THE WORLD GAME IS A SCIENTIFIC MEANS FOR EXPLORING EXPEDITIOUS WAYS OF EMPLOYING THE WORLD'S RESOURCES.................

so efficiently and omni-consierately as to be able to provide a higher standard of living for all of humanity - higher than has heretofore been experienced by any humans - and on a continually sustainable basis for all generations to come, while enabling all of humanity to enjoy the whole planet Earth without any individual profiting at the expense of another and without interference with one another, while also rediverting the valuable chemistries known as pollution to effective uses elsewhere, conserving the wild resources and antiquities. The World Game discards the Malthusian Doctrine which is the present working assumption of the major states. Malthus held that humanity is multiplying much more rapidly than it can supply resources to support itself, and compounds with Darwin's survival of the fittest, to assume that only the side with the greatest arms can survive. The World Game demonstrates that the Malthusian Doctrine is fallacious. If we apply to direct human support all the high technology resources now going into the world's annual 200 billion dollar war preparation, all of humanity can be brought to economic success within one quarter century. This eliminates the fundamental raison d'etre of war. The World Game employs design science to produce progressively higher performance per units of invested time, energy, and know-how per each and every component function of the world's resources. The World Game makes it possible for intelligent amateurs to discover within a few weeks of simulated design revolution illustrated on the World Map that the foregoing premises are valid.

R. Buckminster Fuller

History

World Game started as an idea in Buckminster Fuller's mind over 40 years ago. It progressed to its present state and name through the development of :

World-Town Plan	1927
Conning Tower	1932
Earth, Inc.	1946
Mini-Earth	1951
Geoscope	1954
World Game	1961

and published in:

Shelter magazine - 1932
Nine Chains to the Moon - 1938
Education Automation - 1961
World Design Science Decade - Vol. 1,2,4,5 - 1964-1967
Ideas and Integrities - 1963
Operating Manual for Spaceship Earth - 1969
No More Secondhand God
Utopia or Oblivion - 1969
World Game: How It Came About - 1969
Dymaxion World of R. Buckminster Fuller - 1960
Robert W. Marks
Buckminster Fuller - 1962
John McHale
World Game Report - 1970

Dr. Fuller, John McHale, and their staff in Carbondale laid the foundation of the World Game in the World Design Science Decade Volumes. It is these publications that contain most of the hard data to which World Game constantly refers.

Last Summer (1969) in New York City, the first World Game workshop/seminar was held. Twenty-six people from various disciplines met for eight weeks; transforming by their presence, involvement, and the artifacts they produced, the metaphysical idea into a physical reality. They documented the concepts and ideas of Dr. Fuller and they realized through their research and simulated plays, that the World can be made to work, that 100% of humanity can be successful.

The documentation of their research and findings - the maps, charts, and words - were brought to Dr. Fuller's office in Carbondale as the foundation of the ongoing World Game development and the ***World Game Report*** was published as an overview of the process and products of that workshop.

The Department of Design of Southern Illinois University at Carbondale, in collaboration with the staff at Dr. Fuller's office, held a class in the World Game for the academic year '69-70. Research into comprehensive design strategies and data display evolved from the basics of the New York experience into more sophisticated and elaborate set-ups. In New York, work was done on strategies for the electrification of the entire world via a seasonal and time zone crossing, inter-connecting electrical network; the food needs and supplies for the world; and a housing needs analysis for the world. In Carbondale, work progressed in such areas as air pollution, transportation, education-communication, and wildlife. Data displayed moved from acetate overlays to carousel slides.

As the conceptual development and documentation of World Game continued, it became more and more apparent that the World Game needed a mechanism, a process, for the inter-relating of all the facts and strategies that were being dealth with. An effective model of Spaceship Earth needed to be developed and computerized. Evolution brought us from the development of strategies for the World Game to the development of the World Game tool; from the content to the media.

The workshop held at Carbondale this past summer was primarily for this purpose. Thirty-four people met for eight weeks developing models for subsequent computerization, reduction to a simple game board, and gaming formats for more involved interactive situations - as in the high school and college classroom.

Dr. Fuller's 40-year commitment to and development of the World Game is acceleratingly being realized. The comprehensive metaphysical idea is being systematically documented into physical reality. World Game evolution is becoming conscious development, i.e. evolution being natural flow; development being natural flow valved and shunted by minds' generalized principle cognizing capability for greatest more and lessing advantage. The World Game, the comprehensive planning tool to aid decision makers of the Earth, the tool that will make visible and conscious the reactions and resultants of mans collective planned actions before he is actually comitted to taking them, is not a reality, it is not complete. It and the Comprehensive Anticipatory Design Science strategies are being developed; the World Game needs intellect, energy and time.

II Simulation

A. Overview

Introduction To Modeling and Gaming Section

The goal of those who come to work on World Game is to discover "the most scientifically expeditious ways to make 100% of mankind an ongoing biological and metaphysical success." Within the context of this goal the particular pathway of the World Game is to create a simulation model of the world upon which people/players can develop a working consciousness through insight into the operation of critical patterns on our spaceship and, subsequently, to research and text various strategies for realizing the overall goal.

Anyone familiar with the state of the art of simulation must be aware of the magnitude of such an undertaking. Presently, even large computers and their system analysts and programmers are taxed by simulation models of such local situations as a state or city. The designers of such models, because they are usually commissioned to deal solely with a local problem, must relegate to "environment" many of the varibles and patterns which are at the root of the dynamics of the model and its core. We feel that the difficulties encountered by other simulation attempts result from the specialized and local systemic approach to the problem.
If one is to apply closed-system analysis to a system and gain both descriptive and predictive validity, the system must be truly closed within the scope of the consideration. We think that Buckminster Fuller's approach of starting with Universe and subdividing into smaller relevant subsystems (e.g. Spaceship Earth) will allow us to create the model we need..

As the main goals of the workshop, we proposed to concentrate on explicit models as a presursor to World Game simulation, and on the creation of a game board (non-computer) version of World Game. To attain these goals, three groups formed early in the workshop, two of which attacked the long-range problem of computer based models and modeling, while the third focused on the creation of the game board. Although each group set its own special goals and determined its own directions, the work of each parallelled and complemented the work of the others. The common links, beyond those of the overall World Game goals, were that all the groups were working within the framework of modeling and simulation gaming strategies.

Now is a good time to ask; what is a game and what are its characteristics? To paraphrase from Abt's ***Serious Games,*** a game is an activity within which **actors** (players) make relatively independent decisions concerning the ways they will achieve **objectives** in order to satisfy some specified **win criteria.** The **scope** of the game is, at least, implicit in its structure. For example, Monopoly is a game dealing with problems of urbanization. A game further includes **moves** describing increments of change; the **interactions** which make up the change; and **resources** upon which change is made. Finally, some **scoring** system measures the performance or weighs the decisions of the players. A game can be competitive, cooperative, or mixed in terms of player interaction.[1]
The beauty of simulation and gaming is that one can deal with complex realities in a relatively simplified fashion and, by doing so, enhance one's ability to deal with the real situation – an end to the action/thought dichotomy.
At the core of any game is a model of some reality, be it of some societal, mathematical, physical, or psychological system – a model of a system.

[1] ***Abt, Serious Games,* etc., etc., etc.**

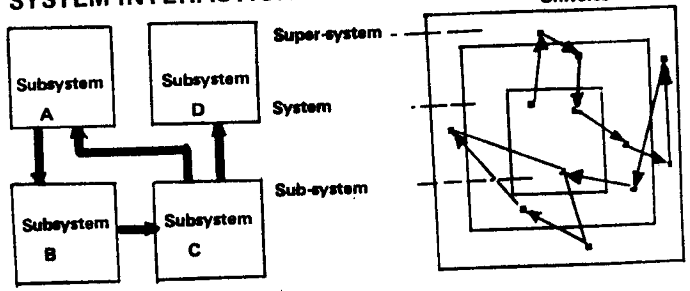
The description of a system that will satisfy our requirements for experimentation consists of choosing symbols to represent components as mathematical and logical statements. This process is known as abstraction, and the resulting set of symbolic expressions is called a model of the system being studied.[2]

Now that we know the characteristics of a gaming simulation model -- and that we want to create one -- we can return more explicitly to World Game. Dr. Fuller has spent some forty years abstracting trends, patterns, and generalized principles from detailed, special case observation. The really important patterns of universe and earth are buried, he shows, under mountains of special case details and its attendant confusion and kept there by the blinding effects of misinformed attitudes and opinions. It seems then, that we have the task of making as clear an elucidation of those patterns and causing as effective an un-learning of the misinformation as possible. The prime consideration in building a game whose scope is an entire planet is to represent approximately **all** the critical patterns and, simultaneously, keep their quantity and number of requisite interactions to a humanly comprehendible and manageable minimum.

The most relevant pattern to be recognized in analyzing our 100% successful mankind problem is that of the **pattern of the patterns**. In other words, one must ask, in what order are the sub-components, the principles, and patterns arranged so as to be omin-complementary. Unfortunately, for ease of analysis, we do not have a situation of isolated systems operating along simple linear casual paths, but rather an embeddation/recursion system.

[2] Mizal Cox, *Essentials of Simulation*, page 6.

SYSTEM INTERACTION GRAPHICS



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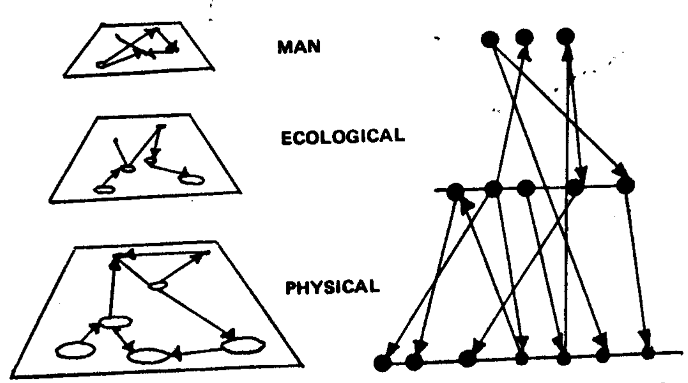
We can attempt to deal with this imbedded system by progressively modeling each one internally and then cross-connecting each with the critical "inter-imputs and out-puts" as shown.



SEPERATE MODELS

MODELS AND INTERACTIONS

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As one can see by the above right hand shematic, the interaction vectors continually leave the boundaries of one sub-system, and enter another before returning to the original sub-system. This is the type of systemic arrangement which characterized the physical transformation of Spaceship Earth: geophysical phenomena occuring within the context of Universe, ecological behaviors within the geophysical systems constraints and, man/automata within that. With this type of ***pattern pattern,*** sub-system boundaries become blurred and may be differentiated only by noting a certain ***richness*** or density of interaction types. For example, within a forest, processes other than biological growth, maturation, and decay occur -- transpiration is actually a physical evaporation process -- yet we can and do differentiate between the ecological system type of a forest and the physical system type of an open pail of water.

Since we are, ultimately, dealing here with earth and man, and since we are aware of Earth's evolutionary development from a primeval physical to an ecological and then ***noological*** system, we can attempt to deal with this embedded system by progressively modeling each one internally, like the concentric skins of an onion, and then cross-connecting each with the critical ***inter - inputs and outputs*** as shown. Figure 2a shows the internal interactions while 2b gives the external or cross-linked interactions, figure 2a and 2b show this as figure 1b exploded and viewed sideways.

Next we have to consider what to leave in and what to leave out of any sub-model we wish to derive. A very necessary consideration and decision is that of ***level of aggregation,*** or the level of detail to be considered and brought into a model. For example, one may, in modeling a human diet, aggregate at the level of "3,000 calories, 45 grams protein, x, y, and z vitamins per day" or go all the way to detail "kosher hot dogs, hold the onions, and french dressing on the salad".

All of us, who have worked on a world simulation model have been, consciously or not, coming to decisions on levels of aggregation. Continually, we find that in our first approximations, we are dealing with extremely generalized conceptions of populations, food need, and energy models. For various reasons, we often do not see consistency of aggregation throughout our sub-models. Further, we often find unclosed loops. Usually, this is simply because the world is complicated and we've been stuck juggling all our information long hand. With the above preliminaries in mind, one may view the work of the three groups with a common frame of reference.

The models developed can be viewed in the context of a relevancy tree:

1. Universe

2. Generalized Principles

3. Man and his Information Organization (Know-how)

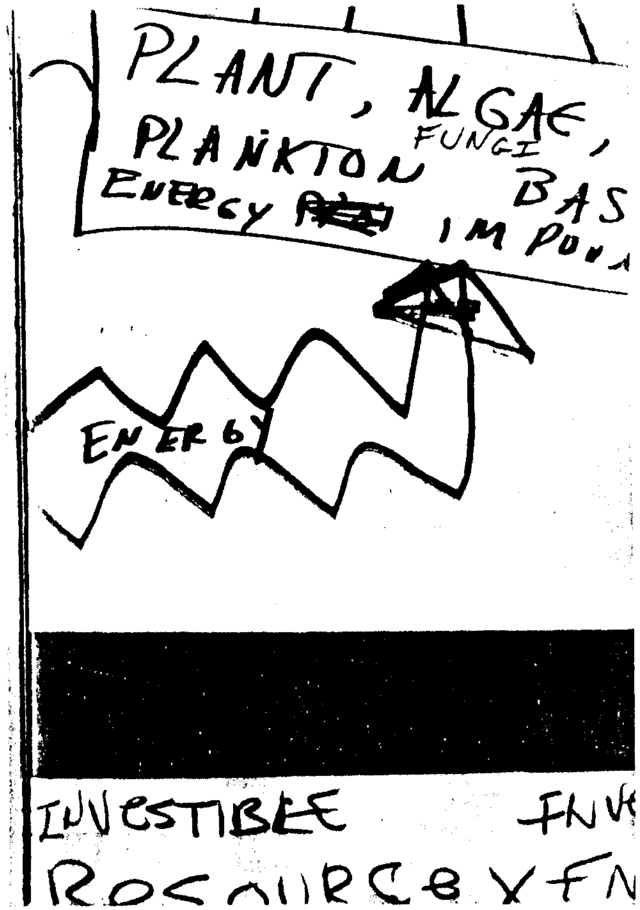
4. Matter-energy transformation interrelationships toward EARTH

5. Special interrelationships of EARTH parameters

All models implicity deal with all levels; all levels are necessary for successful dealing with the total planetary context. Of necessity, however, different groups started in different places, and wound up filling each other's gaps.

Levels one and two were the common starting points of all three groups. Levels three, four and five correspond to the most salient aspects of the three models developed: Man's External Metabolics, corresponding to level three, was written from the point of view of man as space captain (*Operating Manual for Spaceship Earth*), as the governor of this organism, and from the point of view of his functioning and his needs. It relates level two, Generalized Principles, to level four, the physical context in which man is embedded. It reflects man's understanding of the generalized principles. The Input-Output Model of the Technologised Ecosystem was written from the point of view of level four, and explicates on a comprehensive but gross level the matter and energy transformational pattern existing on earth, It deals with resources, it implicitly relates this level, three, with level five.

The Dymaxia Board Game Group worked from the perspective of level five: it started out with geography by constructing a toy world, an allegorical ecosystem, and then started relating environmental parameters to each other and to population distribution aboard Dymaxia, thus relating level three (Man, his needs and his know-how) to level four (Matter-Energy transformations).



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"Simulation
C. Hardware

World Game at the moment is engaged in the development of sophisticated gaming and simulation models and techniques aimed at making the world a success for 100% of humanity. To accomplish this goal, large amounts of information must be gathered and processed to give the players of the World Game a rational basis for decision making. Previous World Game Workshops have shown that the return in terms of the comprehensive world view is becoming marginal with the use of iconic display systems and linear trending techniques. For example, two-dimension flowcharts of world critical variables soon reach gargantuan size and tremendous unreadability when only a few of the variables are charted. One finds he soon loses his total systems outlook as he gets lost in the intricacies of the model; a model which in the beginning was designed to give a simplified representation of that being modeled.

The solution is the computer systems processing system. It gives the problem specifier and solver a descriptive means of getting the problem or model specified concisely and worked out with minimum effort expended on the part of the problem-solver. With the development of management information systems and time-sharing computer systems, a new modeling tool has been opened up to the problem-solver. Through the use of these new tools, World Game development may move into a second generation of complex simulation and gaming systems, oriented towards doing "more with less".

The computer effort at this summer's Workshop began with the implementation of the general purpose programming and simulation language SIMSCRIPT II. SIMSCRIPT was developed at the RAND Corporation a number of years ago and has been steadily improved in terms of efficiency and ease of use. The language itself is very easy for the non-programmer to learn as it has an English-like syntax that enables one to simply converse with the computer in a subset of English. SIMSCRIPT has five levels at present, with ascending degrees of difficulty. Level one, is especially designed for the novice programmer and gives him the necessary rules to program most types of numerical problems. The remaining levels introduce more advanced concepts such as list processing, set membership and ownership, entities attributes and finally simulation.

The computing facility which was available to the workshop was the S.I.U. S/360 Model 50 with 512k bytes of memory. After a number of technical problems (non-standard I/O facilities) were taken care of and accounts set up for access to the system, the SIMSCRIPT II compiler was installed. SIMSCRIPT manuals were ordered from Prentice-Hall Publishers and a class was started in the workshop to teach SIMSCRIPT.

To test the Carbondale facility, simple simulation test cases were developed and run to access the run-time efficiency of SIMSCRIPT. It was found that the language was running about three times slower than it does on the model 360/65, and available memory was quickly used up. Adding to the run-time problems, was the fact that no user could store data on the available disk space on the system. Tapes then were the only storage medium that was inexpensive enough for the workshop to afford, but very little information could be stored on the tape relative to the disk pack.

At this point, a study was instigated to determine whether

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or not World Game needed its own computer system to continue program development or whether the in-house facilities could be used in some way to accomplish the aforementioned goals of the workshop.

From this study, it was decided that World Game needed a dedicated computer with time-sharing and graphic capabilities. Time-sharing would make possible a large, dispersed user community which would share the resources of the computer and would be an aid in problem-solving. Graphic display capability would facilitate the graphic representation of data stored on the system and allow the user to manipulate the data according to the nature of the problem.

The system best suited to our needs is the PDP-10 manufactured by Digital Equipment Corporation of Maynard, Massachusetts. The system can support up to 63 users simultaneously (allowing for extension workshops) and has a virtual memory capability that puts the PDP-10 in the performance class of IBM 360 model 67 at a fifth of the cost. It is anticipated that a terminal could be installed at any World Game extension group so that they could tie into the larger system. Also, the PDP-10 could be used as an interface with other computer installations which would increase the over-all performance of the system. A description of the PDP-10 system, its cost and some of the rational as to why it was choosen is appended at the end of this report.

Once it was decided to try to procure the PDP-10 for World Game, ideas to pay for the system were investigated. Digital Equipment Corporation, expressed interest in our proposed development of a SIMSCRIPT II compiler for the PDP-10. They would pay World Game for the package and market it to their customers, or give World Game PDP-10 hardward in exchange for the compiler. Also, unused time on the system could be leased to outside users for a nominal cost. The writing of the compiler is a major undertaking and would in all likelihood take one-half year to complete and debug. Work would also be started on a more developed version of SIMSCRIPT for the S/360 which would have features not presently implemented and would run faster than the present version released by IBM. This package could also be sold to S/360 users to defer system operating costs. The main reason for the development of SIMSCRIPT II is to provide a standard computer language for all World Game groups across the world. The emphasis being on an easy to learn but powerful language that is not dependent on any particular machine.

One reason for the lack of progress in the field of simulation has been the lack of good documentation of the methods used in a particular simulation. Every installation appears to have its pet language that it uses for all of its work, but because of this practice, useful results cannot be shared with others in the same field since they don't understand the language. Since World Game has a world orientation, the standardization problem is being handled now.

The previous paragraphs have given a description of the workshop's computer work and a few thoughts on the future of World Game computer usage. The Fall will see the start of an extensive literature search in the areas of simulation, gaming and problem-solving. The purpose of this search is to become familar with the state-of-the-art in these fields so that advances in the respective fields may be applied by World Game groups to their own needs. Plans are being readied to schedule a simulation conference at S.I.U. sometime in the Fall to bring together a group of pace-setters in the field for fruitful discussions. Also, portions of Fuller's Design Science Curriculum will be implemented in the Design Department at S.I.U. to inform interested people of the advances and users of general systems theory, information theory, cybernetics and heuristics.

APPENDIX

Rough Cost Breakdown

Proposed World Game PDP-10 System

NUMBER	COMPONENT CODE	DESCRIPTION	PRICE UNIT	TOTAL
1	KA10	Arithmetic Processor	142,000	142,000
1	KM10	Fast Registers	9,000	9,000
1	KT10A	Protection and Relocation Registers	9,000	9,000
1	MD10	Core Memory (32k)	70,000	70,000
1	MD10E	Memory Expansion (32k)	42,000	42,000
2	DF10	Data Channel	12,000	24,000
1	RC10	Swapping Disk Control	17,000	17,000
1	RD10	Swapping Disk File	32,000	32,500
1	RPO2	Disk Pack	26,000	26,000
1	TD10	DEC tape Control	15,300	15,300
4	TU55	DEC tape Unit	2,350	9,400
1	CR10A	Card Reader	15,000	15,000
1	LP10A	Line Printer	25,000	25,000
1	DC10A	Control Unit	9,000	9,000
1	DC10B	8-Line Control	5,000	5,000
Basic Computing System Cost w/o Terminal and Modem Costs				455,200
1		Display Processor		
1		Matrix Multiplier		
1		Clipping Divider		
1		Display Generator		
1		Scope		
Basic Display System Costs				198,000
		SYSTEM TOTAL		$653,200

The computer system described in the report, is the minimum configuration of the PDP-10 that could service World Game's computer demands. The entire system is upward compatible and can be updated quite easily at a later date as funds become available. Possible extensions would be more memory, the addition of terminals, more tape drives, disk drives, and an additional CPU for multi-processing. There is a large library of programs and languages available for the PDP-10 including COBOL, FORTRAN, and SNOBOL 4.

The LDS-1 display costs little in terms of system overhead, and up to eight additional displays may be added for a small cost, and it can be plugged right onto the system without modification, when funds are available for its procurement. The display operates in conjunction with the PDP-10's memory to display vector and character information. The graphic features are embodied on the hardware, which leaves only the manipulation of data to be handled by the programmer, a vast improvement over existing display systems.

The proposed date for the delivery of the system is June 1, 1971. The interim period would be devoted to preparation and debugging software, conversion of data bases into machine readable form, and training. This could be done on a PDP-10 system in Chicago, which DEC informs us has time for leasing available at a very small cost.

1. World Game Information System
2. Interactive Computer Time-sharing
3. Computer Gaming and Simulation
4. Computer-aided Design and Graphic Display

The necessary hardward and softward to accomplish these goals are outlined below.

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1. Management information systems (MIS) are computer models of information systems that handle all tasks associated with the flow of information in a large organization. MIS stores in memory all relevant information introduced in the system. MIS sorts data according to several prescribed formats and traces the flow of information through the system. MIS retrieves information when interrogated and performs all required arithmetic and logical operations necessary on the storage, flow, and retrieval of data.

MIS is a large integrated model consisting of many functional blocks on a modular design. The modularity is characterized by many routines, each planned to execute a specific function. Each routine is independent of every other routine and is used only when required in the operation of the model. MIS operates for both scheduled and unscheduled operations. In the scheduled operations, MIS handles all routine procedures on the system in some basic time unit on a cyclic manner, such as daily. Unscheduled operations include non-routine procedures in the system that have sufficient priority to preempt the systme of any operations of lesser priority. MIS outputs include status report of system operations at critical times on the processes of information in the system. The effectiveness of the system is determined by the efficiency with which information or data flow through the system with minimum delay, correct routing, and quick retrieval. Queries, delays, looses in the system, etc., can be observed and modified as the system operates.

A MIS would be suited for the management of a large, heterogeneous data bank that World Game is envisioned to develop in the future. The ability to query the system for selected items of information according to the user's needs and display the data on a meaningful report structure, is also quite attractive for World Game developments.

2. Time-sharing of computers developed over the years, and has proved to be a useful tool for the design and implementation of large complex programs. It has many advantages over batch processing, which maximizes efficiency on routine data processing operations where turn-around is not critical. But for program development and modification, the user requires another mode of operation. The user needs a way to "interact" with the computer; to feed his program to the system, line by line, and continuously check the results.

The user may wish to develop interactive programs to help in the development of special case problems such as statistical analysis. Here the computer designs the system by asking the designer questions and manipulating his answers. In addition, interaction provides new viastas on information reporting. With an interactive terminal, a user can request summaries, plot trends on system operation and activity, and select data for use on decision making. An added advantage is that many users may be using the resources of the system at the same time. In a simple time-sharing system, each program is completed. Users may share their programs and data with others by declaring their files to be private or public. Users may also use graphic display terminals interactively, for the display and manipulation of data stored or entered into the system.

With the advent of "intelligent" monitoring software system, the user can engage in a man-machine symbiosis, where the inductive capabilities of man are optimally coupled with the flexible deductive capabilities of the machine. This type of system will provide better facilities, more power, faster processing, and higher reliability. These advances will open even greater information processing through creative time-sharing.

3. Another field related to simulation is gaming. Games are designed to create a learning environment based on the level of participation of the participant. If the game gets too intricate to play it loses its sense of purpose and approximate reality only to the extent that there are people intelligent enough to comprehend constraints. The idea behind gaming models is to create a comprehensive decision-making environment for its players to operate in and on. Among the goals of gaming, is to teach the participants the interrelatednedd of a whole system's approach and the hopelessness of making decisions with the techniques of only one discipline.

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