:

> At the same time at which the questionnaires are being sent directly to the selected recipients, six of the same questionnaires are sent to the UNDP offices with a request to pass on copies of the questionnaire to any individual or organization which from the perspective of the local UNDP representation could contribute to the substance of the inquiry and which was not already directly addressed as indicated through a list provided together with the survey blanks.

Such persons could be identified as the authors of their works through computerized data banks available in the United States. In this connection we have found three data banks that appear to be particularly useful:

7 - ECONOMIC LITERATURE INDEX

> which provides a comprehensive review of 200 economic journals produced world-wide. It currently contains approximately 160,000 items, covering the period from 1969 to date.
>
> The database is property of the American Economic Association.

8 - FOREIGN TRADE AND ECONOMIC ABSTRACTS

with, approximately, an equal number of indexed items, including about half from non-English language sources.

This data base originates with 'De Stichting Economische Publicaties' and is produced by the Netherlands Foreign Trade Agency, The Hague.

9 - MANAGEMENT CONTENTS

This data bank contains about 175,000 items and (according to the originators) "is intended to provide the most current and retrospective information on a variety of business- and management-related topics to aid decision making and forecasting".

We have examined some of the supporting information on this data bank and established that it contains a very sizeable number of entries under such headings as 'developing countries', 'industrial development', 'industrial management' and 'management development'.

As a final recommendation, we would also suggest contact with the World Bank's'Economic Development Institute (EDI)'at Washington, D.C., which is continually engaged in the training of top-level personnel in decision-making positions in the developing countries. Dr. Price Gittinger is Special Advisor for Institutional Development of EDI. We have discussed specifics with this agency. We believe that due to its unique relationship with the developing countries, it will be able and willing to make highly useful recommendations to UNIDO, relative to the present project.

The following is a suggested draft for a letter to be sent by UNIDO to its field representations, at the time at which the 'Questionnaires' are mailed to persons/institutions with interest in, and knowledge of the locally prevailing situation relative to computer applications to 'Industrial Management'.

To the Office of the Resident Representative

at_____

(For the attention of the SIDFA, if available)

Subject: Project UF/GLO/84/192 ("Computerized Decision Aids for Industrial Management")

Since autum, 1984, UNIDO and IIASA (the International Institute for Applied Systems Analysis at Laxenburg/Austria), have been engaged in a project that will develop microcomputer-based tools:

"....to increase the expertise of industrial managers and public officials responsible for allocating financial and personnel resources within industry."

The aim is to be achieved through training tools that can compensate for the lack of industrial management personnel, using modern microcomputers and specially adapted 'software'.

The project is being carried out with the assistance of a consultant organization in the United States of America (the Resource Policy Center of Dartmouth College).

In order to assure that the project indeed will provide suitable remedial action for the perceived shortcomings, a mail survey is currently being conducted to elicit the opinion of about 100 institutions and individuals around the world who are interested in, and knowledgeable about possible computer tools for addressing industrial management problems in their respective areas.

The list of addressees has been carefully prepared from the best available information contained in documentation at hand. We feel, however, that we may well have overlooked institutions/individuals who could be helpful; and we hereby request the assistance of your office in this connection.

Included you will find six copies of our questionnaire, as well as a list of those institutions/persons in your area to which we have sent such questionnaires directly.

Would you please look through the list, identify any additional institutions/individuals who in your opinion can contribute to our efforts; and transmit to them a copy of the questionnaire with the request to return it, filled in, to us, either directly, or through your office.

Sincerely yours,

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SUMMARY OF PARTICIPANT RESPONSES ON THE WORKSHOP EVALUATION QUESTIONNAIRE

1. What is the nature of your work?

Resource modelling (economic and system dynamics). System consultant.

Teaching research.

Environmental systems analysis.

Organic gardening.

Teaching mathematical and computer-based methods for managers and research work on this topic.

Research and teaching on optimal, though sustainable use of forests.

Energy and environmental systems research and teaching; management.

An implementation of numerical methods of system analysis in the management and training of managers (top level).

Dozent, lecturing graduate and post-graduate students; running training courses for senior management.

Writer; editor; communicator.

Research and teaching of water resources systems.

Applied Systems Analysis, Research, Design and Teaching on Informatics in IDCS.

Anthropology - small farm system analysis - agricultural development policy.

Teaching programming languages and modeling methods.

General economics of environment, including resource discussions.

Research on the evolution of the cooperative agriculture of Hungary.

Deputy Director of research institute, Researcher and Advisor to Environmental Commission.

UN Ind. Dev. Officer

Research and teaching mathematical ecology.

Studying soil-water-plant systems; the water dynamics in it.

Environmental protection. Metal contamination. Modeling.

Systems analysis/Agricultural modeling.

Teaching; research; service.

Graduate student in System Dynamics and Resource Policy.

Graduate student in computer modeling, policy design and analysis.

Institute for T_____Systems Engineering as a u_____eng.

Applied mathematics in economics.

Ecological development/Third word.

Models for forest harvest, linear programming, leontieff-models.

Agricultural/Environmental modeling.

Industrial Engineering.

2. What was the most valuable part of the workshop for you?

The concise summary and package of material that I can use in my own country; professional contacts. To see how participants reacted to aspects of workshop.

Integration of variety of resource systems; using of gaming as learning tool.

Integrated view - same systems principles demonstrated in many different systems.

The games. They gave me better understanding of structures and events and the amount of time it takes to make changes.

To come to know new training games and the approach to systems by their structures.

To learn the power of games in education to deepen insights in system-structure and behaviour, by playing the games and have debriefings.

Playing the games (beer production, deer game, STRATEGEM-1) and (parts of the) introduction and debriefing.

The games for strategic planning - industrial games.

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To gain insight into the concepts of systems dynamics; to run games, especially the complex Strategem-1 game; to exchange experience in developing and running games.

An increased understanding of the mechanics of system dynamics and the potential for application in management and conflict resolution. Also, the contacts.

The concept of modeling the world on systems as positive and negative loop with stocks of buffers and delays.

Agri Models, Strategem I, II - learning that such models CAN be built as games; how to present games as teaching devices.

The lectures and exercises and games were all closely integrated. Their union was what made it work. No single part was more valuable that the rest, all were important learning tools.

Presentation of systems which behaviour you experience in real life and which internal mechanism are still mysterious, not only for ordinary people, but also for politicians and top government decision makers.

The basic thinking of system function and loops, especially concerning global resources.

To learn the principles of systems analysis as a tool to approach the understanding of the world.

Games - advanced and in_____ed important systems principles; illustration - how a microcomputer may be used.

Exposure to the various models.

W_2N cycles, watershed model.

To see in work dynamic simulations; to understand their basic rules, loops; to meet experts.

The perspective coming out of the lectures and games.

Professional contacts were equally important as realizing the importance and effectiveness of gaming at conveying complex relationship, concepts.

Games.

Lectures and games demonstrating system behaviour.

Interaction with other participants; learning different views, ideas about the needs and applications of systems analysis in resource issues.

The use of gaming in order to make clear some basic structural connections, and the understanding of these.

Having the audience actively take part in the workshop, which was very well organized and prepared.

The development of a epistemology, that in my view has a future. The delineation of behaviour, structure and events, the levels and relationship of systems which approach reality and the ability to "see" time - past, present, and future.

The understanding that small simulation models can be very useful instead of very big - which are difficult to run.

The experience with playing games.

The games, which proved that you can have a better idea of systems by them, and that they make you ask questions that might not have come to mind otherwise.

3. What was the least valuable part?

Intro sections on systems and modeling methods, but these are most important for most.

About the sustainable agriculture, data from Germany and U.S.A.

(Parts of the) lectures because they were written down and were too narrowly focused or too disconnected to over-all aims.

Insufficient explanation or instruction in technical areas.

The minerals deflation model (if at all) better say none.

Cannot recall not being kept interested.

We did not have enough time to think the models presented over and over again. The lectures were loaded with information and kept us concentrated all the days long.

The time is too limited to get a real, deep understanding of all the variables used in the model.

Global modeling concepts.

The economic applications.

The microcomputer models, because I have some experience on that.

Small scale models seem poorly developed, in general, the small amount of feedback - too easy to win - gives a simplistic and negative impression of the value of these tools.

Lack of presentations by other people working in Resource Systems.

The goals, stated objectives, were almost too comprehensive for a 5-day conference. The 5 days were a great introduction to systems concepts.

Some details in certain models were far from my interest - at the moment at least.

Had not enough time to read our notes and think them over, as we received them on the first day. It would be useful when participants got them in advance.

All of it was relevant, as I am not a systems dynamist, or a computer expert.

To play games without having a preliminary introduction of the model.

Lectures on the basics of systems dynamics.

4. What one change or addition would most improve the workshop?

A better ice-breaker at the beginning of the conference to better encourage social interaction between participants. Perhaps a facility with a more inviting lounge area could be better. Country on nametag.

More use of computers to demonstrate behaviour of very simple systems at the start as lead-in to more complex models.

Better documentation for Stratagem game; brief for reference during the game. Complete notes for all sessions, following same general outline (systems principles - components - specific system - model - results). Workbook to take home.

For non-economists it would be helpful to have some definitions of the vocabulary used in Strategem.

To have a broader and more comprehensive review of new results, including the list of references, publications, names of best authors on the topic, etc.

To start with a lecture about principles of modeling (and system dynamics) because I myself for instance have not practical experience on modeling. The importance of loops came out during the week.

A more systematic, concentrated introduction into the possibilities, limits and principles of system dynamics (analysis); adding a session in which you construct/analyse a small system yourself together with two or three other people, in depth.

To give an instruction for each topic for what sort of audience is most important and which is the way to introduce the topic and the game.

This workshop was mainly concerned with environmental problems. If the participants would come from industry, other kinds of models would be requested as well.

Better definition of the role of aides or supervisors in games - e.g. as advisors, consultants, sources of information.

Film in the middle of the workshop showing the dynamics of the system. (In Stratagem-1 not known end of game (the moderator sets it during the game to 40, 45 or 35). The results of some changes in useful data that are available on the computer can be seen in the film in a continuous way, e.g., showing how the limit becomes erodable, etc. However, it is necessary to start by computer exercises and the film can add the possibilities and will be better understood if it is given after the computer exercises.

More time to study the structure of each game/model before it is played (Maybe this is not desirable).

Increasing skills is causal loop diagramming so that we could use those tools to replicate our understanding of the structure after the games. It was still hard for us to verbalize or communicate our understanding of structural relationships.

More time for reviewing models, concepts, etc.

The relation in the model are primarily of physical type, that means that the models are too optimistic because the international and national political restrictions are not in the model. In all of the model the goals of the people, the firms and the political leaders (in all countries) are the same because of the building of the models (games). This point is not specified in the model (or the lessons). I think because of these reasons that the models can be misleading. If they are used to teach decision-makers the function of the world.
Of these reasons, I think it will be very good to have some lessons on political science in the workshop.

To situate the systems approach within the sets of other analysis tools.

Better understanding of principles of the games in advance (That may provide more possibilities to check my strategy during a game instead to learn its principles).

Have a few managers from the developing world (cross-section).

Problems of system identification on conceptual level, maybe some theoretical background for the Kaibab model.

Something more detailed on the functions of the models.

Of course, there have to be changes in the presentation according to the audience. This workshop in this form will not work for all types of audiences.

MORE WORK ON CAUSAL LOOPS.

Addition - Get together activities for the whole group or small groups.

More roundtable discussions, exchange of participants knowledge and experience with policy implementation.

I think it would be useful and come easier to have a longer introduction before playing a game, in order to have a better understanding for people having different backgrounds than economists.

You should invite to such a workshop also operating managers and not only experts from different institutes. (Or not only managers should be invited, but practical policy makers tool).

It may not be possible in the time, but I would like to learn how to make a model.

It will be very useful (for me!) to have an idea what sorts of applications need simulation or optimization or human decision-making.

Reduction of lectures on basics; extension of gaming - have another possibility to play after evaluation, (more) lectures on the issues learned in the games and possibilities to discuss them.

5. Please describe in what way, if any, you intend to use the concepts, materials, or techniques of this workshop in your own work.

Direct use of written material for teaching purposes/reference.

Will be part of research and teaching programme at RPC.

In graduate and undergraduate teaching; running 2-3 day seminars for policymakers; adoption of approaches to <u>local</u> and <u>regional</u> management problems in the areas of energy, resources, environment.

I will try to disseminate these structure-focused approaches, concepts, methods and, of course, to use these games too, in my teaching and research more.

First, I am going to use a model-game to give students insight on the consequences of cutting decisions in the long-term (compare different methods which are usable) Second, with my colleagues to use the stratagem play in workshops which are held on rural development.

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1) Introduce one or more games into our 6-month resource environment course (merged with our own models).
2) Induce researchers to construct small models to get insights into their system-under-investigation.
3) Offer to government officials, civil servants, utility managers, etc. to play the game.

1) I think to use the___games - Strat. 1,2 in the courses for our managers. I will adopt the games and I will do some experimenting with them. I will write you about the results and changes in the games.
2) To create games like these.

The Strategem-1 game will be used in several universities and polytechnics of the GDR. I will use it on the 1984/85 UNEP Course with Technical University of Dresden.

I shall use the concepts to advocate an ecologically benign approach to politics, policy lifestyle, world view in teaching and writing, (books, articles, newspaper columns).

I intend to prepare a computerized game on water resources systems with _____ _____in two versions.
Version 1 - simple for teaching purposes (3 hours maximum playing time);
Version 2 - more complicated for a group of researchers I am the chairman of.

1. Will be used in training Systems Analysts.
2. Will be used to begin teaching Systems Dynamics.
3. Will be used with the Western___Project at Poona View.
4. Will be used in workshops/seminars sponsored by Dept. of Environment.
5. Will be included in training courses on luprmetics for Government officials at the SRI and also at state and central government training centers.

I think that the basic set of concepts of System dynamics have a very wide application in many kinds of analytic thinking. I would try to teach those concepts and use the games that illustrate them with students of development policy or with planners. They are critical in the arena of socio-economic change. I would also use them to more effectively implement policy. Analyzing farming system.

Excellent way of communicating people. Perfect organization of lectures - I am going to use the same technique in teaching. Since I got a full set of materials - I will be promoting the method of S.D. among students, university staff and state government staff through games rather than just lectures.

I am going to discuss with other persons in what way it is possible to use this material in the state administration and in university, technical schools, also.

I intend to use this material as a complementary tool in my economic research. Also, I want to use it as a teaching tool to make students understand the relationship among structural behaviour and events.

They will enlarge concepts and tools for solving problems I face in my research and_____ation activities. They will help me to convince decisionmakers to understand and use systems approach in their d.m. process (I hope).

For teaching (exposing) managers in the developing world to concepts discussed during workshop. Similar types of workshop will be developed.

Gaming is probably the most powerful teaching aid. They help in visualizing the theoretical results in the ecological research.

Adapt the models which are close to my field and try to improve their parts that they be more adoptive. To use them up for demonstration of structure and function of given systems (e.g., scil N) for students and experts, too.

I would like to use it for teaching at University. Also, I would like to be able to bring out the perspective to management people, politicians, and media.

I will be trying to encourage planning people of FAO/Rome (Agriculture Dept.) to use causal loops, gaming in development work.

Viewing system in the S.D. approach by using games to gain insights into the problems.

This workshop has helped me improve my ability to explain these concepts to others. Games and models are an excellent, quick way to add an interdisciplinary dimension to the work of many specialists.

I got new ideas for modeling that can be useful in my work, though those models are a bit different.

The main purpose was here to learn as much as possible. To tell the truth, the most useful things I have learned here were in the theory of system, i.e., those things which I have learned about the role of feedback loops, about nature of over__ __ing-collapse systems, etc. I would have liked to hear more about the creation of systems: What kind of relations are supposed between the different factors, how were these relations calculated, etc. (This was only briefly concerned when you spoke about nonlinearity.)

First, as a way of assessing the economics and structures of countries I work in.
Secondly, as a conceptual basis for natural resource development.
Third, I want to link the design principles of one organization with systems dynamics models, to create forms that are a synthesis of both.

To build some simulation models for the harvest policies.

1) Include the concepts into my own models.
2) Eventually use gaming techniques in conveying results - in addition to plain model results.

With my_____at the University. Some of the games are applicable in the form they are. Some have to be implemented for_____I think by trying to keep this high standard ____by the workshop they will be very useful.

6. In your home country, for what sort of audience do you think a workshop like this is most appropriate?

Government policy makers, business school students (and teachers).
Business executives. Teachers on all levels.

For workshops: Mid-level managers in sectoral agencies, congressional support staffs (federal, state).
For gaming materials: Very broad audience including college and pre-college students, etc.

Junior and senior policy makers; key people in the media (press, radio, publishing, TV); politicians.

Students

First of all, for the young researchers (like me).
I think, it is very important for them to get international practice and personal relations, and, on the other hand, young people can understand the new methods (rather than old ones).

1) Top-level officials in ministries, because they stay after government changes.
2) Politicians
3) Teachers, lectures.

In rough priority:
1) Government/research people with resource/environment/economics interest.
2) Industrial/utility, etc. managers
3) Teachers (university, teaching schools, etc.)

For researchers and managers' trainers.

For scientists who are willing and able to run complex games in all kinds of higher education. The aim of such a workshop could be: to teach people how to run games in order to provide knowledge and awareness of the dynamics of very different real world processes. Therefore, it seems to be important to teach the teachers! - because it would not be possible to run such a workshop together with all peoples being interested.

Teachers, managers of all sorts - industrial, government (at all levels), students.

1) For the graduate course that is scheduled on water resources systems on 1986 (may be 1985).
2) Decisionmakers in the ministry department leader levels.
3) Researchers, students.

Smart civil servants, PhD students, faculty involved in Agro-socio-economic-science faculties.

Students, planners, managers - the basic concepts should be integrated into education at an early level.

University staff; students; top managers and government officials (they often neglect methods or models they do not understand).

Persons in Central Administration (ministry of environment, agency of foreign aid); universities, technical schools.

For social science students; for executives from private sector; for government medium and high level officials.

Research workers and decision makers.

Ministers

1
1
Guard (Army)

Top level managers; environmental scientists; students.

Medium level leaders of bureaus making decisions (e.g., in the Ministry of Food and Agriculture)and some of the lecturers at Universities.

Almost all types of audiences that have any influence could benefit from this type of workshop.

Almost anyone. But most valuable to local policy makers.

Young and potential administrators; graduate students.

Policy makers and policy researchers. So far this message seems to be directed to those we expect to be receptive. How do we teach those whose initial interest is lower?

APPENDIX I

People with backgrounds in resource analysis and management and some idea of modeling. Anybody can use a clearer understanding of system structure/behaviour. In this form, though, the workshop is most effective for people who are already familiar with and receptive to a systems modeling concept.

For the people making the long-term decisions, or for those, who will make these decisions in 15/25 years from now.

Perhaps it would be appropriate for university students. For example, in the University of Economics of Budapest there is a compulsory course for <u>everyone</u> playing a game which is something similar to the distribution one.

I think all types of people and sectors would benefit equally, much like mediation for conflict resoultion applies from interpersonal realtions to nations. Personally, I would like to see bioregional groups get a high priority of attention.

Top decisionmakers (and/or) programmers for planning models.

Advisors to decisionmakers right now - but after a certain success these decisionmakers themselves should be the target.

To all kind, if so well done as this one.

Comments:

Need -

Redesign of Strategem-1 description sheets is badly necessary (lay out change).
Debriefing manual;
Description of how to run the game.

Develop a comprehensive workbook, following the general sequence of (most of) the present notes. Text should cover:

- list of principles
- explanation of corresponding generic structure
- system/casual loop diagrams
- real world examples (verbal)
- models thereof
- simulation results
- small basic models to run on your own house computer
- suggestions for similar studies - related systems
- references/literature, etc.

Send literature and a collection of recommended articles (like in the Notebook used here at the workshop) <u>before</u> the seminar. It would be <u>much more</u> effective if participants would have ahead to prepare for it.

A more thorough discussion on the actual impacts/limits/ benefits of the S.D. approach and method. (More) insight into interdependencies and the need to know about the whole.
An inspiring tool to get people's attention and energy to deal with resource, etc., systems/problems.
(About Strategem-1) There may be an inherent "interventionist bias" in the game, inducing the illusion/arrogance/expectation that some people are governing (managing, mastering) a system for some (mostly implicit) system goals. In the end life is by and for people, who are not to be sustained but are to be enabled to live their sustainable life. (or shift the burden to the (addicted)(STRATEGEM) interventionist). To put it otherwise: many of the people in the world are 'rigidized' into relations without giving them flexibility/freedom/ anticipation/resoulution or whatever.

I would like to receive all of the next materials about the Games, if it is possible. I think it is possible to hold the next workshop in Bulgaria next year in the summer again.

If it would be of interest for another workshop, I would be glad to present a complex management game that shows how to manage industrial enterprises in GDR, their interdependencies and problems of international trade between the GDR and Great Britain.

1)_____was very good. Much better than any course to which I have gone.
2) Teaching. All the instructors were very clear; they also had genuine command over their material, which gave great credibility.
3) First Faculty and Assitants. The Dartmouth staff were very good in that they were there, they were helpful without being pushy or directive. Dr. and Mrs. Todd were an excellent addition to the resources.
4) Use of technology for teaching. Very impressive and instructive how micros and other tools were harnessed.

1) In the gaming and computer simulations more emphasis should be placed on always relating them back to the structure which caused the behaviour. The tendency was for attention to slip to behaviour and the structure remained mashed in certain occasions - particularly computer simulations.

2) The diagraming provides a vocabulary for talking about structure and dynamic systems - A few exercises for the participants in this vocabulary in the beginning might help them to more clearly perceive and conceptualize the structure in the systems reviewed later. This would have been very useful.
3) Perhaps a little clearer definition of goalds and code. Ultimate goal is to learn about system dynamics modeling as conceptual tool? Or, to use that as a means to understand about sustainable agriculture? This seemed to get somewhat confused, although I personally found the balance appropriate.

If it was possible I would like to participate in the next workshop of this kind, to be able to:

- share my experience with playing the games shown here with different audiences in my country.
- learn more about methods, concepts and models of sustainable resources.

I think, that in respect of the topic of the conference, which was to teach people to think in terms of interrelated mechanisms resulting with very surprising behaviour, you manage to get the best people in the world to do this job. Prof. D. and D. Meadows and Prof. H. Bossel did it in a perfect way and made us participants not only think about reality in this new way, but also willing to promote this method itself and the methods used during the workshop, back in our countries, to convince other people that this is the way to understand the reality better we do now.

I think that having a time spaced for the presentation of a positive experience just as John Todd's would be very useful to see an actual result. Also, teaching at high school level in developing countries is very important for creating a more analytical mind.

Thank you for providing this opportunity.

The workshop was organized on a very high level.

Thanks for the invitation!

As mentioned before - I would like less flow diagraming more causal loops. I also think that one make of computer for all models would be better, less confusing. All games should be immediately debriefed by asking participants (as a group or as individuals) to write causal loop diagrams of the systems.

Models and games in this workshop will be modified/adjusted to that situation and environmental condition in order to explore solution to existing resource and environmental problems in Thailand. The concepts, materials, and techniques acquired from this workshop will be used to organize similar workshops, seminars or teaching conferences for government officials of different ministries.

These concepts, materials and techniques will also be used in graduate courses in sustainable resource systems at Mahida University as well as other universities in Thailand. Thai case studies in resource management and problems will be used to bring these techniques to appropriate people in government sectors and private sectors.

Some comments on Strategem-1:

1) The high equilibrium conditions given on the score sheet provide an only one set of desirable results. They seem to distract people from thinking about structure and behaviour.

2) The game board still needs work, somehow the relationships between sectors need to be made more graphically clear.
3) The initial conditions are confusing for the players to set up. How about a neatly printed cardboard sheet, for each table with the equations clearly shown on one side and the set-up procedure on the other side.
4) I have observed over the past few months, that people whose first language is not English and those from non-western countries have the most trouble getting started with the game. The written descriptions need much simpler language and possibly graphics.
5) A great spinoff version of Strategem-1 would expand the energy sector into renewable and non-renewable energy types with varying capital lifetimes costs, etc. Other sectors of the game might have to be aggregated in order to maintain a playable level of complexity.

The goals, stated objectives, were almost too comprehensive for a five-day conference. The five days were a great introduction to systems concepts.

III. STRATAGEM I

STRATEGEM I is one of the three computer programmes that will be developed by UNIDO/IIASA.

For additional information on Strategem I and the forecoming programmes, please send your inquire to the following:

Factory Establishment and
Management Section - FCTY

UNIDO

P.O. Box 300

A-1400 Vienna, AUSTRIA

or

Prof. Dennis Meadows

Box 8000

Dartmouth College

Hanover, NEW HAMSPHIRE 03755

U.S.A.

COMPUTERIZED DECISION AID FOR INDUSTRIAL MANAGEMENT

A key factor governing the success of activities to establish factories is balanced structural development within the sectors of a regional economy. Creating a successful strategy requires insights into sectoral interactions, marginal rates of return, delays inherent in investment, and many other concepts.

This model, the first element in the UNIDO library of mangement training tools, is designed to convey those insights.

In this report we provide a complete description of the theoretical content of the model, indicate how it may be used to train managers responsible for investment strategy, and give all technical details required to implement the model on the microcomputers selected as the standards for this project by UNIDO and IIASA staff.

PAGE

ANATOMY OF A TYPICAL SESSION

In the game between 5 and 10 players are required to make up the team required to operate one country, represented by one complete board. A single instructor, with an assistant who enters data into the computer, can monitor 2-3 boards. I generally have 1-5 assistants, and my sessions have typically involved 5-35 participants.

I gather players together in a group for a brief lecture on the different purposes of operational gaming, the specific goals of the present session, and the history of STRATEGEM-1. This may take between 5 and 90 minutes depending on the total time available for the whole session and the prior preparation of the participants. If it all possible, distribute one role description to each player in advance of the game, so that he may study the precise rules of his sector before the briefing.

Next I assign each person to a specific board and particular sector (population, energy, agriculture & environment, industry & human services, and international). This permits each person to focus special attention on those parts of the instructions that especially affect the sector he will manage. Then I explain the purpose of the game; the function of the board, the markers, and the computer; the character of the five different flows on the board (population, energy, food, goods, and money), the steps of play, the ways to win, and the function of the data sheets. Finally, I go quickly over the basic cause-effect relationships that will govern the behavior of each sector during the game. All of this is accomplished through reference to a set of overhead projector slides (8"x11" clear plastic sheets).

Then I sit the participants at their respective boards and sectors and tell them precisely how to make the first four decisions in the first cycle. This acquaints them with the cycle of play and familiarizes them with the movement of the markers and the function of the data sheets. I next set each timer for about 15 minutes and tell each team to make decisions #5 - #9 for themselves. They must allocate their investment capital among the six capital stocks and decide what to do about loans and imports. It is important during this period to make sure that the players record their decisions properly. By listening to the discussions it is often possible to detect serious mistakes in some individual's or group's understanding of the rules or the underlying cause-effect mechanisms. These should be corrected immediately without mandating any particular decision.

At this point the groups are ready to go through the remaining cycles more or less on their own. I use the timers to stagger the groups, so that each one delivers its data sheets to the computer operator at a different time. It typically takes about 3-5 minutes to check the internal consistency of decisions written on the data sheets, to enter the data, and to print out the resulting inputs for one group's subsequent cycle.

Initially it may take 25 minutes for a group to get through the decision cycle. By reducing the time setting on the timer each occasion the computer results are handed back, it is generally possible to reduce the cycle time to 15 minutes after three or four rounds. If one group is especially slow, I ask them to change the way they decide how much to invest in each of the six capital stocks. Instead of making the decision by consensus, I have them make decision #5 by distributing the goods available for investment equally among the players managing each of the five sectors. If five minutes of discussion does not produce a group consensus on the allocation of that capital, each sector's players are then free to decide individually how they wish allocate their share of the goods for investment among the six capital stocks. This speeds the game considerably.

It is crucial to have at least 60 minutes to discuss the game and reflect on its lessons after the play. Even 2-3 hours may be fruitfully used for this purpose, if it is available. Schedule constraints may sometimes require that the game be terminated before the full ten cycles are played. This is very undesirable, since some lessons only become clear over the full period of play. However, most principles illustrated by the game may be observed from the game's behavior over as few as 5-8 cycles. The session is ended upon conclusion of the debriefing.

The description above applies to the occasions when the game is played in one period without interruption. However, STRATEGEM-1 is also suited for use over several weeks or more. For example, students in a university course might play the game over the entire semester - submitting decisions for one cycle each week. This approach gives much more time for reflection, negotiation, and the development of sophisticated strategies. It also permits the professor to integrate the principal lessons of the game with the schedule for the course.

DESCRIPTION OF REQUIRED MATERIALS

Each game requires the following materials and equipment (except that only one computer and STRATEGEM-1 computer program are required for up to 5-10 boards. To administer a session with one or more boards, the operator should have:

* a version of the STRATEGEM-1 computer program in a form which can be loaded onto the computer that will be used with the game. Since each program can monitor several boards simultaneously (up to 10, depending on the memory of your computer), only one computer and program are normally required for each gaming session.

* a full listing of the computer program for STRATEGEM-1 (provided on pages 65-73 of this user's manual).

- a computer with screen and printer compatible with the program (when more than one group plays at the same time, the printer should preferably be 40 characters per second or faster).

- an electrical socket adapter or a special power supply, if those are required to operate your computer and printer in the host country.

- an operating manual for the computer plus a user's guide to the specific version of BASIC implemented on the computer.

- sufficient printer paper to produce all the printouts required during the game.

* a copy of the official STRATEGEM-1 playing board with a denomination key suited to the pieces that represent capital in the game. This board (illustrated on page 11 of this manual) is about 30" x 40", and it is imprinted with a denomination key suited for the pieces normally distributed with the game. Two alternative keys are provided on page 87 of this manual.

* a 30-minute clock timer with bell to pace the cycles (a spring-driven timer designed for use in the kitchen works well).

* 10 or more pieces of each denomination of money used in the game - typically these are 10's, 50's, 100's, 500's, 1000's, and 5000's. These may be reproduced

or cut out from the originals included on pages 87-99 of this manual.

* goods markers differentiated by size and color to represent the different denominations of physical capital - typically six denominations are used: 10, 50, 100, 500, 1000, and 5000 (the amounts required vary between 25 and 100 of each marker). I have experimented with many different sorts of markers. Currently I use pieces of three different sizes - 8mm, 12mm, and 16mm - in two contrasting colors.

* population markers differentiated to represent units of 10 and 100 people (10 units of 10 and 5 units denoting 100 will suffice).

* five different role description sheets, each 3-5 pages in length (provide one of these to each player).

* five different data sheets (only one set is required for each sector; the energy sector set has two pages and the other four sectors have only one page). These are the only materials in the game that must be replaced for each new session.

- a wall chart summarizing each group's progress over the course of the game is optional. A sample is illustrated on page 57 of this manual.

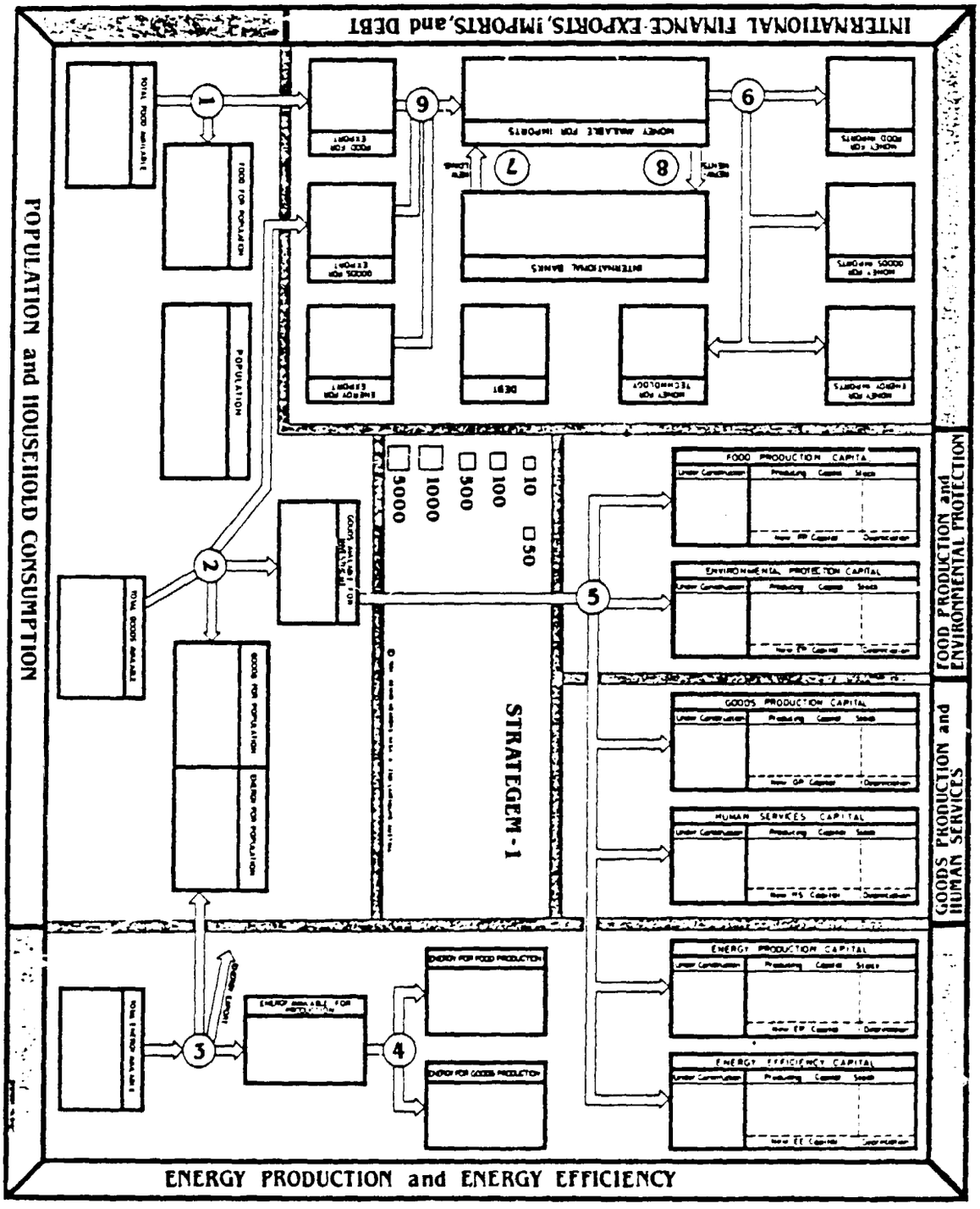
- a wall chart showing all the principal graphical relationships is optional. This simply provides in one place all of the graphs provided in this manual as figures 1-15.

- supplies that are useful for the operator but not mandatory include tape (for holding down the boards or taping together two tables so the surface is big enough to work on), pencils, a few cheap calculators for use by the players, and extra data sheets.

* a set of overhead projection slides that are designed to facilitate the introduction and debriefing.

- an overhead projector, if you intend to use overhead projector slides. This should come with a spare projector bulb and a plug that matches the style of electrical outlet found in the host country.

ILLUSTRATION OF THE GAME BOARD



SETUP PROCEDURES

It takes about 30-60 minutes to set up the games. Be sure to leave time enough to complete this step fully before arrival of the participants.

Lay out the boards so that all are arranged in the same way, for example with the population sector on the north side of the table. Make this alignment correspond with the orientation of the overhead projector slide of the game board that you use during the introduction. It is best to find tables that leave 8" to 15" of clear space around the edges of the board, although this is not absolutely essential. It is convenient if the players can have this space for their papers. Tables should be placed far enough apart that the conversations of one team do not disrupt the discussions of teams nearby. A distance of 2-3 meters is normally sufficient.

In the center space of the board put:

- a timer.
- cups holding the extra markers segregated at least into three categories (10 & 50, 100 & 500, 1000 & 5000).
- one of each size and color marker located on the appropriate place on the denomination key to indicate its numerical value.

In the INTERNATIONAL BANKS area put the money in separate piles by denomination.

Then initialize population (probably = 200), all the physical capital stocks, and available food, goods, and energy. Put into each square the amount specified in the top section (labeled "YOUR SECTOR'S STOCKS") of the left-hand column of the data sheets - the initial conditions for cycle #1, 0-4 years. It is generally more convenient to put a number of smaller denominations of pieces representing some factor such as "TOTAL ENERGY AVAILABLE" in the square (for example five 10's and one 50 rather than one 100). This makes it more convenient for the players to make their subsequent allocations of the factor.

Put the data sheets and the role descriptions next to their corresponding sectors. Lay down there name tags as well, if you wish to have your participants wear labels that designate their team number and their sector.

Set up the computer at some convenient place and make sure that it is producing results consistent with the initial conditions used in your data sheets. Be certain that your batteries will last through the entire session, if your computer is not

connected to the main electricity grid. Be sure that you have enough computer paper.

To save time you may wish to fill out the first and the last columns of the data sheets for all five sectors (the columns for "YEARS Ø-4" and for "HI. EQ." using the numbers generated by the computer program. These benchmark outputs are listed for your use in a later section of this manual. Alternatively, give the players in each sector of each team the two printouts they need to fill out their own sheets for the columns labeled "Ø-4" and "HI.EQ.". In either event have them check their sector of the board and see explicitly the correspondence between the initial column of their data sheets and the quantity of physical markers on the playing board.

HINTS ON OPERATING THE COMPUTER MODEL

If at all possible, give one person in your team full-time responsibility for operating the computer, so that you and the other operators may concentrate fully on monitoring the boards, answering any questions, and correcting any mistakes.

Set up the computer and the printer far in advance of the play to give plenty of time for correcting errors, in case there are any problems. Lock the computer keyboard in upper case mode (D, H, Y, N), since the game program will not accept responses typed in small letters (d, h, y, n).

Assign one member of each group of players to act as a team captain. The captain accumulates all the data sheets at the end of each cycle and checks the decisions of each sector in his group for accuracy and internal consistency. Then he or she brings the sheets over to the computer operator and waits for the printout, which must be cut into five pieces - one for each sector - and returned to the group members along with their respective data sheets.

The following are the computer's and the operator's statements during the first cycle of play together with my explanatory comments. To distinguish them from the remainder of the text, questions generated by the computer are in bold type and underlined while statements entered by the computer operator are in bold type without underline.

RUN STRATEGEM-1 This or some equivalent statement is used to initiate execution of the model. Of course the precise command depends on the identity of the computer and the BASIC compiler you are using.

ENTER THE NUMBER OF COUNTRIES=? **#** In place of # the operator types in the integer that equals the number of boards to be operated from this computer. The theoretical maximum number is dictated by the memory in your computer, but the practical maximum is not more than 5-6. More games than that operated from one computer will impose great delays on the different teams as they wait for data to be entered and printouts to be produced. The major delay is not caused by the process of computation, which is only 10-30 seconds, but by the speed of the operator who inputs the data. When I have to operate more than three games simultaneously, I run two computers in parallel.

DO YOU WANT TO START FROM DEVELOPING OR FROM HIGH EQUILIBRIUM? (D/H)? **D** This response initializes the game with coefficients representative of a developing country. The other option, H, sets up the game in a high-equilibrium, with constant population, food consumption, etc. The H option is therefore not useful for initiating a game. The H option is only included to illustrate one possible outcome for the game. This is not the only

successful outcome, and it is not even the best that is attainable.

COUNTRY: 1
REPORT: FULL, RECORD, SUMM, NONE (F/R/S/N)? F There are three different, optional parts to the printout:

1. data required for the Data Sheets of all five sectors,

2. data that summarize the present value of the x-axes on the 21 graphs used in each game. In STRATEGEM-1C only 15 graphs are active in the game. They are illustrated in the user's manual. Six more are involved in defining new technology options. Those six relationships are incorporated in this version of the computer program, but they are set with coefficients that render them inactive. Consequently, they are not illustrated in the manual.

3. data that summarize the score and overall success of each team.

"F" gives all three, exactly as shown in pages 83-85 of the User's Manual (where the left-hand column results from initializing the game with "D", and the right-hand column results from initializing the game with "H". "R" gives only the data for the data sheets of the five sectors. "S" gives only the Score Sheet data - 14 numbers that generally summarize the current status of the region. "N" suppresses the output entirely and takes the computer program immediately to the point where it asks for the number of the next country for which the next set of decisions will be entered. Normally one would use "F" or "R". "N" is useful only if some mistake terminated the execution of the model in the middle of the game, and the operator wants quickly to get back to the cycle in which the mistake occurred. In this case he would type in all decisions made for all earlier cycles, but suppress the printouts, since the outputs will be identical to those already recorded on the data sheets.

After you have indicated which of four possible output options you prefer, the computer prints out the requested data. Notice that each line of data for the data sheets is coded by sector and variable number. For example, PO:1 is the first variable output by the computer for the population sector. IO:6 is the sixth variable output by the computer for the international sector.

TYPE IN THE NUMBER OF THE COUNTRY FOR WHICH DECISIONS WILL BE ENTERED!
COUNTRY=? #

Of course # must be less than or equal to the number of countries initially entered for the game being played on this particular computer. -

COUNTRY=X YEARS= X-X
IS THAT CORRECT? (Y/N)? Y

If you respond "Y", then the next cycle of data input prompts are initiated. In this question the computer program follows a procedure that it uses after each subset of data has been entered; it prints out the most recent entries and asks the operator whether or not they are correct. The recent data may be reentered at this point, if the operator types in "N". However, after "Y" has been entered, it is impossible to alter the data in the computer program without breaking out of the program and starting from the first cycle to reenter all data for all teams.

If the operator enters "Y", the computer begins to type out prompts for each of the decisions - PI:1, PI:2, etc. The data for each cycle must be entered in precisely the order they are recorded on the data sheets. It is a great aid to the person operating the computer if each team can put its country number (1, 2, 3 etc.) in the upper right hand corner of all their data sheets and if it can submit the data sheets to the operator in the proper order - population, energy, food, goods, and international.

An error checking routine is entered at the end of each subset of data, approximately 2-6 entries. If an error has been made while entering that subset, entering "N" to the computer's question, "Is that correct? (Y/N)" will give the opportunity to reenter all the decisions for that subset. Please note that once the operator has entered "Y" to signal that the immediately preceding entries were correct, it is impossible to alter those responses in the computer. The only way to change them is to break out of the computer program and reenter all decisions for all teams from the first cycle.

Of course the data for each cycle in a particular country must be entered in numerical order. You cannot enter decisions for country #2, cycle #3 before you have entered the decisions for country #2, cycle #2. However, you may consecutively enter data from several cycles from one country, For example, decisions for country #2, cycles 3,4, and 5 can only be entered after you have entered the decisions for country #2 for cycle 2. However, this may be done before any data have been entered for country #1. In other words, all countries need not complete one particular cycle, before one country can have its data entered for the next cycle. However, as a practical matter, you should keep all the teams moving together through the game at roughly the same pace.

Let me repeat four cautions that can save new operators substantial difficulty.

1. Run the game all the way through (10 cycles) at least once with a group of friends, before attempting to operate it for an important group of clients. <u>There will always be some unexpected difficulty in the first run, so save yourself the embarrassment of appearing to be ill-prepared and incompetent in front of strangers</u>.

2. When you do run the game for real clients, set up the computer well before the participants arrive. Test your program and computer by executing the model at least far enough to print out the first set of outputs. Check that these numbers match the ones recorded in the first columns of the data sheets for the five sectors. Do this early enough to correct any problems you may find. You should always have a listing of the model from this <u>User's Manual</u> nearby whenever you are using the computer model with a group of players. By listing out the BASIC equations for that part of the model that is causing problems, you can generally figure out the source of the difficulty.

3. Lock the keyboard into the capital letter mode, since the computer program responds to lower case letters with an error message.

4. Be careful not to break or interrupt the execution of the model in the middle of the game.

AT PRESENT THERE IS NO EASY RECOVERY PROCEDURE. IF YOU ACCIDENTALLY BREAK OUT OF THE BASIC PROGRAM EXECUTION. IF YOU INTERRUPT THE MODEL EXECUTION, FOR EXAMPLE BY TURNING OFF THE COMPUTER, YOU MUST RESTART THE PROGRAM.
THIS MEANS YOU MUST RETYPE ALL DECISIONS FOR EACH CYCLE FOR ALL COUNTRIES IN ORDER TO GET BACK TO THE CYCLE WHERE THE MISTAKE OCCURRED, SO THAT YOU MAY ENTER IN NEW DECISIONS!!!

<u>Note on the outputs related to table function settings.</u>

To provide information on table function settings, we have adopted a special convention. The data available on the current value of the variable on the x-axis of each graphical relationship are provided as 21 numbers (10 related to this version of the game, and 6 more for the version that has implemented energy resource depletion and technological advance). Each lies between 0 and 1. A value of 0 means that the x-axis variable is at the far left of the graph, and a value of 1 means that the variable

on the x-axis currently has a value that places it on the far righthand side of the graph. The x-axis variables may move outside these limits during the play. In that case the data printed out for table function settings will have values less than 0 or greater than 1. However, the y-axis variables will retain the the extreme values illustrated at either side of their respective figures. For example, even if energy production capital rises above 10,000 units, annual energy production will not exceed 7000 units.

In version 1-C of the model, the version listed in this manual, the labels for the output on table settings correspond exactly to the figure numbers used in this version of the User's Manual. In some earlier versions of the model, they do not. You can determine the version you are using by looking at line #1000 in the listing. If you do not have version 1-C, interpreting the printout requires use of a translation table. The relationship appropriate for most earlier versions of the model is given below:

TABLE OF CORRESPONDENCE ON TABLE FUNCTION SETTINGS

Number shown on the Output	1	2	3	4	5	6	7	8	12	13	14	17	18	20	21
Corresponding Figure # in Manual	1	2	3	4	11	7	6	5	9	10	8	12	13	15	14

9, 10, 11, 15, 16, and 19 are technology relationships. These table functions are included in the model but the coefficients defining them have been set to make them inactive. They are not illustrated in this version of the User's Manual.

For example, if ENERGY PRODUCTION CAPITAL (the x-axis in Figure #5) equalled 10,000, (the right-hand extreme value on the graph), then output variable #8 in the computer print out would equal 1.0. If HUMAN SERVICES CAPITAL/PERSON (the x-axis on Figure #12 equalled 10 (half way between the lower and the upper limits, 0 and 20, respectively), then output variable #17 would equal 0.5.

If you are using version 1-C of the strategem model, this translation is unnecessary. The output numbers do correspond precisely with the graph numbers used in this version of the manual.

It is important to note that the energy sector plays a crucial role in the game. It requires a great deal of capital, impacts on the environment, and often produces energy shortages that force capital to be idle in the food and the goods sectors.

There are five ways to reduce or eliminate energy shortages. You can invest in more energy production capital. However, this gives you increased energy only starting two cycles after the investment is made. You can allocate money to energy imports. This gives increased energy in the next cycle, but it is very expensive. You can invest in energy efficiency capital. This reduces energy requirements in the next cycle already. Fourth, you can shift investment away from energy-consuming capital stocks (food and goods production) and into human services capital or environmental protection capital, which use no energy. Finally, you can reduce goods allocated to the population, so that less energy needs to be allocated to the population. This last strategy is rather weak, since the population's demand for energy is rather small in any event. However, it is the only approach that becomes effective in the same period.

Even though you are exporting food, your agriculture sector operates at much lower productivity than it might. You have let your environment deteriorate seriously, and you have not invested much in food production capital. Environmental degradation currently reduces food output by 30 percent, and maximum investments in production capital could raise food output by six times.

There is also substantial room for increased productivity in the goods sector. Labor productivity is only one-tenth of what could be attained through maximum investments in goods production capital and human services capital.

You have no debt at present. Thus you may borrow money for only 10 percent per year. You earn 1 money unit for each unit of energy, food, or goods that you export. You must pay 1.1 money unit for each unit of food or goods that you import and 1.0 money unit for each unit of energy imported. Terms of trade shift against your country, if its debt rises too high relative to average exports. In that event, all imports rise in cost. Additionally, the energy price may be raised even more during the game by an OPEC action. Therefore, it is not a good strategy to export a commodity, for example goods, and then use the money to import the same commodity. You lose 10 percent and one cycle's use of the commodity in such an exchange.

It is difficult to achieve a stable, high productivity society. The most common outcome in STRATEGEM-1 is stagnation, with growth in population offsetting all gains in the economy. It is possible to "crash" the society. If you let debt rise out of control, environment deteriorate too far, energy shortages mount, or population grow too high, the economy of the region you are managing can spiral downward out of control.

BEGINNING SCENARIO

Before playing the game, it is best for each player to read through all five role descriptions, paying special attention to the description of the sector he or she will manage. Even when the five sector descriptions have been read by everyone ahead of time, it is useful to read the following scenario to all players.

Your team will function during this game essentially as an extremely powerful cabinet for a country which has reached a stage of economic and social development like that found widely in Latin America. You are free to implement a wide range of social and economic decisions, though your actions must be carefully designed to be consistent with the cause-effect relationships that govern the behavior of the total society.

Your country has a modest population, just 200 people. The standard of food consumption is fair (2 on a scale of 0-5), so that death rates are low (18/1000-year). However, material standard of living is low (2 on a scale of 0-15), so that the population birth rate is high (41/1000-year). As a consequence your population growth rate is 2.3 percent per year - giving a doubling time of about 30 years. Though your nutrition levels could be raised, you currently export food to obtain funds required to import energy.

You have not made any investments in energy efficiency, so that each unit of food production capital and goods production capital use three times as much energy as they would, if optimum investments had been in energy saving capital. Last cycle you imported 500 units of the 15,000 units of energy available to you; still you lack the energy required to operate all your food and goods capital.

Your sources of domestic energy are like waterpower. They cannot be depleted. In the early cycles of the game, you receive tremendous returns on investments in energy production capital. Later you will encounter seriously declining returns to scale. These become so serious that it is eventually impossible to produce all the energy required domestically. However, you may find yourself with excess energy initially. This can be exported to earn money for imported food or goods. It may also be held over, that is left in the TOTAL ENERGY AVAILABLE box, for use in subsequent cycles of the game.

It is very important to note that your energy production currently offers fantastic returns on investment. One unit of capital invested in energy production currently returns almost 20 units of energy during a 5-year cycle! Since you pay only 10% per year (50% per cycle) on your loans, it pays to borrow money and invest in new energy production - at least during the initial cycles of the game.

To avoid this your team has to make a set of important policy decisions. Will you borrow to the limits of your credit or not? Will you raise the standard of living of the population quickly, even though that reduces the goods available for investment, or will you let population grow rapidly for the first few cycles while you attempt to achieve high growth rates in the economy.

Will your team pursue balanced development, or will it emphasize growth in one sector - hoping that the surplus goods from that sector can be exported to pay for imports needed of the other commodities? What balance of investments in energy production and energy conservation do you wish to maintain? At what point does investment in environmental protection, energy production, energy efficiency, and other important sectors reach the point of diminishing return - the point where the next unit of investment costs more than it produces?

Several different approaches can give an attractive development path, but you must work out your strategy with a careful understanding of the many delays and cause-effect relationships that govern the behavior of your country.

There are several insights that can improve the effectiveness of your policies. Among the useful guidelines are six of particular value. (1) Notice the difference in the lifetimes of the capital stocks. All else equal, it is more cost effective to invest in the capital stocks that have longer lifetimes.

(2) Recognize that human services are an especially fruitful area for investment. The capital has a long lifetime, 40 years, it requires no energy, does not impact on the environment, raises labor productivity in the goods sector, and reduces the birth rate.

(3) Take early advantage of the great returns to investment in energy production capital, but be aware that midway through the game you will be forced to become a net energy importer.

(4) Do not invest in any capital stock beyond the point of diminishing returns. At some point every capital stock costs more to increase than it produces in marginal output.

(5) Note that many investments impose related, "hidden" costs on you. Whenever you invest in goods production capital, for example, you must also add to the stock of energy production captial and the stock of environmental protection capital to maintain balance in the system.

(6) Be aware of the long delays in the system. For example, money invested in energy production capital only first raises total energy available two cycles later.

ROLE DESCRIPTIONS

A cardinal aspect of the game is that players collectively have all information about the cause-effect relationships that govern the success of their decisions. There are no exogenous influences (unless you implement the oil price increase), no random influences, and no unknown relationships. Consequently, if a team does well, it can assume full credit. If it does poorly, there are no "outside" influences to blame. All of the information about the cause-effect relationships is contained in the role sheets. This information should be summarized at least briefly in your opening remarks. However, even if the game operator has time to go exhaustively through each relationship for the group, there is absolutely no possibility that players can fully understand or remember all the causal factors. Time must therefore be given at the start of the game for them to read their own sector's role description thoroughly. Even then, full understanding will only come over several cycles of play. You must strike some compromise between total confusion and full understanding at the start of the game. The first makes learning difficult and the second takes too long to achieve merely by studying the written materials.

This version of the game differs slightly from earlier releases. The game described in this manual permits players to:

1) carry energy over from one cycle to the next, and

2) export energy.

Included in the computer code for the game are equations that will also permit players to:

3) experience a step increase in the oil price during the game,

4) face depletion of domestic energy resources, and

5) have five different opportunities to invest in technological advances that raise:

   a) land productivity,
   b) labor productivity in the goods sector,
   c) the stock of domestic energy resources,
   d) the effectiveness of energy efficiency investments, and
   e) the effect of investments in environmental protection.

The role descripton do not refer to the last two options, #4 and #5, but the board and the data sheets will accommodate decisions made to employ them (except that the precise nature of investments in technology must be specified on a separate piece of paper - only the total investment in technology would be entered on the data sheet for the international sector.) Though the computer program provided in this manual has been written to includ

the parameters and relationships for all 5, the parameters have been set to make the options #3, #4, and #5 inoperative.

After you have gained experience playing version 1, you may wish to experiment by resetting the parameters to make the last three relationships operative. Change #3 is quite simple: the operator must only specify new values for New Energy Price (NP) and for the time of the step increase (OB). The values should be selected so that:

$1.0 \leq NP$ and $0 < OB \leq 50$.

The values for these parameters are specified on line #1470 of the program. Presently NP=2 and OB=80, so that the price doubles after the step, but this happens only at time=80, too late to have any influence on the game, which only goes to time=50.

Changes #4 and #5 require the operator to alter the coefficients that express six table functions defined in lines 1870-1883 of the computer program. This is not a trivial operation, since these table functions define coefficients that influence the balance and robustness of the entire model.

Thus all changes should be made with caution. Even without the above factors the game plays well. It is possible to achieve a high quality sustained equilibrium in STRATEGEM-1 over ten cycles of play. But it is very difficult. Most of the above changes (except energy depletion) should make the high quality outcomes much easier to attain.

I know that the game in its current version is "well-behaved" and robust. It gives plausible results under a wide variety of player strategies. I have not yet experimented with versions of the game that incorporate energy price increases, energy depletion, or imported technologies. I am able to state forcefully, however, that it would be unwise to offer a version of STRATEGEM-1C even with only slight changes in it, until you have tested those changes through 5 complete games, in which decisions were used that takes the game model to a variety of limits. The game model has many internal compensating mechanisms in it, just like real life, but alterations in one sector can easily produce implausible results in other sectors in ways that are extremely difficult to anticipate merely by inspecting the equations.

If you wish to make changes, you will obviously have to change the final column of the data sheets to show the new numerical values for a feasible, high equilibrium result. I suggest that any changes you make be chosen to leave the present initial conditions specified for years 0-4 just as they are.

POPULATION & HOUSEHOLD CONSUMPTION SECTOR
STRATEGEM-1: ROLE DESCRIPTION

Goal: Your objective is to obtain a stable population with a high standard of food and goods consumption and a high level of services.

Initial Conditions: You have 200 people. Food consumption standards are moderate - 2 units of food per person per year. The maximum possible in the game is 5 units of food per person per year. Material standards are also low - 2 units of goods per person per year, where 15 units of goods per person per year is possible. Nor are human services (health and education) well developed. Currently the ratio of human services capital to population is only 2.25; 20 is possible. As a consequence your region is experiencing a very high birth rate, 41 per 1000 people per year and a rather low death rate, 18 per thousand per year.

Though your population is not richly fed, you do not presently consume everything you grow. The extra food is exported to earn money for your energy imports. You earn one unit of money for each unit of food you export. During the last cycle you exported 1000 units of food.

Goods may also be exported at a price of one unit of money for each unit of goods. However, you have not been exporting goods. All goods not used by the population have been invested inside your region. Your most important problem is to allocate enough goods to consumption, so that the material standards will rise enough to reduce birth rates, without at the same time lowering investment so far that economic growth stagnates.

Decisions:

#1: Allocate Total Food Available to:

- Food for Population
- Food for Export

#2: Allocate Total Goods Available to:

- Goods for Population
- Goods Available for Investment
- Goods for Export

Your actions indirectly affect:

- the birth and death rates, thus the size of the population, hence the size of the labor force.

- the energy required for the population, hence the energy that is available to the agricultural and goods production sectors,

- export income, and

- import requirements.

The cause-effect relationships of interest to you include:

- Actual goods per person per year is averaged over three cycles to obtain the average consumption. It starts at 2.0 The normal birth rate (which can vary from 10 to 30 per 1000 people per year) is determined by average goods consumption per capita (which ranges from 0 to 15). This relationship is shown in Figure 1.

- The actual birth rate is a product of the normal birth rate and birth multiplier from services, a multiplier reflecting the level of health and education. This multiplier ranges from 1 to 1.5: it depends on the ratio of human services capital to the total population (which can vary between 0 and 20). It is shown in Figure 2.

- The normal death rate (ranging from 10 to 60 per 1000 people per year) is determined by food per person per year (which can range from 0 to 5.) The influence of food per capita on the normal death rate is shown in Figure 3.

- The actual death rate is the product of normal death rate and death multiplier from quality of the environment, a multiplier (ranging from 1 to 1.75) that deperds on the quality of the environment. Quality of environment is 1.0 when everything is perfect and 0 under the worst possible circumstances. This multiplier is illustrated in Figure 4.

- For each unit of goods you allocate to goods for population your colleagues in the energy sector must allocate 0.2 units of energy to energy for population. This demand has absolute priority over allocations of energy to carryover, to exports, or to support production in the agricultural and industrial sectors.

- The allocation of food and goods made at the beginning of each cycle determines the rate of population growth during that cycle.

- Significant reductions in percapita food or goods consumption from one cycle to the next will lower production in the corresponding sector. The relationships are shown in two curves that are included in the role descriptions for the food and the goods sectors.

DEATH RATE TABLES

Figure #3: DY

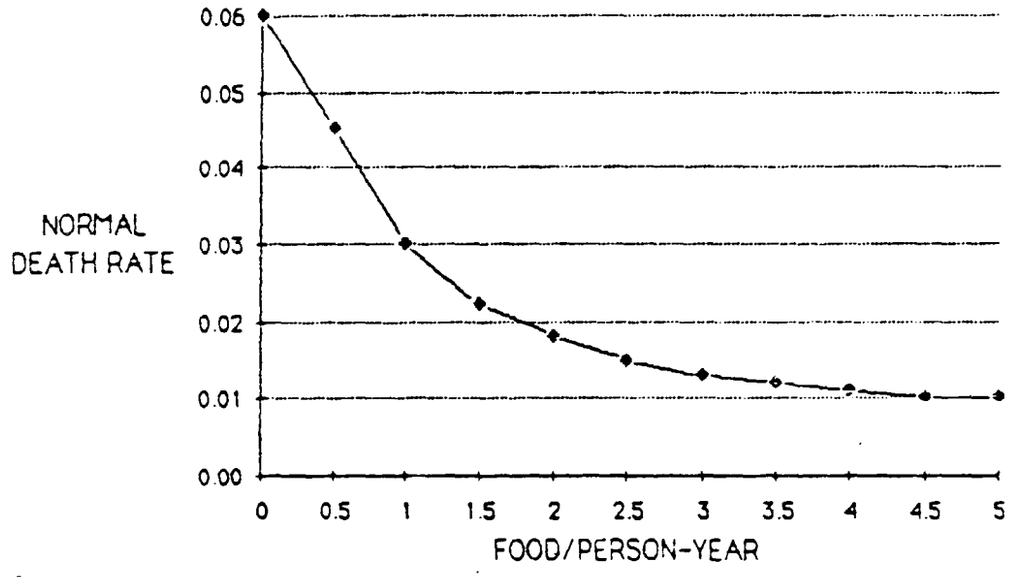
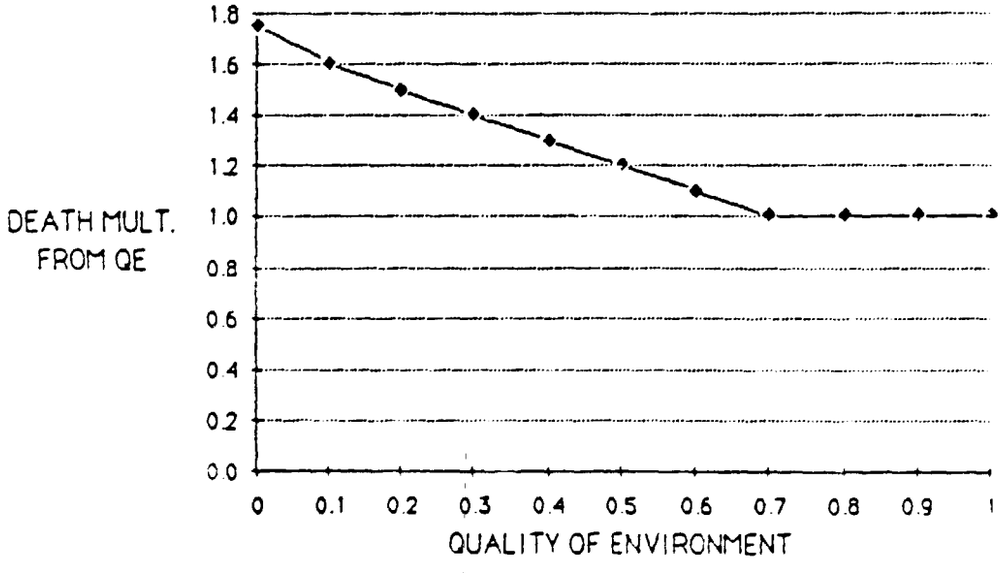


Figure #4: DY



ENERGY PRODUCTION AND ENERGY EFFICIENCY SECTOR
STRATEGEM-1: ROLE DESCRIPTION

Goal: Your primary objective is to ensure that there is enough energy to operate the goods consumed by the population and to operate the stocks of food production capital and goods production capital. You can reach this goal by requesting energy imports, by investing in energy production capital, or by reducing energy requirements through investments in energy efficiency capital. A secondary goal may be to export energy for funds that can finance food or goods imports.

Initial Conditions: Your region has made no investments in energy efficiency, so that energy use by each unit of food production capital and goods production capital is high. The energy required to operate each unit of food production and the energy required to operate each unit of goods production capital is over three times greater than it would be with maximum investment in energy efficiency capital. Domestic energy production does not cover your domestic needs. Last cycle you imported 500 units of energy, a serious drain on your export earnings, and still you do not have enough energy available during the first cycle to provide full capacity utilization of the food and goods capital stocks.

Decisions:

#3: Allocate Total Energy Available to:

- Energy for Population,
- Energy for Export
- Energy Carried to Next Cycle
- Energy Available for Production.

#4: Allocate Energy Available for Production to:

- Energy for Food Production and
- Energy for Goods Production.

#5 Allocate some portion of the Goods Available for Investment to:

- Energy Production Capital Under Construction and
- Energy Efficiency Capital Under Construction.

Your actions indirectly affect:

- energy import requirements,

-

- the goods available for investment in the other physical capital stocks,

- the capacity utilization in the agricultural and the industrial sectors,

- funds available for imports or debt repayment, and

- the quality of the environment.

The cause-effect relationships of interest to you include:

- Energy production depends only on the amount of energy production capital. The energy sector in this version of the model is analogous to water power. There is no depletion, but there are diminishing returns to investment. This means that if you maintain your energy production capital at a constant level, it will produce the same amount of energy each year forever (achieving this will, however, require enough investments to offset depreciation). However, each further addition to the energy production capital stock produces a smaller and smaller additional amount of energy. The relationship between energy production capital and energy production is shown in Figure 5.

- In each cycle you must allocate 1 energy unit to the population for each 5 units of goods they receive in that cycle.

- When you have surplus energy, you may export the energy at the rate of one money unit for each energy unit sold. Alternatively, you may simply leave the surplus units in the box, TOTAL ENERGY AVAILABLE, and carry it over to the next cycle. Thus the energy available at the beginning of each cycle is the sum of last cycle's production, plus imports, plus energy carried over.

- Your allocations of energy to food and goods production determine the capacity utilization of the respective capital stocks. Capacity utilization (designated by % in the graphs) is the ratio:

$$\% = \frac{\text{energy allocated}}{\text{energy required}}$$

It may vary from 0 to 1.1. Any energy in excess of that required to provide both sectors with 110% capacity utilization is wasted. Note that by allocating up to 10 % more energy than is required for full use of a production capital stock, you can effectively multiply your capital stock by up to 10 % above its actual level.

The price of imported energy is normally 1.0. Its price can double, if your region's debt grows to a level 5 times your

average exports. In some versions of the game we have implemented an OPEC oil embargo that raises the price of oil imports during the game even more. That is not normally active.

- PLEASE NOTE: Money allocated to energy imports in one cycle does not serve to reduce an energy deficit during that same cycle. Money spent on energy imports gives energy that only first shows up in the stock of Total Energy Available at the beginning of the next five-year cycle.

- You can reduce the energy required by each unit of food and goods production capital to 30% of its original value (from 4.0 down to 1.2 for goods and from 2.5 down to 0.75 for food capital) through investments in energy efficiency capital. One unit of energy efficiency capital will achieve full energy savings for one unit of capital. The relationship is shown in Figure 6.

- Since energy efficiency capital investments can only work on new capital, you are limited in the rate at which you can invest in energy efficiency capital. In each cycle the maximum possible investment in energy efficiency capital is equal to the sum of two investments: (FOOD PRODUCTION CAPITAL UNDER CONSTRUCTION + GOODS PRODUCTION CAPITAL UNDER CONSTRUCTION made during that same cycle.

- The average lifetimes of energy production and energy efficiency capital are 25 years, so that one-fifth of each capital stock is removed from producing capital at the end of each cycle after the cycle's production has been calculated.

ENERGY PRODUCTION AND EFFICIENCY TABLES

Figure #5: PY

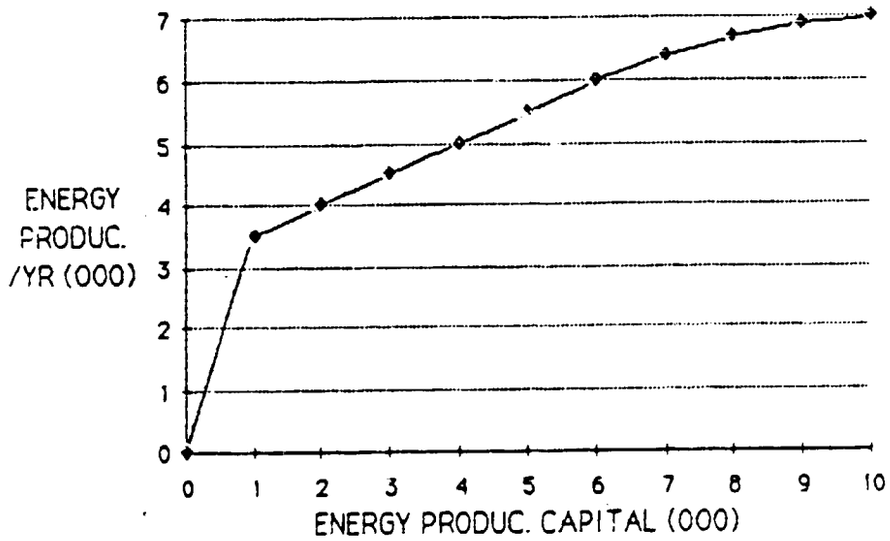
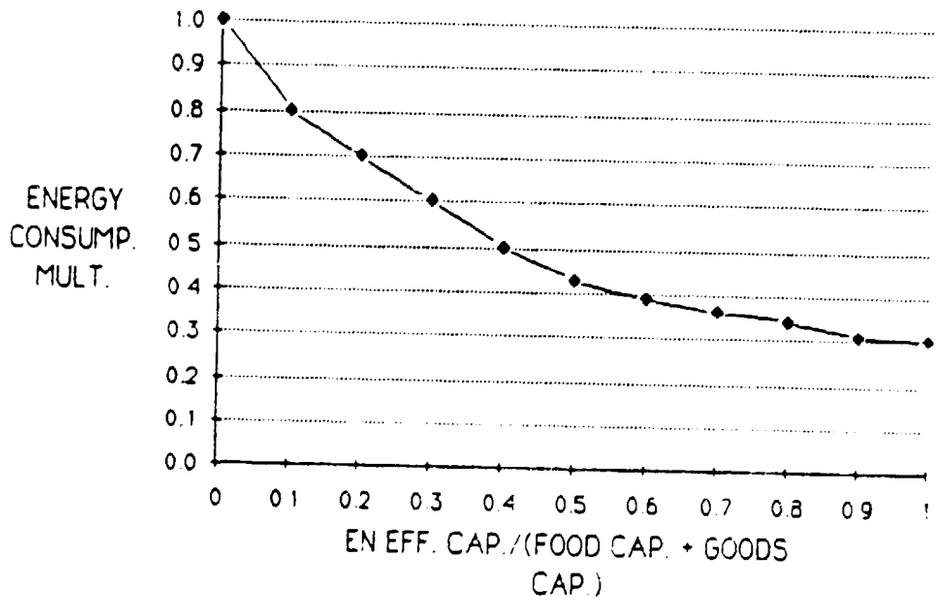


Figure #6:EY



FOOD PRODUCTION AND ENVIRONMENTAL PROTECTION SECTOR
STRATEGEM-1: ROLE DESCRIPTION

Goal: Your objective is to produce the food required to feed your population and support the necessary exports. This should be done in a way that maintains the environment at a high level of quality (max = 1.0).

Initial Conditions: You have made no investments in environmental protection, thus the quality of the environment has deteriorated drastically. Currently it is 0.69. Thus you are losing 31% of the productive potential of your agricultural capital. In other words, your food production is 31% lower than it would be if the environmental quality were 1.0. Nevertheless, you remain a net exporter of food, though your population still has only moderate food consumption levels, and it is growing rapidly. Because the energy sector has made no investments in energy efficiency, it is still comparatively expensive to fulfill the energy demands of your sector.

Decisions:

#5 Allocate some portion of the Goods Available for Investment to:

- Food Production Capital Under Construction and

- Environmental Protection Capital Under Construction.

Your actions indirectly affect:

- the goods remaining for investment in the other physical capital stocks,

- export income,

- quality of the environment,

- the lifetime of the population,

- total energy requirements in the region.

The cause-effect relationships of interest to you include:

- food production is a product of: arable land (constant at 1000 hectares), normal productivity of land (constant at 1.25 in this version of the model), the multiplier on production from changes in the population's per capita food consumption from the last cycle to this one (.4 - 1.0), quality of the environ-

ment (0 - 1), and the land output multiplier from food capital (1 - 5).

FF = L * C * CMOF * QE * LOMFC

- The consumption multiplier on food production is shown in Figure 7.

- The quality of the environment is a level, ranging from 0 to 1. It is governed both by regeneration and degeneration whose behaviors are described below.

- The land output multiplier from food capital depends on the ratio of active food production capital to agricultural area. Active food production capital is the product of currently producing capital and the capacity utilization factor for food capital during the cycle. Energy shortages will reduce the effective food production capital during each cycle that the energy sector does not allocate as much energy to food production as would be required for full operation of the capital stock. In this case the capacity utilization factor will be less than one, and the food output will be correspondingly reduced. The relationship is shown in Figure 8.

- The energy required to support food production is the product of food production capital, normal energy use (a constant equal to 2.5 in this version of the model), and the energy consumption multiplier (which ranges from 0.3 - 1.0).

- The environment is degenerated by energy production capital, goods production capital, and food production capital. The negative influences of these capital stocks can be offset by investments in environmental protection capital. Each unit of environmental protection capital will offset the impact of 3.0 units of production capital. The relationship governing degeneration is shown in Figure 9. Note that food production capital and goods production capital are multiplied by their respective capacity utilization factors (indicated by % in Figure 9) to determine their impact on the environment. This simply indicates that if energy shortages prevent some production capital from being used during one cycle, the unused capital does not affect the environment during that cycle.

- The environment can regenerate itself. The annual percent regeneration depends on the current quality of the environment, which ranges from 0 to 1. The relationship is depicted in Figure 10. Note, when quality of environment equals either 0 or 1, there is no regeneration.

- The lifetime of food production capital is 25 years, and the lifetime of environmental protection capital is 30 years. Thus one-fifth of the food capital and one-sixth of the environmental capital stock is removed from production at the end of each cycle, after the production for that cycle has been calculated.

FOOD PRODUCTION TABLES

Figure #7: CY

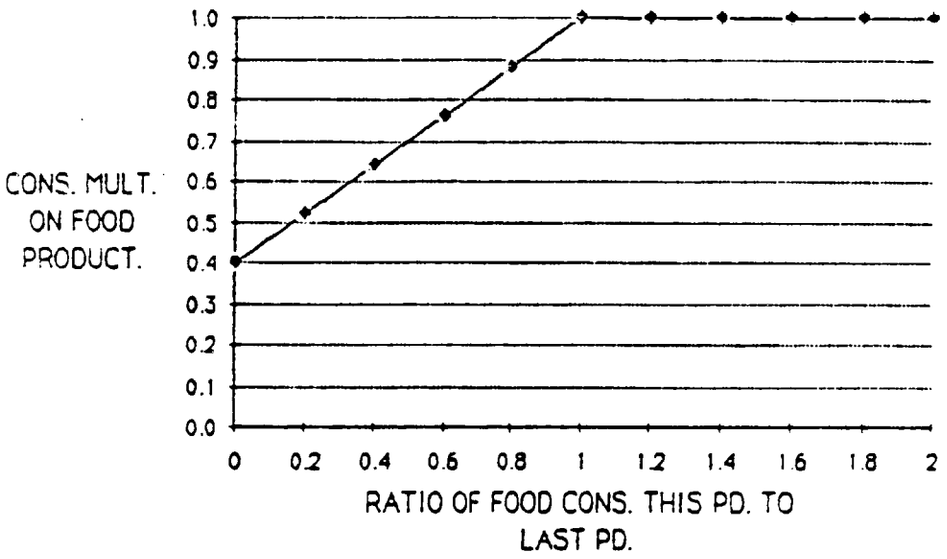
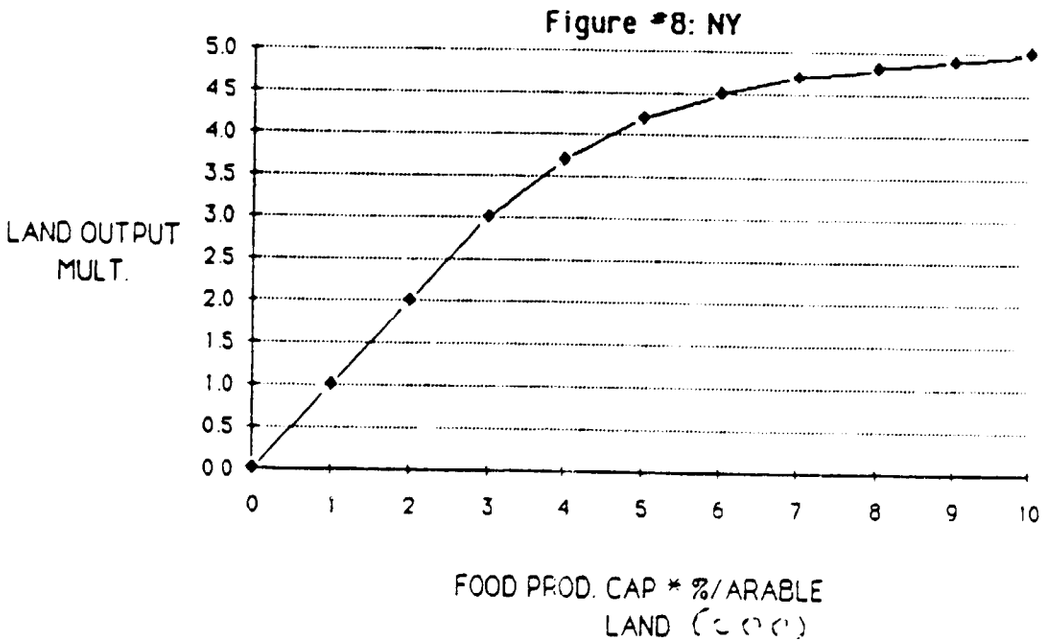
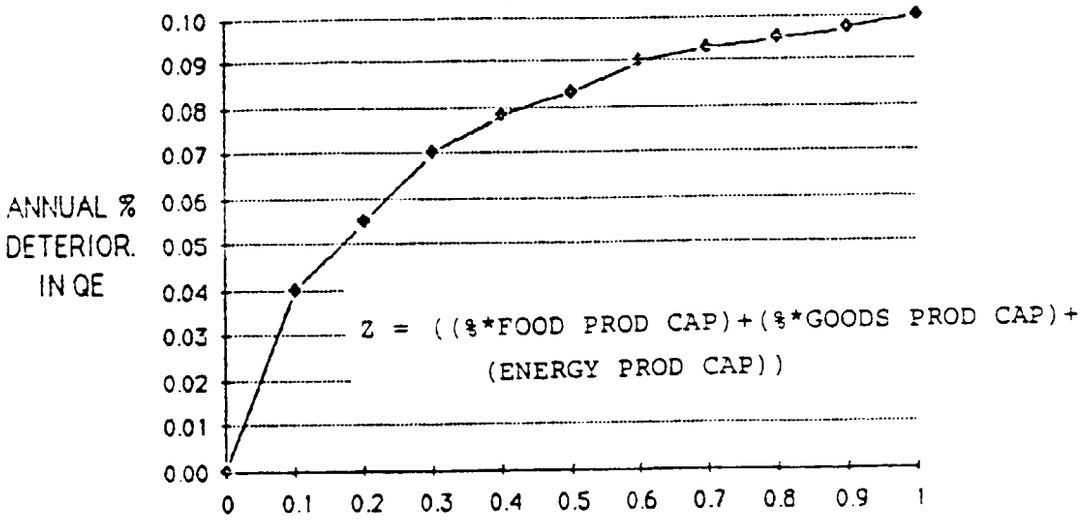


Figure #8: NY



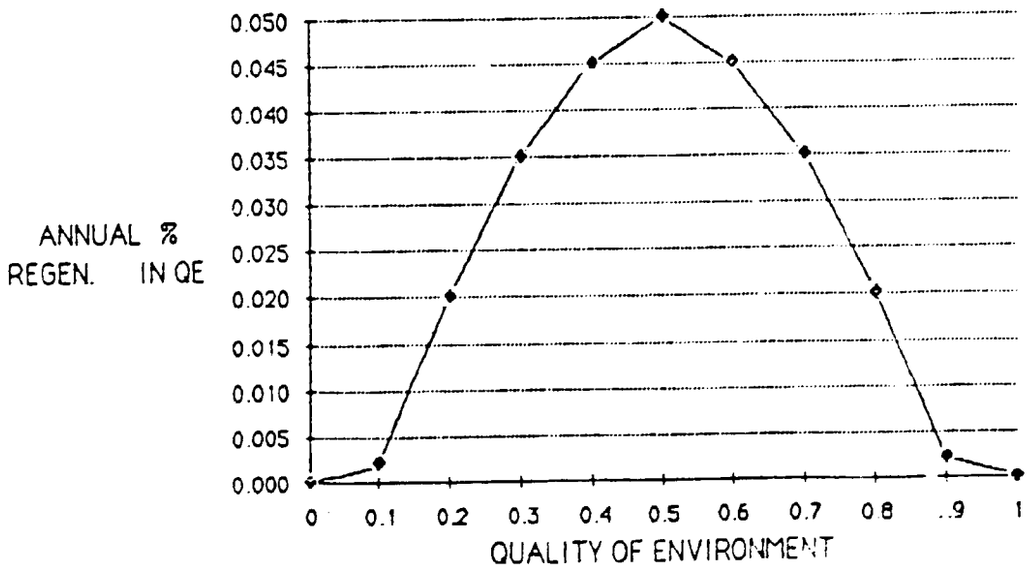
QUALITY OF THE ENVIRONMENT TABLES

Figure #9: QY



$$Z = \frac{3 * \text{ENERGY EFF. CAP}}{20{,}000}$$

Figure #10: RY



GOODS PRODUCTION AND HUMAN SERVICES SECTOR
STRATEGEM-1: ROLE DESCRIPTION

Goal: Your principal objective is to produce sufficient goods to satisfy the consumption needs of the population, the investment needs of the economy, and the requirements for export income from goods. You should also raise the health and education standards of the population (which will help reduce the birth rate) by investing in human services capital.

Initial Conditions: Productivity of the labor force is low, about 1/10th of what could be attained by maximum investment in goods production capital and human services capital. Your region's labor force is not receiving a very high standard of living - that is, the goods allocated for the population during the previous cycle were low. They equalled only 2 per person per year (15 is the maximum possible). Similarly, human services (health and education) are also low. Presently the ratio of human services capital to population is only 2.25; a maximum of 20 is possible.

Decisions:

#5 Allocate some portion of the Goods Available for Investment to:

- Goods Production Capital Under Construction and

- Human Services Capital Under Construction.

Your actions indirectly affect:

- the amount of goods available for investment in the other physical capital stocks,

- the requirements for energy by the region,

- the quality of the environment,

- the productivity of labor,

- the birth rate.

The cause-effect relationships of interest to you include:

- The production of goods each cycle is the product of the labor force (25% of the population), the normal productivity of labor (a constant 1.155 in this version of the model), a multiplier

that reflects changes in percapita consumption of goods between last cycle and this cycle (.4 - 1.0), the labor output multiplier from human services capital (1 - 5), and the labor output multiplier from goods capital (1 - 20).

$$GF = L * C * OMOF * LOMHS * LOMGO$$

- The labor force is always 25% of the population.

- The normal productivity of labor is constant at 1.155.

- Reduced consumption of goods per capita from one cycle to the next will lower the productivity of the labor force in the goods sector. The multiplier ranges from .4 to 1.0, and it is shown in Figure 11.

- The labor output multiplier from human services capital depends on the ratio of human services capital to the total population. The relationship is shown in Figure 12.

- The labor output multiplier from goods production capital depends on the ratio of active goods production capital (the actual stock of capital multiplied by the capacity utilization factor) to the labor force. The relationship is shown in Figure 13.

- If there are energy shortages, the active goods production capital during the cycle will be reduced, and output will be correspondingly lower. The capacity utilization factor (shown by % in Figure 13) is simply the ratio of energy allocated to goods production during the cycle and energy required for full production of the capital stock. Capacity utilization may range between 0 and 1.1.

- The average lifetime of goods production capital is 25 years, and the average lifetime of human services capital is 45 years. Thus one-fifth of the goods production capital stock and one-ninth of the human services capital stock are removed from producing capital at the end of each cycle after the cycle's production has been calculated.

GOODS PRODUCTION TABLES

Figure #11: CY

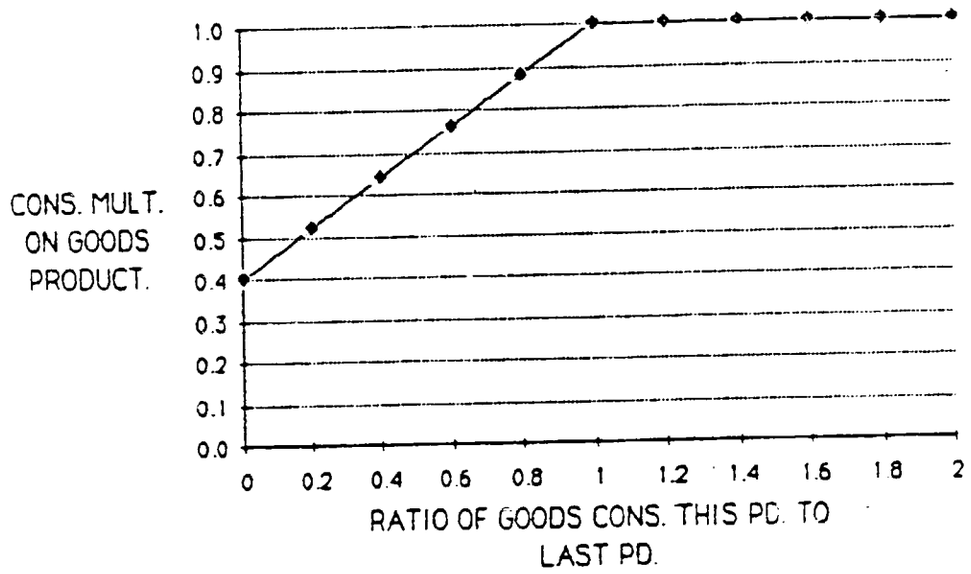
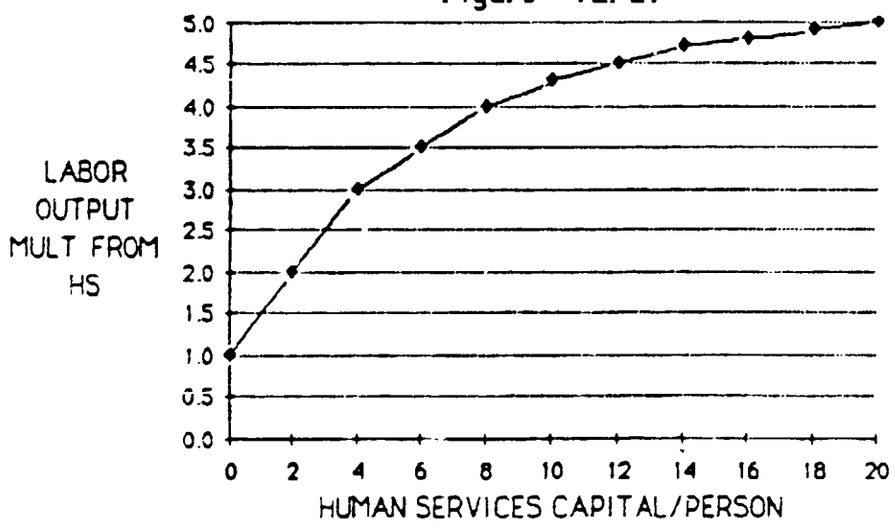
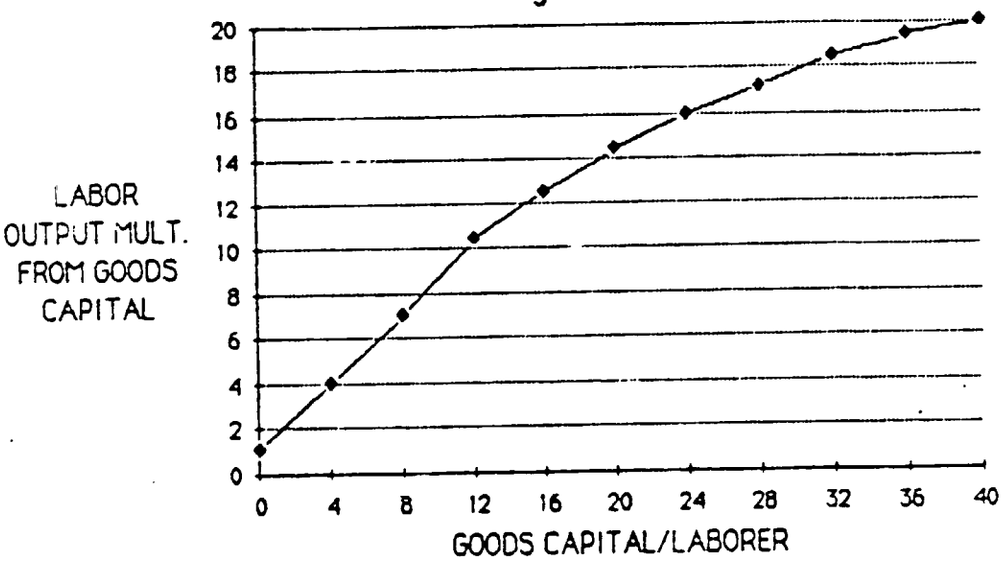


Figure #12: LY



GOODS PRODUCTION TABLES

Figure #13: OY



INTERNATIONAL FINANCE, EXPORTS, IMPORTS, AND DEBT SECTOR STRATEGEM-1 ROLE DESCRIPTIONS

Goal: You handle the region's foreign trade. You convert exports into their money equivalents, manage its debt, and allocate money to imports. Your objective is to manage the country's trade, so that there are enough goods, energy, and food to attain satisfactory consumption and investment levels, while avoiding unbearable interest payments and preventing serious erosion in the terms of trade.

Initial Conditions: You start with a slight surplus of exportable food and no debt to the international banks. Your interest rate is 10 percent, much lower than the return you can earn on many investments in productive capital.

Decisions:

#6: Collect Foreign Aid, if any, and convert Energy for Export, Food for Export, and Goods for Exports into Money Available for Exports.

#7: Borrow money if you wish to provide for greater imports, and if your Maximum Loan is greater than 0.

#8: Repay part of your Debt if you wish to reduce interest charges and lower the price of imports.

#9: Allocate Money Available for Imports to one or more of the three possible imports: energy, goods, and food. Technology imports are indicated on the board, but they are not normally active in the game.

Your actions affect:

- the amount of energy, goods, and food available in the next cycle,
- the interest rate, hence the interest charges, paid on your region's debt, and
- the price of purchased energy, food, and goods.

The cause-effect relations of interest to you include:

- Foreign aid is an exogenous input to the game, determined by the game operator. Typically there is no foreign aid.

- The export price of food, energy, and goods is constant at 1.0; total exports are averaged over about three cycles to determine your maximum debt and your interest rate.

- The terms of trade will deteriorate, if your debt rises above average exports. The import price of food and goods is normally 1.1. The normal price of energy imports is 1.0. These prices are multiplied by the import price multiplier which grows from 1 - 2, if the ratio of average debt to exports rises to 5. The relationship governing the price multiplier on imports is shown in Figure 14. An OPEC oil embargo may also be activated to raise oil prices permanently; normally this factor is not employed in the game.

- You may not increase your debt with new loans, if the current debt is greater than your region's average exports. Of course your debt may rise above average exports, if your exports fall or if interest charges accumulate.

- The interest rate paid on your debt each cycle depends on the ratio of average exports to debt: it rises from 10% per year (that is 50% per cycle) to 20% per year, if debt rises to 5 times the average exports. The relationship is shown in Figure 15.

- Imported materials are not available for use in the period during which money is allocated to them. They first show up in the stocks of available food, goods, and energy at the beginning of the next cycle.

- If you have excess money, you can "repay" more debt than you actually owe. In that case you will earn interest on the loan at the prevailing rate.

- **PLEASE NOTE:** If your debt rises above 1/2 of your region's total product, approximated here by the sum of total food available, total goods available, and total energy available, the game operator will act on behalf of the IMF to intervene and seize 10% of your total goods available at the start of the next cycle.

INTERNATIONAL SECTOR TABLES

Figure # 14: MY

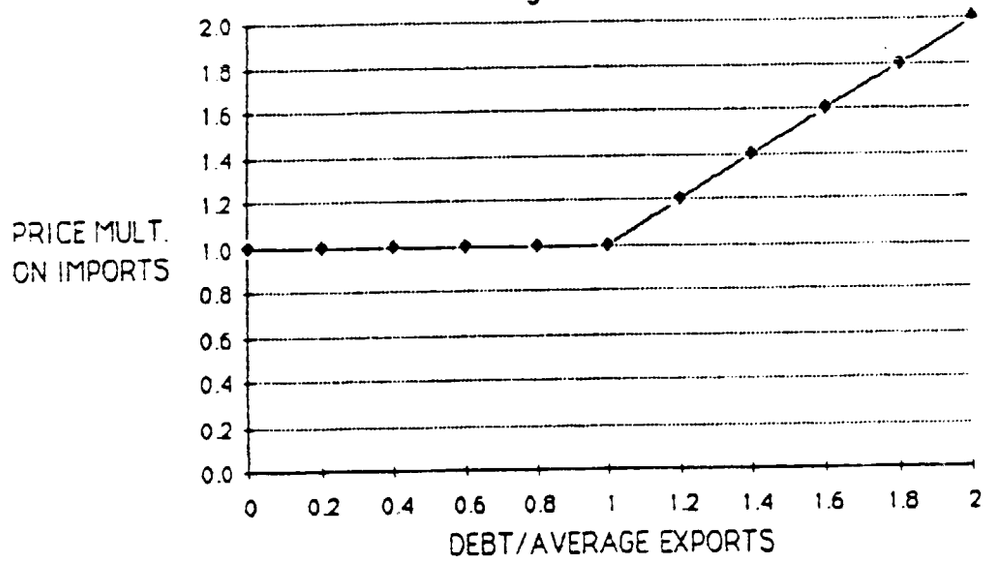
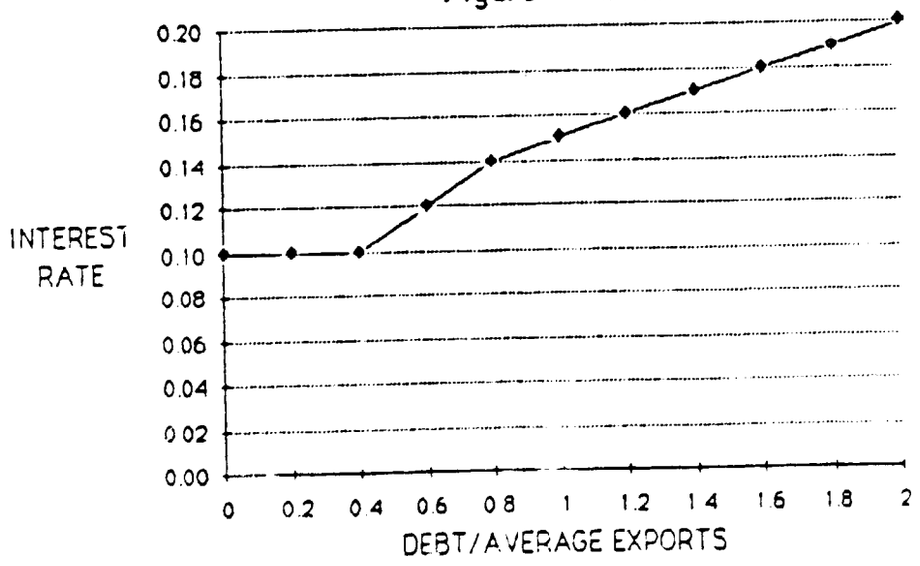


Figure # 15: IY



POPULATION & HOUSEHOLD CONSUMPTION: STRATEGEM-1, 1/9/84

YEARS	0-4	5-9.	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	Hi Ex
YOUR SECTOR'S STOCKS											
PO:1 POPULATION											
PO:2 TOTAL FOOD AVAILABLE (from Food Imports & Food Production last 5 years)											
PO:3 TOTAL GOODS AVAILABLE (from Goods Imports & Goods Production last 5 years)											
USEFUL INFORMATION											
PO:4 FOOD PER CAPITA (per year, last cycle)											
PO:5 ANNUAL DEATHS PER 1000 (per year, last cycle)											
PO:6 GOODS PER CAPITA (per year, last cycle)											
PO:7 HUMAN SERVICES CAPITAL PER CAPITA (last cycle)											
PO:8 ANNUAL BIRTHS PER 1000 (per year, last cycle)											
↔1 ALLOCATE TOTAL FOOD AVAILABLE:											
PI:1 FOOD FOR POPULATION (total for this 5 years)											
PI:2 FOOD FOR EXPORT											
↔2 ALLOCATE TOTAL GOODS AVAILABLE:											
PI:3 GOODS FOR POPULATION (total for this 5 years)											
PI:4 GOODS AVAILABLE FOR INVESTMENT (total for this 5 years)											
PI:5 GOODS FOR EXPORT											

ENERGY PRODUCTION & ENERGY EFFICIENCY: STRATEGEM-1, 1/9/84

YEARS	0-4	5-9.	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	Mi Eq
YOUR SECTOR'S STOCKS											
ENERGY PRODUCTION CAPITAL:											
EO:1 Depreciation											
EO:2 New EP Capital											
EO:3 Producing Capital Stock											
ENERGY EFFICIENCY CAPITAL:											
EO:4 Depreciation											
EO:5 New EE Capital											
EO:6 Producing Capital Stock											
EO:7 TOTAL ENERGY AVAILABLE (from Energy Imports + Energy Production last 5 years) + carry over)											
USEFUL INFORMATION											
EO:8 ENERGY REQUIRED PER UNIT OF GOODS FOR POPULATION											
EO:9 ENERGY FOR POPULATION (last 5 years)											
EO:10 ENERGY CONSUMPTION MULTIPIER											
EO:11 ENERGY TO OPERATE ONE FOOD PROD. CAPITAL UNIT (for 5 yrs)											
EO:12 ENERGY REQUIRED FOR FULL USE OF FOOD PRODUCTION CAPITAL (total for this 5 years)											
EO:13 ENERGY TO OPERATE ONE GOODS PROD. CAPITAL UNIT (for 5 yrs)											
EO:14 ENERGY REQUIRED FOR FULL USE OF GOODS PRODUCTION CAPITAL (total for this 5 years)											
EO:15 TOTAL ENERGY REQUIRED FOR PRODUCTION (this 5 years)											
EO:16 AVERAGE ENERGY FROM ONE UNIT OF ENERGY PRODUCTION CAPITAL (for this 5 years)											
EO:17 ENERGY PRODUCTION THIS 5 YEARS (available in next cycle)											
EO:18 ENERGY EXPORTS (last 5 years)											
EO:19 ENERGY IMPORTS (last 5 years)											

ENERGY PRODUCTION & ENERGY EFFICIENCY: STRATEGEM-1, 1/9/84

YEARS	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	In Eq
#3: ALLOCATE TOTAL ENERGY AVAILABLE:											
E1:1 ENERGY FOR POPULATION (equals E0:9 = GOODS FOR POPULATION)											
E1:2 ENERGY FOR EXPORT											
E1:3 ENERGY CARRIED TO NEXT CYCLE											
E1:4 ENERGY AVAILABLE FOR PRODUCTION (total for this 5 years)											
#4: ALLOCATE ENERGY AVAIL. FOR PRODUCTION:											
E1:5 ENERGY FOR FOOD PRODUCTION (total for this 5 years)											
E1:6 ENERGY FOR GOODS PRODUCTION (total for this 5 years)											
#5: ALLOCATE GOODS AVAIL. FOR INVESTMENT:											
E1:7 ENERGY PRODUCTION CAPITAL UNDER CONSTRUCTION											
E1:8 ENERGY EFFICIENCY CAPITAL UNDER CONSTRUCTION											

FOOD PRODUCTION & ENVIRONMENTAL PROTECTION: STRATEGEM-1, 1/9/84

YEARS	0-4	5-9.	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	MI Eq
YOUR SECTOR'S STOCKS											
FOOD PRODUCTION CAPITAL											
FO:1 Depreciation											
FO:2 New FP Capital											
FO:3 Producing Capital Stock											
ENVIRONMENTAL PROTECTION CAPITAL											
FO:4 Depreciation											
FO:5 New EP Capital											
FO:6 Producing Capital Stock											
USEFUL INFORMATION											
FO:7 QUALITY OF THE ENVIRONMENT (this cycle)											
FO:8 RATIO OF FOOD PRODUCTION CAPITAL TO AGRICULTURAL LAND AREA (this cycle)											
FO:9 EXPECTED FOOD PRODUCTION (total this 5 years, if energy is available)											
FO:10 CAPACITY UTILIZATION (last cycle)											
FO:11 FOOD PRODUCTION (last 5 years)											
FO:12 FOOD EXPORTS (last 5 years)											
FO:13 FOOD IMPORTS (last 5 years)											
ALLOCATE GOODS AVAIL. FOR INVESTMENT:											
FI:1 FOOD PRODUCTION CAPITAL UNDER CONSTRUCTION											
FI:2 ENVIRONMENTAL PROTECTION CAPITAL UNDER CONSTRUCTION											

GOODS PRODUCTION & HUMAN SERVICES: STRATEGEM-1, 1/9/84

YEARS	0-4	5-9.	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	NI EQ
YOUR SECTOR'S STOCKS											
GOODS PRODUCTION CAPITAL											
GO:1 Depreciation											
GO:2 New GP Capital											
GO:3 Producing Capital Stock											
HUMAN SERVICES CAPITAL											
GO:4 Depreciation											
GO:5 New HS Capital											
GO:6 Producing Capital Stock											
USEFUL INFORMATION											
GO:7 GOODS PRODUCTION CAPITAL/LABORER (this cycle)											
GO:8 LABOR OUTPUT MULT. FROM GPC (this cycle)											
GO:9 HUMAN SERVICES CAPITAL/PERSON (this cycle)											
GO:10 LABOR OUTPUT MULT. FROM HSC											
GO:11 CAPACITY UTILIZATION (last cycle)											
GO:12 GOODS PRODUCTION (last 5 years)											
GO:13 GOODS EXPORTS (last 5 years)											
GO:14 GOODS IMPORTS (last 5 years)											
GO:15 EXPECTED GOODS PRODUCTION (total this 5 years, if energy is available)											
GO:16 TOTAL GOODS AVAILABLE (for consumption + investment this 5 years)											
GO:17 TOTAL DEPRECIATION (at end of this cycle)											
↔5											
ALLOCATE GOODS AVAIL. FOR INVESTMENT:											
GI:1 GOODS PRODUCTION CAPITAL UNDER CONSTRUCTION											
GI:2 HUMAN SERVICES CAPITAL UNDER CONSTRUCTION											

INTERNATIONAL FINANCE: EXPORTS, IMPORTS, & DEBT: STRATEGEM-1, 1/9/84

YEARS	0-4	5-9.	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	Hi Eq
YOUR SECTOR'S STOCK											
10:1 DEBT (at start of this cycle)											
USEFUL INFORMATION											
10:2 INTEREST RATE (this cycle)											
10:3 PRICE MULTIPLIER FOR IMPORTS											
10:4 INTEREST CHARGES (last 5 years)											
10:5 MAXIMUM LOAN (this cycle)											
10:6 PRICE OF IMPORTED ENERGY											
10:7 PRICE OF IMPORTED GOODS											
10:8 PRICE OF IMPORTED FOOD											
#6 SELL EXPORTS AND RECEIVE AID											
11:1 MONEY FROM FOREIGN AID											
11:2 MONEY FROM ENERGY FOR EXPORT											
11:3 MONEY FROM GOODS FOR EXPORT											
11:4 MONEY FROM FOOD FOR EXPORT											
#7 DECIDE ON LOANS:											
11:5 NEW LOANS											
#8 DECIDE ON REPAYMENTS:											
11:6 REPAYMENTS											
#9 ALLOCATE MONEY AVAILABLE FOR IMPORTS:											
11:7 MONEY AVAILABLE FOR IMPORTS	(not implemented)										
11:8 MONEY FOR TECHNOLOGY (not implemented)											
11:9 MONEY FOR ENERGY IMPORTS											
11:10 MONEY FOR GOODS IMPORTS											
11:11 MONEY FOR FOOD IMPORTS											

SAMPLE SCORE SHEET

I sometimes use a 1 meter square version of the following sheet to show all teams their relative performance during the game. Data for recording on this sheet are provided by the summary score sheet printed out at the end of each round.

TEAM	TEAM SCORES INDICES	CYCLE 10	20	30	40	50

GUIDE TO DEBRIEFING

The 30-60 minutes spent debriefing the game are essential if the participants are to take away any lessons that will be of relevance to them back in their own organizations. The precise form of the debriefing depends on the size of the group, the length of time available, and the extent to which the lessons of the game will be brought out in subsequent course materials. In any event, however, the purpose of debriefing is to:

- give players the opportunity to "unwind" from the tension of the game,
- give all players an opportunity to express any personal feelings and opinions they have from the play,
- teach each player about the general guidelines, heuristics, or principles she or others in the game used as the basis for successful decisionmaking within the game,
- teach each player about the serious errors he or the others in the game committed during the play,
- demonstrate that the game model shares many essential features with the real-world system,
- suggest that the keys to success in playing the game therefore also have potential utility for actual decisions that govern long-term economic development and natural resource productivity,
- help the participants decide what changes in their day-by-day decisions are justified by the lessons of the game and secure from them a public commitment to making those changes, and
- give the operator constructive feedback on the operation and the design of the game, so that both may be improved.

An extremely important part of the debriefing is the list of insights that result from playing the game. Below are listed a number of such insights.

- Exponential growth in population and capital exhibits certain relationships between each stock and its associated rate of increase - for example, the effect of growth rate on a stock's doubling time (the doubling time equals 72/%growth); for example, a 3% annual growth rate doubles the associated stock in 24 years), and the conceptual and practical difference between rate of growth and absolute increase (the first may be

declining steadily while the second is still growing larger with each cycle).

- The determinants and the magnitudes of a population's birth and death rates pass through certain characteristic phases during the course of the demographic transition.

- Capital investments impose significant delays on the system: once placed in one sector, capital normally cannot be moved: once it is put in place, an investment continues to impact on the system (for example, by degrading the environment or raising energy demands) for the capital's full lifetime, often 25-35 years or more.

- The cost of measures to protect the environment are generally much lower if the measures are taken early before great damage has already been done. When the quality of the environment in STRATEGEM-1 is still relatively high, the intrinsic regenerative capacity of the environment complements the efforts at restoration made through investments in environmental protection capital. But when environmental quality has slipped badly, most of the work of restoration must be done through expensive capital investments.

- There are several short-term versus long-term tradeoffs in the game. Investments in environmental protection do deprive the society of some immediate consumption, but they raise the level of production from the food sector over the long term. By diverting goods to the population early in the game, investments are reduced and growth in output is lower than it might otherwise have been. However, early increments in the material standard of living lower population growth rates and mean that the total output in later periods need not be distributed among as many people.

- Some environmental processes, for example pollution of groundwater, may involve enormous (25-75 year) delays, posing very difficult problems of environmental management, since the harmful consequences of pollution must be borne for a long time after their level has grown high enough to stimulate corrective actions.

- A gap between what is needed and what is produced may be eliminated either by producing more or by needing less. For example, energy deficits may be solved through greater amounts of energy (from imports or domestic production) or through investment in energy efficiency measures. The latter is quicker and cheaper.

- Regeneration of renewable resources involves several quite general relationships among growth, fertility, harvest, death, the resource's sustainable yield, and its standing stock (or population).

- The marginal productivity of investments typically declines with increasing intensity of exploitation of a resource. The returns to investments in food production capital are high at first, but eventually they decline to levels that make them uneconomic. Similarly, though early allocations to energy efficiency capital pay high dividends, it is not worthwhile to push the energy consumption multiplier much below 0.4.

- The short-term results of a resource policy may be opposite in direction from the long-term results of that policy. By denying capital to environmental protection, more may be invested in agriculture. The result is higher food production in the short term. However, the longer-term consèquence is erosion of environmental quality and, therefore, reduced agricultural production.

- Interconnections among resources can often mean that measures taken to increase the utilization of one resource will raise or lower the productivity of others. For example, capital invested to raise energy production can erode the quality of the environment and thus reduce the productivity of the agricultural land.

- One must carefully consider the influence of a capital stock's average lifetime and the cost of maintaining it. The benefits associated with a capital stock typically depend on its magnitude; in contrast, the costs associated with a capital stock typically depend on the rate at which investments flow into it. Consider, for example, a capital stock with lifetime of 20 years. To maintain the stock at 1000 units requires an investment of 50 units/year or 250/cycle. If the capital stock had an average lifetime of 50 years it would take only 20 units/year or 100 units per cycle to maintain it at that constant level.

- One must be careful to weigh all costs of each policy. Often a decision that seems quite attractive when viewed only from the perspective of one sector will be found to impose significant costs on other sectors. For example, it seems relatively inexpensive to achieve increased goods production through investments in goods production capital. But each unit of goods production capital imposes indirect costs on both the energy and the food sectors of the system. For each new unit of goods production capital one must add additional energy production capital or energy efficiency capital. Further, each unit of goods production capital imposes costs on the food sector. Either new investments must be made in environmental protection or there will be losses in food output because of declining quality of the environment.

- Some measures may actually be more productive than they appear, just because they have indirect benefits. For example, investments in human services capital do not normally add to goods production as quickly as do investments in goods

production capital. However, associated with additions to goods capital are the indirect costs listed just above. Human services capital does not require additional energy and it does not burden the environment. In addition, human services capital investments help reduce the population growth rate, so that higher material standards can ultimately be achieved with lower total output.

The following conclusions are among those illustrated only by the model when energy depletion and technology imports have been activated in the model.

- Depletion of a nonrenewable resource generally raises the inputs required to produce the next increment of output.

- Technological change can alter the precise timing and impact of any relationship mentioned above, but it cannot permanently eliminate any of them for any resource.

MISCELLANEOUS REFLECTIONS ON THE GAME

This space in the manual will be used in future editions to summarize the questions, comments, and suggestions that are provide to me by those operating the game. I will record here, however, a few of my own observations.

STRATEGEM-1 is great fun to play, and it is very satisfying to run it for a group of participants. The level of attention, excitement, effort, and communication that takes place in a group which is intent on the play exceed anything ever found in formal teaching situations. However, the operator must not settle just for this pleasure associated with the play. If he does, the participants will have left with little more than a pleasant half day behind them. Great care must be taken during the introduction and the debriefing to relate the game to the participants' own problems and to help participants see what concrete implications the game's lessons have for their own actions. This takes constant attention and careful experimentation to achieve.

Many potential operators have suggested changes in the game. These invariably make it more realistic, but also more complicated. Perhaps these changes will make it possible to base more lessons on the game, but I already find it difficult in the time normally available for debriefing to extract all the lessons that are already embedded in STRATEGEM-1, and participants accept the game as quite realistic without further elaboration. Thus I think users of STRATEGEM-1 should use the game in its present form for a dozen times or more before attempting to "improve" it.

A common suggestion is to develop some sort of decision support system that players could use on the computer to think through the best decision during the game. This, of course, totally changes the purpose. Players would quit taking responsibility for the results and would likely not become so personally engaged in the play.

LISTING OF THE COMPUTER PROGRAMME

```
1000  REM STRATEGEM-I.C 2/19/85
1010  REM  ENERGY/ENVIRONMENT GAME
1020  REM  THE MEADOWS & TOTH
1025 PROGRAM FOR NEC PC-8201A
1040  SCREEN 0,0:CLS
1050  INPUT "ENTER THE NUMBER OF COUNTRIES=";K
1060  DIM QY(11),DY(11),BY(11),IY(11),Z(22 ),EY(11),OY(11)
1070  DIM WY(11),VY(11),LY(11),RY(11),NY(11),MY(11),PY(11),FY(11)
1080  DIM JX(21),J$(21),IC(6),CY(11),Y1(11),Y2(11),Y3(11),Y4(11),Y5(11)
1090  DIM AC(K,6),AE(K),AL(6),AN(K),AP(K),AX(K),BR(K),CA(K),CL(K)
1100  DIM CO(K),CU(K),DE(K),DR(K),EA(K),EF(K),EG(K),EI(K),EL(K),EM(K)
1105  DIM EE(K),EC(K),KF(K),KG(K),RE(K),XF(K),XE(K),ME(K)
1110  DIM EO(K),ER(K),EW(K),FO(K),GE(K),GP(K),HD(K),HP(K)
1120  DIM IM(K,6),IR(K),LF(K),LP(K),ML(K),NE(K),OM(K),OS(K),PD(K,6)
1130  DIM PL(K),PM(K),PN(K),PO(K),PH(K)
1140  DIM PT(K),QE(K),RI(6),RR$(6),T(K),TA(K),TC(K),TE(K),TF(K),TL(K)
1150  DIM TP(K),UE(K),UF(K),UG(K),VM(K),WA(K),WG(K),WM(K),XI(K),XR(K)
1160  DIM RC(K,6),ZE(K),ZF(K),ZG(K),FL(K),GL(K),CE(K),QQ(K),AG(K)
1165  DIM S1(K),S2(K),S3(K),S4(K),S5(K)
1170  B0$ = "Total          ="
1180  B1$ = "MUST BE="
1190  B3$ = "Total not equal to"
1200  C0$ = "Your decision is:"
1210  C1$ = "Is that correct?(Y/N)"
1220  C2$ = "Y for YES, N for NO"
1240  RR$(0) = "HOUSEHOLD          ="
1250  RR$(1) = "FOOD PRODUCTION ="
1260  RR$(2) = "ENVIRONMENT PROT="
1270  RR$(3) = "GOODS PRODUCTION="
1280  RR$(4) = "HUMAN SERVICES  ="
1290  RR$(5) = "ENERGY PRODUCTN.="
1300  RR$(6) = "ENERGY EFFICIENCY="
1310  DATA 2500,4000,4500,9000,6000,4200
1320  FOR I = 1 TO 6: READ IC(I): NEXT I
1330  DATA 5,6,5,9,5,5
1340  FOR I = 1 TO 6: READ AL(I): NEXT I
1350  DATA 1E3,10,2.5,2E4,3,1.25
1360  READ AA,DA,SA,SC,XE,KF
1370  DATA 2.5,12500,1,.8,12500
1380  READ AN,AP,CA,QE,TF
1390  DATA .2,.25,10,10
1400  READ HE,LA,KB,KD
1410  DATA 15,5,7500,500,37500,10,10
1420  READ CO,FO,HD,PO,TC,BR,DR
1430  DATA 1,1,1
1440  READ AR,GA,EB
1450  DATA 0,0,.1,1,0,26E3,26E3,0,0,26E3,26E3
1460  READ AX,DE,IR,PM,EF,GE,UE,UF,UG,AE,XI
1470  DATA        1,80,1E4,2,10000,1,1,1
1480  READ EP,OP,NM,NF,RE,XF,PN,PW
1490  DATA 12500,26E3,56E3,56E3,3E4,36E3,.6,0
1500  READ EG,EI,NE,TE,EL,EO,EW,CE
1510  DATA 100,1.4,1.155
1520  READ CL,GN,SG,HG
1530  DATA 68600,68600,0,1
1540  READ TA,GF,QT,CU
1542  DATA 0,0,0,0,0
1543  READ S1,S2,S3,S4,S5
```

Arrays for Country Variables

Alphabetic Strings

SECTOR CONSTANTS AND INITIAL VALUES

Initial Capital Stocks and Average Lifetimes

Food Production and Environmental Protection

Population Growth and Household Consumption

International Trade and Debt

Energy Production and Energy Efficiency

Goods Production and Human Services

Cumulative Expenditures for Technologies

```
1550  REM
1560  REM TABLE FUNCTIONS
1570  REM                                                    x-axis
1580  L = 11
1590  FOR I = 1 TO 21 STEP 2:Z(I) = (I - 1) / 20: NEXT I
1600  DATA  0,1,2,3,3.7,4.2,4.5,4.7,4.8,4.9,5
1610  FOR I = 1 TO 11: READ NY(I): NEXT I                    Land Output Mult.
1620  DATA  0,40,55,70,78,83,90,93,95,97,100
1630  FOR I = 1 TO 11: READ QY(I): NEXT I                    Percent Degeneration
1640  DATA   .4,.52,.64,.76,.88,1,1,1,1,1,1
1650  FOR I = 1 TO 11: READ CY(I): NEXT I                    Consumption Mult.
1660  DATA  0,2,20,35,45,50,45,35,20,2,0
1670  FOR I = 1 TO 11: READ RY(I): NEXT I                    Percent Regeneration
1680  DATA  3,2.8,2.6,2.4,2.2,1.9,1.6,1.3,1.1,1,1
1690  FOR I = 1 TO 11: READ BY(I): NEXT I                    Normal Births
1700  DATA  6,4.5,3,2.2,1.8,1.5,1.3,1.2,1.1,1,1
1710  FOR I = 1 TO 11: READ DY(I): NEXT I                    Normal Deaths
1720  DATA   1,1.5,1.45,1.4,1.35,1.3,1.2,1.1,1,1,1
1730  FOR I = 1 TO 11: READ WY(I): NEXT I                    B. Mult. from HS
1740  DATA  1.75,1.6,1.5,1.4,1.3,1.2,1.1,1,1,1,1
1750  FOR I = 1 TO 11: READ VY(I): NEXT I                    D. Mult. from QE
1760  DATA  10,10,10,12,14,15,16,17,18,19,20
1770  FOR I = 1 TO 11: READ IY(I): NEXT I                    Interest Rate
1780  DATA   1,1,1,1,1,1,1.2,1.4,1.6,1.8,2
1790  FOR I = 1 TO 11: READ MY(I): NEXT I                    Payments Mult.
1800  DATA  0,.35,.4,.45,.50,.55,.60,.64,.67,.69,.70
1810  FOR I = 1 TO 11: READ PY(I): NEXT I                    Energy Production
1820  DATA   1,.8,.7,.58,.5,.42,.4,.35,.33,.31,.3
1830  FOR I = 1 TO 11: READ EY(I): NEXT I                    Energy Reg. Mult.
1840  DATA  1,2,3,3.5,4,4.3,4.5,4.7,4.8,4.9,5
1850  FOR I = 1 TO 11: READ LY(I): NEXT I                    Output Mult. HS
1860  DATA  1,4,6,10.4,12.5,14.4,16,17.2,18.5,19.4,20
1870  FOR I = 1 TO 11: READ OY(I): NEXT I                    Output Mult. Goods
1872  DATA 1,1,1,1,1,1,1,1,1,1,1
1873  FOR I=1 TO 11:READ Y1(I):NEXT I     Land Prod.
1874  DATA 1,1,1,1,1,1,1,1,1,1,1
1875  FOR I=1 TO 11:READ Y2(I):NEXT I     Labor Prod.        TABLES OF
1876  DATA 1,1,1,1,1,1,1,1,1,1,1                             TECHNOLOGY
1877  FOR I=1 TO 11:READ Y3(I):NEXT I     Energy Res.        EFFECTS
1878  DATA 1,1,1,1,1,1,1,1,1,1,1
1879  FOR I=1 TO 11:READ Y4(I):NEXT I     Energy Eff.
1880  DATA 1,1,1,1,1,1,1,1,1,1,1
1881  FOR I=1 TO 11:READ Y5(I):NEXT I     Environ. Prot.
1882  DATA 1,1,1,1,1,1,1,1,1,1,1
1883  FOR I=1 TO 11:READ FY(I):NEXT I     Energy Prod. Cap. Eff.
1885  PRINT:PRINT "DO YOU WANT TO START FROM DEVELOPING OR"
1890  INPUT "FROM HIGH EQUILIBRIUM? (D/H)";W$
1900  IF W$ = "H" GOTO 2050
1910  IF W$ = "D" GOTO 1930
1920  CLS:PRINT "PLEASE TYPE D OR H":PRINT:PRINT:GOTO 1880
1930  DATA 800,0,300,450,800,0
1940  FOR I = 1 TO 6: READ IC(I): NEXT I                    Choice of Initial Values
1950  DATA .8,3500,.7,3500
1960  READ AN,AF,QE,TF                                      Resets Parameters for
1970  DATA 41,2,18,2,400,200,4000                           Developing Country
1980  READ BR,CO,DR,FO,HD,PO,TC
1990  DATA 1000,0,.1,1,1000,0,500,0,500,1000,1000,0
2000  READ AX,DE,IR,PM,EF,GE,UE,UF,UG,AE,XI,DS
2010  DATA 0,3000,2E3,15E3,15E3
2020  READ EI,EL,EO,NE,TE
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```
2030  DATA 3000,3500
2040  READ GP,PA
2050  JX(1)=CO/15:JX(2)=FO/5:JX(8)=(IC(1)*CA)/(AA*OA):JX(7)=.5:JX(11)=.5
2060  JX(13)=(IC(3)/(10*PO))                                   Initializes Tables & Capital
2070  FOR J = 1 TO K: FOR I = 1 TO 6:AC(J,I) = IC(I): NEXT I: NEXT J   Stocks
2080  FOR J = 1 TO K
2090  AN(J)=AN:AP(J)=AP:QE(J)=QE:TF(J)=TF:CO(J)=CO:FO(J)=FO
2100  HO(J)=HO:PO(J)=PO:TC(J)=TC:BR(J)=BR:DR(J)=DR:AG(J)=CO
2110  CU(J)=CU:CA(J)=CA:AX(J)=AX:DE(J)=DE:IR(J)=IR:PM(J)=PM:EF(J)=EF
2120  GE(J)=GE:UE(J)=UE:UF(J)=UF:UG(J)=UG:AE(J)=AE:XI(J)=XI
2130  EG(J)=EG:EI(J)=EI:NE(J)=NE:TE(J)=TE:EL(J)=EL:EW(J)=EW
2140  TA(J)=TA:GP(J)=GP:EO(J)=EO:T(J)=0:CE(J)=0:QQ(J)=0
2145 EE(J)=0:XR(J)=0:EC(J)=0:KF(J)=KF:KG(J)=KG:RE(J)=RE:XF(J)=XF:XE(J)=XE
2146 S1(J)=S1:S2(J)=S2:S3(J)=S3:S4(J)=S4:S5(J)=S5
2150  NEXT J                                                   Initializes Country Parameters
2160  TT = 0
2170  FOR J = 1 TO K                                           Cycle Counter
2180  TP(J) = 0
2190  FOR I = 1 TO 6                                           Depreciation of Six Capital
2200  PD(J,I) =  INT ((AC(J,I) / AL(I) + 5) / 10) * 10         Stocks
2210  RC(J,I) = AC(J,I) - PD(J,I)                              New Producing Stocks and Total
2220  TP(J) = TP(J) + PD(J,I): NEXT I                          Depreciation
2221 S1(J)=S1(J)+P1(J):S2(J)=S2(J)+P2(J):S3(J)=S3(J)+P3(J)
2222 S4(J)=S4(J)+P4(J):S5(J)=S5(J)+P5(J)                      New Cumulative Technology Expenditures
2223 X=S1(J):JX(19)=X:FOR I=1 TO 11:Z(2*I)=Y1(I):NEXT I
2224 GOSUB 4500:KF(J)=KF*Y                                    Normal Land Productivity
2225 X=S2(J):JX(21)=X:FOR I=1 TO 11:Z(2*I)=Y2(I):NEXT I
2226 GOSUB 4500:KG(J)=KG*Y                                    Normal Labor Productivity
2227 X=S3(J):JX(16)=X:FOR I=1 TO 11:Z(2*I)=Y3(I):NEXT I
2228 GOSUB 4500:RE(J)=RE*Y                                    Total Energy Resources
2229 X=S4(J):JX(18)=X:FOR I=1 TO 11:Z(2*I)=Y4(I):NEXT I
2230 GOSUB 4500:XF(J)=XF*Y                                    Energy ff Cap. Mult.
2231 X=S5(J):JX(20)=X:FOR I=1 TO 11:Z(2*I)=Y5(I):NEXT I
2232 GOSUB 4500:XE(J)=XE*Y                                    Env. Protection Cap Mult.
2233 X=CE(J)/RE(J):JX(17)=X:FOR I=1 TO 11:Z(2*I)=FY(I):NEXT I
2234 GOSUB 4500:ME(J)=Y                                       Energy Prod. Cap. Mult.
2235  CL(J) =  INT (10 * AC(J,1) / AA + .5) / 10               Capital Land Ratio
2240  EZ = CA(J) * AC(J,1) + CU(J) * AC(J,3) + AC(J,5)
2250  X = (EZ-XE(J)* AC(J,2)) / SC                            QE Deterioration
2260  JX(9)=X
2270  FOR I = 1 TO 11:Z(2 * I) = QY(I): NEXT I
2280  GOSUB 4500:QD = Y / 10
2290  X = QE(J)
2300  FOR I = 1 TO 11:Z(2 * I) = RY(I): NEXT I                QE Regeneration
2310  GOSUB 4500:QR = Y / 10
2320 CE(J) =  INT (100 * QE(J) + 5 * (QR - QD) * QE(J) + .5) / 100 Quality of Env.
2330 LC = AC(J,1) / (AA * OA)
2340 X = LC:JX(8) = X                                         Land Output Multiplier from
2350  FOR I = 1 TO 11:Z(2 * I) = NY(I): NEXT I                Capital with Full Energy
2360  GOSUB 4500:AN(J) = Y
2370 PL(J) =  INT (100 * AN(J) * QE(J) *KF(J)+.5) / 100       Land Productivity per Hectare
2380 HP(J) =  INT (100 * AC(J,4) / PO(J) + .5) / 100
2390 X = HP(J) / 20:JX(12) = X                                Labor Output Mult. from HS
2400  FOR I = 1 TO 11:Z(2 * I) = LY(I): NEXT I
2410  GOSUB 4500:LP(J) =  INT (100 * Y + .5) / 100
2420 LF(J) = PO(J) * LA                                       Labor Force
2430 CS(J) = INT(AC(J,3)/LF(J) + .5)                          Capital Labor Ratio
2440 X = CS(J) / 40:JX(13) = X
2450  FOR I = 1 TO 11:Z(2 * I) = CY(I): NEXT I                Labor Output Mult. from Capital with
2460  GOSUB 4500:OM(J) =  INT (100 * Y + .5) / 100            Full Energy
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2470 TL(J) =  INT (10 * OM(J) * LP(J)*KG(J)+ .5) / 10 'Labor Productivity Per Person
2480 X = AC(J,5) / NM:JX(5) = X
2490  FOR I = 1 TO 11:Z(2 * I) = PY(I): NEXT I        Energy Output Mult. from Capital
2500  GOSUB 4500:PN(J) =  INT (100 * Y + .5) / 100
2510 NE(J) = 5 *  INT ((RE(J) * PN(J)*ME(J) + 5) / 10) * 10  Energy Production
2515 CE(J)=CE(J)+NE(J)
2520 X = HP(J) /20:JX(2) = X
2530  FOR I = 1 TO 11:Z(2 * I) = WY(I): NEXT I        Birth Mult. from Services
2540  GOSUB 4500:WM(J) = Y
2550 X=QE(J):JX(4)=X:JX(12)=X
2560  FOR I = 1 TO 11:Z(2 * I) = VY(I): NEXT I        Death Mult. from QE
2570  GOSUB 4500:VM(J) = Y
2580 AE(J) =  INT ((AE(J) + (XI(J) - AE(J)) / 3 + 5) / 10) * 10  Average Exports
2590 ML(J) = AE(J) - DE(J)
2600  IF ML(J) < 0 THEN ML(J) = 0
2610  IF AE(J) > 0 GOTO 2640                          Maximum Available Loan
2620 IR(J) = 10:PM(J) = 1
2630  GOTO 2710                                       Interest Rate
2640 X = (DE(J) / AE(J)) / 5:JX(15) = X
2650  FOR I = 1 TO 11:Z(2 * I) = IY(I): NEXT I
2660  GOSUB 4500:IR(J) = Y
2670 DA = DE(J) / AE(J)
2680 X = DA / 5:JX(14) = X                            Price Multiplier on Imports
2690  FOR I = 1 TO 11:Z(2 * I) = MY(I): NEXT I
2700  GOSUB 4500:PM(J) = Y
2710 IR(J) = ( INT (IR(J) + .5)) / 100                Interest Rate
2720 EP = 1
2730  IF T(J) >  = OB THEN EP = NP                    Imported Energy Price
2740 ZG(J)=GA*1.1*PM(J):ZF(J)=AR*1.1*PM(J):ZE(J)=EP*PM(J) Actual Import Prices
2750 EX=XF(J)* AC(J,6) / (AC(J,1) + AC(J,3))          Average Energy E&S Capital Ratio
2770  X = EX:JX(6) = X
2780  FOR I = 1 TO 11:Z(2 * I) = EY(I): NEXT I        Energy Consumption Multiplier
2790  GOSUB 4500:EM(J) =  INT (100 * Y + .5) / 100
2800 WA(J) = 5 *  INT ((AA + AN(J) * QE(J)*KF(J)+ 5) / 10) * 10 Projected Food Prod.
2810 WG(J) = 5 *  INT ((TLF(J) * OM(J) *LP(J)*KG(J)+ 5) / 10) * 10 Projected Goods Proc
2820 HM = HE
2830 ER(J) = 5 *  INT ((AC(J,3) * SG * EM(J) + 5) / 10) * 10  Energy Requirements HH,
2840 EA(J) = 5 *  INT ((AC(J,1) * SA * EM(J) + 5) / 10) * 10      Goods, and Food
2850 PT(J) = EA(J) + ER(J) + HD(J)     Projected Energy Requirements This Cycle
2860 FL(J) = FD(J):GL(J) = CO(J)                      Consumption Last Cycle
2870  REM  REPORTS GENER.
2880  GOSUB 4620                                      Country Cycle Indicator
2890  IF TT > 0 GOTO 2910                             General Reports
2900  NEXT J:TT = 1
2910  IF TT >(K * 10+1) GOTO 4490
2920 TT = TT + 1
2930 CLS
2940  REM INPUTS
2950  REM
2960  PRINT "TYPE IN THE NUMBER OF THE COUNTRY FOR"
2970  PRINT "WHICH DECISIONS WILL BE ENTERED!"        Specify Country for Inputs
2980  PRINT:INPUT "COUNTRY=";J1
2990  IF J1 > K THEN  PRINT "MUST BE <=";K: GOTO 2960
3000  IF J1 < 1 THEN  PRINT "MUST BE >= 1": GOTO 2960
3010 J = J1
3020  CLS:PRINT "COUNTRY=",J,"YEARS  =";T(J);"-";T(J)+4
3030  PRINT C1$: INPUT  W$
3040  IF W$ = "Y" GOTO 3070
3050  IF W$ = "N" GOTO 2960
3060  PRINT C2$: GOTO 3030
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3070  CLS
3080  INPUT "PI:1=";DF                                    Food Consumption and Exports
3090  INPUT "PI:2=";EF(J)
3100  IF DF + EF(J) <  > TF(J) THEN  PRINT B3$,TF(J): GOTO 3080  Error Checking
3110 FO(J) =  INT (100 * DF / (PO(J) * 5) + .5) / 100          Food Per Capita
3120  CLS:PRINT C0$: PRINT "CONSUMPTION",DF: PRINT "EXPORTS",EF(J)
3130  PRINT C1$: INPUT W$
3140  IF W$ = "Y" GOTO 3170
3150  IF W$ = "N" GOTO 3080                               Error Checking
3160  PRINT C2$: GOTO 3130
3170 AX(J) = EF(J) * AR
3180  CLS                                                 Food Export Income
3190  INPUT "PI:3=";TC(J)
3200 CO(J) =  INT (100 * TC(J) / (5 * PO(J)) + .5) / 100
3205 AG(J)=AG(J)+(CO(J)-AG(J))/3
3210  INPUT "PI:4=";TI
3220  INPUT "PI:5=";GE(J)
3230  IF(TC(J)+TI+GE(J))<>(TA(J)*1)THEN  PRINT B3$;TA(J):GOTO 3190
3240  CLS:PRINT C0$: PRINT "CONSUMPTION=",TC(J)
3250  PRINT "INVESTMENTS=",TI: PRINT "EXPORTS=",GE(J)
3260  PRINT C1$: INPUT W$
3270  IF W$ = "N" GOTO 3190
3280  IF W$ = "Y" GOTO 3300
3290  PRINT C2$: GOTO 3260                               Error Checking
3300 GX = GE(J) * GA                                     Goods Export Income
3310 XI(J) =  INT ((TAX(J) + GX + 5) / 10) * 10          Total Export Income
3320 HD(J) =  INT ((TC(J) * HE + 5) / 10) * 10           HH Energy Demand
3330 ET = EA(J) + ER(J) + HD(J)                          Total Energy Demand
3340  IF HD(J) <  = TE(J) THEN ED = TE(J) - HD(J): GOTO 3360
3350  HD(J) = TE:ED = 0                                  Energy for Production
3360  CLS
3370  INPUT "EI:1=";XD                                   Energy for Population
3380  IF XD <  > HD(J) THEN  PRINT B1$,HD(J): GOTO 3370
3385 INPUT "EI:2=";EE(J)                                 Energy Carried Over
3390  INPUT "EI:3=";EC(J)
3395  INPUT "EI:4=";ED                                   Energy for Production
3400 IF ED <> TE(J)-XD-EE(J)-EC(J) THEN PRINT B1$,TE(J)-XD-EE(J)-EC(J):GOTO 3385
3420  INPUT "EI:5=";EG(J)                  Energy for Goods and Food Production
3425 INPUT "EI:6=";EO(J)
3430  IF ED <> EG(J)+EO(J) THEN PRINT B3$;ED: GOTO 3420
3440  CLS:PRINT C0$: PRINT RR$(0);XD:PRINT "EXPORTS=";EE(J): PRINT RR$(1);EG(J)
3450  PRINT RR$(3);EO(J):PRINT "CARRIED OVER=";EC(J)
3460  PRINT C1$: INPUT W$                                Error Checking
3470  IF W$ = "Y" GOTO 3500
3480  IF W$ = "N" GOTO 3360
3490  PRINT C2$: GOTO 3460
3500 XR(J)=EE(J)+EB: CLS
3510  INPUT "EI:7=";RI(5)
3520  INPUT "EI:8=";RI(6)
3530  INPUT "FI:1=";RI(1)                                Investment Allocations
3540  INPUT "FI:2=";RI(2)
3550  INPUT "GI:1=";RI(3)
3560  INPUT "GI:2=";RI(4)
3570 XB = 0                                              Error Checking
3580  FOR I = 1 TO 6:XB = XB + RI(I): NEXT I
3590  IF XB <  > TI THEN  PRINT B0$;XB:PRINT B1$;TI:GOTO 3510
3600  IF RI(6)>RI(1)+RI(3)THEN PRINT "MAX EI:8=",RI(1)+RI(3):GOTO 3510
3610  CLS:PRINT C0$
3620  FOR I = 1 TO 6
3630  PRINT RR$(I);RI(I)
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```
3070  CLS
3080  INPUT "PI:1=";DF
3090  INPUT "PI:2=";EF(J)                                   Food Consumption and Exports
3100  IF DF + EF(J) <  > TF(J) THEN  PRINT B3$,TF(J): GOTO 3080  Error Checking
3110 FO(J) =  INT (100 * DF / (PO(J) * 5) + .5) / 100        Food Per Capita
3120  CLS:PRINT C0$: PRINT "CONSUMPTION",DF: PRINT "EXPORTS",EF(J)
3130  PRINT C1$: INPUT W$
3140  IF W$ = "Y" GOTO 3170
3150  IF W$ = "N" GOTO 3080                                 Error Checking
3160  PRINT C2$: GOTO 3130
3170 AX(J) = EF(J) * AR
3180  CLS                                                   Food Export Income
3190  INPUT "PI:3=";TC(J)
3200 CO(J) =  INT (100 * TC(J) / (5 * PO(J)) + .5) / 100
3205 AG(J)=AG(J)+(CO(J)-AG(J))/3
3210  INPUT "PI:4=";TI
3220  INPUT "PI:5=";GE(J)
3230  IF(TC(J)+TI+GE(J))<>(TA(J)*1)THEN  PRINT B3$;TA(J):GOTO 3190
3240  CLS:PRINT C0$: PRINT "CONSUMPTION=",TC(J)
3250  PRINT "INVESTMENTS=",TI: PRINT "EXPORTS=",GE(J)
3260  PRINT C1$: INPUT W$
3270  IF W$ = "N" GOTO 3190
3280  IF W$ = "Y" GOTO 3300
3290  PRINT C2$: GOTO 3260                                 Error Checking
3300 GX = GE(J) * GA                                       Goods Export Income
3310 XI(J) =  INT ((TAX(J) + GX + 5) / 10) * 10            Total Export Income
3320 HD(J) =  INT ((TC(J) * HE + 5) / 10) * 10             HH Energy Demand
3330 ET = EA(J) + ER(J) + HD(J)                            Total Energy Demand
3340  IF HD(J) <  = TE(J) THEN ED = TE(J) - HD(J): GOTO 3360
3350  HD(J) = TE:ED = 0                                    Energy for Production
3360  CLS
3370  INPUT "EI:1=";XD                                     Energy for Population
3380  IF XD <  > HD(J) THEN  PRINT B1$,HD(J): GOTO 3370
3385 INPUT "EI:2=";EE(J)                                   Energy Carried Over
3390  INPUT "EI:3=";EC(J)
3395  INPUT "EI:4=";ED                                     Energy for Production
3400 IF ED <> TE(J)-XD-EE(J)-EC(J) THEN PRINT B1$,TE(J)-XD-EE(J)-EC(J):GOTO 3385
3420  INPUT "EI:5=";EG(J)                                  Energy for Goods and Food Production
3425 INPUT "EI:6=";EO(J)
3430  IF ED <> EG(J)+EO(J) THEN PRINT B3$;ED: GOTO 3420
3440  CLS:PRINT C0$: PRINT RR$(0);XD:PRINT "EXPORTS=";EE(J): PRINT RR$(1);EG(J)
3450  PRINT RR$(3);EO(J);PRINT "CARRIED OVER=";EC(J)
3460  PRINT C1$: INPUT W$                                  Error Checking
3470  IF W$ = "Y" GOTO 3500
3480  IF W$ = "N" GOTO 3360
3490  PRINT C2$: GOTO 3460
3500 XR(J)=EE(J)+EB: CLS
3510  INPUT "EI:7=";RI(5)
3520  INPUT "EI:8=";RI(6)
3530  INPUT "FI:1=";RI(1)                                  Investment Allocations
3540  INPUT "FI:2=";RI(2)
3550  INPUT "GI:1=";RI(3)
3560  INPUT "GI:2=";RI(4)
3570 XB = 0                                                Error Checking
3580  FOR I = 1 TO 6:XB = XB + RI(I): NEXT I
3590  IF XB <  > TI THEN  PRINT B0$;XB:PRINT B1$;TI:GOTO 3510
3600  IF RI(6)>RI(1)+RI(3)THEN PRINT "MAX EI:8=",RI(1)+RI(3):GOTO 3510
3610  CLS:PRINT C0$
3620  FOR I = 1 TO 6
3630  PRINT RR$(I);RI(I)
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3640  NEXT I
3650  PRINT C1$:INPUT W$
3660  IF W$ = "Y" GOTO 3690
3670  IF W$ = "N" GOTO 3510
3680  PRINT C2$: GOTO 3650
3690  CLS
3700  INPUT "II:1=";FA
3705 INPUT "II:2=";XN
3707 IF XN < > XR(J) THEN PRINT B1$;XR(J):GOTO 3705
3710  INPUT "II:3=";XG
3720  IF XG <  > GX THEN  PRINT B1$,GX: GOTO 3710
3730  INPUT "II:4=";XA
3740  IF XA <  > AX(J) THEN  PRINT B1$,AX(J): GOTO 3730
3750 XI(J) = AX(J) + GX+XR(J)
3760  INPUT "II:5=";DN
3770  IF DN > ML(J) THEN PRINT "MAX LOAN =",ML(J):GOTO 3760
3780  INPUT "II:6=";DP
3790  CLS
3800  PRINT C0$
3810  PRINT "NEW LOAN =",DN
3820  PRINT "REPAYMENT=",DP
3830  PRINT "FOREIGN AID=",FA
3840  PRINT C1$: INPUT W$
3850  IF W$ = "Y" GOTO 3880
3860  IF W$ = "N" GOTO 3700
3870  PRINT C2$: GOTO 3840
3880 PU = INT(((XI(J)-DP+FA+DN)+5)/10)*10:CLS
3890 INPUT "II:7=";XP
3900  IF XP <  > PU THEN  PRINT B1$,PU: GOTO 3890
3910  IF PU > 0 GOTO 3943
3920 PE = 0:PG = 0:PF = 0
3930  PRINT "NO PURCHASES THIS PERIOD"
3940  GOTO 4060
3943 INPUT "II:8=";PH(J):P1(J)=0:P2(J)=0:P3(J)=0:P4(J)=0:P5(J)=0
3944 IF PH(J)=0 GOTO 3950
3945 INPUT "AGRIC.PRO.TECH.=";P1(J)
3946 INPUT "GOODS.PRO.TECH.=";P2(J)
3947 INPUT "ENERG.PRO.TECH.=";P3(J)
3948 INPUT "ENERG.EFF.TECH.=";P4(J)
3949 INPUT "ENVIR.PROT.TEC.=";P5(J)
3950 IF P1(J)+P2(J)+P3(J)+P4(J)+P5(J)<>PH(J) THEN GOTO 3952
3951 GOTO 3955
3952 PRINT B3$,PH(J):GOTO 3943
3955  INPUT "II:9=";PE
3960  INPUT "II:10=";PG
3970  INPUT "II:11=";PF
3980 IF PU <> PE+PG+PF+P1(J)+P2(J)+P3(J)+P4(J)+P5(J)  THEN PRINT B3$,PU:GOTO 3943
3990  CLS
3995 IF PH(J)=0 GOTO 4010
4000 PRINT C0$:PRINT "AGTEC=";P1(J);" GOOD.TEC=";P2(J)
4001 PRINT "EN.PRO.TEC=";P3(J);"EN.EFF.TEC=";P4(J);"ENV.PROT.TEC=";P5(J)
4002 PRINT C1$: INPUT W$
4003 IF W$ = "Y" GOTO 4010
4004  IF W$ = "N" GOTO 3943
4010  PRINT C0$:PRINT"TECH",PH(J):PRINT"ENER",PE
4011 PRINT"GOODS",PG:PRINT"FOOD",PF: PRINT B0$;PU
4020  PRINT C1$: INPUT W$
4030  IF W$ = "Y" GOTO 4060
4040  IF W$ = "N" GOTO 3943
4050  PRINT C2$: GOTO 4020
```

Foreign Aid Input
Money from Energy, Goods, and Food Exports, Input
New Loans
Repayments
Error Checking
Money for Imports
Money for Imports, Input
Money for Technologies, Input
Money for Energy, Goods, and Food Imports, Input
Error Checking

```
4060  CLS:PRINT:PRINT:PRINT "     PLEASE WAIT"
4070 UG(J) =  INT ((PG / ZG(J) + 5) / 10) * 10        Goods, Food, and Energy
4080 UF(J) =  INT ((PF / ZF(J) + 5) / 10) * 10          Imports
4090 UE(J) =  INT ((PE / ZE(J) + 5) / 10) * 10
4100 CA(J) =  INT (100 * EG(J) / EA(J) + .5) / 100
4110  IF CA(J) > 1.1 THEN CA(J) = 1.1                 Food Capital CU
4120 LC = (AC(J,1) * CA(J)) / (AA * DA)
4130 X = LC:JX(8) = X                                 Normalized Capital Land
4140  FOR I = 1 TO 11:Z(2 * I) = NY(I): NEXT I          Ratio Actual
4150  GOSUB 4500:AN(J) = Y
4160 X=FO(J)/(2*FL(J)):JX(7)=X
4170 FOR I=1 TO 11:Z(2*I)=CY(I):NEXT I                Consumption Mult on Land
4180  GOSUB 4500:CM = Y                                 Productivity
4190  AF(J)=5*INT((AA*AN(J)*CE(J)*KF(J)*CM+5)/10)* 10  Food Production (5 years)
4200 CU(J) =  INT (100 * EO(J) / ER(J) + .5) / 100
4210  IF CU(J) > 1.1 THEN CU(J) = 1.1                 Goods Capital CU
4220 OS(J) = (AC(J,2) * CO(J)) / LF(J)
4230 X=OS(J)/40:JX(13) = X                            Land Output Mult. from Goods
4240  FOR I = 1 TO 11:Z(2 * I) = OY(I): NEXT I
4250  GOSUB 4500:OM(J) = Y
4260 X=CO(J)/(2*GL(J)):JX(11)=X
4270  FOR I = 1 TO 11:Z(2 * I) = CY(I): NEXT I        Cons. Mult. from Goods
4280  GOSUB 4500:CM = Y
4290 GP(J)=5*INT((LF(J)*OM(J)*LP(J)*GG(J)*CM+5)/10)*10  Goods Production (5 Years)
4300 TA(J) = GP(J) + UG(J)
4310 TE(J) = NE(J) + UE(J) +EC(J)                     Total Goods, Energy,
4320 EL(J) = NE(J)                                    Food Available
4330 TF(J) = AF(J) + UF(J)
4340 X = FO(J) / 5:JX(3) = X
4350  FOR I = 1 TO 11:Z(2 * I) = DY(I): NEXT I        Normal Deaths
4360  GOSUB 4500:DR(J) =  INT (Y * VM(J) * KD + .5)
4370 X = AG(J) / 15:JX(1) = X
4380  FOR I = 1 TO 11:Z(2 * I) = BY(I): NEXT I        Normal Births
4390  GOSUB 4500:BR(J) =  INT (Y * WM(J) * KB + .5)
4400 ZZ = DE(J) - DP + DN
4410 DS =  INT ((5 * IR(J) * ZZ + 5) / 10) * 10       Debt Services
4420 DE(J) = ZZ + DS                                  Debt
4430 PO(J)=INT((PO(J)+5*(BR(J)-DR(J))/1000*PO(J)+5)/10)*10  Population
4440  FOR I = 1 TO 6
4450 AC(J,I) = AC(J,I) - FD(J,I) + RI(I)
4460  NEXT I                                          New Capital Stocks
4470 T(J) = T(J) + 5
4480  GOTO 2180
4490  END
4500  REM  TABLE FUNCTION SUBR.
4510  IF X <  = Z(1) GOTO 4580
4520  IF X > Z(2 * L - 1) GOTO 4590
4530  FOR NN = 3 TO (2 * L - 1) STEP 2
4540  IF X > Z(NN) THEN  GOTO 4570
4550 Y=Z(NN-1)+(Z(NN+1)-Z(NN-1))*(X-Z(NN-2))/(Z(NN)-Z(NN-2))
4560  GOTO 4600
4570  NEXT NN
4580 Y = Z(2): GOTO 4600
4590 Y = Z(2 * L): GOTO 4600                          Table Function Subroutine
4600  RETURN
4610  REM  REPORTS GEN. SUBR.
4620  PRINT:PRINT "COUNTRY:",J
4622 QQ(J)=QQ(J)+CO(J)+4*FO(J):QT=QT+1
4630  INPUT "REPORT:FULL,RECORD,SUMM,NONE  (F/R/S/N)";W$
4640  IF W$ = "F" GOTO 4690
```

```
4650 IF W$="S" GOTO 5540
4660  IF W$ = "N" GOTO 5710
4680 LPRINT "POP. & HH CONS.":LPRINT
4690 LPRINT "COUNTRY:";J
4700 LPRINT "YEARS:";T(J);"-";T(J)+4,:LPRINT
4710 LPRINT "PO:1",PO(J)
4720 LPRINT "PO:2",TF(J)
4730 LPRINT "PO:3",TA(J)
4740 LPRINT "PO:4",FO(J)
4750 LPRINT "PO:5",DR(J)
4760 LPRINT "PO:6",CO(J)
4770 LPRINT "PO:7",HP(J)
4775 LPRINT "PO:8",BR(J)
4780 LPRINT :LPRINT
4790 LPRINT "ENERGY PROD. & ENERGY EFF.":LPRINT
4800 LPRINT "COUNTRY:";J
4810 LPRINT "YEARS:";T(J);"-";T(J)+4:LPRINT
4820 LPRINT "ED:1",PD(J,5)
4830 LPRINT "ED:2",RC(J,5)
4840 LPRINT "ED:3",AC(J,5)
4850 LPRINT "ED:4",PD(J,6)
4860 LPRINT "ED:5",RC(J,6)
4870 LPRINT "ED:6",AC(J,6)
4880 LPRINT "ED:7",TE(J)
4890 LPRINT "ED:8",HE
4900 LPRINT "ED:9",HD(J)
4910 LPRINT "ED:10",EM(J)
4920 LPRINT "ED:11",INT(50*SA*EM(J)+.5)/10
4930 LPRINT "ED:12",EA(J)
4940 LPRINT "ED:13",INT(50*SG*EM(J)+.5)/10
4950 LPRINT "ED:14",ER(J)
4960 LPRINT "ED:15",EA(J)+ER(J)
4970 LPRINT "ED:16",NE(J)/AC(J,5)
4980 LPRINT "ED:17",NE(J)
4990 LPRINT "ED:18",EE(J)
4995 LPRINT "ED:19",UE(J)
5000 LPRINT :LPRINT
5010 LPRINT "FOOD PROD. & ENV. PROT.":LPRINT
5020 LPRINT "COUNTRY:";J
5030 LPRINT "YEARS:";T(J);"-";T(J)+4:LPRINT
5040 LPRINT "FO:1",PD(J,1)
5050 LPRINT "FO:2",RC(J,1)
5060 LPRINT "FO:3",AC(J,1)
5070 LPRINT "FO:4",PD(J,2)
5080 LPRINT "FO:5",RC(J,2)
5090 LPRINT "FO:6",AC(J,2)
5100 LPRINT "FO:7",QE(J)
5110 LPRINT "FO:8",CL(J)
5120 LPRINT "FO:9",WA(J)
5130 LPRINT "FO:10",CA(J)
5140 LPRINT "FO:11",AP(J)
5150 LPRINT "FO:12",EF(J)
5160 LPRINT "FO:13",UF(J)
5190 LPRINT :LPRINT
5200 LPRINT "GOODS PROD. & HUM. SERVICES":LPRINT
5210 LPRINT "COUNTRY:";J
5220 LPRINT "YEARS:";T(J);"-";T(J)+4:LPRINT
5230 LPRINT "GO:1",PD(J,3)
5240 LPRINT "GO:2",RC(J,3)
```

```
5250 LPRINT "GO:3",AC(J,3)
5260 LPRINT "GO:4",PD(J,4)
5270 LPRINT "GO:5",RC(J,4)
5280 LPRINT "GO:6",AC(J,4)
5290 LPRINT "GO:7",OS(J)
5300 LPRINT "GO:8",OM(J)
5310 LPRINT "GO:9",HP(J)
5320 LPRINT "GO:10",LP(J)
5330 LPRINT "GO:11",CU(J)
5340 LPRINT "GO:12",GF(J)
5350 LPRINT "GO:13",GE(J)
5360 LPRINT "GO:14",UG(J)
5370 LPRINT "GO:15",WG(J)
5380 LPRINT "GO:16",TA(J)
5385 LPRINT "GO:17",TP(J)
5390 LPRINT :LPRINT
5400 LPRINT "INTERNAT. FINANCE, EXP., IMP., & DEBT":LPRINT
5410 LPRINT "COUNTRY:";J
5420 LPRINT "YEARS:";T(J);"-";T(J)+4:LPRINT
5430 LPRINT "IO:1",DE(J)
5440 LPRINT "IO:2",IR(J)
5450 LPRINT "IO:3",PM(J)
5460 LPRINT "IO:4",DS
5470 LPRINT "IO:5",ML(J)
5480 LPRINT "IO:6",ZE(J)
5490 LPRINT "IO:7",ZG(J)
5500 LPRINT "IO:8",ZF(J)
5510 LPRINT:LPRINT:IF W$="R" GOTO 5710
5511 LPRINT "TABLE FUNCTION SETTINGS":LPRINT
5512 LPRINT "COUNTRY:";J
5513 LPRINT "YEARS:";T(J);"-";T(J)+4
5514 LPRINT
5520 FOR I = 1 TO 21:LPRINT I,JX(I): NEXT I
5530 LPRINT:LPRINT
5540 LPRINT "SCORE SHEET":LPRINT
5550 LPRINT "COUNTRY:";J
5560 LPRINT "YEARS:";T(J);"-";T(J)+4:LPRINT
5570 LPRINT "POPULATION=",PO(J)
5572 LPRINT "FOOD PC   =",FO(J)
5574 LPRINT "GOOD PC   =",CO(J)
5576 LPRINT "POP. G.R. =",(BR(J)-DR(J))/1000
5580 LPRINT "DEBT      =",DE(J)
5590 LPRINT "QUAL. ENV =",QE(J)
5592 LPRINT "EN EF MULT=",EM(J)
5630 LPRINT "FOOD CAP P=",WA(J)/AC(J,1)
5640 LPRINT "IND CAP P =",WG(J)/(AC(J,3)+AC(J,4))
5650 LPRINT "ENE CAP P =",NE(J)/AC(J,5)
5660 LPRINT "TOTAL FOOD=",TF(J)
5680 LPRINT "TOTAL GOOD=",TA(J)
5684 LPRINT "TOTAL ENER=",TE(J)
5700 LPRINT "AV. SCORE =",OO(J)/QT
5710 LPRINT:LPRINT:LPRINT:LPRINT
5711 IF DE(J)*2 < TF(J)+TA(J)+TE(J) THEN GOTO 5717
5712 LPRINT "*************************************************************************"
5713 LPRINT "COUNTRY ";J;" HAS EXCEEDED ITS DEBT LIMITS"
5714 LPRINT "GAME OPERATOR SEIZES ";TA(J)/10;" UNITS FROM TOTAL GOODS AVAILABLE"
5715 TA(J)=TA(J)-TA(J)/10
5716 LPRINT "*************************************************************************"
5717  RETURN
```

ALPHABETIZED VARIABLE LIST FOR STRATEGEM - 1b

Version November 10, 1984

AA Agricultural Area

CAPITAL STOCKS:

AC(1) - Food Production
AC(2) - Environmental Protection
AC(3) - Goods Production
AC(4) - Human Services
AC(5) - Energy Production
AC(6) - Energy Efficiency

AE Average Exports

AG Average Consumption Goods Per Capita (over last 3 cycles)

LIFETIME OF CAPITAL STOCKS:

AL(1) - Food Production
AL(2) - Environmental Protection
AL(3) - Goods Production
AL(4) - Human Services
AL(5) - Energy Production
AL(6) - Energy Efficiency

AN Land Productivity

AF Food Production (5 years)

AR Food Export Price

AX Money from Food for Export, (calculated)

BR Birth Rate

BY(11) Normal Births per 1000, Table

CA Food Capital Capacity Utilization

CE Cumulative Energy Production (from year 0)

CL Food Production Capital/Land Ratio

CM Consumption Multiplier on Production (has 2 values during each cycle one for food production and one for goods)

CO Consumption Goods per Capita

CP Energy Capital Productivity Multiplier

CU Capacity Utilization in Goods Production

CY(11) Consumption Multiplier Table

DA Debt Ratio

DE Debt

DF Food for Population, (input)

DN New Loan, (input)

DP Debt Repayment, (input)

DR Death Rate

DS Debt Services

DY(11) Normal Deaths per 1000, Table

EA Energy Requirement for Agriculture

EB Exported Energy Price

EC Energy Carried to Next Cycle, (input)

ED Energy for Production, (input)

EE Energy for Export, (input)

EF Food for Export, (input)

EG Energy for Food Production (5 years), (input)

EI Energy Imports

EL Domestic Energy Production Last 5 Years

EM Energy Consumption Multiplier

EO Energy for Goods Production (5 years), (input)

EP Imported Energy Price

ER Energy Requirements for Goods Production

ET Total Energy Demand

EW Average of EX

EX Ratio of Energy Efficiency Capital to Production Capital

EY(11) Energy Requirements Multiplier, Table

EZ Capital Stock Deteriorating the Env.

FA Foreign Aid, (input)

FL Food Consumption/person - last cycle

FO Food Per Capita

FY(11) Energy Production Capital Productivity Multiplier, Table

GA Goods Export Price

GE Goods for Export, (input)

GL Goods Consumption/person - last cycle

GP Goods Production

GX Money from Goods for Export, calculated

HD Energy for Population, (calculated)

HE Household Energy Demand Multiplier

HP Human Services Capital Per Capita

INITIAL CAPITAL STOCKS:

IC(1) - Food Production
IC(2) - Environmental Protection
IC(3) - Goods Production
IC(4) - Human Services
IC(5) - Energy Production
IC(6) - Energy Efficiency

IR Interest Rate

IY(11) Interest Rate, Table

J Country Number

J# Graph numbers for the x-axes reports

JX(11) Values of the x-axes on table functions

K Number of Countries Playing the Game,(input)

KB Birth Rate Normal

KD Death Rate Normal

KF Normal Productivity of Land

KG Normal Productivity of Labor

L Number of Values Specified for the X-axis of the Tables

LA Fraction of Population Employed

LC Normalized Capital Land Ratio Actual

LF Labor Force (LE on the SHARP)

LP Labor Output Multiplier from Human Services Capital

LY(11) Labor Output Multiplier from Human Services Capital, Table

ME Energy Production Capital Multiplier

ML Maximum Loan Permitted

MY(11) Price Multiplier on Imports, Table

NE Domestic Energy Production

NM Maximum Useful Domestic Energy Capital

NN Index Used in Table Function Subroutine

NP New Oil Price

NY(11) Land Output Multiplier from Food Capital, Table

OA Maximum Useful Food Production Capital/Land Ratio

OB Oil Price Increase Time

OM Labor Output Multiplier from Goods Capital

OS Capital/Labor Ratio

OY(11) Labor Output Multiplier from Goods Capital, Table

MONEY THIS CYCLE FOR TECHNOLOGIES THAT:

P1 - Raise the Normal Productivity of Land
P2 - Raise the Normal Productivity of Labor
P3 - Increase Energy Resources
P4 - Raise the Energy Efficiency Capital Multiplier
P5 - Raise the Environmental Protection Capital Multiplier

PD(6) Projected Depreciation

PE Purchases for Energy Imports

PF Purchases for Food Imports

PG Purchases for Goods Imports

PL Actual Productivity of Land (AN*QE)

PM Import Price Multiplier

PN Productivity of Domestic Energy Capital

PO Population

PT Projected Total Energy Requirements

PU Money for Imports

PY(11) Energy Production, Table

QD Deterioration in Quality of Environment

QE Quality of the Environment

QQ Cumulative Score

QR Regeneration in Quality of the Environment

QT Number of Periods Played

QY(11) Percent Deterioration in Quality
of the Environment, Table

OTHER PRODUCING CAPITAL STOCKS:

IC(1) - Food Production
IC(2) - Environmental Protection
IC(3) - Goods Production
IC(4) - Human Services
IC(5) - Energy Production
IC(6) - Energy Efficiency

RE Total Energy Resources

INVESTMENT ALLOCATED TO:

RI(1) - Food Production
RI(2) - Environmental Protection
RI(3) - Goods Production
RI(4) - Human Services
RI(5) - Energy Production
RI(6) - Energy Efficiency

RR$ Matrix of Labels for Seven Sectors

RY(11) Percent Regeneration in Quality
of the Environment Table

CUMULATIVE MONEY FOR TECHNOLOGIES THAT:

S1 - Raise the Normal Productivity of Land
S2 - Raise the Normal Productivity of Labor
S3 - Increase Energy Resources
S4 - Raise the Energy Efficiency Capital Multiplier
S5 - Raise the Environmental Protection Capital
Multiplier

SA Specific Energy Reqs. for Food Prod. Cap.

SC Sustainable Capital

SG Specific Energy Reqs. for Goods Prod. Cap.

T(J) Year in the Game for Country J

TA Total Goods Available

TC Goods for Population (5 years), (entered)

TE Total Energy Available

TF Total Food Available

TI Total Investments

TL Actual Productivity of Labor (OM*LP)

TP Total Depreciation

TR Total Energy Resources
(not used in current version of game)

TT Counter for the total number of decision cycles played so far by all countries

UE Energy Imports

UF Food Imports

UG Goods Imports

VM Death Rate Mult. from Quality of Env.

VY(11) Death Multiplier from Quality of the Environment, Table

WA Projected Food Production

WG Projected Goods Production

WM Birth Rate Mult. from Human Services

WY(11) Birth Multiplier from Human Services, Table

X Table Function (input)

XA Money from Food for Export, (input)

XB Investment Allocation Check

XD Energy for Population, (calculated)

XE Environmental Protection Capital Mult.

XF Energy Efficiency Capital Mult.

XG Money from Goods for Export, (input)

XI Total Export Income

XN Energy for Export, (input)

XP Money Available for Imports

XR Money from Energy for Export, calculated

TABLES OF EFFECTS OF TECHNOLOGIES, THAT:

Y1(11) - Raise the Normal Productivity of Land
Y2(11) - Raise the Normal Productivity of Labor
Y3(11) - Increase Energy Resources
Y4(11) - Raise the Energy Efficiency Capital Multiplier
Y5(11) - Raise the Environmental Protection Capital Multiplier

Y Table Function Output

Z(22) Table Subroutine Array

ZE Actual Import Price for Energy

ZF Actual Import Price for Food

ZG Actual Import Price for Goods

ZZ Adjusted Debt

BENCHMARK COMPUTER OUTPUTS FOR THE
DEVELOPING AND HIGH EQUILIBRIUM RUNS

POP. & HH CONS.

COUNTRY: 1
YEARS: 0 - 4

PO:1	200
PO:2	3000
PO:3	3500
PO:4	2
PO:5	18
PO:6	2
PO:7	2.25
PO:8	41

ENERGY PROD. & ENERGY EFF.

COUNTRY: 1
YEARS: 0 - 4

EO:1	160
EO:2	640
EO:3	800
EO:4	0
EO:5	0
EO:6	0
EO:7	15000
EO:8	.2
EO:9	400
EO:10	1
EO:11	12.5
EO:12	10000
EO:13	20
EO:14	6000
EO:15	16000
EO:16	17.5
EO:17	14000
EO:18	0
EO:19	500

FOOD PROD. & ENV. PROT.

COUNTRY: 1
YEARS: 0 - 4

FO:1	160
FO:2	640
FO:3	800
FO:4	0
FO:5	0
FO:6	0
FO:7	.69
FO:8	.8
FO:9	3450
FO:10	1
FO:11	3000
FO:12	1000
FO:13	0

POP. & HH CONS.

COUNTRY: 1
YEARS: 0 - 4

PO:1	500
PO:2	12500
PO:3	68600
PO:4	5
PO:5	10
PO:6	15
PO:7	18
PO:8	10

ENERGY PROD. & ENERGY EFF.

COUNTRY: 1
YEARS: 0 - 4

EO:1	1200
EO:2	4800
EO:3	6000
EO:4	840
EO:5	3360
EO:6	4200
EO:7	56000
EO:8	.2
EO:9	7500
EO:10	.4
EO:11	5
EO:12	12500
EO:13	8
EO:14	36000
EO:15	48500
EO:16	5
EO:17	30000
EO:18	0
EO:19	26000

FOOD PROD. & ENV. PROT.

COUNTRY: 1
YEARS: 0 - 4

FO:1	500
FO:2	2000
FO:3	2500
FO:4	670
FO:5	3350
FO:6	4000
FO:7	.8
FO:8	2.5
FO:9	12500
FO:10	1
FO:11	10500
FO:12	6
FO:13	0

GOODS PROD. & HUM. SERVICES

COUNTRY: 1
YEARS: 0 - 4

GO:1	60
GO:2	240
GO:3	300
GO:4	50
GO:5	400
GO:6	450
GO:7	6
GO:8	5
GO:9	2.25
GO:10	2.13
GO:11	1
GO:12	3000
GO:13	0
GO:14	500
GO:15	3100
GO:16	3500
GO:17	430

GOODS PROD. & HUM. SERVICES

COUNTRY: 1
YEARS: 0 - 4

GO:1	900
GO:2	3600
GO:3	4500
GO:4	1000
GO:5	8000
GO:6	9000
GO:7	36
GO:8	19.4
GO:9	.9
GO:10	4.9
GO:11	1
GO:12	68600
GO:13	25000
GO:14	0
GO:15	68600
GO:16	68600
GO:17	5110

INTERNAT. FINANCE, EXP., IMP., & DEBT

COUNTRY: 1
YEARS: 0 - 4

IO:1	0
IO:2	.1
IO:3	1
IO:4	0
IO:5	1000
IO:6	1
IO:7	1.1
IO:8	1.1

INTERNAT. FINANCE, EXP., IMP., & DEBT

COUNTRY: 1
YEARS: 0 - 4

IO:1	0
IO:2	.1
IO:3	1
IO:4	0
IO:5	26000
IO:6	1
IO:7	1.1
IO:8	1.1

TABLE FUNCTION SETTINGS

COUNTRY: 1
YEARS: 0 - 4

1	.133333
2	.1125
3	.4
4	.69
5	.08
6	0
7	.5
8	.08
9	.295
10	.69
11	.5
12	.1125
13	.15
14	0
15	0
16	0

TABLE FUNCTION SETTINGS

COUNTRY: 1
YEARS: 0 - 4

1	1
2	.9
3	1
4	.8
5	.6
6	.6
7	.5
8	.05
9	.9
10	.05
11	.5
12	.9
13	.9
14	0
15	0
16	0

17	0
18	0
19	0
20	0
21	0

SCORE SHEET

COUNTRY: 1
YEARS: 0 - 4

POPULATION=	200
FOOD PC =	2
GOOD PC =	2
POP. G.R. =	.023
DEBT =	0
QUAL. ENV =	.69
EN EF MULT=	1
FOOD CAP P=	4.3125
IND CAP P =	4.13333
ENE CAP P =	17.5
TOTAL FOOD=	3300
TOTAL GOOD=	3500
TOTAL ENER=	15000
AV. SCORE =	10

17	0
18	0
19	0
20	0
21	0

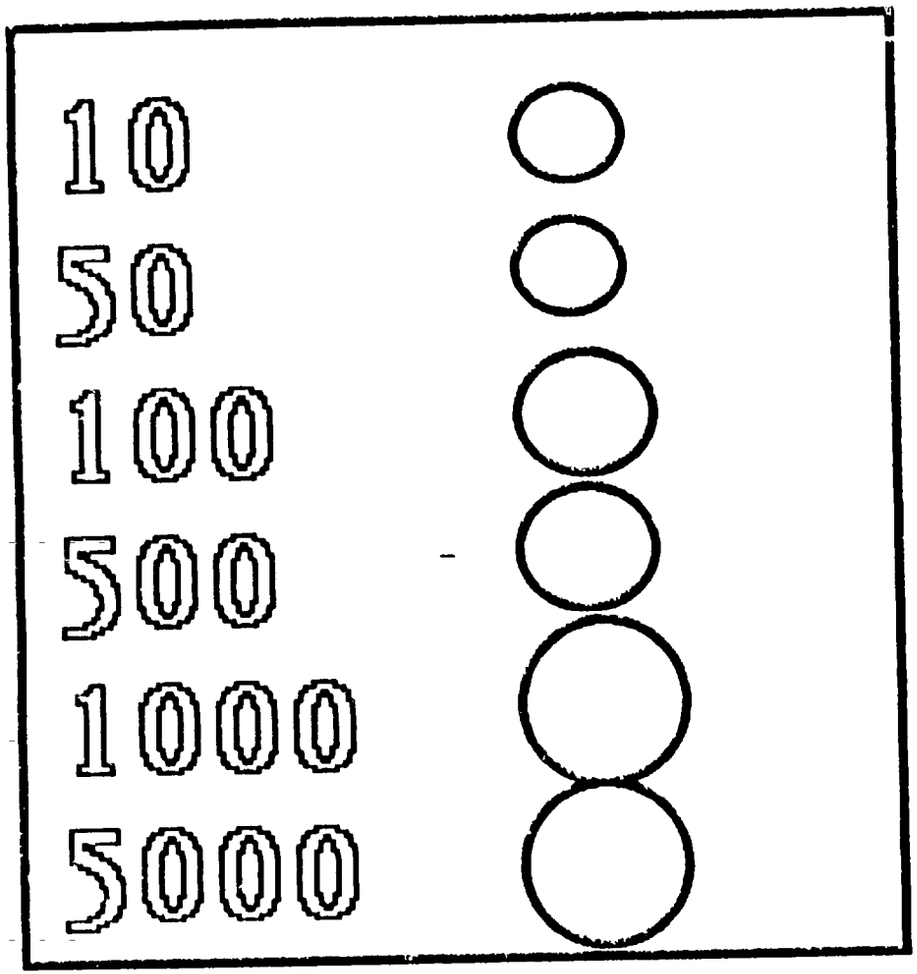
SCORE SHEET

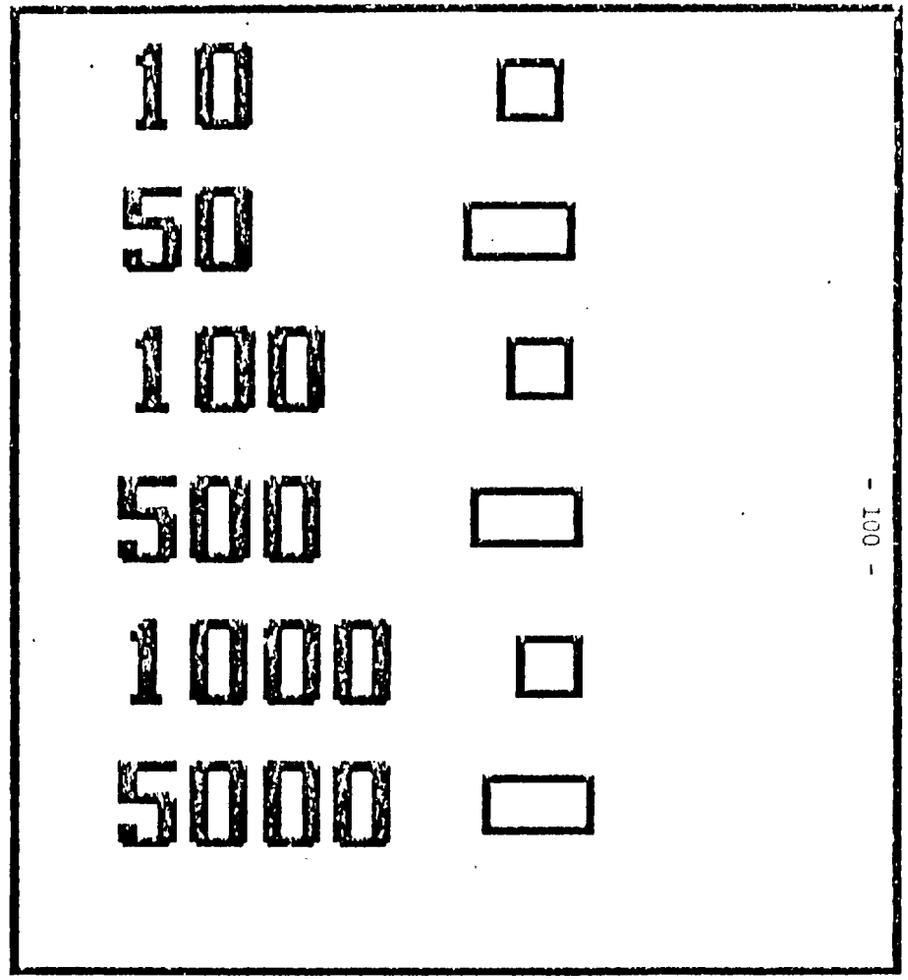
COUNTRY: 1
YEARS: 0 - 4

POPULATION=	500
FOOD PC =	5
GOOD PC =	15
POP. G.R. =	0
DEBT =	0
QUAL. ENV =	.8
EN EF MULT=	.4
FOOD CAP P=	5
IND CAP P =	5.08148
ENE CAP P =	5
TOTAL FOOD=	12500
TOTAL GOOD=	68600
TOTAL ENER=	56000
AV. SCORE =	35

When you have installed the STRATEGEM-1 computer program on your computer, test it by reproducing the above two lists. The left columns of pages 83-85 are produced in the first cycle, when you choose "D", the developing option, as you initialize the model. The right columns of pages 83-85 are produced in the first cycle, when you choose "H", the high-equilibrium option, as you initialize the model. If you can reproduce each list precisely, you may be quite confident that your program is free of typing errors.

ALTERNATIVE DENOMINATION KEYS FOR THE CAPITAL MARKERS





For some versions of the game, the markers used to designate food, goods, energy, and capital do not fit into the shapes on the denomination key in the center of the game board. In that event, one of the above keys can be reproduced and placed over the current key for reference by the players.

ORIGINALS FOR REPRODUCING THE SIX DENOMINATIONS OF MONEY

10 MONEY 10	10 MONEY 10	10 MONEY 10
10 MONEY 10	10 MONEY 10	10 MONEY 10
10 MONEY 10	10 MONEY 10	10 MONEY 10
10 MONEY 10	10 MONEY 10	10 MONEY 10
10 MONEY 10	10 MONEY 10	10 MONEY 10
10 MONEY 10	10 MONEY 10	10 MONEY 10

50 MONEY 50	50 MONEY 50	50 MONEY 50
50 MONEY 50	50 MONEY 50	50 MONEY 50
50 MONEY 50	50 MONEY 50	50 MONEY 50
50 MONEY 50	50 MONEY 50	50 MONEY 50
50 MONEY 50	50 MONEY 50	50 MONEY 50
50 MONEY 50	50 MONEY 50	50 MONEY 50

100 MONEY 100	100 MONEY 100	100 MONEY 100
100 MONEY 100	100 MONEY 100	100 MONEY 100
100 MONEY 100	100 MONEY 100	100 MONEY 100
100 MONEY 100	100 MONEY 100	100 MONEY 100
100 MONEY 100	100 MONEY 100	100 MONEY 100
100 MONEY 100	100 MONEY 100	100 MONEY 100

500 MONEY 500	500 MONEY 500	500 MONEY 500
500 MONEY 500	500 MONEY 500	500 MONEY 500
500 MONEY 500	500 MONEY 500	500 MONEY 500
500 MONEY 500	500 MONEY 500	500 MONEY 500
500 MONEY 500	500 MONEY 500	500 MONEY 500
500 MONEY 500	500 MONEY 500	500 MONEY 500

1000 MONEY 1000	1000 MONEY 1000	1000 MONEY 1000
1000 MONEY 1000	1000 MONEY 1000	1000 MONEY 1000
1000 MONEY 1000	1000 MONEY 1000	1000 MONEY 1000
1000 MONEY 1000	1000 MONEY 1000	1000 MONEY 1000
1000 MONEY 1000	1000 MONEY 1000	1000 MONEY 1000
1000 MONEY 1000	1000 MONEY 1000	1000 MONEY 1000

5000 MONEY 5000	5000 MONEY 5000	5000 MONEY 5000
5000 MONEY 5000	5000 MONEY 5000	5000 MONEY 5000
5000 MONEY 5000	5000 MONEY 5000	5000 MONEY 5000
5000 MONEY 5000	5000 MONEY 5000	5000 MONEY 5000
5000 MONEY 5000	5000 MONEY 5000	5000 MONEY 5000
5000 MONEY 5000	5000 MONEY 5000	5000 MONEY 5000

GAME PARTS ORDER FORM

Mail this form to: Prof. Dennis Meadows, Box 8000, Dartmouth College, Hanover, NH 03755, USA or FCTY/UNIDO.

ITEM	NUMBER	UNIT COST	TOTAL
Game board (100 cm x 80cm)	_____	$ 10.00	_____
Pieces: people, money, capital investment cubes, and timer	_____	20.00	_____
Computer program: (listing is in user's manual) - recorded for			
SHARP PC-1500A cassette ____			
NEC PC-8201A cassette ____			
Commodore 64 cassette ____			
Commodore 64 disk ____			
Apple II disk ____			
IBM PC Disk ____	_____	15.00	_____
User's manual with operating instructions, role descriptions, all forms required to play STRATEGEM-1, and lecture notes.	_____	5.00	_____
NOTE: The following 3 items are copies of items which are reproduced only once in the user's manual. They will be useful to those who run the game many times and who cannot xerox the originals provided in the user's manual.			
Package of 2 sets of extra role descriptions	_____	1.00	_____
Package of 10 sets of the record sheets (one set is used per game)	_____	3.00	_____
Set of about 25 plastic overhead projector transparencies for use in the lectures that introduce and debrief the game. These are reproduced from the illustrations provided in the user's manual.	_____	25.00	_____
User's manual for STRATEGEM-2, a 1 or 2-person game on the Kondratiev Cycle (this includes everything required to operate the game except markers)	_____	2.00	_____
		TOTAL	_____

SEND TO:

Name: _____

Address: _____

_____

_____

_____

Telephone number: _____

STRATEGEM-1 OPERATOR REGISTRATION FORM

We are working to develop several versions of STRATEGEM-1 with parameter values set to represent different countries. Other games in the STRATEGEM family are also being created. Please fill out this page and return it to: Prof. Dennis Meadows, Resource Policy Center, Box 8000, Dartmouth College, Hanover, NH 03755, USA, or FCTY/UNIDO so that you may be included on the mailing list of those who will receive revised versions of the users manual and information about other games in the series. In the event that you have questions about the game, you may also contact me by telephone: 603/646-3551

NAME: _____

ORGANIZATION: _____

TITLE: _____

ADDRESS: _____

_____

_____

NUMBER OF GAME SETS YOU ARE USING:

EXPECTED FREQUENCY OF USE AND GROUP SIZE:

POTENTIAL USES FOR THE GAME:

BRAND OF COMPUTER ON WHICH THE GAME WILL BE RUN:

SOURCE OF INITIAL INFORMATION ABOUT THE GAME: