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A PROPOSAL FOR IIASA RESEARCH  
ON GAMING 1980/81

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## PREFACE

A workshop on the use of operational gaming as an aid to policy development and decision making was held at IIASA in August 1978 (Collaborative Paper forthcoming) which recommended that there should be a continuing program of work on this topic at IIASA. This report translates those general recommendations into specific proposals. It is hoped to start work on these lines in 1980.



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GOALS AND RESTRICTIONS

This report concerns the question of IIASA research on gaming from 1980 onwards, with particular emphasis on the first two years, 1980 and 1981, and with particular emphasis on gaming as a tool for applied systems analysis.

The goals in the gaming area should naturally be consistent with IIASA's generally stated goals. Hence the work on gaming should lead to some advancement of systems analysis, by work satisfying criteria of good science. It should include dissemination of the current "state of the art" and it should deal with problems of international importance, global or universal.

The goals of this gaming research should also be in line with the policy of the MMT and the SDS Areas as expressed in their statements of policy and overall research programs. This stresses, inter alia, the importance of disseminating knowledge of gaming methods for the solution of real problems and the importance of ensuring that gaming methodology is improved, in particular as regards areas that are not adequately covered by existing research. Furthermore, the collaborative work with institutions in National Member (NMO) countries is stressed.

The present report was partly initiated by an IIASA workshop on gaming in August 1978. At this conference a great interest in an IIASA gaming research effort was shown, in particular in:

- The dissemination of important aspects of gaming, in particular as regards operational gaming.
- A development towards some more solid foundations for "operational gaming".

- The utilization of IIASA's unique international position, not the least in terms of east-west relations.

As regards a potential two-year program (1980-81) it further appeared desirable that this should be a viable gaming activity, i.e., this two-year activity should not be an end in itself; rather a measure of the potential program's success would be whether it could continue after this initial period. This in turn would involve a fairly cautious starting approach, since the chances of continuation of the program would drastically decrease by failure to meet the expectations. More bold approaches could furthermore, wait until later stages.

In order to be able to make recommendations as regards an IIASA program in gaming it appeared suitable to further transform these goals into the following more specific criteria of choice:

- Does the research program properly utilize IIASA's comparative advantages, i.e. that of an international institute with unique east-west contacts?
- Is the research program properly focussed on IIASA's needs in other programs?
- Does the research program cover areas that can be regarded to be among the areas presently in most 'need' of further research, i.e. that are insufficiently covered in relation to promise of contribution?
- Does the research program carry with it a reasonably high chance of being successful in terms of set up goals and will it thus facilitate research also after 1981?
- Is the program reasonable with regard to capabilities of personnel that are likely to be available in the period 1980-1981?

Closely related to the question of goals, is the question of budgetary restrictions. The analysis below was carried out with the following restriction in mind:

A project financed mainly by the MMT and SDS areas should as an upper limit involve 4-6 man years of commitment during 1980-1981.

#### WHAT IS GAMING?

Before proceeding, it is very important to define more clearly what we mean by "gaming", and how gaming is related to other similar methods or areas of study. This is not the least necessary, since our discussions showed that the term "gaming" was used with many different meanings. In order that the following discussion be concretely understood some definitions must be stated.

Gaming is an interactive simulation where at least two decision makers supply decisions.

Interactive means that each decision maker supplies his decisions several times, and that he, in most of these instances, does this after having received feedback of what has happened due to his and the other decision makers' actions.

With this definition two things are stressed:

- Gaming activity involves several decision makers. Hence the word gaming does not include man-machine simulation where only one decision maker is involved.\* Hence simulation of so-called games against nature, where only one person makes decisions and the output is, e.g., dependent on a stochastic process will not be referred to as gaming. Nor is it gaming, if one single person plays the roles of all the players.
- Gaming must be interactive, i.e., some decisions must be made after feedback has been obtained regarding the result of earlier decisions. Hence the playing of a game in so-called normal (matrix) form (where one at once supplies a complete plan for playing the whole game) is not included in the gaming concept either.

We hence see gaming as the intersection of two larger sets: interactive simulation and game playing, where game playing is the playing of a game involving at least two players. After these definitions we can define the relationship between the concepts, game, game theory, game simulation, game playing, interactive game simulation, and gaming.

We define a game as a situation involving at least two decision makers, whose choices noticeably influence each other (hence excluding so-called "games against nature" = stochastic decision situations).

Game theory is then defined as that theory which deals with games and where the players are assumed to behave rationally and entertain correct expectations about each other's behavior and expectations.

Game simulation can then be defined as any manipulation of a model of a game, regardless of which assumptions are made regarding the behavior of the players; we reserve the term game playing for any such manipulation by at least two independent players.

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\*It should in this context be stressed that we can, as a decision-maker include a robot--a computer program--provided he passes the so-called Turing test, i.e., he is believed to be a human decision maker by other human decision makers.

Interactive game simulation would be a game simulation, where the manipulator - decision maker, makes most of his decisions after receiving some feedback. Gaming, finally, is interactive game playing.

It should finally be mentioned that game theory in the normal matrix form cannot be represented as gaming, since all interaction has disappeared. The game theory which is most closely connected with gaming is the extensive form, i.e., the tree form. Any game can be depicted in this form and hence gaming activity can also be represented in the extensive form. While extensive form game theory will seek to establish a solution (an equilibrium point), analysis of gaming using the extensive form will rather look for the behavioral rules causing the players to choose certain branches in the game tree. It should here be noted that the extensive form constitutes the most suitable bridge between game theory and gaming analysis, i.e., the analysis of what happened in a certain gaming exercise. Figure 1 summarizes the above discussion.

#### DIFFERENT TYPES OF GAMING

Several different typologies of gaming are available (e.g., Shubik, Bowen, etc.) and there is hence also some confusion as to what, for example, "operational gaming" is. Instead of giving a complete typology Figure 2 is presented where various potential benefits to be derived from gaming are given. In this figure a basic distinction is made between Educational, Operational, Experimental, and Research games.

First of all the diagram points at the very broad spectrum of effects to be obtained by an "operational game". Since few, if any, operational games aim at all of these effects, this demonstrates the ambiguity of the concept "operational gaming".

Furthermore, the first three effects are very similar to the effects of an educational game. They differ only with regard to the contents of the ideas, principles, or insights. While the educational games deal with a more general subject or discipline, the operational game deals with a specific decision problem.

As regards the fourth factor (in the middle column), the testing of models, the counterpart of this component in the operational game (where the focus is on testing of models specifically aimed for use in a decision situation) is the experimental game, where one tests models aimed at a general increase of theoretical knowledge.

The components: forecast and "what if", i.e., several forecasts with slightly different set up of inputs, belong to research games, if the intent is to increase empirical (or "pseudo-empirical") knowledge in a general field (e.g., world modeling of the GEM-type), while they belong to operational games, if they are focussed on giving answers to questions facing actual decision makers. The final components, dress rehearsal and opening lines of communication refer mainly to operational gaming.



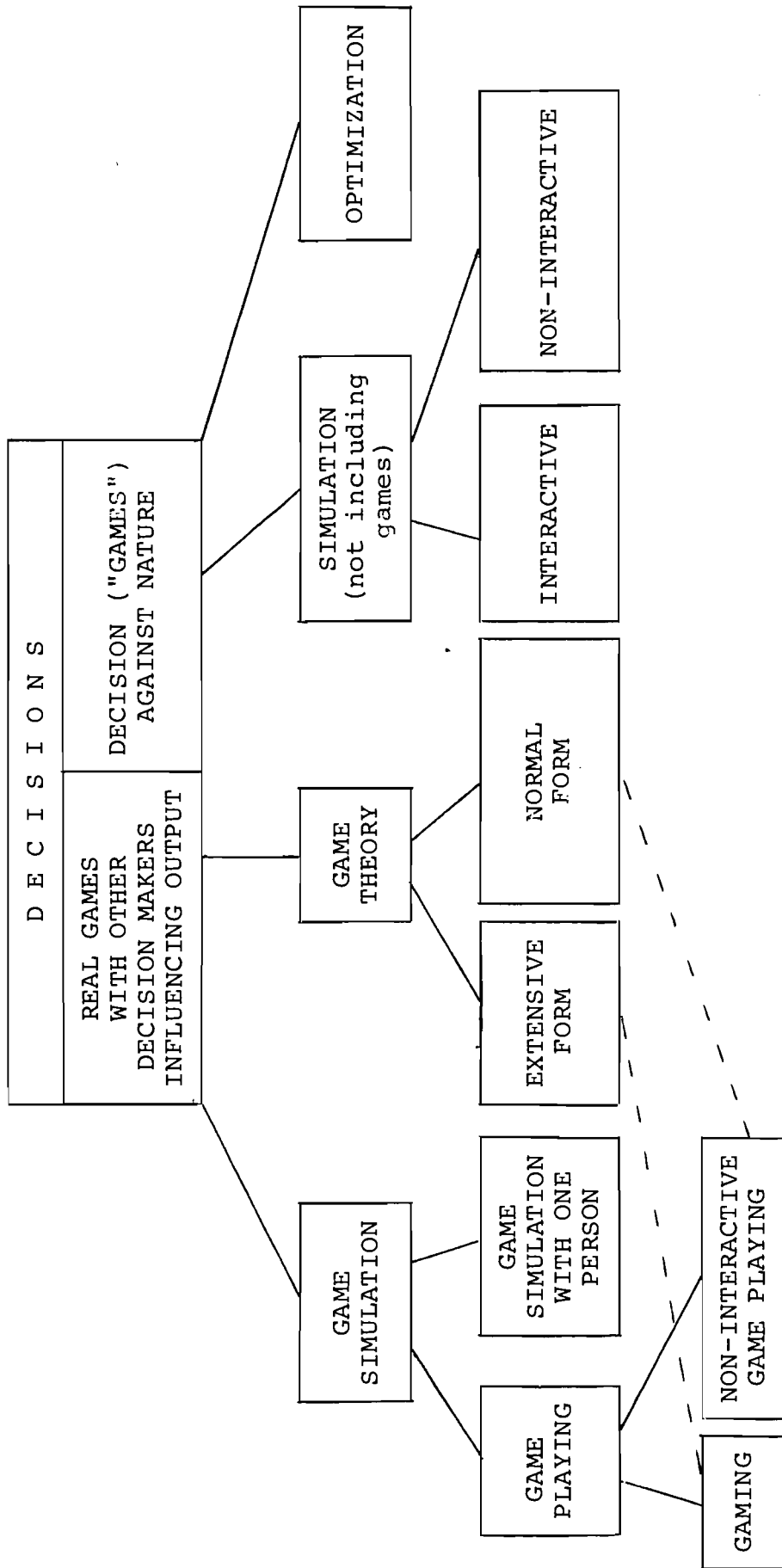


Figure 1

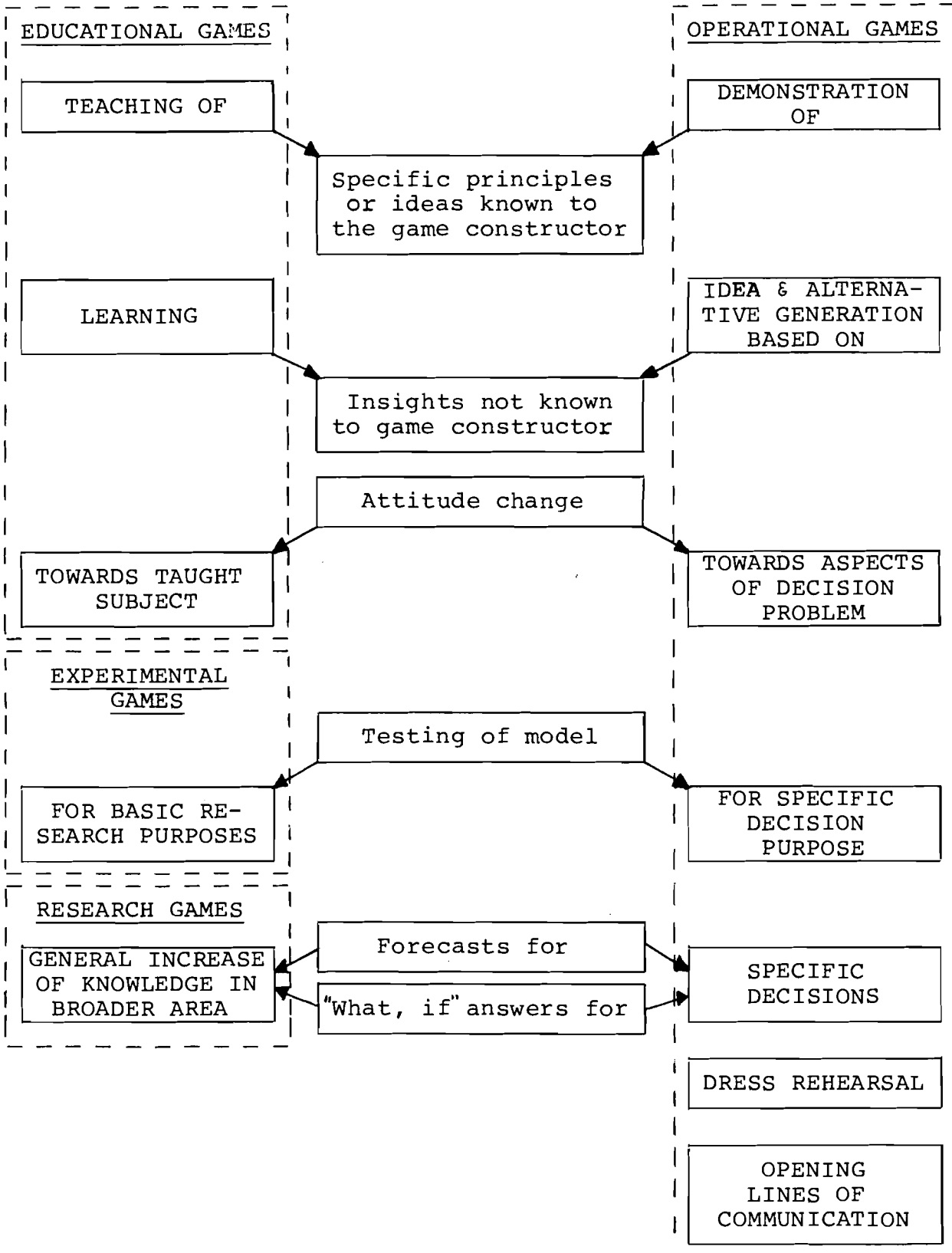


Figure 2

Finally, it should be stressed that the attempt at typology as described above, is our own temporary one, made only with the specific purpose of facilitating the discussion regarding what specific type of gaming, if any, should be dealt with in an IIASA program.

In this connection, one should also present the distinction between rigid-form games and free-form games. In the rigid-form games all the rules of the game are exactly defined at the start of the game, most often in the form of a computer program. The outcome of every set up of the players' decisions (with due regard taken to a pseudo-random mechanism) is thus exactly defined. In a free-form game the players will, to a large extent, invent the rules as the game goes along. The outcome of the decisions might, for example, be the object of long discussions among the participants. While management games for example, where the players decide on quantities, such as price, production, etc., have usually been of the rigid form, games involving exchange of verbal messages such as international diplomacy games, have been of the free form.

#### PRELIMINARY PROPOSAL FOR AN IIASA PROGRAM IN GAMING FOR 1980-1981

##### Introduction

The first fundamental question as regards a future IIASA research program on gaming is, of course, if there should be such a program at all. A well-grounded answer to this question can however, first be given, when one has specified a research program. Then one can compare such a program with the alternative of no research at all.

There are, however, several general reasons making gaming an important area of research for IIASA. These concern, inter alia, gaming as a tool in IIASA's own programs; gaming as an important applied systems analysis tool that has generally not been adequately explored; gaming as an instrument for the validation of game theory models and interactive simulation models etc. In addition, there have been some gaming activities at IIASA in the past, such as O. Helmer's GEM-game and the activities of V. Sokolov and I. Zimin. Some work on gaming is also being started in the Energy Program (The Irkutsk Game) and in the Regional Development Area (The Notec Area Game). The question of whether IIASA should do work in gaming is hence rather whether IIASA should be involved in a more systematic gaming effort.

A preliminary proposal for such a program for 1980-81 is outlined below. It should first be mentioned that when constructing this program several gaming activities brought up at the gaming workshop and in discussions with IIASA staff, had to be left for possible future research. Among these were:

- free form gaming research;
- interactive simulation with only one input;

- construction of other types of new large games;
- a very general handbook.

Detailed reasons for eliminating these proposals from the present plan are given in a separate paper.

It should further be stressed that the program presented below is focussed on gaming as a tool for systems analysis, i.e., as an aid for ultimate decision-making regarding some concrete problem.

The demands on resources are discussed in an appendix. It is sufficient here to note that the manpower demands estimated at four man years are well within the earlier limits set down.

We shall first present the main topics of the program and then go into detail as regards each topic:

- a. A specific handbook (or rather a monograph to a great extent of handbook character), focussed partly on decisions in the problem areas of IIASA (energy, food, human settlements, etc.) partly on international aspects of gaming.
  - b. A collection activity, not only of literature, but also of some games. The purpose is mainly to support the handbook but it could also lead to a very limited clearing house activity.
  - c. Some original research, mainly on the playing of smaller sized operational games by actual decision makers, aimed at giving some better foundations for operational gaming, at studying international differences as regards certain types of decision related variables and, if possible, also giving some information of relevance regarding a specific problem preferably in an IIASA area.
  - d. A workshop in gaming in the late fall of 1981 including inter alia a presentation of a draft version of the handbook, the research activity, and some different types of operational gaming.
  - e. Consulting activity within IIASA in particular in relation to the Irkutsk Game in the Energy Area.
  - f. Planning for further gaming research after 1981.
- a. Handbook with Specific Focus

With a handbook we mean a book which, to a large extent, deals with the research done by other people and which aims at being directly useful for people in a certain area. It should in no way be regarded as a synonym to "cook-book", which is prescriptive without motivations.

Earlier the idea of a general handbook was rejected, mainly because of the disadvantages of covering too broad an area and because there were many good general books on gaming available. It appears to be more reasonable that the IIASA handbook together with say three or four other existing, easily available, books would constitute such a general handbook.

One purpose of the IIASA handbook would hence be to fill in on such material that does not appear to be well covered in these other books. This seems to be particularly true of operational gaming. In this area there is both a need of exemplification and of some steps towards theoretical foundations. Such a theory of operational gaming should for example, cover how gaming could be used for validation of other parts of the decision model, how one by replicative use of gaming can draw conclusions about the effect of decision actions etc. The emphasis should be on rigid rule gaming.

As regards exemplification of operational gaming one is still confronted with the problem of the material being very wide. Another purpose of the IIASA handbook should, however, be to cater directly to the needs of the IIASA staff as well as those persons which through the IIASA dissemination channels such as the NMOs, follow the IIASA research in particular research areas. Looking at this purpose it appears to be suitable that the exemplification of operational gaming in the handbook should to a great extent focus on what has in different places been done in the IIASA decision areas, i.e., food, energy, human settlements, environmental policies, innovation policies, industry policies, etc. Hence, when one gives examples of experiences of gaming, one should as far as possible try to draw the examples from these areas.

Another important area, where an IIASA handbook, due to its unique comparative advantages, has a mission to fill, is the international transfer of gaming methodology; in particular the two-way dissemination of gaming experiences east-west. Not only is there a great gap in the English literature as regards gaming in the CMEA countries, but also there would be an interest in how some games first used in the western countries have been modified for use in the CMEA countries. In this connection the handbook should also report on the gaming concerning US-Soviet trade. It would also be of wide interest to have some comparisons of game playing behavior in different countries with different institutional set ups.

These international gaming comparisons could be important for IIASA modelling efforts in several programs and areas, since these comparisons will attempt to give some answers to the following important question:

Are there systematic differences between different countries (e.g. east-west) as regards fundamental economic behavior of the decision makers?

This concerns, for example, such factors as tendency towards maximization, degree of risk advertence, tendency to play

cooperatively, etc. Hence the comparative gaming sessions might give some initial indications as to whether it is possible to use the same type of models, with the same behavioral assumptions, for decisions in different IIASA countries or whether one has to construct different types of models for different countries.

Furthermore, the handbook, by drawing from the experiences in the sections referred to above, will attempt to answer some more general questions, that would be raised by a person who is contemplating the use of an operational game in a decision situation. Some examples would be:

- how much detail should be put into a game?
- how does one strike a compromise between replication and realism?
- how many times does one have to replicate the game to draw conclusions?
- how experienced do the players have to be?
- how does gaming fit into an analysis using many other systems analysis tools? etc.

It is obvious that the handbook can in no way give a definite answer to these questions, but it should at least help the person asking the questions to think somewhat more clearly on these issues in regard to a specific problem. The answers would, as mentioned, to a great extent be based on examples and discussions in other parts of the handbook. It is in this connection that this section of the handbook would be greatly reliant on the original research outlined below in section c.

Finally, there would have to be an introductory chapter on gaming, including definitions of various gaming concepts (in order to assure a proper understanding of the material) and discussions of the connection of gaming to similar activities. There would also have to be a biography, as far as possible filling in where the three or four other standard books on gaming fail, as well as a brief description of the IIASA file of games (see section b).

Summing up, the handbook might contain the following main parts:

- I Introduction, definitions, terminology of gaming concepts, classification of games.
- II Experiences of operational gaming in different IIASA-related areas, noting both where successful and where unsuccessful (indicating, if possible, reasons for this):
  - (a) energy
  - (b) agricultural planning
  - (c) human settlement planning

- (d) environmental planning
- (e) innovation policies
- (f) industrial policies (e.g. forestry) etc.

III Some steps towards a theory of operational gaming with particular emphasis on rigid form games:

- (a) experimental manipulation of gaming variables
- (b) construction of robot players
- (c) operational gaming used for validation of other model concepts
- (d) determination of complexity and realism of game etc.

IV International gaming:

- (a) overview of use of games in different countries (not well covered in standard literature in English), e.g., gaming within CMEA countries
- (b) comparison of a few similar games used in different countries under different institutional set ups
- (c) comparison of game playing behavior in different countries
- (d) report on USA-USSR trade game

V Discussion of some of the most common problems as regards the application of gaming to a specific real world issue

VI Bibliography

Areas covered well in other three of four "standard" books not unduly repeated here. Together with bibliography of these books, this bibliography should be the most comprehensive available.

Brief review of IIASA file on operational games.

As a companion to this handbook one should be able to get a computer listing of this IIASA file on operational games.

b. Collection and Clearing House Activity

It is obvious that in order for the handbook to be of the type discussed above, i.e., focussed on material not easily available in the most common gaming literature, an important material gathering activity is needed. This must obviously first of all include a gathering of literature, in particular, literature in IIASA related gaming areas and on gaming within CMEA. But literature gathering is far from sufficient. Many of the most interesting games from an IIASA viewpoint are believed not to be described at all in the literature, or if mentioned, the information is in many cases not likely to be sufficient for our purposes. Due to this a specific game gathering activity is envisaged in the early phase of the program (however, after the initial collection of literature). This game gathering activity should operate along two lines:

- A questionnaire is sent out to some 100 institutions asking for information in a specific manner regarding available games. The questions should concern, for example, purpose, problem area, number of players, length of play time, size of computer program, computer language, host computer, available documentation, number of times the game has been played, results of this, etc.
  
- In many respects the information to be obtained from such a questionnaire could not be expected to be sufficient for purposes discussed in connection with the handbook. It would have to be complemented by a more specific in-depth search for information about gaming in various institutions involved in this area. This refers particularly to three areas: (i) the east-west gaming activity; (ii) the collection of whole games (programs, manuals), etc. of interest to IIASA; and (iii) the selection of a game that is suitable for the replicative game playing envisaged in the original research. The questionnaire should be helpful when selecting these institutions. A fair amount of traveling is envisaged. The collaboration with local contactmen in NMO countries is foreseen to be of great importance in this connection.

The answers received would be input into a computer file on the IIASA PDP 11/70. An up-to-date printout of this file could then be obtained as a companion to (or second part of) the handbook.

The data gathering activity should, however, not be limited only to this file. As discussed earlier, it is important to be prepared for activities after 1981 in terms of somewhat larger games. One important reason for not starting activities on such games already in the 1980-81 program was that a very similar game might have been developed at some other institutions. Hence one should, in the questionnaires, and when visiting various institutions, look for such games. For those which look promising one would assemble more information. If the game appears to be of real interest one should try to get it to IIASA, e.g., in the form of the computer program and manuals, in order to possibly make a test-run with the interested IIASA staff. If the game cannot be easily transferred to the PDP 11/70, or some other computer in the IIASA network, a simple test run might be done over long distance telephone. It is probable that only by having actually seen the play of a real game the IIASA staff will be able to state precisely what kind of gaming activity they would be interested in.

It is therefore not inconceivable that a small IIASA game bank will be built up, including also the GEM game, the Sokolov-Zimin games, the Irkutsk energy game, and the Notec area game. Some very limited efforts should perhaps be made to improve the documentation of some of these game if there appears, from outside sources, to be an interest in obtaining these games. IIASA would



then in a limited sense serve as a clearing house for operational gaming in particular areas. The main part of this clearing house activity would, however, come after the 1980-81 period.

c. Original Research

The 1980-81 program in the gaming area also includes a smaller amount of original research that would fit into the limited manpower framework. The main reasons why it appears necessary to include such an element of original research are mainly the following:

1. It would improve the handbook considerably. In the plans for the handbook there are some points that require some amount of original research, namely Chapter III, some steps towards a theory of operational gaming; and Chapter IV, section c, Comparison of game playing behavior in different countries; and Chapter V, discussing the most common problems when applying gaming.

In particular it seems important to be involved in some concrete discussions: how one can draw conclusions from a gaming exercise by manipulating the experimental variables; how one can use robot players for this purpose; how many times one has to play a game; how one uses gaming for the validation of other kinds of models; how one determines how much detail should be put into a game; what the effect of using different types of players is, etc. Very little appears to be written on these aspects. On the other hand, it appears very dubious to be involved in only a purely deductive discussion. The arguments must be backed up by reference to concrete experience from game playing. It is furthermore obvious that the author of this more theoretical chapter must have some recent first hand experience of such extensive game playing. It is unlikely that one could obtain these experiences without an original research effort.

Furthermore, there does not appear to exist any documentation of the extensive playing of an identical game in both east and west, making direct comparisons possible.

2. In view of IIASA's general policy of developing good research such a small program of original research appears reasonable. One should, in this connection, mention that this original research should, besides chapters in the handbook, also be expected to generate some research memoranda of interest.
3. Also the collection activity should benefit from such original gaming research. IIASA would then become a more interested party, not only asking for information, but also supplying it. This is important particularly when visiting various institutions for discussion of gaming activity or when attending gaming conferences.

4. Also in view of attracting the right personnel to the gaming project it appears necessary to engage in a certain amount of original research.

The main aim of the original research should, however, be the handbook chapters mentioned above under (1). This implies in turn a repeated game playing. The requirement of playing the games a considerable number of times comes from two sources:

1. The discussions of how to vary game variables, how to construct robot players, etc. (in the chapter on theory of operational gaming and the chapter on the practical application of gaming) are all naturally focussed on repeated game playing.
2. The comparison of game playing behavior, attitudes, etc. in an international comparison perspective would obviously require repeated game playing.

This, in turn, implies if one would for example, assign a maximum of one man year of effort to the original research, that the game playing would have to be concerned with games of fairly small size. Also other considerations speak for small games:

1. It appears important to get real decision makers to be involved with game playing. The playing of games by for example, only university students without practical experience, is of more limited value. A game that could run in a couple of hours, and thus attract some real decision makers, is probably of greater interest from a research point of view than a much longer game that could attract only students without any real life experience.
2. Another criterion of smallness is the extent to which the game corresponds to a game theoretic model. Such a correspondence is important when one wants to use gaming to test the use of a game theory model, used as a decision aid tool.
3. A third criterion of smallness concerns the replicability factor. The replication hinges particularly on the fact that all outside influences should be under as tight a control as possible. One important factor is the set of instructions given to the players of the game. If the game rules have to be presented orally, allowing for considerable question-answer interaction between game-leader and players, this control is severely damaged. Hence, the game should preferably be so simple that written instructions are sufficient.
4. The fourth criterion applies to the size of the computer program. Since a game playing in several countries is foreseen, and the games should be of the rigid form and played in a short time, some computer power would have to be available on the spot in various different countries.

Linkage over the telephone-net might in some cases be troublesome and expensive. By far the most practical and also least expensive solution should be to have the game run on an inexpensive micro-computer. This would, however, probably set an upper limit on the computer game model to around 700-1000 lines of BASIC program.

Therefore several theoretical and practical reasons speak for a fairly small game. A natural question then arises as to the validity of a small game. Among some IIASA staff members there is an undoubted preference for very large games particularly in terms of empirical content, i.e., with a very extended model in the so-called "black box" of the game, transforming the decisions into result. This insistence on detail is in line with recent developments in some simulation modeling.

If we, on the other hand, look at more traditional economic models for analytical solutions, there has been a stress on not including unnecessary detail, but rather focusing on the most important aspects of the problem at hand. "Occam's razor" has been the idea. As regards gaming there is much to be said for the latter approach, i.e., of simpler models emphasizing the most important aspects. Each player will be required to have some mental model of the black box. The general experience seems to have been that gaming has not been very enlightening if the players have not had a reasonable understanding of how this black box works.

This problem is, of course, avoided in gaming where the black box is a careful description of some real problem and all players have a very good knowledge of this problem. One must then, however, be extremely careful in constructing the black box, so that it fits the players' perception of realism. This requires very extensive game construction work (several man years) and we are then back to the larger games which do not fit into the limits of the 1980-81 program.

The other way to solve the problem is to make the black box so simple that you can, in the written gaming instructions, give a reasonable description of how it works. This appears to be the only feasible way when wanting to play the same game in different countries. It would be difficult to find decision makers in different countries with good knowledge of the reality depicted in an extensive black box.

The question of the importance of increasing the complexity of the black box might be one of the things that one would want to study by experimentation. Will the game playing really be significantly affected by, for example, some 50% increase in the complexity of the black box?

It should finally be stressed that the actual application of small games to real world decisions have the great advantage of requiring only a short time for construction and repeated playing. This is important in all cases when decisions cannot be delayed a long time.

The above discussion was centered only on the size of the game. The further specification, that of making international game playing comparisons, preferably playing the same game in countries with different institutional set ups, must be taken into account. This raises the problem that the game should be felt reasonably relevant and interesting by players in these different countries: a further criterion of choice is that one should, if possible, try to find a game which is of relevance to some IIASA research area, for example, energy, agriculture, industry studies, innovation policy, etc.

At this stage one cannot determine which game should be chosen. Instead it appears reasonable that one should make it an important part of the collecting activity to find a game that is as suitable as possible with regard to the above mentioned aspects. It is very likely that one would, in a pre-test activity involving only a few game runs, test more than one single game. Furthermore, these pre-tests would have to be carried out in more than one country in order to test the relevance of the game in different institutional setups. These pre-tests should also allow for some testing of the experimental design to ascertain that allowance can be made for some manipulation of the game, for example, the amount of information given to the players.

Finally, it should be said that the pre-tests would determine whether the research of repeated game playing in different countries is feasible or not. Thus, this research becomes reasonably risk-free, since by the insistence on not developing a new game and by spending at the very most two months on this pre-testing, very little effort would be lost if the project proves not to be feasible.

Although it is impossible at present to say what game will actually be played, it might be of interest to indicate two areas where one might find simple games that would be of relevance to the IIASA research areas, namely homogenous oligopoly and bilateral (or possibly trilateral) bargaining.

- Homogenous oligopoly refers to markets with a limited number of players of significant size where all the players supply very similar goods, so that price is the main means of competition. One advantage of homogenous oligopoly is that the demand model is fairly easy to depict with a reasonable degree of realism.

A great many possible products could be used, e.g., coal, oil, pulp, bauxite, (cf. IIASA paper PP-76-9 on the bauxite cartel) and similar raw materials. Another alternative is the market for a specific mechanical engineering product, e.g., tankers, offered in sealed bidding to perhaps a third world country.

- As regards bilateral (or trilateral) bargaining, there are also a wide host of possible applications. Some international trade bargaining might be of interest. One could also look at bargaining in a specific industry,

for example, purchase of trees from a farmer's cooperative by a forest corporation. One could also look for bargaining games for studying the full vertical structure of an industry, e.g., forest-pulp paper.

As regards the actual game playing in the different countries five points should be stressed.

1. The game playing in the different countries should, as far as possible, be a collaborative effort with institutions in the NMO countries.
2. The gaming sessions should preferably be combined with a short lecture and discussion on operational gaming (held after the actual gaming session). Hence, these gaming sessions could also be seen as part of a dissemination program on gaming. The original part of the gaming program will thus influence dissemination of knowledge, not only indirectly by improving the handbook, but also directly by the participation of actual decision makers in these gaming sessions.
3. International gaming comparisons ought not be made ad hoc, but one should preferably have specific hypotheses, in order to know more clearly what to look for. Games of the types described above would give data on such aspects as "uncertainty avoidance" and "toughness". Hence, to some extent the work could, as regards hypothesis generation for example, also be connected with cross-cultural studies like those of Geert Hofstede at IIASA-MMT.
4. The games would be homogenous as regards player participation, i.e., only persons from one country would take part in a specific gaming session. This is necessary in order to make the intended comparisons. Gaming with participants from several countries is more difficult and will have to be left for future research.
5. The chance that the research outcome of such international comparisons of gaming behavior will be of interest is enhanced by the fact that this research program is focused on "symmetry of outcome", i.e., both systematic differences in gaming behavior and the lack of such differences would be interesting results.

#### d. The Workshop on Gaming

The workshop on gaming suggested for the fall of 1981 should serve the triple purpose of getting feedback on the handbook, (including items that have been left out), disseminating some of the IIASA work on gaming and getting new ideas to aid the post 1981 planning phase. It should be stressed that the preparation of this workshop would be very closely connected with the other outlined tasks and that the resource demands would, therefore, not be considerable.

e. Consulting Activity

It is natural that a gaming group should as far as possible consult on gaming within IIASA. As discussed earlier the Irkutsk general energy game is the first candidate for such consulting since it is an already started program. Another is the plan for some gaming activity in connection with regional planning in the Notec area in Poland. Consulting might also be useful as regards the Sydsvatten game model for cost allocation in the Resources and Environment Area. Even if no gaming is planned at the moment, it could be of interest in, for example, a choice between various game theory concepts. A very small "quick and dirty" gaming activity might be helpful in this regard.

The consulting activity should also be closely connected with future planning activity, so that one could at an early planning stage determine if and how gaming could be of use.

f. Planning of Future Gaming After 1981

As mentioned several times earlier, some of the most interesting forms of gaming, i.e., the construction and use of larger games, must be postponed until after 1981. At present there appear to be many ideas at IIASA about the use of such games in many areas, e.g., agricultural natural policy, various sorts of energy assessments, health care planning, environmental cost-allocation, expert assessment of new technology, R & D budget, specific industry structure, etc. The reasons for not venturing upon any of these projects at present are three-fold: (1) Planning on most projects are at present too far evolved and have no budget for considerable expansion. (2) The value of gaming to the project, due to the lack of methodological knowledge, is extremely difficult to assess. (3) One cannot rule out the possibility that people are doing something very similar elsewhere which after slight modifications could be used at IIASA.

The planning work must to a large extent be focussed on dealing with these restrictions. By the consulting activity outlined above and by further general discussions with people in various programs and areas one must be able to evolve the right gaming ideas at an early stage. By disseminating handbook chapters and research memoranda, participating in internal seminars, etc., one should be able to acquaint various IIASA staff members with the advantages and limitations of gaming as a systems analysis tool. Finally, during the collection task one should attempt to bring in games that could be of interest at IIASA post 1981.

Altogether, future planning should be well integrated with the other tasks of the gaming program and so do not require any considerable amount of extra resources.

SUMMARY

The outcome of the specified research program can be summed up in the following points:

- a. A handbook with a specific focus on topics of interest to IIASA and its NMOs.
- b. A collection of games and gaming information of interest to future IIASA activities.
- c. Some research findings of general interest on international comparisons of gaming behavior.
- d. Some research results relating to a theory of operational gaming, particularly focussed on smaller games suitable for a fairly rapid analysis of concrete problems.
- e. Some dissemination activity in connection with gaming research in both NMO countries and within IIASA.
- f. Some consulting activity within IIASA, particularly in the energy area.

It is therefore envisaged that a fair amount can be accomplished in a four man year program.