COMPUTERIZED CONFERENCING & COMMUNICATIONS CENTER

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NEW JERSEY INSTITUTE OF TECHNOLOGY

COMMUNICATION PROCESSES IN THE DESIGN AND IMPLEMENTATION OF MODELS, SIMULATIONS AND SIMULATION-GAMES: A SELECTIVE REVIEW AND ANALYSIS, FROM THE VANTAGE POINT OF COMPUTERIZED CONFERENCING

RESEARCH REPORT NUMBER 4

by

JULIAN M. SCHER

c/o Computer & Information Science Department
New Jersey Institute of Technology
323 High Street, Newark, N. J. 07102

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Julian M. Scher
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PREFACE

Computerized conferencing is a new form of communication which permits a group of individuals, who could be separated in time as well as space, to engage in an interactive dialogue with each other through the convenience of their computer terminals. The software for a computerized conferencing system is designed to keep track of all messages communicated in the system, as well as insure that the various protocols for communication are observed by all.

Our objectives in this report are to examine the communication processes found in the design and implementation of models, simulations and simulation-games, and to identify those areas where computerized conferencing, as a new form of communication, has the potential to impart a significant impact on the aforementioned disciplines. The theme which underlies this report is that computerized conferencing presents us with the capability to structure a communication process to satisfy a set of preformulated design objectives.

In Part I, we introduce the reader to some basic terminology used to identify models, simulations and simulation-games. Part II attempts to enumerate the potential impacts computerized conferencing is expected to have on the model building process. A key component of this section is the author's causal-loop "model of the modeling process" which seeks to capture the feedback relationships responsible for both the growth processes and limitations inherent in modeling, and the key role computerized conferencing is expected to play.

Our attention next turns to the area of simulation-games. In Part III, we define a simulation-game as a gestalt communication process, and reiterate many of Richard Duke's thoughts on the communication processes found in simulating-games. The next chapter examines the "marriage" of computerized conferencing and simulation-games, and identifies the numerous benefits to be achieved by this union. These benefits include not only logistic breakthroughs and the attainment of new degrees of verisimilitude to the object human interaction systems being modeled, but an opening up of the simulation-game as a research tool to gain theoretical insight into the sociological processes that take place in human interaction systems.

In Part V, we present to the reader summaries of those major efforts relating to conferencing based simulation-games. These include the work of Lincoln Bloomfield and his associates at MIT (the CONEX simulation-games), the Polis system of R. Noel at the University of California at Santa Barbara, and the experiments conducted by the Institute for the Future with the CRISIS simulation-game.

In Part VI, we explicity prescribe some methodologies by which a simulation-game designer can structure the communication processes found in simulation-games to satisfy certain design objectives. We refer to this as a constrained computerized conference (i.e., dynamic constraints are imposed on the communication process). A mathematical model is developed for the communication that takes place in the simulation-game. Design applications are then discussed as specific extensions of the mathematical model.

The penultimate chapter presents a hypothetical language for describing the communication processes found in simulation-games and other group communication models. The language begins with the world view of SIMSCRIPT II-5, acknowledged to be the most powerful discrete event simulation language, and builds in some powerful features designed to model and structure human communication processes. The language is illustrated with both a university fiscal crisis simulation-game and the SYNCON communication model.

The final chapter synthesizes the ideas expressed in the preceding chapters by an analogy of models, simulations and simulation-games with the conceptual foundations of the scientific method, and sees computerized conferencing as a key aspect in making "scientists" out of "systems scientists." It calls for a conferencing-based International Archives of models, simulations and simulation-games, both to aid in model scrutization and confirmation as well as to provide a mutual pooling of resources from which users can "draw" as they please.

I. INTRODUCTION AND TERMINOLOGY

As a prelude to a discussion of the potential of computerized conferencing in the simulation and gaming area, it would be most desirable if we could establish a working definition of some commonly used terms so as to distinguish the directional efforts of work in this field. That is, one often hears the terms "simulation-games," "gaming," etc., used in a variety of contexts, with an associated list of diverse meanings. A cursory glance at the literature in this field will suffice to convince the reader that the pioneering researchers and current experts are still unable to agree on the meaning of the terminology they often use in everyday parlance.

The lack of a suitable taxonomy leads to severe problems in comparative review work in the field and further necessitates our specification of the definitions needed for this effort.

For instance, Inbar and Stoll present the following simplistic definition for their (social science oriented) audience:

> "....a simulation is a representation and abstraction of something else. In some cases, the 'something else' may be almost purely theoretical.... while in other cases there is a considerable content or reality base." (1, pg. 10).

We note that simulation may have a variety of "modes d'emploi." To a social scientist who observes the field, they may appear as common everyday games, while others might view simulations as sophisticated computer software developments. A synthesis of these two "attitudes" finds certain types of simulations which utilize both people and computers in their operation. Inbar and Stoll, (1, pg. 9), state that the generic term for all these forms is "simulation." To distinguish the different forms, they employ the following terminology

i) man-simulation: a simulation where the decision-makers are human actors;

ii) machine-simulation: a simulation where the decision-making functions are imbedded in a computer software model;

iii) man-machine simulation: a simulation where the decision-making apparatus is divided, in some (not necessarily equal) manner between man and computer.

Inbar and Stoll are of the opinion that if one uses the term "simulation" without qualification, it "is meant to apply to any simulation (above) regardless of mode, and regardless of whether or not it is a 'game'." Numerous other individuals in the field would take exception to this attitude, claiming that "machine-simulations" are the only "legitimate" forms of simulation, while man-simulations and man-machine simulations are, in reality, what we refer to as "games." A reply to this attitude that permeates the field today is offered by Inbar and Stoll (1, pg. 10 - Footnote) who defend their reluctance to utilize the term "game" for man-simulations and man-machine simulations:

"'Game' adds the nuance of a formal winner. In the literature man and man-machine simulations are generally called games, although this is not always in accord with strict definition. In fact, from our own use of the term in research on the sociology of games, we would be forced to deny that 'game' is an appropriate choice of words here. Games have three factors: (1) a structure of more or less explicit rules about the constraints under which a goal is to be achieved with certain resources; (2) players' psychological orientation that the goal is valueless in itself; (3) social consensus that the activity is inconsequential for the serious business of life. Not all man-machine simulations have these features. Furthermore, the proper terminology would in any case be simulation-game. 'Game,' however, is a much less cumbersome term, so we continue its application here whenever we emphasize that a simulation has formal winners, recognizing that it is an impressive use of words."

In this paper, our preference will be to utilize the term "simulation-game" when referring to either a man-simulation or a man-machine simulation.

A simulation-game, in our context, will be the union of what has been referred to by Shirts (2, p.75-81) as "noncontest simulation games," and "simulation game contests." Shirts considers three types of activities (Figure 1), and by overlapping, one may obtain a total of seven groups (Figure 2).

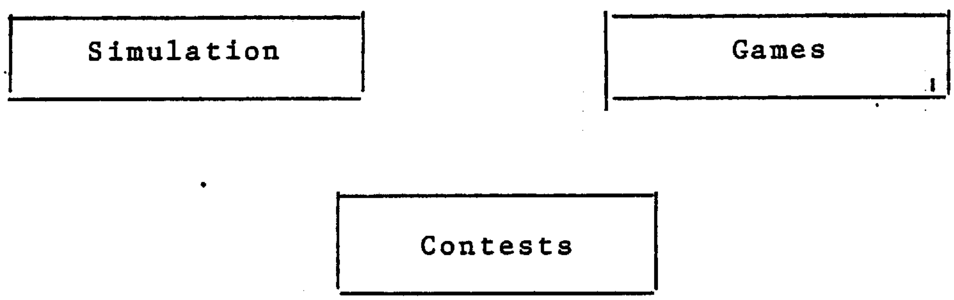


Figure 1

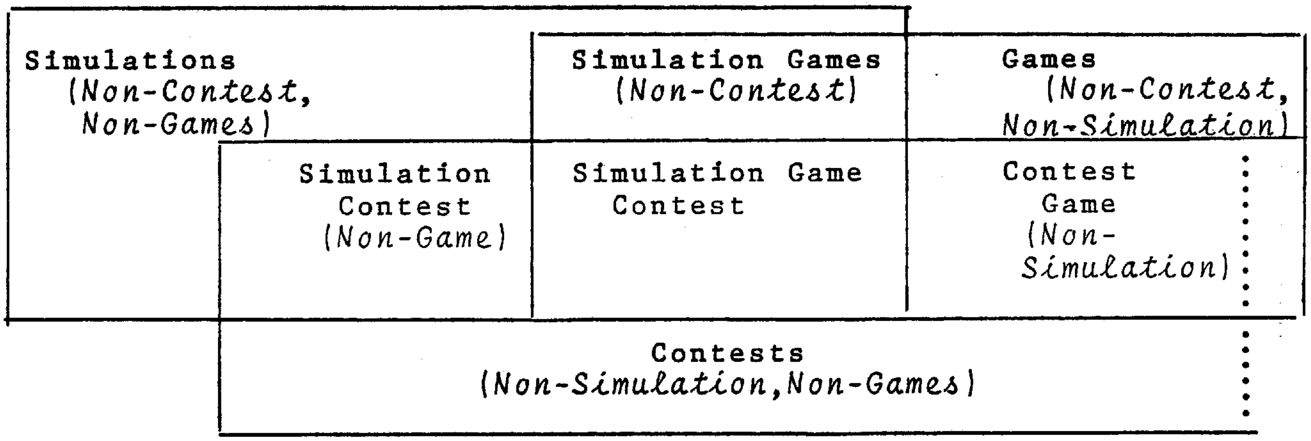


Figure 2 - from (2; p.76)

In the Shirts categorization, a simulation is a model of reality, a contest is a competitive activity and a game is characterized by an activity in which people agree to abide by a set of conditions (which need not be "rules") in order to achieve a desired state or end. Our definition embodies both the competitive and noncompetitive simulation games in the Shirts categorization, while excluding the "familiar" contest games (sports, word games, etc.)

Thus, while some writers feel that the distinguishing features between models, simulations and games are minimal (e.g., Martin Shubik collectively refers to them as MSG's!), we feel that distinctions should be made and concur with McLeod (3) who states:

> "The term simulation is generally used to cover modeling, simulation and gaming. Current usage, however, suggests that more properly, modeling should refer to the gathering and structuring of data in such a way that the values of the parameters, the initial values of the variables, and their interrelationships are formalized .... The term

simulation, strictly speaking, should be reserved to mean the use of a model to carry out "experiments" specifically designed to study selected aspects of the simulant, i.e., the real-world or hypothesized system that has been modeled. ... Gaming refers to simulations in which human judgment is exercised to influence the dynamics of the model during the course of a study."

In this report, we shall not attempt to dwell on the various philosophical questions related to simulation. While it certainly will be true that the benefits one can hope to achieve using computerized conferencing would vary somewhat depending on whether one's simulation viewpoint is Leibnizian (i.e. structurally oriented) or Lockean (i.e. data oriented), our inquiry system perspective will tend to be Kantian (i.e., data and models tend to be inseparable). Further discussions of this may be found in (4,5).

II. COMPUTERIZED CONFERENCING AND THE MODEL BUILDING PROCESS

The potential role of computerized conferencing in the model building process can best be illustrated by examining a causal loop diagram for the author's viewpoint as to current and future trends in modeling. In Figure 3 we present a model of the modeling phenomenon," which seeks to capture those levels and interrelationships which are deemed critical to our understanding of the growth processes which are taking place in modeling. Whereas Free's "model of the modeling process" (6) represents a "micro" viewpoint of the interactions of one modeler as an information processor, our macro approach is more future-oriented and examines the total spectrum of modelers and the demands they will impose on society as well as each other. Indeed, one of our critical assumptions is that the need for one-modeler efforts will tend to diminish in the future, as our modeling efforts take on a more holistic tone.

In examining the modeling phenomenon we have witnessed an explosive growth in modeling and simulation efforts in the past decade. To a certain extent, this has generated a "knowledge explosion" in that we now have available a literature on methodological tools such as higher level languages, statistical techniques, etc., and this in itself has made "entry" into modeling quite easy for the novice. The buildup of expertise is, in part, responsible for the more sophisticated and holistic models, where we seek to broaden our perspective in regard to the boundaries which we wish to have in our models. In essence, to comprehend

A MODEL OF THE MODELING PHENOMENON

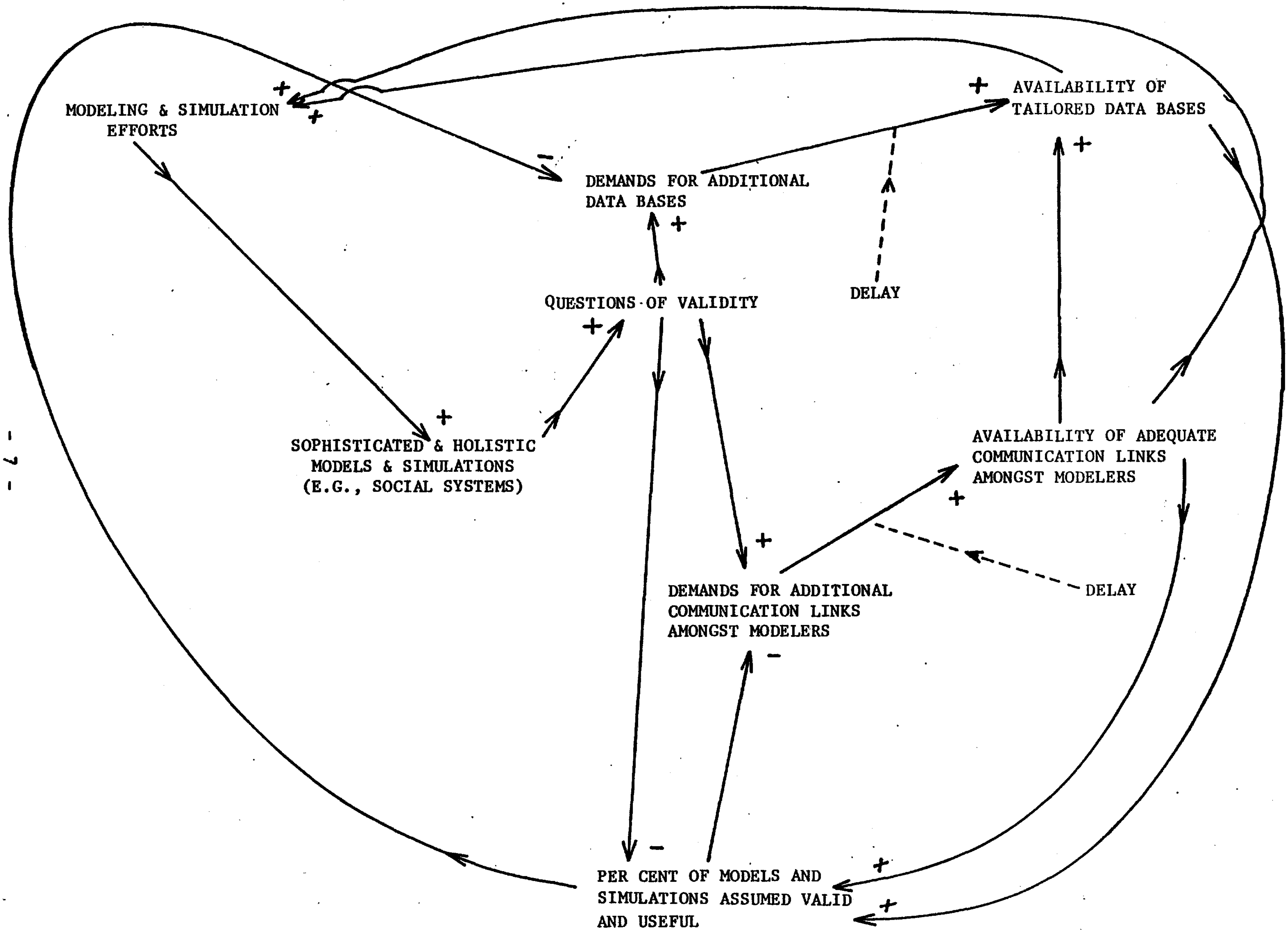


FIGURE 3.

the "gestalt" of an object system, we must have a model that relates all of the component parts, rather than looking at each part separately. The ideal example of this would be the "world models" which have been proposed in recent years since Forrester's introduction of WORLD2 (7). The overall general interest in models of social systems which currently exists is indicative of a more holistic philosophy which is pervading the field today.

As our models have become more sophisticated and holistic, we've witnessed an unusual but welcome occurrence - both modelers and nonmodelers alike are questioning the validity and credibility of the products we put forth as modelers. The world model that formed the basis for the "Limits to Growth" has found its underlying assumptions questioned by a broad range of people; every major simulation conference will have a session on model validity and credibility, and we even find modelers examining the data for a fellow-modeler's model. It should be noted that a good portion of the debate surrounding the validity and usefulness arises from a general misunderstanding of the capabilities of models of social systems. This has been pointed out by Naill (8), who depicts the goals of social systems modeling as obtaining "conditional, imprecise projections of dynamic behavior modes" such as we get when we answer the question "If corn prices are stabilized, will hog prices tend to fluctuate more or less strongly?" The "absolute, precise predictions" and conditional, precise predictions" which models of physical systems can produce "do not appear to be feasible goals for social model building." (8)

The criticisms of models that have been generated and subsequent critical reexaminations of model assumptions will, of course, lower the percentage of models and simulations that are deemed valid, credible and useful. But, more importantly, we are becoming aware of the fact that model builders should be talking to each other <u>while</u> the models are being developed, rather than <u>after</u> the model has been "completed." As we have become more holistic in our model building approach, we should be crossing several disciplines to seek the expertise necessary for comprehending the structure of a complex system. Moreover, the interdisciplinary team that we are seeking may not all be physically present at the same location, but, more likely, would be spread out geographically. Thus, the WORLD2 model was developed by a noninterdisciplinary team in Cambridge, with the work being apologetic about the degree of "aggregation" occurring in the model. But certainly, any world model should not only seek the expertise in different parts of the "world" but also the academic expertise in the different academic disciplines needed to adequately understand the structure of a world system. Thus, we are making demands for "additional communication links amongst modelers," as depicted in Figure 3.

An additional outcome of the growth in validity criticisms has been our demands for additional good data bases to be used both as input to our models as well as for verification. Meadows has stated that he had available only a fraction of a percent of the data to adequately develop his world model. In the past, we've tended to be apologetic about this, too, saying "let's model the interrelationships, and let someone else worry about building the data base," but we're beginning to realize that a model and its data are not as separable as we think they are. Thus, we are beginning to make "demands for additional data bases."

The reader will note in Figure 3 that there are present delay factors between our demands for additional data bases and communication links, and the actual attainment of these goals. It is our contention that we are, at the present time, in the midst of this delay. But, fear not, for we can see the horizon. Computerized conferencing is seen to be a mechanism by which we can link together model builders and transcend the seemingly artificial geographic and academic boundaries which heretofore have prevented the pooling of our efforts. Computerized conferencing, then, represents the "availability of adequate communication links amongst modelers." (This idea has previously been suggested by Utsumi (9) on a proposed US-Japan joint modeling simulation effort). It is an essential feature of our efforts to inject (in a "valid" and "useful" manner) the essence of gestalt in our models.

The reader will note an arc between the "availability of adequate communication links amongst modelers" and the "availability of tailored data bases." This is a subtle point, and requires some clarification. Much of the data required for a simulation or model is not what is generally considered as "hard" data, but is "soft" data, which exists in the minds of "experts" in the form of projections, probabilities, estimates, confidence limits, etc. A proscriptive method for obtaining this "soft" data base is the delphi procedure, which utilizes a structured group communication process to "extract" results. Delphi can be a laborious process when carried out in the usual paper-and-pencil fashion; however, when we utilize computerized conferencing to carry out a delphi (via the "delphi conference" (9)), a tremendous savings is exhibited in terms of cost and time. Thus, computerized conferencing may be effectively integrated into the data base development process. (Interestingly enough, the initial motivation for computerized conferencing was the development of a management information system structured as a communication process (10)).

Thus, the availability of good communication links and good data bases will positively affect the quality of the product that we as modelers send out to the marketplace. However, as alluded to previously, this part of the feedback loop is not dominant at present and, until the widespread availability of computerized conferencing becomes a reality, this feedback component will not dramatically change the quality of our product.

It is our conjecture that the current vogue in world modeling portends to become a major beneficiary in the modeling field of a viable computerized conferencing network consisting of geographically dispersed international model builders, government policy makers and analysts, data base specialists, etc. Indeed, at a recent professional society meeting, Carl Hammer concluded

> "As we perfect our growing network of computer communication systems, the density of the resultant data trail will grow beyond all imagination. Relevant data will be available as inputs to sophisticated simulation models whose outputs will aid in the search for viable alternatives and optimal solutions to many man-made problems, some of which may affect indirectly all of mankind. Efforts to build models for testing of "global" decisions, as in the "Club of Rome," can only be successful if international model-makers have access to an appropriate data base through space communications. These efforts must succeed if man is to survive - they will succeed if we have the ability to communicate." (11)

Another major application of simulation modeling which would benefit from an enhanced communications capability is the area of corporate planning models. Corporate planning models seek to depict the interrelationships among a given corporation's marketing, financial and production functions through a machine-simulation. The dramatic growth in usage of corporate planning models is evident; whereas a survey conducted in 1969 was able to identify only 63 firms which were actually using corporate planning models, Naylor (12) reports of a survey conducted in late 1974 which projects nearly 2000 firms which will either be using or developing corporate simulation models. The advent of the multinational and multidivisional corporations has generated a requirement for integrated and consolidated corporate models. This requirement is quite difficult to achieve, given our present-day temporal and spatial constraints which limit our corporate model builders and model users. Thus, we tend to find our corporate planning models as being more micro in nature, rather than having a macro orientation.

A necessary condition for the success of any corporate simulation is "well-known" to be the political support of top-level management. While valid mathematical models coupled with the "proper" computer implementations are obviously necessary for the success of corporate simulation models, it is a grave, and yet common error to feel that they are sufficient. To quote from Naylor (12, p.8): "If the president of the company or at least the vice-president of finance is not fully committed to the use of a corporate model, then the results are not likely to be taken seriously and the model will see only limited use."

It is our contention that the key to successful simulation in the corporate environment rests in the availability of adequate communication structures between the potential users (top level management) and the eager designers (corporate simulation modelers). This point is further elucidated by Maisel (13) who feels that the developers and users of corporate simulation models are naturally inclined to find themselves in adversary roles. The modelers, from their perspective, are fully convinced that their simulations are providing valid results which management ought to accept and implement, while the concern in top-level management is that they are relinquishing control of the corporation to machines that they do not quite comprehend. The obvious remedy, of course, is for corporate management to maintain a continuing dialogue with the simulation model-builders, with the dialogue initiating in the predevelopmental stages of the simulation model and continuing through the post-developmental stages. Adequate communication structures are necessary for building an atmosphere of mutual respect and confidence between model developers and manager-users. But conventional communication structures are usually not cognizant of the fact that many demands are placed on a manager's time, thus making it difficult for model builders to convene regular meetings with a management team. Computerized conferencing has the potential here, therefore, to directly involve management in the model building process through the flexibility of an asynchronous communication process which provides the convenience for management to confer with the simulation modeling group at times convenient to management. If desired, individuals from the management team could maintain a conference of their own to discuss pertinent aspects of the evolving model; moreover, they can interact in an anonymous mode, if desired. This application of computerized conferencing to augmenting the involvement of management in computer simulation model building is a prime example of the requirements imposed as to when computerized conferencing represents a "preferred" mode of communication.

With a computerized conferencing environment, therefore, we should readily be able to secure an active dialogue with management in the model building process, with the following modes

i) Dialogue before development: It is crucial that modelers obtain from management their specifications as to the kinds of information that they hope a corporate simulation model will provide. A dialogue between management people themselves as well as with the model building staff is absolutely essential here, since

a) management will often not know what information they specifically need for the decision-making process, or whether the simulation model can generate this information with the required degree of accuracy;

b) management is probably not aware of the breadth of information that could be generated by a simulation model, as well as the limitations;

c) management might be using this information to solve the wrong problem, i.e., they are moving in the direction of what Turoff and Mitroff have referred to as "an error of the third kind" (14).

ii) Dialogue during development: As envisioned by Maisel, there ought to be two kinds of briefings for management during model development: reportorial and participatory. "In a reportorial briefing, management is told of the progress of the simulation to date, accompanied perhaps by demonstrations of those components of the simulation that are functional. These briefings should be short. Participatory briefings, on the other hand, might be longer and should be given when a major problem arises in the development of the model that requires a management-level decision. The briefing should present the background leading up to the problem and the choices that are available. There should be substantial give-and-take in this kind of briefing..." (13)

iii) Dialogue after development: Corporate models are never completed in the usual sense of the term, but will be continually "fine-tuned" and expanded in the typical corporate environment. The dialogue between model builders and users should not cease after the first "success."

In addition to world modeling and corporate modeling, model builders in other fields will welcome the augmented communication capabilities provided by computerized conferencing. It is interesting to note the striking similarity between evaluators of model-building efforts in differing fields. E.R. Stoian, the Science Adviser to the Science Council of Canada, based on a comprehensive national survey of energy model building efforts, concluded:

"There is a wide gulf between policy makers and energy policy modelers... Experience shows that it is far simpler to develop an operational energy model than to understand the consequences of its application within the relevant policy environment... Common objectives and mutual support among model builders and decision makers are necessary before the potential contributions of energy models can be realized... The most startling discovery (was) in the unexpected mismatching between solution techniques and types of problems being posed." (15)

Some further perspectives on energy modeling were given by Stoian at the recent National Computer Conference's session on energy modeling. We present below some of his comments which impact our perspective on the communication structures (or the lack of them) in model building:

> "We should not dismiss lightly the idea that there is poor communication between energy model users and builders" (16, p.3)

> "First, the market mechanism, especially in the case of large-scale societal models dealing with energy, is imperfect. There are only a few buyers (e.g., Club of Rome, OPEC) and only a few big sellers (e.g., Forrester and Meadows, Mesarovic and Pestel, Hoffman, Deam). In addition, in the case of large societal models incorporating energy systems, only a few institutions have an established reputation (e.g., Massachusetts Institute of Technology, Boston; Case Western Reserve University, Cleveland, Technische Universitat, Hannover; Queen Mary College, London). At once, here we have monopoly and oligopoly.
>
> Second, because models must be "tailor made," a very special relationship must exist between model builders and model users. Not only must the users believe in the ability of the model builders to do the work effectively, but there must exist between the users and builders a kind of political, economic and social contract" (16, p. 7-8).

If there is one common theme which is prevalent in all of the model building efforts we have studied, it is the need to integrate the efforts of the policy maker, the technical expert, the informed citizen, and the model builder. Several promising communication-oriented methodologies are available for achieving this goal. The policy delphi, as evolved by Turoff (17), is a structured communication process geared towards generating opposing views on the potential resolutions of a major policy issue. It is not a decision-making tool, but rather an <u>aid</u> to the process, in the sense that its objective is to generate options and supporting evidence. The policy delphi can thus play an important role in the overall development of large modeling efforts by generating both information and involvement.

Another recent methodological breakthrough which utilizes an interaction scheme with a group of "experts" to assess the impact which the occurrence (or nonoccurrence) of one potential future event has on the occurrence (or nonoccurrence) of other potential future events is cross-impact analysis (18). The cross impact technique provides the model builder with not only the sought-after involvement of policy makers and others with "expert" judgment, but it can simultaneously provide the data base and even the structure for a model. These latter two capabilities have been effectively utilized by John Stover of the Futures Group in his development of the Probabalistic Systems Dynamics technique. PSD represents a synthesis of "traditional" systems dynamics modeling with a time-dependent version of cross-impact analysis. It enables one to model and analyze

a) The impact of event occurrences (via the cross-impact matrix) on relationships in the (Systems Dynamics) model.
b) The impact of (System Dynamics) model variables on the event probabilities (in the cross-impact model).

In Figure 4, we illustrate the conceptual features of a Probabilistic Systems Dynamics model.

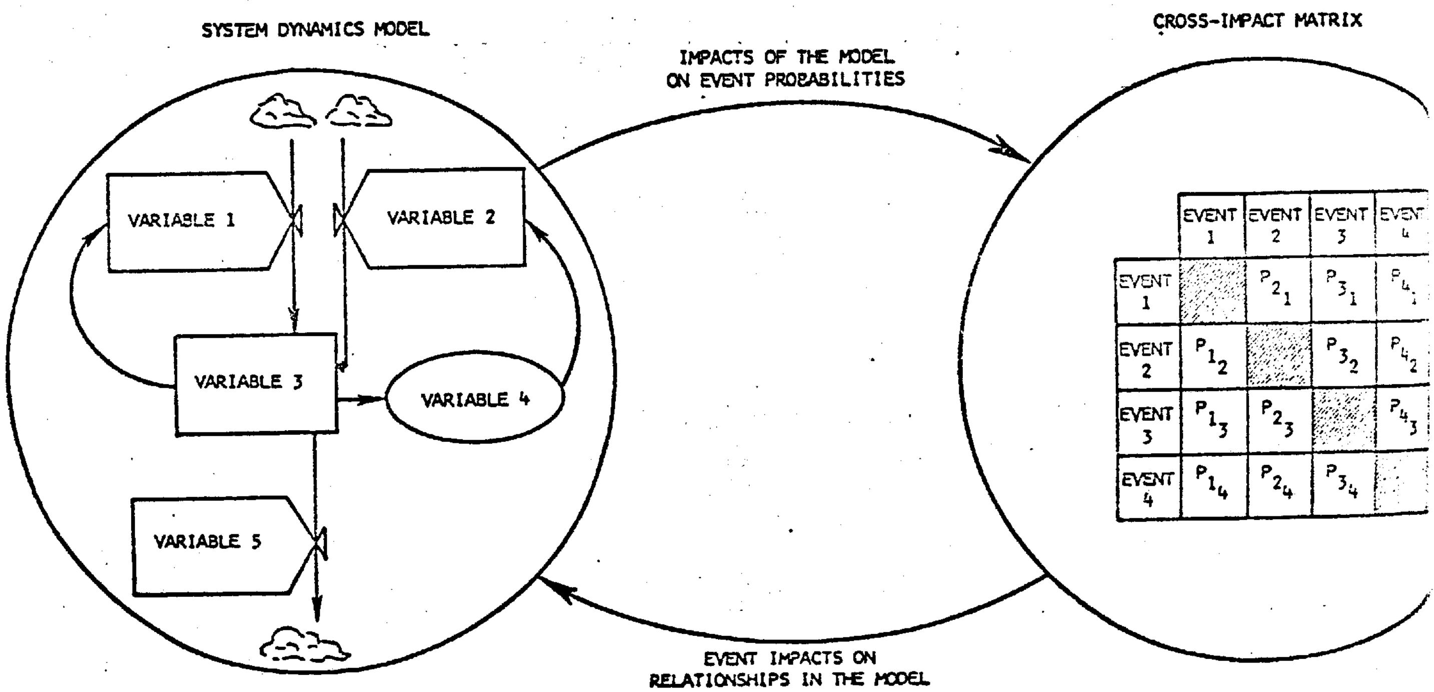


Figure 4, From (20)

PSD has been applied in the literature to models of Japanese energy policy (19), The Uruguay economy (20), and a subset of U.S. agriculture (21). The role of computerized conferencing here rests in generating the event set and aiding in the interactive generation of the cross-impact matrices.

III. THE GESTALT COMMUNICATION PROCESS

While the literature in the simulation-gaming area is quite enormous (22,23,24,25), most writers have neglected to prudently examine the communication processes that are fundamental to the play of a simulation-game.

Richard Duke, a leading simulation-game designer at the University of Michigan (designer of "METROPOLIS" and "METRO/APEX"), presents in his recent book "Gaming: The Futures Language" (26) a lucid discussion of the critical role that communication has played in the implementation and development of simulation-games. Because Duke is perhaps the only writer in the simulation-gaming field who has adopted a communication-oriented perspective for simulation-games, we shall take the liberty to reiterate several of his philosophical thoughts and ideas.

The rationale for the recent rapid growth and attractiveness of simulation-games becomes evident when we examine the object systems which the simulation-games seek to mimic. As Duke points out:

> ". . . the problems of today are more complex, involving systems and interacting subsystems that go beyond normal human ken and which do not yield to conventional jargon or traditional forms of communication" (26, p. 3).

In essence, then Duke feels that the nature of the problems which society encounters both today and in the future present challenges not only in determining solutions for these problems, but, more crucially, the actual description and comprehension of the problem is becoming exceedingly difficult when one relies solely on our ordinary communication methodologies. Thus, says Duke:

> "Because of the lack of Gestalt communication modes and therefore the lack of an integrated or holistic perspective, society's management of such complexity has consisted of four concurrent dimensions: false dichotomies, professional elitism, increasing dependency on technology, and gigantism. . . But there is hope that the possibility for a quantum jump exists -- that communication can move from its rigid and limiting sequentiality to a Gestalt mode, and that this Future's Language can be used for simultaneous translation in our modern Tower of Babel" (26, pp. 5-6).

A rationale, then, for invoking the simulation-game concept, is the notion that present language and communication forms are inadequate for the complexities we face today and tomorrow, and that the individual policy maker must initially comprehend the "whole" before the components of the "whole" may be investigated. But a difficulty presents itself here - namely, we often try to transmit gestalt images by means of sequential language descriptions of the component parts. As Duke points out,

> Sequentiality is sufficient as long as the listener can hold initial components while he receives later ones; this requires that the gestalt be simple. Because a mental holding process breaks down very quickly under the strain of today's complexity, another method of transmitting information must be developed. . . . We now need to find a vehicle of communications which better permits us to comprehend the future, and which permits more intelligent dialogue about complexity by larger percentages of mankind. . . . Gaming is a spontaneous solution. . . . to the problem of developing a

gestalt communication form - (we) have developed a new language, a form which is 'future' oriented (26, pp. 10-11).

To put simulation-gaming in its proper perspective as a mode of communication, in Figure 5 we display a communication continuum, taken from (26, p. 18). It states that, as compared to the "primitive" and "advanced" communication modes, a simulation-game is an example of an "integrated" communication mode, which seeks to convey more specialized complex messages than either the "primitive" or the "advanced" modes. It is not only more sophisticated than the "simpler" communication modes, but is viewed by Duke as being the most sophisticated of all the "integrated" communication modes for the following reasons:

(a) A simulation-game normally employs several "languages," including a game-specific language;

(b) The interaction pattern among the "communicators" is not the simple "one-way" or "two-way" communication pattern common to the "primitive" or "advanced" modes, nor the "sequential dialogue" approach which represents the pattern between a central speaker and an audience, but rather it is the uncommon, but very productive multilogue (from "multiple, simultaneous dialogue") interaction pattern, (a pattern which is essential to the simulation-games' ability to convey gestalt).

(c) A simulation-game employs interactive combinations of communication technologies.

In Figure 6, taken from Duke (26, p. 30), we present a graph of the communication continuum, displaying the functional relationships they possess with six characteristics of communication modes.

EXAMPLES		
GRUNTS HAND SIGNALS	INFORMAL	PRIMITIVE
SEMAPHORE LIGHTS FLAGS	FORMAL	PRIMITIVE
CONVERSATION LECTURE SEMINAR	SPOKEN	ADVANCED
TELEGRAM LETTER BOOK	WRITTEN	ADVANCED
MATHEMATICAL AND MUSICAL NOTATION SCHEMATICS	TECHNICAL	ADVANCED
ACTING ART ROLE PLAYING	ARTISTIC	ADVANCED
FILM TELEVISION	MULTI-MEDIA	INTEGRATED
FLOW CHART HIGHWAY MAP	FUTURE'S LANGUAGE	INTEGRATED
ICONIC MODELS ARCHITECTURAL SCALE MODEL	FUTURE'S LANGUAGE	INTEGRATED
GAMING/SIMULATION	FUTURE'S LANGUAGE	INTEGRATED

Figure 5 - From (26; p. 18)

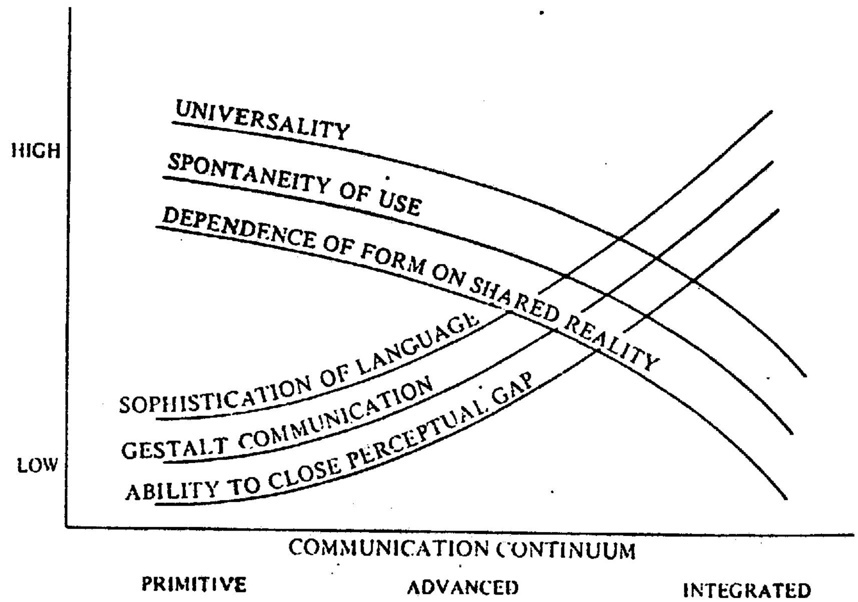


FIGURE 6
Variation of Mode Characteristics
from (26, p. 30)

A model which Duke develops to summarize the communication viewpoint of a simulation-game is presented in Figure 7. In it, the term "complex reality" refers to the interactive, dynamic object system to be studied; it is "complex" in the sense that an understanding of the component human-oriented subsystems will not provide an understanding of the whole, and thus requires a communication process capable of conveying gestalt in order to prudently define and understand the system. There do exist, however, certain "barriers" which impede our interpretation of this complex reality, and thus, after filtering through the barriers, we have a "perceived reality" of the complex system. But then, each individual will go through an internalized heuristic procedure which will subjectively structure the perceived reality into an individual conceptual map. A concept report is a written formalization of a conceptual map, and this is what the simulation-game designer uses when he constructs a game. Thus, the simulation-game structure is a formalization of the conceptual map which the simulation-game designer has of the "complex reality" of the object system.

The simulation-game permits the designer to establish a gestalt communication structure deemed necessary for the comprehension of the holistic aspects of the "complex reality." The implementation phase of the simulation-game is described by Duke as follows, (26, pp. 40-42):

> Participants are asked to identify with certain perspectives (roles) and are required to conform to certain logical constraints within that setting. Discussion of the

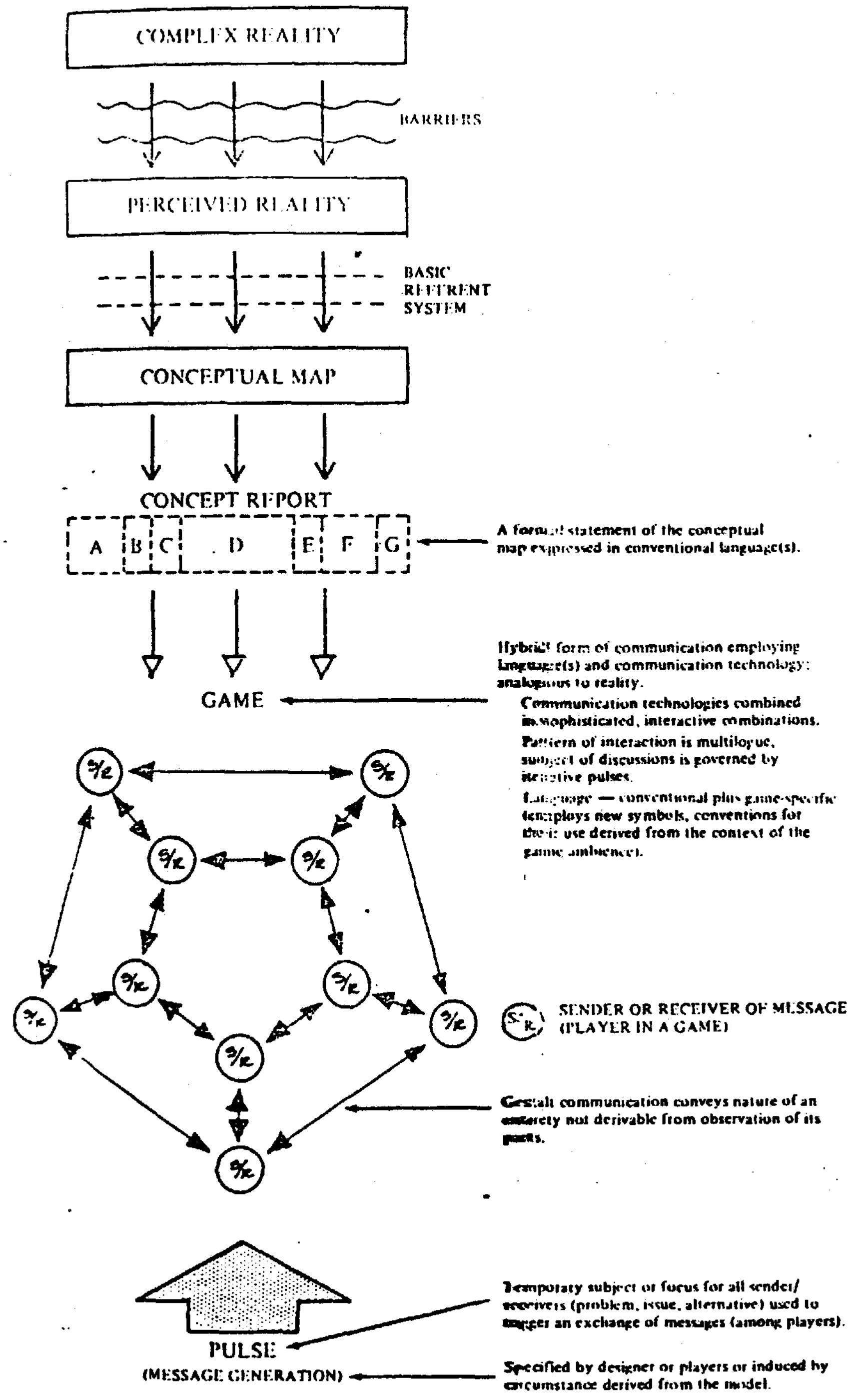


FIGURE 7

Communicating Through Gaming Simulation
from (26; p. 41)

system is prompted by the deliberate introduction of circumstances which tend to sharpen perception of dynamic relationships. A variety of events, problems or issues can be articulated, and their introduction into the gaming context (pulse) helps to focus the many discussions simultaneously underway. . . The discussions obtain their focus from both the basic model represented in the game and from the pulse, which is also a device for organizing the progress of the discussion. Because the pulse may be either prespecified or introduced as a result of participant need during play, there is considerable latitude both in setting the agenda for discussion as well as in establishing the sequence of deliberation. . . It permits and encourages a tumbling ongoing discussion among changing and unstable coalitions who come together as their ideas coincide, and as quickly break away to form new conversational units. . .; back of the room whispered sessions . . . are encouraged to form and pursue their productive course."

Once a simulation-game is developed, it should not remain a static entity, but something open for continued discussion, evaluation and change. That is, the conceptual map of the game designer, upon which the (initial) model of the simulation-game is based, should be receptive to an iterative feedback structure derived from the actual play of the game. In Figure 8 is displayed this iterative process which allows for communication not only among the players (i.e., multilogue), but also a communication structure between players and designer. To quote from Duke, (26, p. 60)

". . . during the critique, players must be encouraged to focus on the reality which the game model attempts to represent. If there are challenges by the players, these must be resolved by offering evidence to sustain the model, or through the modification of the model to more accurately reflect the new understanding of reality."

While we have considered the conceptual framework of the simulation-game process, we should also direct our attention

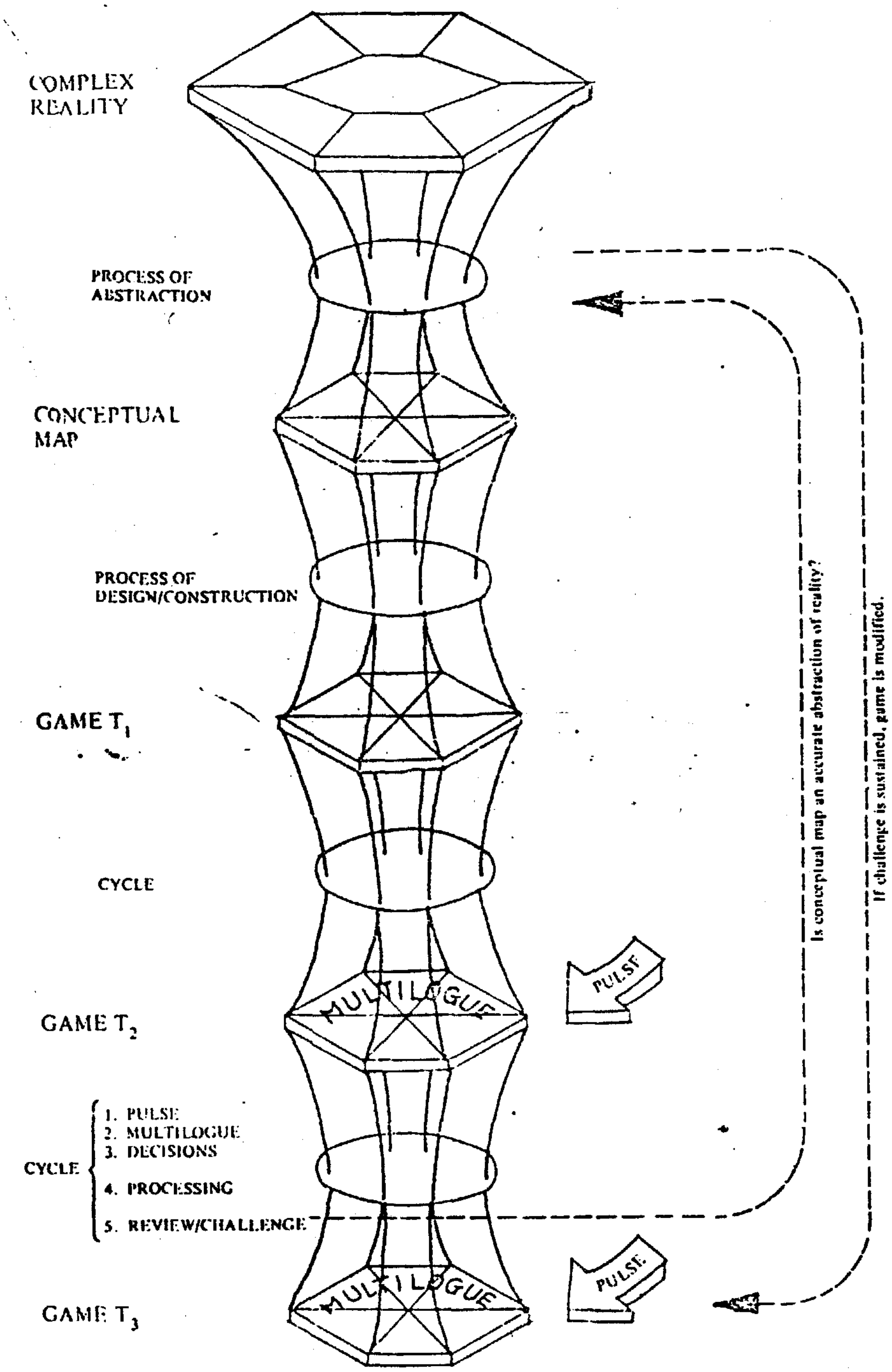


FIGURE 8
Challenging the Game Model
from (26; p. 61)

to defining some objectives which motivate a game designer. These include:

a) establishment of a dialogue to increase communication about some object system or policy analysis;

b) projection of information as pedagogical context;

c) extraction of the "conceptual map" from some group in regard to an object system (or policy evaluation);

d) establish motivation.

The above categorization is by no means mutually exclusive or independent; the objectives overlap in numerous areas, and some game designers conceivably could utilize all four objectives. Objectives (b) and (d) would normally be the objectives for a designer of educational games, while objectives (a) and (c) would be utilized in a research context.

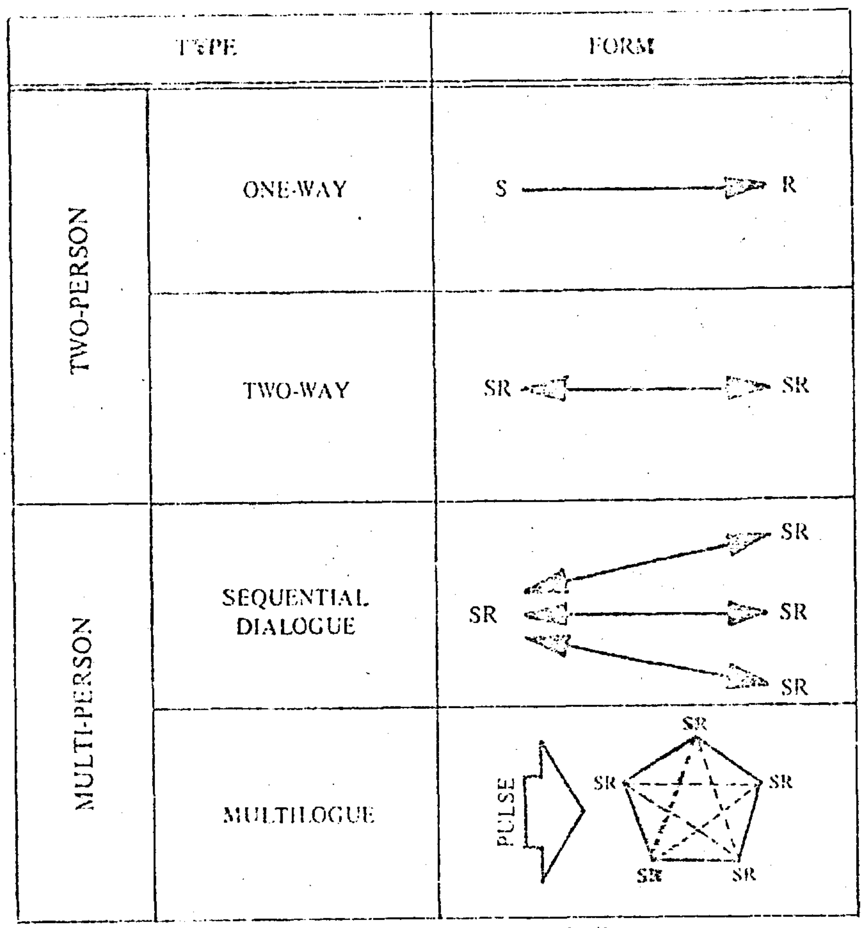
IV. POTENTIAL IMPACT OF COMPUTERIZED CONFERENCING ON SIMULATION-GAMES

If one adopts the Duke viewpoint that a simulation-game is a specialized group communication process for comprehending the gestalt of an object system, then one could infer that any technological advance which enhances the ability of a group to communicate should most favorably impact the gestalt formation. The primary interaction pattern in simulation-games is multilogue (see Figure 9), which is essential to the game's ability to display gestalt. Computerized conferencing is a communications facility which enables a group of individuals who are separated in time and/or space to communicate with each other by means of shared files from a time-sharing terminal (27). It is a fundamental hypothesis of our report that any simulation-game consisting of a high degree of multiple, simultaneous dialogue could appreciably enhance numerous features of the play of the game by imbedding the multilogue in a computerized conferencing environment. Several logistic considerations form the basis for this conclusion:

i) Participants who desire to play the simulation-game might be geographically separated, and it would not be feasible to transport them to a common location to play the game. Computerized conferencing will allow both synchronous and asynchronous remote communication capabilities.

ii) The time requirements for a large-scale simulation-game, along with the time limitations which the individual players have, require that the "simultaneity" aspect of multilogue be "modified" to allow for an asynchronous mode of communication, such as is present in current computerized conferencing systems.

iii) The nature of the multilogue process is such that, without proper planning, multiple dialogues in an existing game, might interfere with each other, raising



S = Sender, R = Receiver, SR = Sender/Receiver.

FIGURE 9

Patterns of Interaction

from (26; p. 22)

the noise factor to an unacceptable level. However, bringing the computer into the communication loop via computerized conferencing will eliminate this concern.

iv) The capability for select groups of individuals to engage in clandestine communications, a requisite structure in the modeling of numerous object systems, is most difficult to achieve when all players in a simulation-game are simultaneously present and communicating in a "game-room." Several game designers have allowed for this clandestine communication by allowing written messages to be sent between individuals by "messengers." This has proven to be a cumbersome procedure and, of course, can be readily replaced by the "private message" capability of computerized conferencing systems.

v) The lack of hard copy availability of the actual communication taking place in the multilogue implies that an individual who is "absent" (in some sense) from any portion of a cycle in the game iteration will experience difficulty in "returning" to the multilogue (even for the trivial reason of having to go to the bathroom!) The simulation-games which are of a long-term nature will be especially susceptible to this limitation. Moreover, researchers interested in the posterior analysis of the simulation-game have no access to a readable transcription of the multiple simultaneous dialogue. On the other hand, computerized conferencing automatically preserves the history of the multilogue and, coupled with a sophisticated retrieval capability, would fill the "vacuum" just described.

vi) One of the motivations of a simulation-game designer, particularly those interested in using gaming as a research tool, is the extraction of the "conceptual map" (8) from some group in regard to an object system (or policy evaluation). Gaming efforts in the past have often had to divorce themselves from attempts to obtain the "conceptual map" from some group due to both the lack of adequate methodology as well as the lack of means of implementation. Recent research efforts have brought forth several promising communication-based methodologies to quantitatively assist the simulation-game designer to extract the group "conceptual map"; these include delphi and cross-impact analysis (28) and multidimensional scaling. It is hypothesized in this report that the simulation-game designer, operating in an interactive mode via computerized conferencing, could effectively apply these three methodologies to obtain the desired "conceptual map." This is of paramount import if the simulation-game is to be utilized as an effective research tool or as a meaningful decision analysis tool. The "conceptual map" is needed to truly determine why certain outcomes occurred. This is an integral part of the "post-mortem" phase of a simulation-game.

vii) The development of excellence in the simulation-gaming area is, for each game, an evolutionary process which requires that a communication structure be established between players and game-designers. In numerous past simulation-gaming efforts, this structure has not been effectively allowed for and, in some cases, virtually ignored altogether. It is a recommendation of this paper that all computerized conferencing based simulation-games establish a two-way communication structure from each individual player to the game designer, and that this communication structure be in effect not only during the "critique phase", but throughout the simulation-game.

We previously stated that multilogue is the primary interaction pattern in a simulation-game, a technique central to the game's ability to display gestalt. Let us now reexamine the concept of the multilogue process. From the Duke viewpoint, multilogue implies (for several groups) that the individuals within a group are communicating with each other, and this communication process is taking place simultaneously within all the groups.* Within each group, at a given instant of time, the group boundaries are fixed (however, during the course of the simulation-game, it is possible that groups will merge into larger groups, or subdivide into smaller groups). We refer to this type of communication as <u>group multilogue</u>.

As soon as we introduce the computer into the communications loop via computerized conferencing, a new dimension is added to the multilogue process. Group boundaries are no longer

*It is entirely possible, of course, that a "spokesman" for one group may communicate with another group (or a "spokesman" for another group).

fixed in the sense that they were with the multilogue; an individual may simultaneously be a member of several groups, and be communicating "simultaneously" with different members in different groups. We thus see that computerized conferencing provides for a unique communication structure that we shall refer to as insilogue (from individual simultaneous dialogue). It realistically reflects the real world status, since humans are normally members of numerous distinct communication structures.

The Simulation-Game as a Research Tool

We do not view a simulation-game as something which can "predict" single events or "outcomes" of processes. They can, however, generate understanding of a human interaction system's behavior--it can tell us about how the relationships among various states of a system might change under given conditions. For instance, we might develop some interesting relationships between frequency-of-communication and level-of-trust, or about the impact of power on coalition formation. These findings can serve as the basis for a new set of assumptions for a simulation-game, which can in turn be used to test the validity of these findings. Thus, we shall be able to evolve and test social science-type theory at the level where most of the theory has been postulated--namely, that of group processes and human interaction behavior. This point has been elucidated by Raser (29, p. 86):

> The experimenter can test hypotheses to gain information about the changes in a system under 'given conditions' in two ways. He can establish his starting conditions, specifying the parameters of the independent variable(s) in which he is interested--for instance, 'personality traits'--and let the system 'run'. Or, he can establish his starting conditions, let the system run for a while, and then introduce the independent variable--a new condition--by intervening either through an accomplice or in a way appropriate to the scenario of the game. After the system has run for a time under the particular condition of interest, that condition can be removed in the same way it was introduced. Since the state of the system can be periodically assessed, it is possible to tap into the processes set in motion by a given condition, and learn something about its impact on other systems variables.

Zuckerman and Horn (30), in compiling their anthology of several hundred simulation-games, categorize the communication processes found in simulation-games as including (from a macro top-down viewpoint) bargaining, negotiation, persuasion, debate, deceit, clandestine dealings, coalition-forming, interteam cooperation, intrateam cooperation, etc. Computerized conferencing is in an outstanding position to support each of these communication functions, through its

--private message capability (to aid in secret deals, coalition-formation, etc.)

--public message capability (such as using a "world newspaper" as a means of persuasion)

--written proceedings of past communication (useful in negotiations)

--capability for anonymity (useful in deceit)

Moreover, in a research environment, one might wish to study the communication features of the processes we call bargaining, negotiation, persuasion, deceit, etc. From Zuckerman-Horn, we have a classification scheme which categorizes the intent of a communication transaction between two or more individuals. This can be coupled with the micro level classification scheme of Bales (31, 32) for the intent of phrase or sentence analysis; the Bales approach describes the functional interactions amongst humans communicating by classifying the individual statements made as to the communication or information function served. Together, both of the preceding categorizations may be combined to form a matrix classification scheme into which individual statements may be classified; this would thereby provide the analytical framework for (comparative) evaluation of the communication patterns occurring in a simulation-game.

It should also be clear that each of the two classification schemes contain implications on the potential design range of communication characteristics for the conferencing-based simulation-game. The designer and the particular simulation-game will strongly influence the communication characteristics to be made available for the Zuckerman-Horn-type categorizations, while the design considerations associated with the Bales scheme should be fairly standard regardless of the particular simulation-game.

The resulting matrix of taking one of the above for rows and the other for columns would provide a classification scheme that could very well shed significant insight to the sociological processes that occur in simulation games. It is only when the communications are captured electronically as in computerized conferencing that potential investigations of this sort become feasible to consider. In normal experimental environments just implementing the Bales Interaction Process Analysis alone evolves into a laborious task in record-keeping.

V. CURRENT WORK IN USING COMPUTER COMMUNICATIONS IN SIMULATION-GAMES

In this section, we shall report on three major efforts to incorporate computerized conferencing methodology in the implementation phase of a simulation-game (a less publicized early effort by Shure (33) with team-to-team communication on a System Development Corporation's Q-32 computer in a bargaining and negotiation simulation-game is not described here). It is interesting to note that one of the efforts "fell in" to a simplified form of computerized conferencing (really message-switching) as a necessary facility for handling the huge amount of communications that the implementation of the particular simulation-game required, and this was achieved after close to five years of an elaborate scheme involving handwritten messages, "Xerox" duplication, tape recordings, human observers, and human messengers to transfer interteam communications. The other efforts to be described were developed with the prime consideration of utilizing computerized conferencing as the essential mode of interteam communication.

The POLEX (acronym for political-exercise) is a technique developed by L. Bloomfield and his associates at the MIT Center for International Studies which utilized a free-form "man-simulation" to "educate policy analysts by projecting international situations that otherwise might not be considered, and to expose diplomats and others to roles their own experience might not otherwise fully comprehend". (34, p. 1009). It is actually an outgrowth of both the war-games first experimented with at the RAND Corporation in the early 1950's and also the very successful

"Inter-Nation Simulation" developed by H. Gu̓etzkow (35) in the early 1960's. The POLEX efforts have been devoted primarily to utilizing the simulation-game as a quasi-research tool in the area of policy planning and analysis. (This is in contrast to the viewpoint of P. deLeon (36, pp. 42-43) of the RAND Graduate Institute for Policy Studies, who views the gaming efforts of Bloomfield as "sensitizing" devices for actual or potential decision makers.) The players in these "political military" exercises are usually senior officials and policy analysts from government, members of Congress, specialists from the academic sector, all of whom assumed the roles (in several teams) of top-level government officials representing the United States and other countries. The research interest of the Bloomfield group was centered in the area of U.S. foreign policy planning and analysis; in particular, a major concern dealt with policy relating to the effects of arms transfers to countries in "low intensity" conflicts in different parts of the world and the resultant probability of direct U.S. involvement. A related concern was: "the possible correlation between decision-making style and U.S. foreign policy choices" (37, p. 3). The particular simulation-games developed would expose the players to "hypothetical situations in which pressures for and against U.S. military intervention were experimentally generated", (13, p. 1012). In terms of the impact on the individual players, the simulation-games not only broadened their concepts for alternatives in strategies and policies available to the United States in international crisis situations, but also forced the individual to reassess their individual policy assumptions by forcing them to deal realistically with a simulated environment not of their own choosing (see (38) for a post-game survey confirming these viewpoints).

The culmination of the effect of the Bloomfield group was a series of four simulation-games--CONEX I,CONEX II, CONEX III and CONEX IV, dealing with different crises in the international area. The general format of the CONEX games has consisted of two or more teams role-playing the governments of countries in a more or less adversary position, plus a managing "Control Group" which provided:

> updates of scenario specifying the synthesized 'results' of team interactions; means of communicating the actions of one team to others; means of conveying to the teams the behavior of other elements in the system that impinged on their initiations; a mechanism for administrative control and support appropriate for the size, duration and objectives of the particular exercise; and a system for evaluating and/or observing performance, consonant with parameters of the research design". (34, p. 1014).

Since the objective of the research was U.S. foreign policy analysis, one of the two or more teams in the game would always represent the United States; in particular, the players in the U.S. team had roles on the level of the National Security Council. Moreover, in three of the four CONEX games, there were, unknown to each other, two U.S. teams, both given identical information to respond to, but with a significant variable manipulated for one team (this permitted an elementary behavior analysis based on this one critical variable).

In Figure 10, we present the communication flow patterns for some of the CONEX games. It should be noted that there were more "national" and "international" actors than actually exhibited, because inside "Control" were one- or two-man "subteams" engaged in a "modified" form of role-playing, representing (as for instance, in Figure 11, the U.N., China, the USSR, Pakistan, U.S. Public Opinion and Congress. Figure 12 presents the logistic arrangement of a particular CONEX game.

This impetus "pulse" to inititate action in the game is a "scenario-problem"--a document of up to a dozen pages in which a hypothetical but plausible series of events is presented in detail to the game players. (In CONEX I, it was an overthrow of a government in a Central American country). This initiates the game, and remains the basis for intra and interteam interaction (as well as interaction with the Control Group and its subteams) for however long the game lasts. It should be noted that in this game there is no "winner" in the conventional sense--the objective is solely to study foreign policy planning and analysis.

In CONEX IV, the role players were, as depicted in Figure 11, two U.S. teams (working, as mentioned, independently of one another), a team representing India, and various control "subteams." In the initial scenario presented to all teams, India was faced with an incipient internal crisis in West Bengal and Nagaland, and there was the possibility that China and/or Pakistan would attempt to exploit the internal Indian problems by military intervention. The U.S.S.R. was positioned to provide economic and military assistance to India when requested. The initial scenario viewed the U.S. in a neutral role between India and

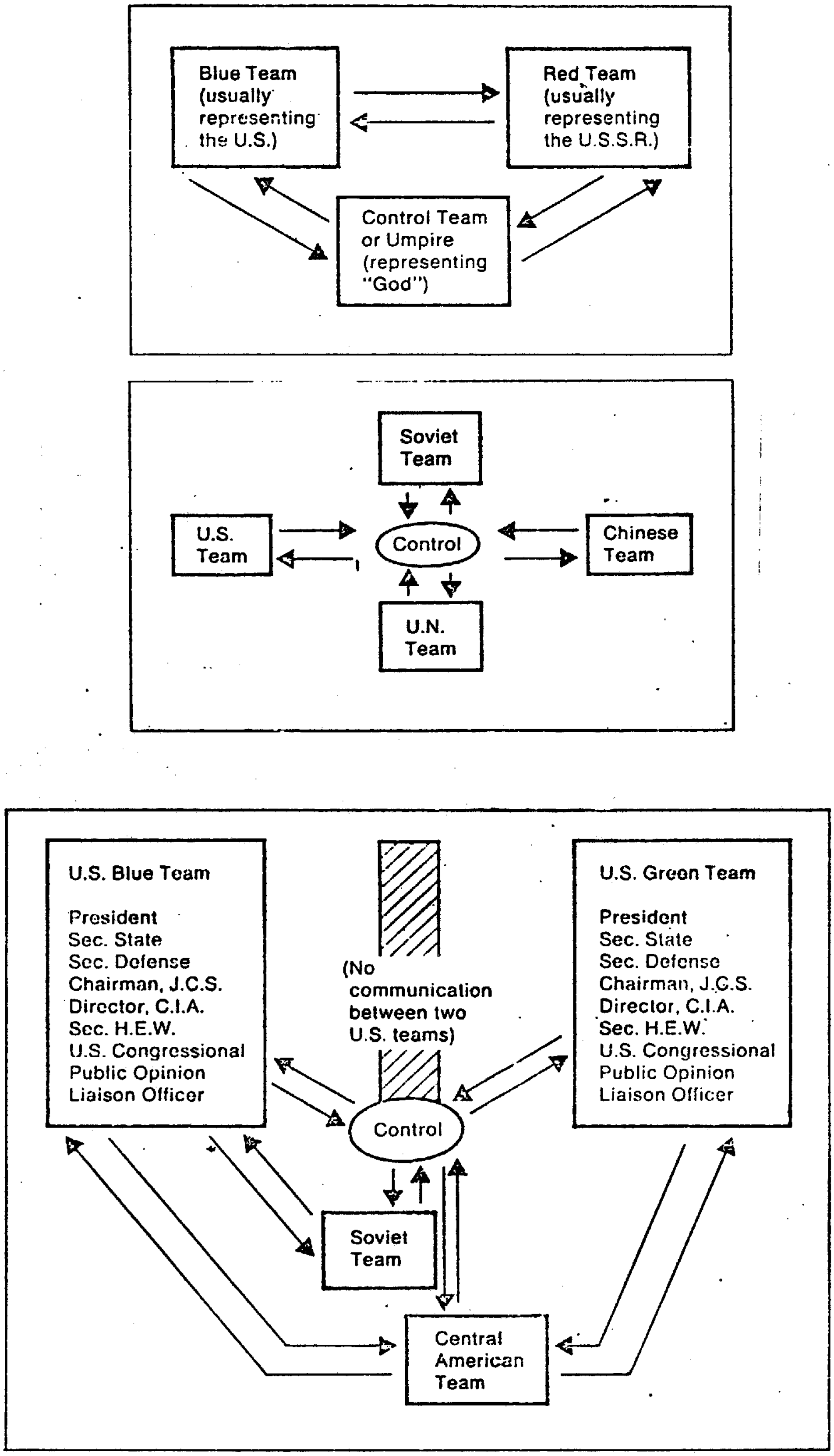


Figure 10 (from 37; pp. 4 and 6)

Communication Flow Patterns in CONEX games

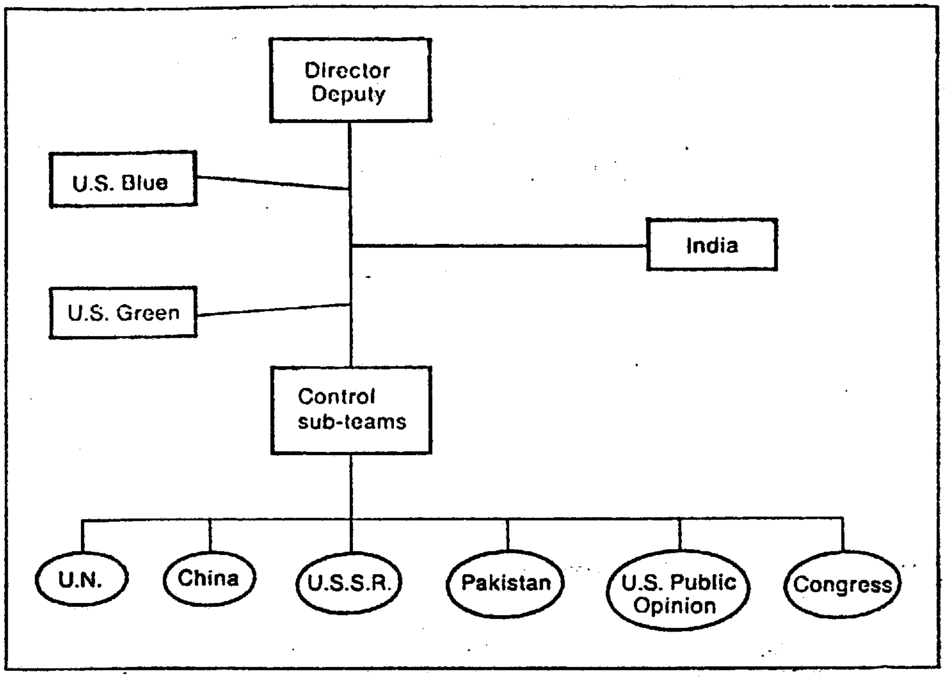


Figure 11, from (37; p. 7)

Communication Flow Pattern in CONEX IV

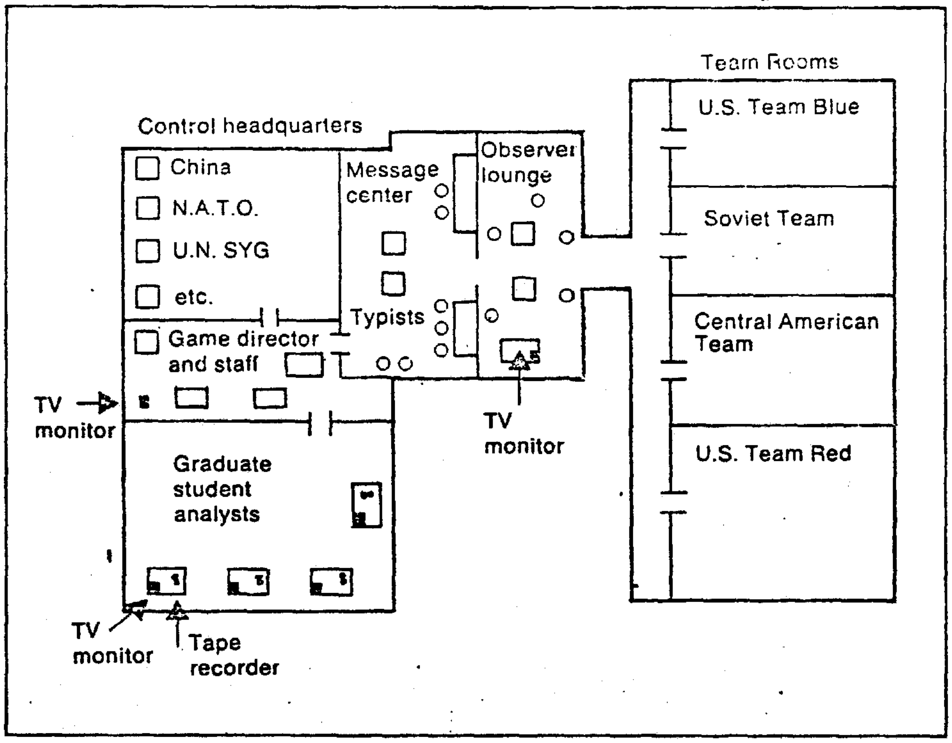


Figure 12 - from (37; p. 6)

Communication Logistic Arrangements

For a CONEX Game

Pakistan, but adamantly opposed to any overt Chinese aggression. In successive iterations, "Control" provided updated scenarios which were meant to gradually increase the probability of military intervention by China and/or Pakistan in India, with the objective of ascertaining whether U.S. willingness to intervene was a function of the intensity of the dispute.

Let us now turn to the communication processes invoked by the CONEX games. A typical game consisted of four iterations spread out over a two-day period. After an initial introduction to the selected scenario, each team would meet for an hour and a half to determine a general strategy. Each team would then give an oral summary of its policy decisions, which would be observed on closed-circuit television by the control team. The control team would then create an updated version of the scenario which reflected the results of the interaction between the teams' strategies. The updated scenarios would then go back to the teams, which reacted again with a policy formulation. All intrateam discussions were monitored via closed-circuit television in an effort to identify the most influential factors involved in the decisions. Messages could be sent from one team to another (through the Control Group). Human monitors were assigned to observe each team; their task involved the completion of a questionnaire each time a team member advocated a specific policy objective. These coded forms were used to judge the shifts in team attitudes from one period to the next. Tape recordings were also used to preserve intrateam discussions; commenting on their close monitoring of the communications processes, Bloomfield and Gearin state:

". . .between the independent variables fed into the 'black box' of the team decisional process, and the dependent variable of policy outcome, lie intervening variables that link the two, but which generally are taken on faith. To analyze and reassure them requires systematic observation of individual and team behavior. . . The closed circuit television and tape-recording systems conferred several benefits that fully justified the costs. Team discussions were not interrupted by visitors or staff members. Control could monitor discussions and anticipate questions or judge reaction to input; e.g., when a Control expert dispatched a message depicting increased "Soviet" activity, he could observe team reaction and decide whether his message had been correctly perceived. Control also monitored oral briefings of team strategy that were presented on a staggered schedule prior to drafting the basic move period paper, thereby permitting the Control staff to begin work on its scenario projection for the next period while the teams completed their work. The collection of data was enhanced by isolating the observers from players and other distractions. Their ability to follow the discussions enabled them to contribute to scenario projections and post-exercise critique sessions. The tape recordings of team discussions also provide a source of data for other types of analysis, e.g., content or transaction analysis of policy discussions that might be accomplished independently of CONEX." (34, p. 1023-1024).

It should be noted that a limited amount of face-to-face contact between opposing teams or between a team and Control staff was permitted under special circumstances--it was, however, deliberately minimized to avoid lengthy discussions as well as to capitalize on written documents for post-game analysis. Controlled face-to-face communication, on a limited scale:

"tempered the impersonality of written exchanges. . . and reduced frustration attributable to the games' common suspicion that a malevolent and insensitive Control has preordered all outcomes. Above all, it enables a substantial increase in the number of steps that can be taken by teams during a single move period by not requiring that a crucial question and answer be delayed until the next move period" (34, p. 1025).

"Intergroup communications is a vexing problem in any interactive game involving large numbers of people," write Bloomfield and Gearin (34). An examination of the message handling mechanisms in CONEX I, II and III convinced Bloomfield that his "manual" communications system which consisted of typists, messengers, machine operators and file clerks who saw to it that all messages (one hundred or more) were typed, reproduced with up to 50 or 60 copies and distributed by messenger to members of the playing teams and the Control staff, had reached a point where the team interaction was becoming adversely affected by the logistics of this communication mechanism. Thus, in CONEX IV, a computerized message switching system was developed by G. Moulton at MIT which utilized "a shared time computer (MIT Compatible Time Sharing System) to transmit, store and reproduce messages" (34, p. 1024). The Moulton system would allow a message to be sent to any combination of individuals. "The program was designed to preclude inadvertent transmission of messages between U.S. teams and to provide for storing the message until the addresses' console was free, and then transmitting" (37, p. 11). All messages that were transmitted to teams were also transmitted to the Control Director, who utilized the information, as before, to prepare updated scenarios. Obviously quite pleased with its performance, Bloomfield writes, "The system functioned well and has excellent potential for expediting game communications. . .The benefits derived from high-speed message handling are increased interaction, transmission reliability, reduced administrative requirements, and accurate recored-keeping" (37, p. 11 and 34, p. 1024).

Before we leave the work of Bloomfield, two issues bear comment. The first deals with the impact computer communication has on the basic taxonomy presented in Chapter I. Some observers might claim that the introduction of the computer into the "man-simulation" implies that we are now dealing with something resembling the hybrid "man-machine" simulation. Indeed, by deLeons' view of a free-form political/military game as being "played strictly between the respective teams (i.e., there is no machine or computer interaction built into the game structure)," (36, p. 41), a casual observer might (mistakenly) feel that the "free-form" structure has been tampered with. It is our contention that we may still have a man-simulation of the "free-form" variety, if the computer is being used solely as a mechanism for facilitating the communication processes, and does not enter as a factor in the "man-oriented" decision-making functions in the game, which are still completely in the hands of the individual teams as well as the Control team. The "interaction" that deLeon refers to, will, after close examination, be seen to suggest "interaction with a model," which, of course, is not the state of affairs when we introduce the computer into the communications loop. However, by pre-programming some human decisions and/or the actions of the Control team, we would then have a man-machine simulation-game.

In particular, those simulation-games which utilize asynchronous communications would probably wish to simulate many (if not all) of the features of a game-control-staff in the form of some intelligent programs. A unique opportunity could develop here in fostering the relationships between AI (Artificial Intelligence) workers and simulation-game designers.

Another issue that we address concerns the difficulties and intrepidations which Bloomfield has in the "iterative" scenario redevelopment scheme used in CONEX:

> "So long as teams are permitted to interact dynamically with the scenario, and with one another's strategy, conditions may be generated in the game that were not in the design plan. Even if the Control group limits itself to implementing its own agreed and previously calibrated game research design (as essayed in CONEX), the interacting teams may move the game away from that design. The price of keeping that from happening may in turn be to undercut the dynamic role-playing process which models the reality one seeks to capture" (34, p. 103).

The point by Bloomfield is indeed critical; deLeon, in his work on scenario design (36), agrees that the conceptual design of the scenario is the primary tool for team involvement in the game, but he provides little insight into the vexing problem of scenario update composition under time-constrained conditions. It is our contention that if CONEX and other free-form "political-military exercises" were to utilize computerized conferencing in the communication process, then the simultaneous "on-line" type requirement would disappear, and the Control group would be given a more adequate amount of time to assess the messages received from individual teams and synthesize them into revised scenario designs. (We remind the reader that CONEX was held for two consecutive days, and the rigid structure imposed required that the Control group perform the message analysis and scenario update in a one to two hour period). In addition, this would also reflect a more real world mode of operation for the game.

THE POLIS SYSTEM OF R. NOEL

The most successful application of computerized conferencing to the enhancement of the simulation-gaming environment has been the POLIS network developed by R. Noel and his associates at the University of California at Santa Barbara. Noel credits his successful implementation of the computerized conferencing concept to his earlier association with G. Shure at Systems Development Corporation, where a prototype software package for real time, terminal to terminal communications supporting in-house diplomatic gaming experiments was developed in 1968. The overall architecture of the POLIS system allows one to support numerous information management and communication capabilities; it does not limit itself to merely the support of communication among participants, but also provides the "apparatus" for interaction between participants and computer simulation-models. Thus, it is a system which is as equally adaptable to a man-simulation as it is to a man-machine simulation.

It was Noel's judgment that most prior man-simulations in the social sciences had relied too heavily on oral face to face communications among the participants. Speaking before the 1971 Annual Meeting of the American Political Science Association, Noel states:

> "All too often the impulsive utterances of individuals are substituted for carefully prepared statements emanating in reality from complex political and social organizations. . . . In face to face meetings, group dynamics usually

prevail to the exclusion of structured social and political interactions. Communications by way of public media, (e.g., 'trial baloons'), third party communications, and the use of emissaries are means which tend to be neglected in many gaming exercises. In sum, it is our belief that the subset of political and social communications processes which may be simulated through written communications is substantial both in scope and in theoretical significance" (39, pp. 3-4).

Speaking before the same group two years later, Noel reaffirms his earlier convictions:

"For educational purposes in political science, and perhaps for many research purposes as well, there is reason to suspect that the uncritical acceptance of face to face interaction can be both seductive and unproductive. On more than a few occasions one witnesses a tendency to mistake unstructured small group processes for complex political processes, to confuse style for substance, and to accept animated spontaneity as evidence for intellectuality.

These tendencies may be understandable. In comparison to the hustle and bustle of face to face interaction in the game room, a group of students sitting alone with their writing and their thoughts may appear dull indeed. In a sense, interaction is the only action; but this is an artifact of the observational method. It is difficult to distinguish idleness from thoughtfulness, doodling from drafting. It is understandable too that undergraduate participants seem naturally to thrive on face to face encounters. The informal small group is their natural habitat. . . . They are often impatient with having to formulate their positions in advance and to set their statements to writing. True, it is a great deal easier to run an exercise with unrestricted face to face communications; the burden of managing volumes of handwritten messages, etc., can be overwhelming. But to allow students to conclude, tacitly, that most political communication - especially in international relations - is comparable to a 'rap session,' is surely to err in the direction of oversimplification" (40, pp. 9-10; our underlining).

A valuable side-benefit of the work of Noel has been his preliminary development of a taxonomy for the communication patterns found in the design of various simulation-games. This taxonomy plays a crucial role in the specification of functional requirements when we imbed computerized conferencing in simulation-games. The patterns which Noel enumerates are (41):

1. Direct, Unmonitored Communications
2. Direct, Monitored Communications
3. Direct, Umpired Communications
4. Indirect, Umpired Communications

In Figure 13, are portrayed the various communication patterns that Noel envisions. The simple mode of direct unmonitored communication allows different teams to exchange messages with each other directly, constrained only by the rules of the particular simulation game. There are actually two types of interaction considered here: synchronous and asynchronous. The customary synchronous communication requires real time conversational interaction, thus necessitating that all teams be available for a single "sitting." Asynchronous interaction, however, will provide greater flexibility in the scheduling of gaming sessions, although it has the possible disadvantage of slowing the tempo of games in which a quick tempo is desired. The POLIS system allows for asynchronous communication through a simplistic "inbasket-outbasket" structure. When a user at a terminal wishes to communicate with another player, he requests that a message he types be placed in his "OUTBASKET," where it is then routed to an intervening file structure where it is held in abeyance until its "addressee" makes an "INBASKET" request, at which time the message is printed on the addressees' terminal.

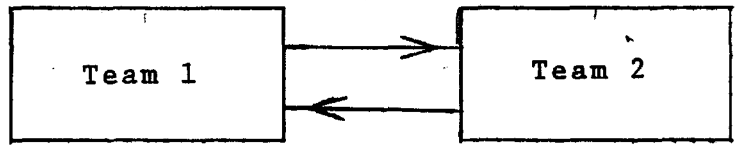


Fig. 13a: Direct, unmonitored communication between 2 players (teams)

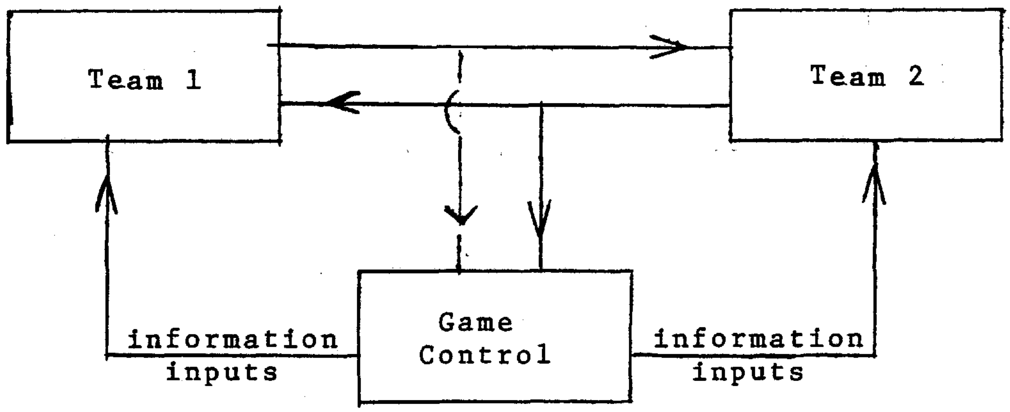


Fig. 13b: Direct, monitored communication between 2 players (teams)

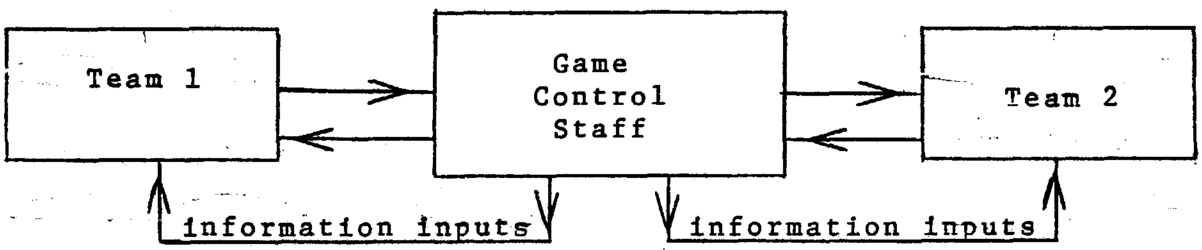


Fig. 13c: Direct, umpired communication between 2 players (teams)

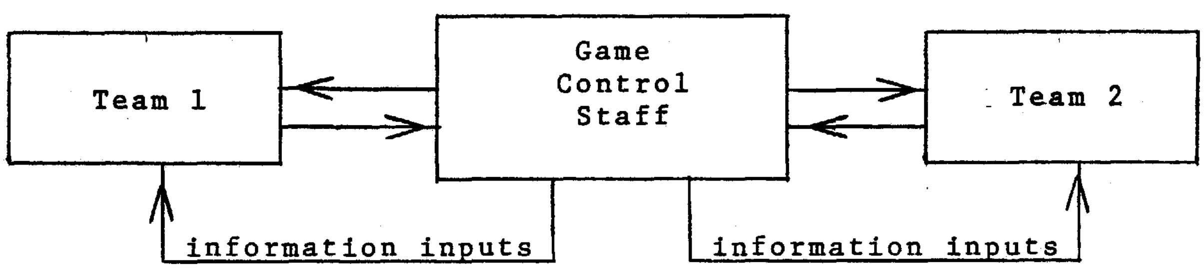


Fig. 13d: Indirect, umpired communication between 2 players (teams)

NOTE: What distinguishes Figure 13c from Figure 13d is the direction of the horizontal arrows; in the latter, there is no direct communication between teams (i.e., teams submit position papers to the Game Control Staff) while the former does permit communication between teams via an <u>active</u> Game Control Staff, which has the power to "alter" messages.

A more sophisticated communication pattern is presented in Figure 13b. Direct monitored communication implies a new element in the communication link - a "game control" staff. The game control staff will not only monitor the communication interaction but will also initiate the input of certain information to the participants. This type of communication pattern was used, for example, by Guetzkow in the Inter-Nation Simulation (35); control would "read" all inter-nation messages and then would provide the role-players with a "world newspaper."

What distinguishes the direct monitored communication pattern from the direct umpired communication pattern is the fact that in the former, the role of control is relatively passive, with no intervention in the inter-team message flow, while the latter implies a more active role for control, with the capability to intercept information flows between teams and acting upon them. The actions might include:

- rejection of the message;
- acceptance of the message, and subsequent transfer to the addresses;
- editing the message prior to transfer.

The last type of communicaton pattern envisioned by Noel is the indirect, umpired structure (Figure 13d). This pattern is characterized by no <u>direct</u> communication between the differing teams. Each team, in this structure, submits position papers and "moves" to the Game Control Staff, which in turn prepares "scenario updates" which are returned to the individual "teams."

An example of this type of communication structure would be some of the early political-military exercises that originated at the RAND Corporation.

A message-handler module of the POLIS system, utilizing the "INBASKET-OUTBASKET" approach discussed previously, allows one to implement the simulation-game communications, envisioned by Noel. The message-handler module allows messages to be communicated in (42):

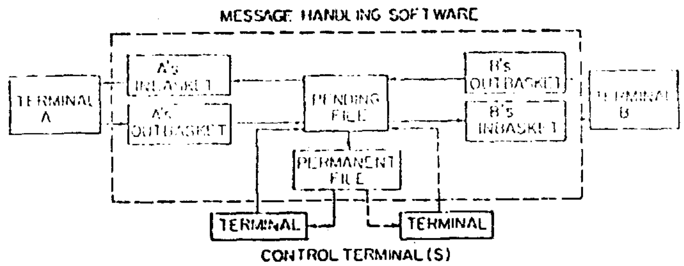
i) a "manual intercept" mode, where messages from an "OUTBASKET" are stored in a "pending file" until acted upon by a "control terminal" after which they are forwarded (or deleted, or edited) to another team's INBASKET (Figure 14),

ii) an "automatic mode" where messages are routed to their destinations without being "intercepted" by control terminals (Figure 15);

iii) a "mixed mode," which allows, within a single simulation-game, certain sets of teams to communicate with each other with the message handler in the "manual intercept" mode, while other sets of teams communicate with the message-handler module in the "automatic" mode.

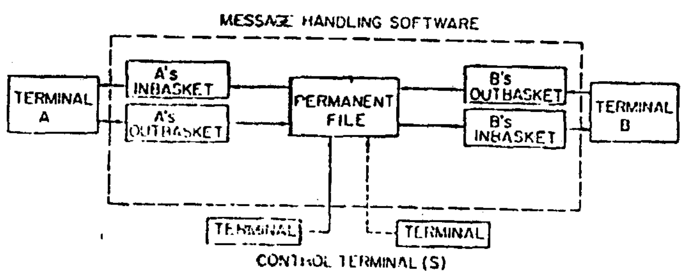
It should be noted that all messages are entered into a permanent game file automatically as they are handled. Numerous data management aids are also available in the implementation and analysis of a simulation-game.

The POLIS system has been used to develop inter-university gaming in international relations and foreign policy. Initially confined to universities within the State of California, this was later expanded to include institutions across the country



Message-handling: Manual intercept mode

Figure 14
from (42; p. 898)



Message-handling: Automatic mode

Figure 15
from (42; p. 898)

(unfortunately, budgeting limitations have forced the Noel group to suspend their interface with ARPA, and so the 1975-1976 POLIS exercises are again confined solely to institutions within California). At some participating institutions, regular courses in international relations and foreign policy have been organized around a POLIS simulation-game; at other institutions, they have been used to supplement and "enrich" existing courses as well as to support specialized independent studies courses . Noel reports (40, p. 3) that recent POLIS exercises ran over a four-week period with daily interaction among the teams (about an hour and a half a day).

The IFF Experiments with Conferencing Based Simulation-Games

We conclude this section with a discussion of some reported experimental results in adapting existing simulation-games to a computerized conferencing environment. The Institute for the Future research group has developed a taxonomy for the classification of computerized conferencing "style"; the group views the simulation-game as an example of the "Encounter" style, which is depicted as representing:

> "... the closest computer analog of a face to face meeting, in which participants are synchronously discussing a topic for a short time (usually a few hours), possible with role assignments among the participants (as in simulation and gaming) and with some degree of intensity." (43, p. 15, our underlining).

While the particular simulation-games studied by IFF belonged to an "Encounter" style, this should not be misconstrued as implying that _all_ simulation-games should fall into the "Encounter" style when implemented in a computerized conferencing environment; indeed, it is entirely possible that a particular conferencing-based simulation-game could possess characteristics of any or all five "styles" presented in the IFF taxonomy (i.e., the "notepad," the "seminar," the "assembly," the "encounter" and the "questionnaire").

The Vallee-Johansen group at IFF performed a total of three simulation-games via computerized conferencing. The first game was entitled, "Freeway Planning" and was a "debate" among role-players at a simulated planning commission meeting to discuss alternative options for designing a freeway on the map in Figure 16 (the freeway running from north to south). The value of each "cell" on this map was, for each role player, a function of its support or nonsupport based on the role-player's constituency.

The IFF group acknowledged that, after initiating this particular conference, logistics problems created by the lack of a common visual space (which would foster discussion of alternative freeway designs amongst the role-players) forced them to curtail effective play of this game. A conclusion that we may infer from this particular experiment is that if we wish to adapt several of the existing "board-type" simulation-games,

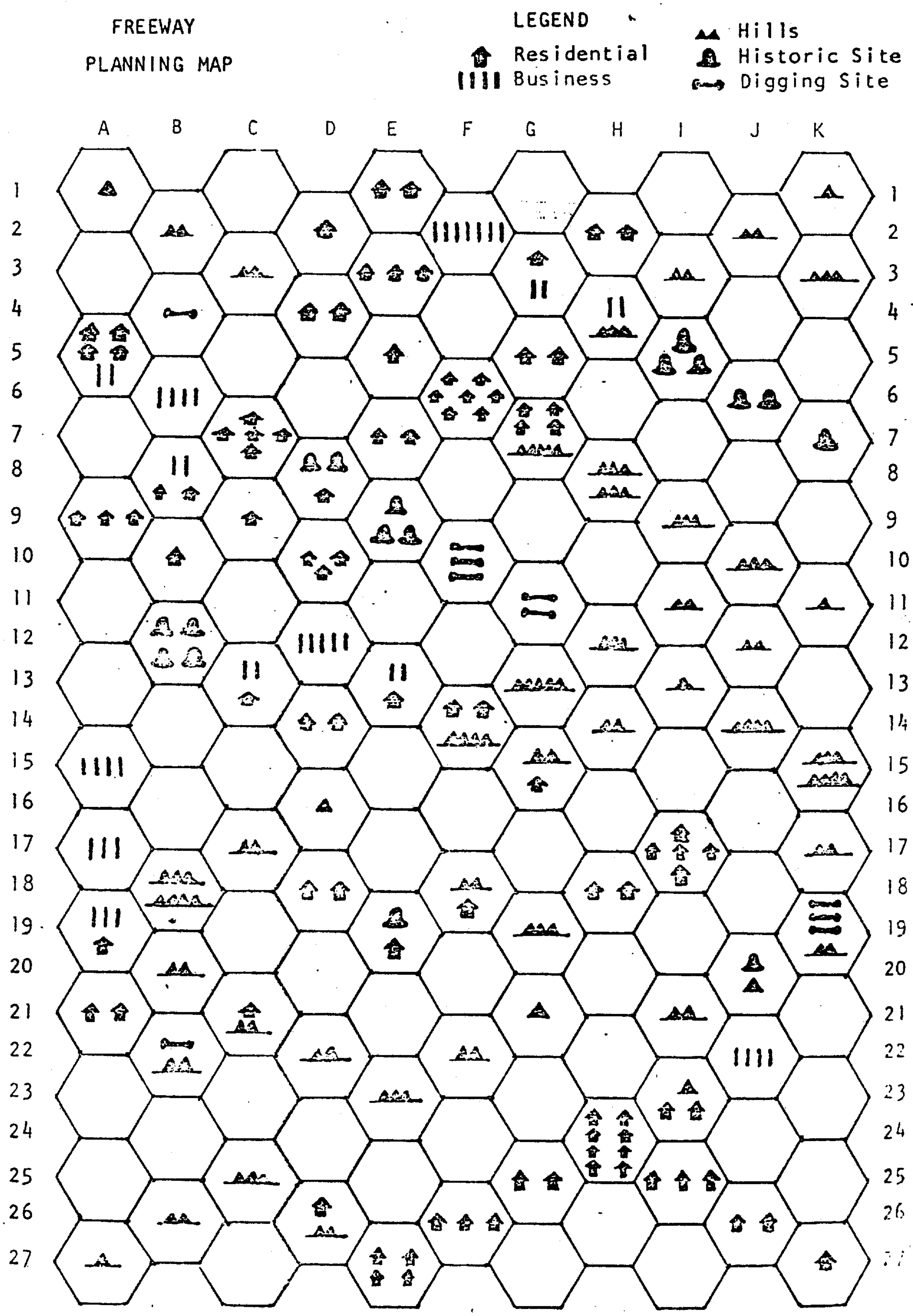


Figure 16
Sample Map for Simulation of Freeway Planning
from (43, p. 38)

or create others which rely on the sharability of a visual space, then it is absolutely essential that a "sharable" computer graphics capability be imbedded into the computerized conferencing environment.

The other two gaming applications investigated by the Vallee-Johansen group dealt with the CRISIS game of R. Shirts (44). CRISIS involves six fictional nations, displayed in Figure 17, who are faced with the problem of determining who should control the "Dermatium Mines" (Dermatium being an essential element for all countries), which lie on the border between Ergosum and Fabuland. The play of the game involves written and oral communication between teams, which lead to either a peaceful resolution of the "CRISIS" or the formation of alliances leading to a war. The written and oral communication were replaced by the computerized conferencing capability.

The private message capability enabled the participants to form coalitions, while the public message mode enabled the participants to present to the "World Organization" national policy statements. All communication was performed in a synchronous mode.

The computerized-conferencing based CRISIS games were analyzed for several parameters. In terms of information flow, there was a message exchange rate of 65 words per minute during the conference which, combined with an average typing speed of 27 words per minute for the group, imply a fairly high degree of synchronous communication. It also was discovered that "winning" coalitions among countries engaged in substantially more private message communication between themselves than did the "losing" nations in CRISIS I. This is displayed in Figures 18 and 19 for the CRISIS I game, where the winning coalition was Axiom, Dolchaveet and Fabuland. In CRISIS II, which ended with four countries engaged in two alliances, while two other countries (Axiom and Camelot) remained neutral, it turned out (see Figure 20) that the neutral countries engaged in relatively little private communication in comparison to the countries that formed coalitions. In both games, however, there was a high degree of private message communication (see Figure 21). It is interesting to note, however, based on the two CRISIS games conducted, that the winning coalitions in the computerized conferencing based game differed from the normal pattern which was found in face to face play of the game. An interesting research point to be further investigated here is the correlations which this readily accessible "secret meeting" capability has on the tendency to form "coalitions."

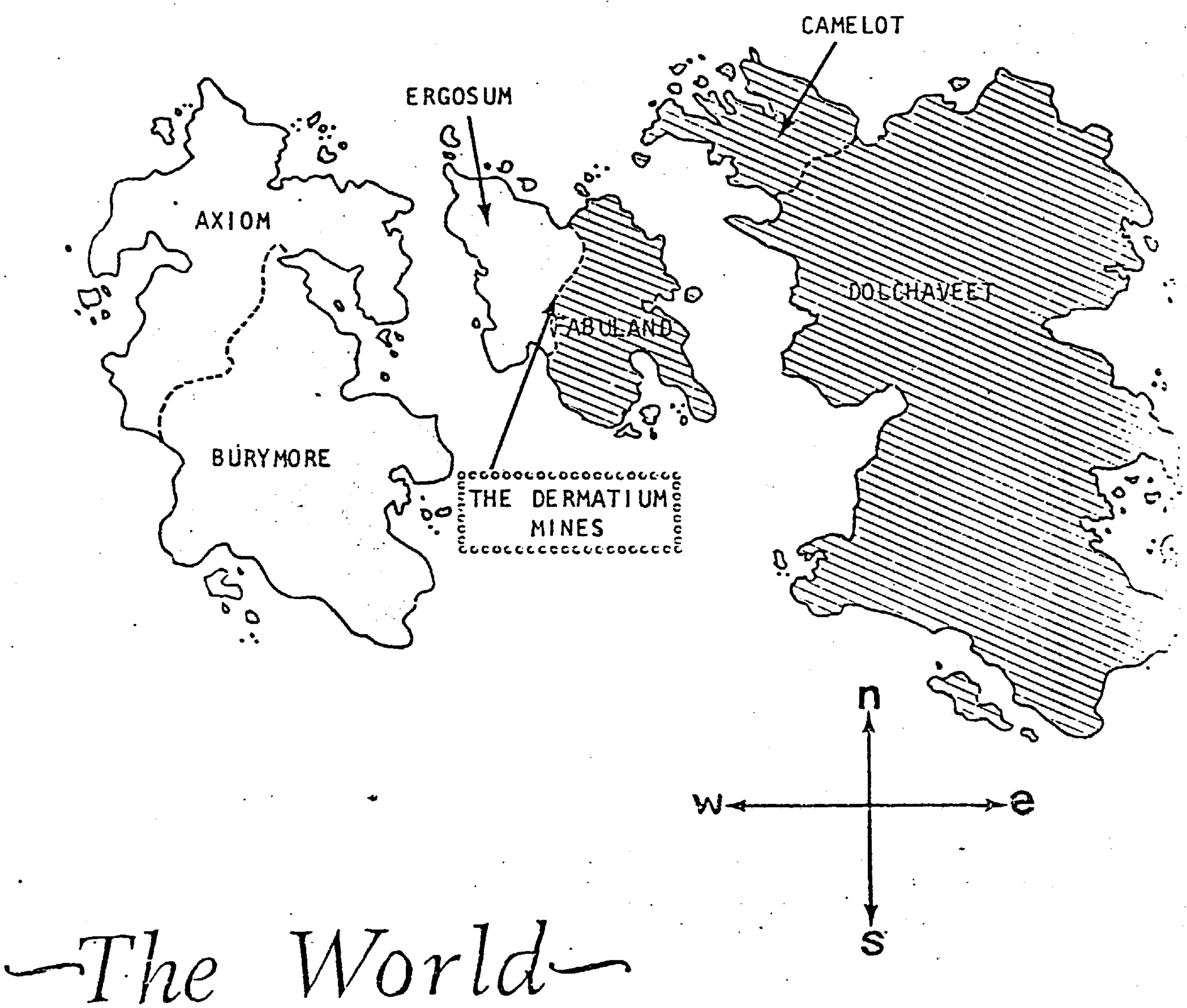


Figure 17
Map of Nations for CRISIS Simulation
from (22, p. 40)

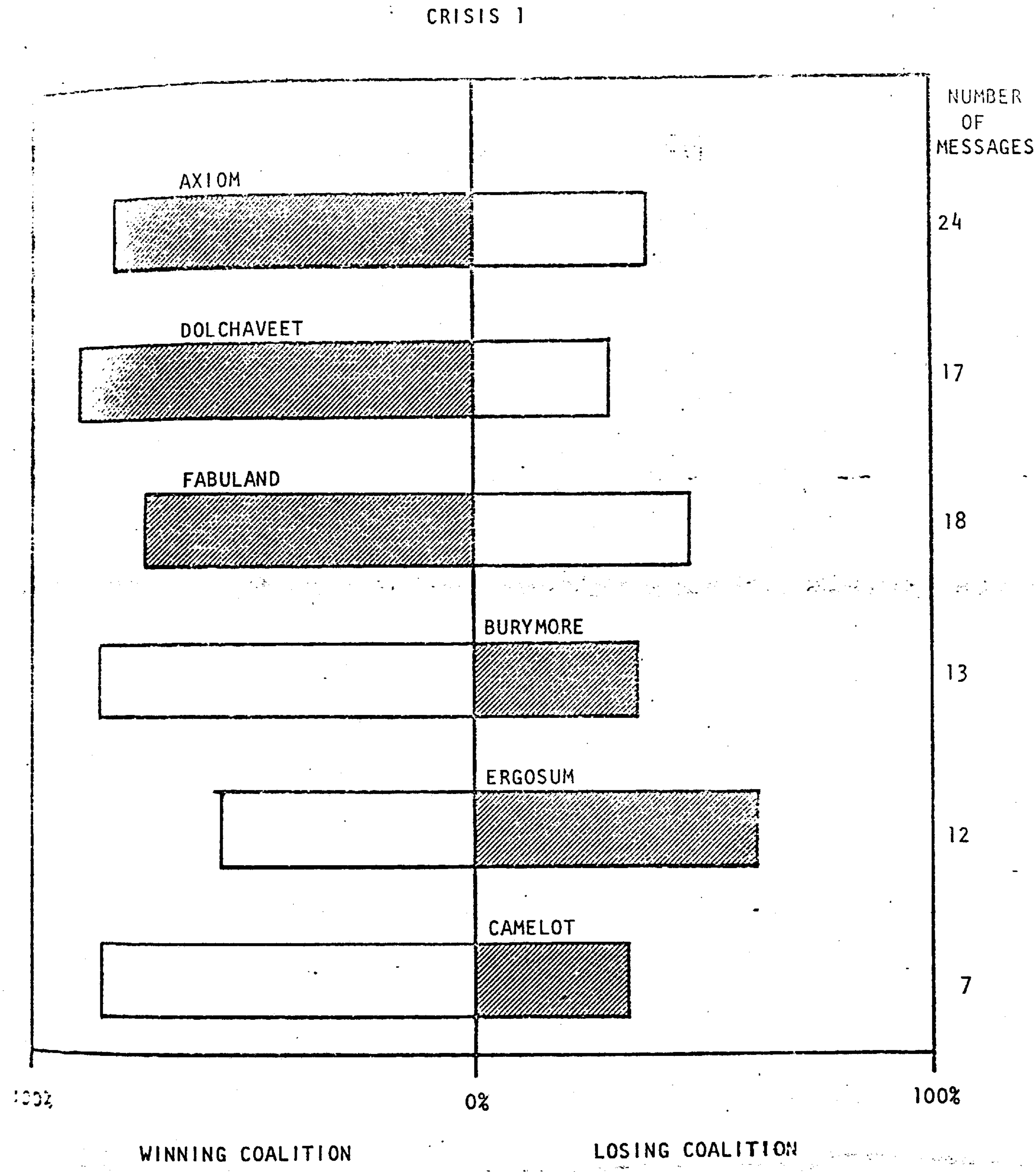


Figure 18. Percent of Private Messages Sent and Received by Each Nation in CRISIS-1

from (22, p. 43)

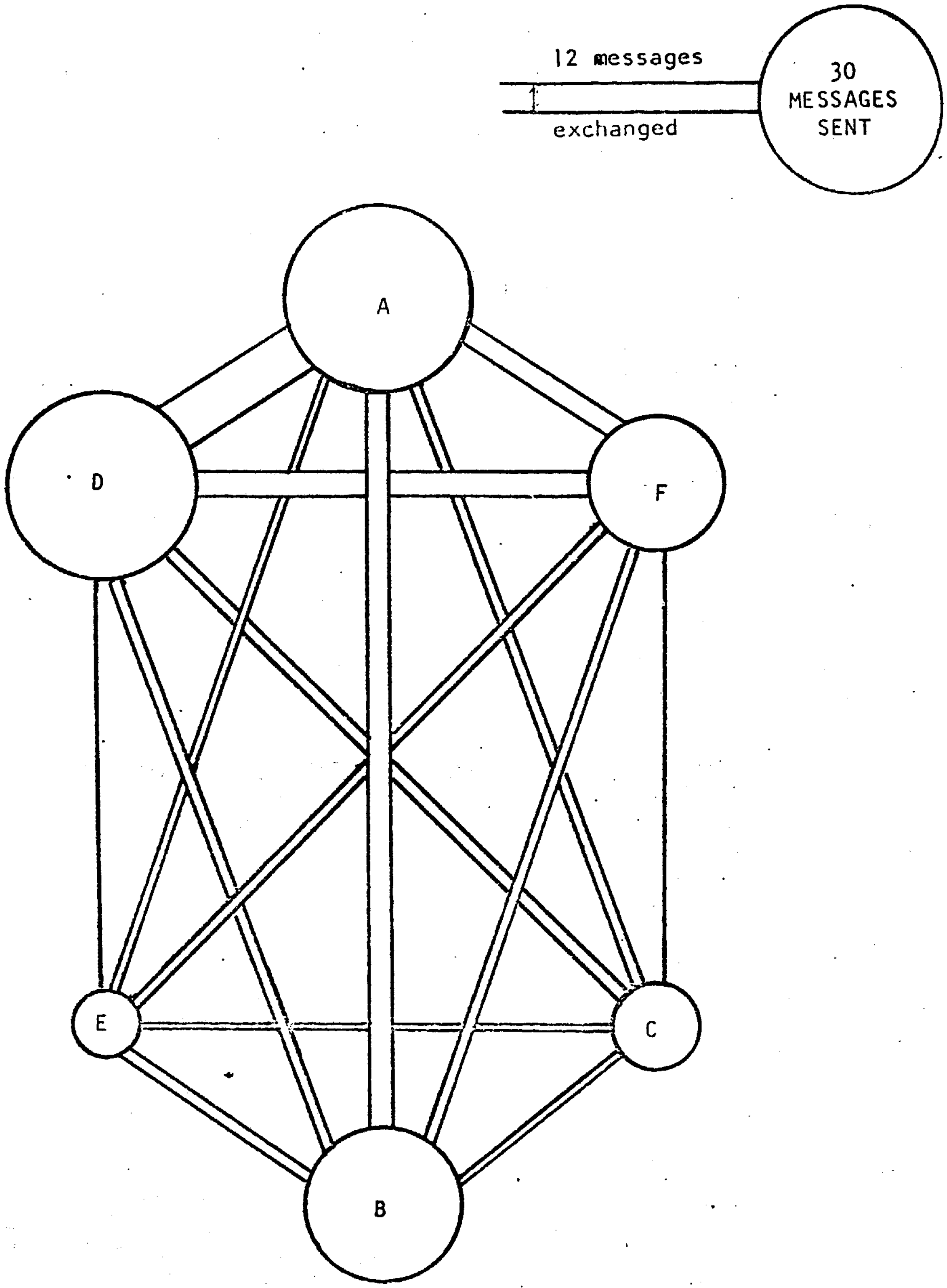


Figure 19. Private Message Exchange

in CRISIS-1

from (22, p. 44).

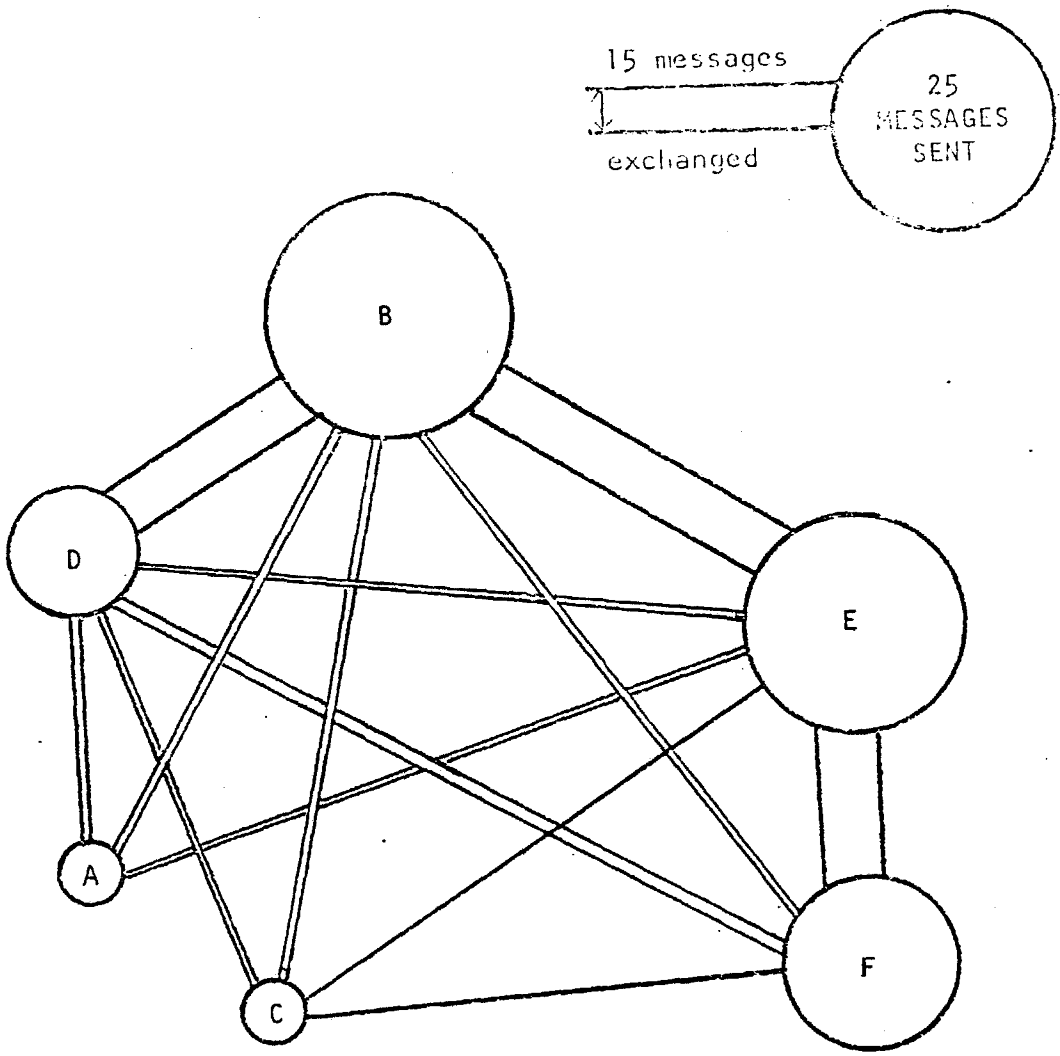


Figure 20. Private Message Exchange in CRISIS-2
from (22, p. 47)

CONFERENCE DURATION: 3 Hours
TOTAL MESSAGES: 385

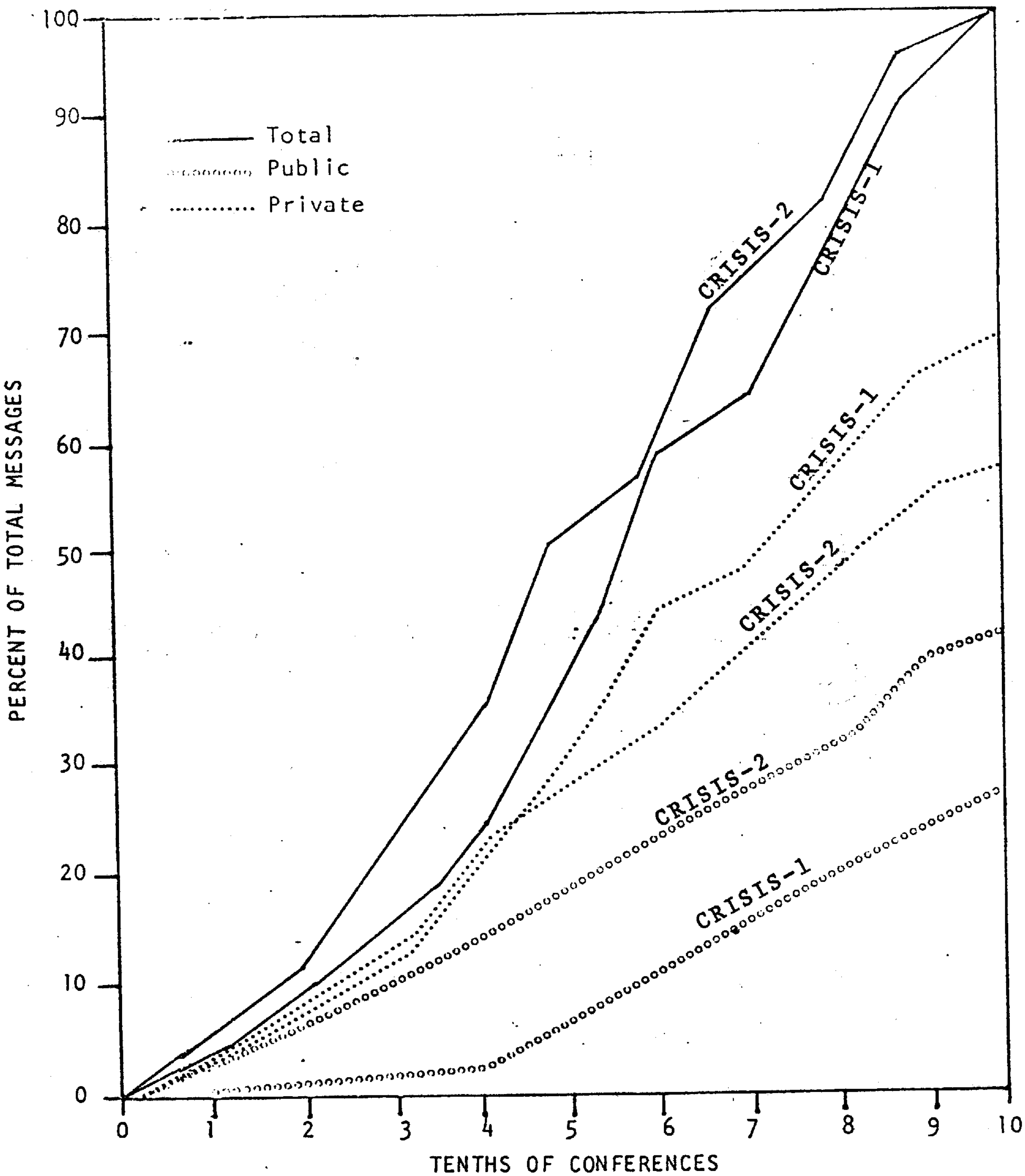


Figure 21. Growth Curves for the Two CRISIS Simulations

From (22, p. 48)

VI. MATHEMATICAL MODEL FOR DESIGNING CONFERENCING-BASED SIMULATION-GAMES

A model will be presented which will permit the simulation-game designer to effectively implement a constrained computerized conference (45) meeting design objectives. A constrained computerized conference is one in which a conference designer has exogenously imposed selected limitations on a communication process. The limitations might take the form of the inability of selected participants to engage in private communications or constraints on the amount of communication selected participants have available to them, or any of a host of other possibilities the simulation-game designer has available in an exogenous-controlled conference. The rationale for a constrained computerized conference is simple: a simulation-game should have a high degree of verisimilitude to the object system it purports to model. This implies that the simulation-game designer must structure the game's communication processes to resemble as closely as possible the communication processes in the target system. It implies that human interaction in the simulation-game should be regulated by the same protocols that exist in the target system. Computerized conferencing offers unique opportunities here in the structuring of communication processes. Our model is an extension of an earlier model proposed by Turoff (46); this model will dichotomize communications into public messages and private messages. For a given computerized conference, we introduce the following notation:

N = number of conferees

Q_{ij} = number of words in private messages sent from conferee i to j during the conference, $i,j = 1, \ldots, N;\ i \neq j$.

M_i = number of words in public messages sent by conferee i during the conference, $i = 1, \ldots, N$.

R_i = min (reading rate for conferee i, terminal print rate for conferee i) for $i = 1, \ldots, N$.

T_i = typing rate for conferee i

W_c = number of words conveyed over the time span of the computerized conference.

I_j = number of words read by conferee j in conference, $j = 1, \ldots, N$.

O_j = number of words typed by conferee j during the conference, $j = 1, \ldots, N$.

We then observe the following relationships:

$$(1) \quad W_c = \sum_{i=1}^{N} M_i + \sum_{i=1}^{N} \sum_{\substack{j=1 \\ i \neq j}}^{N} Q_{ij}$$

$$(2) \quad I_j = \sum_{\substack{i=1 \\ i \neq j}}^{N} (Q_{ij} + M_i)$$

$$(3) \quad O_j = M_j + \sum_{\substack{k=1 \\ k \neq j}}^{N} Q_{jk}$$

If we now let TR_j denote the total time that conferee j spends reading, and TT_j denote the total time in the conference that individual j spends typing, we have

$$(4) \quad TR_J = \frac{I_j}{R_j} = \frac{\sum_{\substack{i=1 \\ i \neq j}}^{N} (Q_{ij} + M_i)}{R_j}$$

and

$$(5) \quad TT_j = \frac{O_j}{T_j} = \frac{M_j + \sum_{\substack{k=1 \\ k \neq j}}^{N} Q_{jk}}{T_j}$$

Let us next compute T_c, the total amount of time all conferees spend in either a reading or a typing mode. Clearly, we have

$$(6) \quad T_c = \sum_{j=1}^{N} \left(TR_j + TT_j \right)$$

or, after substituting,

$$(7) \quad T_c = \sum_{j=1}^{N} \left\{ \frac{\sum_{\substack{i=1 \\ i \neq j}}^{N} \left(Q_{ij} + M_i \right)}{R_j} + \frac{\left(M_j + \sum_{\substack{k=1 \\ k \neq j}}^{N} Q_{jk} \right)}{T_j} \right\}$$

After simplification, (7) reduces to

$$(8) \quad T_c = \sum_{i=1}^{N} \sum_{\substack{j=1 \\ i \neq j}}^{N} Q_{ij} \left(\frac{1}{R_j} + \frac{1}{T_i} \right) + \sum_{i=1}^{N} M_i \left\{ \sum_{\substack{j=1 \\ j \neq i}}^{N} \left(\frac{1}{R_j} \right) + \frac{1}{T_i} \right\}$$

= total private message time + total public message time

This intuitively appealing (and obvious) result merely states that each word in a private message from i to j adds $R_j^{-1} + T_i^{-1}$

time units to T_c, whereas each word in a public message from conferee i adds $\sum_{\substack{j=1 \\ j \neq i}}^{N} R_j^{-1} + R_i^{-1}$ time units to T_c. These results may be prudently utilized by the simulation-game designer to construct exogenous constrained computerized conferences tailored for individual gaming requirements. Several examples to follow illustrate the methodology.

DESIGN APPLICATIONS

Example 1

Design objective: In a simulation-game, the designer wishes to insure that no conferee spends more than Z time units in reading private messages. How should we limit the total private message words between any pairs of players, assuming that the same limitation applies equally to all players.

Solution: In effect, we require that

$$\max_{j} \left\{ \sum_{\substack{i=1 \\ i \neq j}}^{N} \frac{Q_{ij}}{R_j} \right\} \leq Z$$

This is achieved if we allow at most

$$\left[\frac{Z * \min \left\{ R_j \right\}}{N-1} \right]$$ words to be exchanged

in private messages between any two individuals.

Illustration of Example 1: Suppose $\overline{R} = (8,5,5,9,4,2)$, where the reading rates are expressed in words per second. Let us assume the conference designer wishes to constrain (in an "equal" fashion) the private message communications between individuals. In particular, he wishes to insure that no conferee spends more than ten minutes in the reading of private messages. Applying our solution model, we find that $\frac{600X2}{5}$ or 240 is the limiting number of words to be exchanged privately between any pair of individuals to insure this.

Example 2

Design objective: The simulation-game designer requires that the average percentage of time the players devote to reading private messages is F. Determine G_F, the number of words in private messages allowed each conferee during T_c to insure an average percent reading time/conference of private messages of F. Assume all reading rates are equal to R.

Solution: Our requirement is that

$$\frac{\sum_{j=1}^{N}\left(\frac{\sum_{\substack{i=1\\i\neq j}}^{N} Q_{ij}}{R}\right)}{T_c} = F$$

This implies that

$$G_F = \frac{FT_cR}{N}$$

Illustration of Example 2: Suppose there are five players, each with an average reading rate of five words/second. The game designer estimates that the total communication time (T_c) is about 100 hours. (Communication, as we are referring to it, consists of both "speaking" and "listening.") He wishes to insure that the player spends, on the average, about 10% of the total communication time in "listening" to private communication.

Substituting $R = 5$, $N = 5$, $T_c = 360{,}000$ and $F = 10\%$ into our formulas, we find that each player should be allowed about 36,000 words in private messages to meet the design objective.

Example 3

Design objective: Game designer requires that at least 1 - P percent of T_c is devoted to public messages. How should he limit V, the total private message words between any pair of players, assuming that the same limitation applies equally to all players.

Solution: Letting $V = Q_{12} = Q_{13} = \ldots = Q_{N-1,N}$, then, from equation (8), we see that

$$\sum_{i=1}^{N} \sum_{\substack{j=1 \\ i \neq j}}^{N} Q_{ij} \left(\frac{1}{R_j} + \frac{1}{T_i} \right) \leq PT_c$$

or

$$\sum_{i} \sum_{\substack{j \\ i \neq j}} V \left(\frac{1}{R_j} + \frac{1}{T_i} \right) \leq PT_c$$

which implies

$$V \left(\sum_{i} \sum_{\substack{j \\ i \neq j}} \frac{1}{R_j} + \sum_{i} \sum_{\substack{j \\ i \neq j}} \frac{1}{T_i} \right) \leq PT_c$$

or

$$V \left(\sum_{j=1}^{N} \left(\frac{N-1}{R_j} \right) + \sum_{i=1}^{N} \left(\frac{N-1}{T_i} \right) \right) \leq PT_c$$

or

$$V\left(N-1\right)\left(\frac{1}{\Sigma R_j}+\frac{1}{\Sigma T_i}\right) \leq PT_c$$

or

$$V = \left[\frac{\frac{PT_c}{N-1}}{\left(\frac{1}{\Sigma R_j}+\frac{1}{\Sigma T_i}\right)} \right]$$

This expression for V denotes the maximum number of private message words <u>between any pair</u> of players. Furthermore, if we assume that $R_1 = R_2 = \ldots = R_N = R$ and $T_1 = T_2 = \ldots = T_N = T$, we have

$$V = \frac{\frac{PT_c}{N-1}}{N\left(\frac{1}{R}+\frac{1}{T}\right)} = \left[\frac{PT_c\ RT}{(N)(N-1)(T+R)} \right]$$

<u>Illustration of Example 3</u>: A game designer is modeling a human interaction system characterized by an "open" communication structure. He wishes to insure that at least 80% of the total communication time is devoted to "public messages." There are ten role-players in the game, and 100 hours of estimated communication time. The "reading" rate is assumed to be a constant of six words/second for all players, and the typing rate is .5 words/sec per player. Substituting $N = 10$, $T_c = 36 \times 10^4$, $R = .6$, $T = .5$ into our formula, we find that each role player should be allowed to transmit a maximum of

$$\left[\frac{.2*36x10^4*6*.5}{10*9*(\frac{1}{2}+6)} \right] \text{ or 369 words.}$$

Example 4

Design objective: Game designer requires that at least 1-p percent of T_c be devoted to private messages. How should we limit M, the total public message words for any one player, assuming that all players will be subject to this limitation.

Solution: We have $M = M_1 = M_2 = \ldots = M_N$, and from equation (8)

$$\sum_{i=1}^{N} M \left(\frac{1}{T_i} + \sum_{j=1}^{N} \frac{1}{R_j} \right) \leq PT_c$$

or

$$M = \left[\frac{PT_c}{\sum_{i=1}^{N} \frac{1}{T_i} + \sum_{i=1}^{N} \sum_{\substack{j=1 \\ i \neq j}}^{N} \frac{1}{R_j}} \right]$$

If we assume that $T_1 = T_2 = \ldots = T_N = T$ and $R_1 = R_2 = \ldots = R_N = R$, we get

$$M = \left[\frac{PT_c RT}{N(R+T(N-1)} \right]$$

Illustration of Example 4: A game designer, in studying an object system, determines that a significant portion of the communication is done "behind closed doors." Of the thousand hours of communication which he wishes to simulate, he wishes to insure that 75% of this communication time is devoted to private messages. There are N = 10 role players in the game, with reading and typing rates of 6 and .5 words per second, respectively. If we thereby wish to constrain the total public message words equally for all players, our model tells us that each player should be allowed at most 77,142 words to issue public communications.

Example 5

Design objective: Designer wishes to maximize the total number of private message words, subject to required upper and lower bounds for words for each individual participant; the vectors $A = (a_1, \ldots, a_N)$ and $B = (b_1, \ldots, b_N)$ will contain the lower and upper bounds, respectively. Determine the values of M_i to optimize the constrained conference in T_c, where at least 1-p percent of T_c is devoted to private communications.

Solution: We obtain the following integer programming problem

$$\text{Maximize} \quad \sum_{i=1}^{N} M_i$$

subject to

$$\sum_{i=1}^{N} M_i \frac{1}{T_i} \left(+ \sum_{\substack{j=1 \\ j \neq i}}^{N} \frac{1}{R_j} \right) \leq PT_c$$

$$M_i \le b_i \qquad i = 1,\ldots,N$$

$$-M_i \le -a_i \qquad i = 1,\ldots,N$$

$$M_i \ge 0 \text{ and integer, } i = 1,\ldots,N$$

Modification: Let the vectors A and B contain the time limits for bounds on participation. Our mathematical programming problem then becomes

$$\text{Max} \sum_{i=1}^{N} M_i$$

subject to

$$\sum_{i=1}^{N} M_i \left(\frac{1}{T_i} + \sum_{\substack{j=1 \\ j \ne i}}^{N} \frac{1}{R_j} \right) \le PT_c$$

$$M_i \left(\frac{1}{T_i} + \sum_{\substack{j=1 \\ j \ne i}}^{N} \frac{1}{R_j} \right) \le b_i \qquad i = 1,\ldots,N$$

$$- M_i \left(\frac{1}{T_i} + \sum_{\substack{j=1 \\ j \ne 1}}^{N} \frac{1}{R_j} \right) \le - a_i \qquad i = 1,\ldots,N$$

$$M_i \ge 0 \text{ and integer, } \qquad i = 1,\ldots,N$$

The preceding five examples represent only a small sample of the types of constrained conferencing considerations one might incorporate in a design package. Utilizing the methodologies given, the user may tailor the communication process to effectively model the object system under consideration.

Implementation of the Methodologies

There are two modes by which one can implement the total word limitations for selected role-players in selected contexts. In both cases, the designer should first study the object system in order to estimate the total amount of communications taking place - the methodologies heretofore given will then yield individual limitations to be implemented by one of the two following modes:

a) Direct Constraint Mode: In this mode, a role-player is told initially the communication constraints. For instance, a role player might be told: "During the month of April, you may communicate no more than 300 words to Senator Smith."

b) Indirect Constraint Mode: In this mode, constraints on communication are indirectly imposed through the utilization of a cost structure, one which places a relatively high cost on communication patterns which occur rarely in the target system, while placing a relatively low cost on communication patterns which are normal and common in the target system. Thus, a particular environmentalist might have a particularly low cost structure for sending a private message to a college professor or Sierra Club group, but he will have a relatively high cost structure for communicating this same message to a nearby industralist.

It is our contention that the indirect constraint mode, working through the cost structure for communications, represents the more feasible approach for implementing the game designer's structured communication processes. It is recommended that several existing simulation-games whose communication structures are relatively "free-form" and do not resemble communications in the object system, be adapted to a conferencing environment to include a cost structure for communication. An example of this would be "The Public Technology Assessment Game," (47) which currently permits a completely free-form communication structure among all of the legislators, lobbyists and special interest groups.

VII. A HIGHER LEVEL LANGUAGE FOR DESCRIBING A SYSTEM FROM A COMMUNICATION POINT OF VIEW

The author is currently involved in a research effort to develop a language for human communication to implement on a computerized conferencing system. Such a higher level language will have a broad range of applications ranging from small and large group communication experiments to large scale simulation-gaming efforts. It will be, in a sense, a very powerful general purpose language utilizing the latest philosophies of structured programming, but it will also have the capabilities to "describe" some very specialized group communication processes. We shall describe some of the author's thoughts and initial ideas as to the requirements of the language for the implementation phase of simulation-games. While the actual language system being developed differs from what we present, in the sense that it will be Fortran-based, the ideas expressed in this section will be present in the overall structure of the implemented language.

The development of the language requirements for the implementation of the simulation-gaming features have been guided by the following considerations:

- As far as practicable, the language should be as "English-like" as possible, to enable the non-computer scientist to readily read and write communications descriptions expressed in this language.

- The language should enable the analyst to describe, on a generic basis, the attributes of the role-players for given classes of communicants. For a specific implementation, another segment of the program should be able to provide particular information, relative to this implementation, about these features.

- At the beginning of the exercise, certain communication structures (i.e., networks) will be "fixed" throughout the simulation-game; the generic nature of their membership requirements and attributes will be specified at this time. It will be quite possible for a particular assignment at the "housekeeping stage," in a given implementation, that a role-player (communicant) might find himself simultaneously a member of several fixed communication structures. Moreover, during the course of the implementation, a communicant might enter or leave particular communication structures, depending on certain internalized and externalized features established in the game. Thus, specific membership lists are not "fixed" for the fixed communication structure; what are fixed are the generic membership categories and attributes.

- In addition to the "fixed" communication structures (networks), during the course of the simulation-game one may wish to establish certain transient communication structures for selected subsets of role-players. A transient communication structure will be defined to be a network providing a communication "link" between a group of communicants for a "subinterval" of the total time for which the game is operational. Unlike the fixed communication structure, transient communication structures may be "dissolved" during the course of the simulation-game.

- A communication proceedings section is to be included in the language with commands to specify the permissible access to communications generated by given communication structures.

- Above all, our language should not only provide the capability to (statically) describe a "gestalt communication process" consisting of

  1. communicants
  2. communication structures (overlapping networks)
  3. communication proceedings
  4. attributes (properties and rules) for the above

. but it should have the flexibility to dynamically describe the process as a function of time. The dynamic structuring of the communication process is the most vital and challenging aspect of the language development process. As will be seen by examination of our hypothetical language the dynamics of the communication process are implemented via an endogenous controller (as well as a potential exogenous game controller).

It is the author's contention that a simulation-game has very comparable characteristics to a discrete event simulation. The author has adopted a world view of a simulation-game which is analogous to the world view utilized by what is acknowledged to be the most capable (48,49) and "preferred" of the languages used for discrete event simulation, SIMSCRIPT II.5 (50). SIMSCRIPT views the world as structured in terms of entities (representing classes of objects) which have attributes (properties) and belong to sets (collections of individual entities having certain common properties). Events occur which impact the entities, their attributes and set memberships. Our world view for a particular simulation-game consists of generic collections of role-players who maintain unique idiosyncrasies and are members of what we refer to as "fixed communication structures" and "transient communication structures," the former existing throughout a simulation-game, the latter being created and destroyed during the course of the implementation. At certain discrete points in time, events will occur, in a manner to be prescribed, which will impact various aspects of the "world," including the probabilities of occurrence of other events in the simulation-game.

In Figure 22, we present a top down look at our envisioned higher level language for describing the communication structures and processes found in simulation-games. The "world view" section presents, from a static viewpoint, a description of the humans and their interactions (via communications) for a particular simulation-game. The "role idiosyncrasies" subsection, as previously alluded to, describes the generic qualities of the role-players, i.e. each class of role-players shall have a statement describing the overall "idiosyncrasies" for that class of role-players. The "fixed communication structures" and "transient communication structures" subsections describe, for a computerized conferencing environment, the types of communications which may be invoked by the role-players in that substructure, as well as various limitations on the amount of communication which may be invoked by particular role-players. These two subsections are the most critical for the simulation-game designer, since it is his role to structure the communication processes in the simulation-game to replicate the human interactions as they exist in the object system. He must identify the groups which are engaged in both "regular" and "irregular" interactions and moreover, identify the constraints on the communication processes, such as the limitations on "open" communications and limitations on "closed communications."

A TOP-DOWN LOOK AT AN ENVISIONED HIGHER LEVEL LANGUAGE FOR DESCRIBING THE COMMUNICATION STRUCTURES AND PROCESSES FOUND IN SIMULATION-GAMES.

```
WORLD VIEW
     ROLE IDIOSYNCRASIES
          -
          -
          -
     FIXED COMMUNICATION STRUCTURES
          -
          -
          -
     TRANSIENT COMMUNICATION STRUCTURES
          -
          -
          -
     COMMUNICATION PROCEEDINGS
          -
          -
          -
END OF WORLD VIEW

PRELIMINARY HOUSEKEEPING
     PLAYER IDIOSYNCRASIES
          -
          -
          -
     SYSTEM TUNE-UP
          -
          -
          -
     COMMENCE SIMULATION-GAME
END OF PRELIMINARY HOUSEKEEPING

ENDOGENOUS GAME-CONTROLLER
     WHEN ...... BOOLEAN EXPRESSION UTILIZING VARIOUS SYSTEM DESCRIPTORS
     THEN -
          -
          -
     WHEN ......
     THEN ......
          -
          -
          -
          .
          .
          .
END OF ENDOGENOUS GAME-CONTROLLER
EVENT ROUTINES, PROCEDURES AND TEXT AREAS (FOR SCENARIO DEVELOPMENT,'CONCEPTUAL MAP'DELPHIS,
        ETC.) TO FOLLOW
```

Figure 22

The "preliminary housekeeping" section allows the simulation-game designer to tailor the world view embodied in the first section to the unique characteristics of a particular human interaction system. In particular, generic parameters specified in the world view may be given specific values under "player idiosyncrasies" and "system tune-up." The "commence simulation-game" phrase will transfer control to the internal timing routine.

Most simulation-games utilize what is called a "game control staff" to manage the operations of a game, provide for scenario development, monitor communication processes, prepare "world newspapers" and cause certain events to take place in the simulation-game. Our viewpoint is that our language can exhibit some form of "intelligence" by automating some of these functions in what we refer to as an "endogenous game controller." For example, based upon certain aspects and milestones in the simulation-game, we might wish to either "remove" or "file" certain role players from certain communication structures. Since each role-player has associated with it a unique data structure consisting of both idiosyncrasies as well as pointers for communication structure membership, a "remove" of "file" is implemented at the software level by simply manipulating the pointer mechanisms in the linked list of the communication structure. The "endogenous game controller" can also cause certain discrete events to occur when certain conditions in the system are satisfied.

In Figure 23, we illustrate several of the major philosophies of our hypothethical higher leval language by presenting "The College Fiscal Crisis Simulation-Game," which seeks to model the communication structures existing in the academic community when confronted with a fiscal crisis. Such a device could be used by a college president in evaluating policy alternatives for dealing with a fiscal crisis, with their resultant impacts, or it could, with some modifications, be utilized as a "sensitizing" or even a research device for educational administrators and/or those responsible for the funding of higher education. In this model, we have sought to identify the communication structures deemed most critical to the "politics" involved in handling a financial crisis and deciding if and where "cuts" are to be made, if tuitions should be increased or if a new tax structure should be imposed to aid higher education.

The program provides a "glimpse" (or subset) of a more complete program; its intent is to provide a simple illustration of the techniques for modelling human interaction systems. Hopefully, it is mostly self-explanatory. The "HAS" clause of the role idiosyncrasies describes the attributes of the given role-players or communication structures, while the "OWNS" and "BELONGS TO" clauses indicate, respectively, either "ownership" or membership in a communication structure. Also, a "PROF" may belong to only one of the three communication structures for each of the tax reform and tuition communication structures.

```
*THE COLLEGE FISCAL CRISIS SIMULATION-GAME, A DEVICE FOR PLANNING AND POLICY ANALYSIS
*IN ACADEMIA
*
*OR, A DESCRIPTION OF THE COMMUNICATION STRUCTURES EXISTING IN THE (COMPLEX) ACADEMIC
*COMMUNITY
*
 WORLD VIEW
      ROLE IDIOSYNCRASIES
         THE PRESIDENT HAS A PRESENT BUDGET, A BUDGET-REQUEST AND A PRESCRIBED.BUDGET
                       AND OWNS A FACULTY, A STUDENT.BODY, AN ALUMNI.ASSOC,A RESEARCH.STAFF,
                       A NON.ACAD STAFF, AN EXECUTIVE.COMMITTEE, A COMPUTER.ADVISORY.COMMITTEE
                       AND A FACULTY.COUNCIL
         THE SYSTEM OWNS A PRO.TAXREFORM.GROUP,AN ANTI.TAXREFORM.GROUP, A NEUTRAL.ON.TAXREFORM
                       M.GROUP, A PRO.TUITION.INCREASE.GROUP, AN ANTI.TUITION.INCREASE.GROUP
                       AND A NEUTRAL.ON.TUITION.INCREASE.GROUP
         EVERY PROF HAS AN AGE, A NO.OF.YRS.EXP, A TITLE AND A SALARY.LEVEL AND BELONGS TO
                       A FACULTY, A DEPARTMENT, A (PRO.TAXREFORM.GROUP,ANTI.TAXREFORM.GROUP,
                       NEUTRAL.ON.TAXREFORM.GROUP), A (PRO.TUITION.INCREASE.GROUP,
                       NEUTRAL.ON.TUITION.INCREASE.GROUP,ANTI.TUITION.INCREASE.GROUP),
                       AND MAY BELONG TO AN EXECUTIVE.COMMITTEE, A COMPUTER.ADVISORY.COMMITTEE
                       A FACULTY.COUNCIL, A RESEARCH.STAFF AND AN ALUMNI.ASSOC.
         EVERY ALUMNI MAY BELONG TO AN ALUMNI.ASSOC.AND HAS AN INFLUENCE.FACTOR AND A
                       SCHOLARSHIP.CONTRIBUTION.LEVEL
         EVERY UGSTUDENT HAS A FAMILY.INCOME, A YEAR.LEVEL AND A MAJOR AND BELONGS TO A
                       STUDENT.BODY, A (PRO.TAXREFORM.GROUP, ANTI.TAXREFORM.GROUP,
                       NEUTRAL.ON.TAXREFORM.GROUP) AND A (PRO.TUITION.INCREASE.GROUP,
                       ANTI.TUITION.INCREASE.GROUP,NEUTRAL.ON.TUITION.INCREASE.GROUP)
                                              .
                                              .
                                              .
         EVERY FACULTY.COUNCIL HAS A CHAIRPERSON, A VICE.CHAIRPERSON AND A
                       FAC.COUNCIL. SECRETARY
         EVERY STUDENT.BODY HAS A STUDENT.GOVT.PRES AND A STUDENT.PAPER.EDITOR
                                              .
                                              .
                                              .
      FIXED COMMUNICATION STRUCTURES
         THE PRESIDENT*TO*FACULTY COMMUNICATION STRUCTURE CONSISTS OF PUBLIC MESSAGES,
                       CARBON*COPY TO STUDENT.PAPER.EDITOR, SAVED IN OFFICIAL.MINUTES
                       AND IS LIMITED TO 3000 WORDS/MESSAGE WITH 01 MESSAGE PER
                       FUNCTION.PRESFREQ
         THE PROF*TO*PRESIDENT COMMUNICATION STRUCTURE CONSISTS OF PRIVATE MESSAGES
                       WITH 01 MESSAGES PER FUNCTION.PTPFREQ(PROF)
         THE FACULTY.COUNCIL*TO*PRESIDENT COMMUNICATION STRUCTURE IS BI-DIRECTIONAL AND
                       CONSISTS OF PUBLIC MESSAGES WHICH ARE SAVED IN FAC.COUNCIL.FILES
         THE FACULTY.COUNCIL COMMUNICATION STRUCTURE CONSISTS OF PUBLIC MESSAGES WHICH
                       ARE DESTROYED AND PRIVATE MESSAGES WHICH MAY BE USED BY
                       (BIOLOGY.REP, ZOOLOGY.REP,CHEMISTRY.REP) AND (CHEMISTRY.REP,
                       PHYSICS.REP,GEOLOGY.REP) AND (ART.REP,MUSIC.REP)
                                              .
                                              .
                                              .
```

Figure 23

```
TRANSIENT COMMUNICATION STRUCTURES
   EVERY AD.HOC.COLL.COMMITTEE IS CREATED BY THE PRESIDENT, HAS A
                   MEMBERSHIP.LIST, CONTAINS AT LEAST ONE PROF,
                   WHERE EACH MEMBER RESPONDS TO AD.HOC.DELPHI.QUESTIONNAIRE,
                   AND IS DESTROYED BY THE PRESIDENT
   EVERY ADHOC.FC.COMMITTEE IS CREATED BY THE CHAIRPERSON(FACULTY.COUNCIL),
                   CONTAINS ONLY PROFS, HAS A WHYME.LIST , CONSISTS OF
                   PUBLIC MESSAGES AND BI-DIRECTIONAL PRIVATE MESSAGES
                   TO VICE.CHAIRPERSON(FACULTY.COUNCIL) AND BI-DIRECTIONAL
                   PUBLIC MESSAGES TO FACULTY.COUNCIL, AND IS DESTROYED
                   BY CHAIRPERSON(FACULTY.COUNCIL)
                              .
                              .
                              .
COMMUNICATION PROCEEDINGS
   OFFICIAL MINUTES MAY BE ACCESSED BY PRESIDENT, FACULTY,ALUMNI.ASSOC,STUDENT
                   BODY, AND RESEARCH.STAFF
   FACULTY.COUNCIL.NEWSLETTER IS EDITED BY FAC.COUNCIL.SECRETARY AND IS SENT
                   TO ALL FACULTY UPON REQUEST OF CHAIRPERSON(FACULTY.COUNCIL)
                   OR GAME*CONTROL*STAFF
                              .
                              .
                              .
END OF WORLD VIEW

PRELIMINARY HOUSEKEEPING
      PLAYER IDIOSYNCRASIES
                              .
                              .
                              .
         JULIAN.SCHER IS A PROF(32,5,ASPF,64K) AND BELONGS TO A COMPUTER.AND.
                      INFORMATION.SCIENCE.DEPT, A NEUTRAL.ON.TAXREFORM.GROUP,
                      AN ANTI.TUITION.INCREASE.GROUP AND A RESEARCH.STAFF
                              .
                              .
                              .
      SYSTEM TUNE-UP
                         .
                         .
                         .
         SCHEDULE A BAD.NEWS.MEMO(1) FROM PRESIDENT TO ALL NOW
         SCHEDULE A BAD.NEWS.MEMO(2) FROM PRESIDENT TO EXECUTIVE.COMMITTEE NOW
         SCHEDULE A PROPOGANDA.MEMO (1) TO ALL IN ANTI.TAXREFORM.GROUP AND
                      NEUTRAL.ON.TAXREFORM.GROUP NOW
                         .
                         .
                         .
         COMMENCE SIMULATION-GAME
                         .
                         .
                         .
 END OF PRELIMINARY HOUSEKEEPING
```

```
ENDOGENOUS GAME-CONTROLLER
                              .
                              .
                              .
    WHEN N.ANTI.TUITION.INCREASE.GROUP IS GREATER THAN 10*(N.PRO.TUITION.INCREASE
        GROUP + N.NEUTRAL.ON.TUITION.INCREASE.GROUP),
    THEN CAUSE EVENT(23) TO OCCUR AND PERFORM CROSS.IMPACT.CHANGE(TABLE)
                              .
                              .
                              .
END OF ENDOGENOUS GAME-CONTROLLER

TEXT AREA
    BAD.NEWS.MEMO(1)
        TEXT:  "IN OUR EFFORT TO MEET TIGHTER COST CONTROLS BEING IMPOSED, ALL
                TOILET PAPER ROLLS ARE BEING REMOVED FROM ALL JOHNS AND WILL ONLY
                BE ISSUED AT SPECIFIED LOCATIONS BASED ON ACTUAL DEMONSTRATION OF
                NEED.  WE DEEPLY REGRET ANY INCONVENIENCE THIS MAY CAUSE, AND
                REQUEST YOUR COOPERATION."
    BAD.NEWS.MEMO(2)
        TEXT:  "PLEASE INFORM ME INDIVIDUALLY, AFTER DISCUSSIONS WITH YOUR
                DEPARTMENTS, HOW YOUR DEPARTMENT WILL PROVIDE A QUALITY EDUCATION
                AND RESEARCH ENVIRONMENT WITH 25% LESS FUNDS THAN LAST YEAR."
    PROPOGANDA.MEMO(1)
        TEXT:  "THE EVIDENCE IS CLEAR. THE TIME IS NOW FOR US TO INCREASE THE
                TAX ON WIDGETS.  OUR TAX ON WIDGETS IS 34.7629% LOWER THAN THAT
                IMPOSED BY OUR NEIGHBORS.  CONTACT YOUR POLITICOS AND TELL THEM
                WHERE YOU STAND ON THE WIDGET TAX. FOR FURTHER INFORMATION,
                CONTACT PROFESSOR DOE AT EXT. 2345."
                              .
                              .
                              .
END OF TEXT AREA
  EVENTS
                              .
                              .
                              .
END OF EVENTS
```

The <u>fixed communication structures</u> describe whether, <u>within</u> that communication structure, messages will be public, private, a mixture, or whether specialized communication structures, such as a delphi process, are being imposed. Constraints on frequency and amount of the communication are also specified in this section. In the <u>transient communication structures</u> section, we illustrate a concept familiar to those in academia, the creation of the "ad-hoc" committee. In <u>communication proceedings</u> we model the disposition of previous communications. In the <u>player idiosyncrasies</u> section, we provide the specific information on role-players for a particular implementation. In the <u>system tuneup</u>, we provide for what has been referred to by Duke (11) as the "pulse," or that which initiates communications. The <u>endogenous game controller</u> illustrates a statement which provides for a certain event to occur and a cross impact table to be invoked upon the attainment of some condition in the system (namely, when the anti-tuition-increase group has ten times as many members as the "opponents" and "neutrals.") In addition to the endogenous game controller, our simulation-game will also provide for an "exogenous game controller" whereby the simulation-game designer may, if he wishes, examine the communications while the game is "in session" and cause certain changes to occur in the system, specify certain events of an unusual nature, etc.

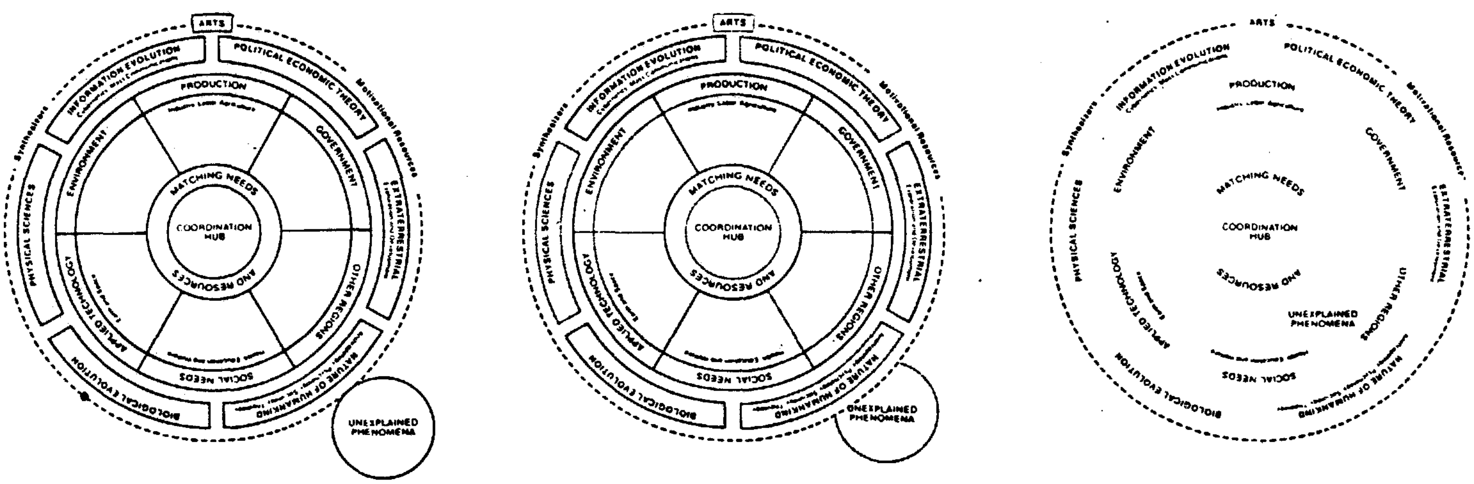
Applications to the SYNCON process

SYNCON (for SYNergistic CONvergence) is a holistic communications based decision-making process which synthesizes a diverse cross section of communicants in the intended solution of complex problems with great societal impact. Developed and implemented by Barbara Marx Hubbard and John J. Whiteside, both founders of the Committee For the Future, there have been 24 syncons conducted to date. As opposed to conventional delphi designs, the SYNCON is, within its prespecified "communication boundaries," a relatively free-form and unstructured communication process.

In Figure 24 is displayed a paradigm of a typical SYNCON

SYNCON HELPS BUILD THE COMMUNITY FOR THE FUTURE

SYNCON is structured into interaction groups the first day, merging, the second day, into larger composite groups, and, on the third day, into one total group. The whole group seeks a "synergistic solution" to each problem one that does not deprive the rights of one sector to realize the needs of another. SYNCON does not impose any doctrine or dogma, but it does force inclusion of the widest horizons of choices. As new options are examined and explored, they become visible and viable, or die. Through the SYNCON process, the options can be examined in an atmosphere of openness, mutual respect and love for the unique potential in each person.



small groups... **merge into larger composite groups...** **to one total group**

Figure 24

Given a complex problem to be examined in the light of current and "projected" knowledge, the individuals in the SYNCON are allocated in separate groups, according to interest, in a specially designed "wheel" shaped environment (where the spokes in the wheel are actually removable walls). The inner sections of the wheel represent the basic functions of society, while the outer sections represent "the growing edge of knowledge."

During the initial stage of the SYNCON (depending on the overall length of the SYNCON, the first stage may range from several hours to several days), participants will meet in their own groups and produce summaries of goals, needs and resources. Through the use of an elaborate closed circuit TV system, each group briefs the others on its goals, needs and resources. After all summaries have been broadcasted, walls between pairs of "conflicting" groups come down, new groups merge, and "synergistic" solutions are sought by the merged groups. In the final stage, all walls are removed, and the group assembles as a whole to address the problem.

The SYNCON model represents an ideal communication structure to be imbedded in a computerized conferencing environment. The present-day SYNCON requires that numerous people travel several thousands of miles in order to communicate over an extended period of time. (A recent SYNCON held in conjunction with an ASIS meeting in Washington, D.C. ran from 4 P.M. to 10 P.M. one day and from 10 A.M. to 6 P.M. the following day.) Many individuals obviously became "communications-weary" over such an extended period. The asynchronous features of computerized conferencing present many other potential benefits for a SYNCON, such as the ability to carefully evaluate goals, needs and resources in a sufficient amount of time, with access to requisite data bases, etc.

In figure 25, we describe the SYNCON communication process using our higher level language.

```
* THE SYNCON A LA ASYNCOM,I.E., SYNERGISTIC CONVERGENCE WITH ASYCHRONOUS COMMUNICATIONS
* OR, AN APPLICATION OF COMPUTERIZED CONFERENCING TO THE SYNCON PROCESS
* COMPUTERIZED CONFERENCING HAD ITS ORIGINS IN THE AREA OF CRISIS MANAGEMENT: HERE,
* WE SHOW AN APPLICATION IN THE AREA OF CRISIS PREVENTION.  SYNCON IS A STRUCTURED
* GROUP COMMUNICATION PROCESS DESIGNED TO GENERATE POLICY FORMULATION WHICH SATISFIES ALL
* HERE, J.M. SCHER ATTEMPTS TO 'DESCRIBE' THE SYNCON PROCESS FROM THE VANTAGE POINT OF
* A COMPUTERIZED CONFERENCING ENVIRONMENT AND A HYPOTHETICAL LANGUAGE

WORLD VIEW
   ROLE IDIOSYNCRASIES
     THE SYSTEM CONSISTS OF 1 SYNCON-COORDINATOR WHO HAS A NAME AND WHO OWNS A SET OF
         PANELS AND A FACILITATOR.GROUP
     EVERY INDIVIDUAL HAS A NAME AND BELONGS TO A PANEL AND MAY BE A FACILITATOR
     EVERY FACILITATOR BELONGS TO A FACILITATOR.GROUP
   FIXED COMMUNICATION STRUCTURES
     THE SYNCON.COORDINATOR*TO*FACILITATOR COMMUNICATION STRUCTURE IS BI-DIRECTIONAL
         AND CONSISTS OF PRIVATE MESSAGES
     THE INDIVIDUAL*TO*SYNCON.COORDINATOR COMMUNICATION STRUCTURE CONSISTS OF PRIVATE
         MESSAGES
     THE SYNCON.COORDINATOR*TO*INDIVIDUAL COMMUNICATION STRUCTURE CONSISTS OF PUBLIC
         MESSAGES, AND PRIVATE MESSAGES UPON DEMAND
     THE FACILITATOR.GROUP COMMUNICATION STRUCTURE CONSISTS OF PRIVATE MESSAGES
   TRANSIENT COMMUNICATION STRUCTURES
     EVERY PANEL COMMUNICATION STRUCTURE CONSISTS OF PUBLIC MESSAGES AND UTILIZES A
         BLACKBOARD MAINTAINED BY THE FACILITATOR
   SYSTEM IDIOSYNCRASIES
     EVERY BLACKBOARD IS LIMITED TO 6000 WORDS AND MAY BE ACCESSED BY ALL
END WORLD VIEW

PRELIMINARY HOUSEKEEPING
   PLAYER IDIOSYNCRASIES
      JOHN.J.WHITESIDE IS THE NAME OF THE SYNCON. COORDINATOR
              .
              .
              .
      JULIAN.M.SCHER IS THE NAME OF AN INDIVIDUAL WHO BELONGS TO THE INFORMATION.EVOLUTION
          PANEL
      RICHARD.MAYNARD IS THE NAME OF AN INDIVIDUAL WHO BELONGS TO THE INFORMATION.
          EVOLUTION PANEL AND IS A FACILITATOR
              .
              .
```

Figure 25

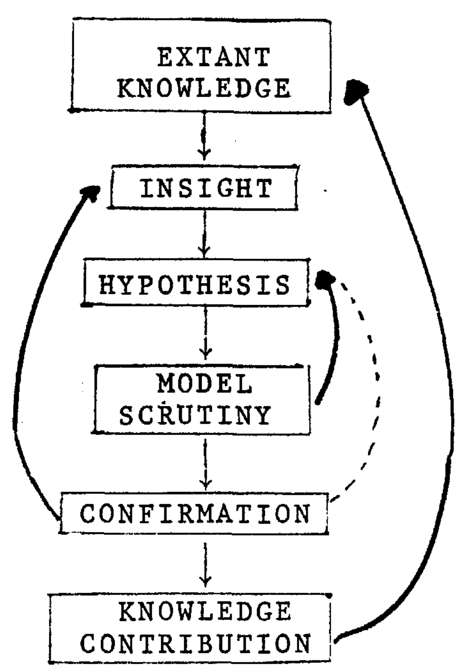
```
SYSTEM  TUNE-UP
   READ TIME.FIVE,WALLS.COME.DOWN, TIME.ALL.WALLS.COME.DOWN AND TIME.SYNCON.ENDS
   CREATE PANEL COMMUNICATION STRUCTURES CALLED
                      ENVIRONMENT
                      PRODUCTION
                      GOVERNMENT
                      TRANSNATIONAL.RELATIONS
                      SOCIAL.NEEDS
                      APPLIED.TECHNOLOGY
                      INFORMATION.EVOLUTION
                      POLITICAL.AND.ECONOMIC.FUTURES
                      ARTS.AND.IMAGES
                      EVOLUTION.OF.HUMAN.VALUES
                      SCIENCES.AND.UNEXPLAINED.PHENOMENA
   COMMENCE SYNCON.A.LA.ASYNCOM
   SEND TEXT.MESSAGE(1) TO ALL NOW
END PRELIMINARY HOUSEKEEPING

ENDOGENOUS GAME CONTROLLER
  AT TIME.FIVE.WALLS.COME.DOWN,
     FOR EVERY PANEL, SEND BLACKBOARD(PANEL) TO ALL AND DESTROY THIS PANEL COMMUNICATION
         STRUCTURE
     MERGE APPLIED.TECHNOLOGY PANEL AND ENVIRONMENT PANEL INTO TECHNOLOGY.AND.
         ENVIRONMENT PANEL
     MERGE PRODUCTION PANEL AND GOVERNMENT PANEL INTO PRODUCTION-GOVT PANEL
     MERGE SOCIAL.NEEDS PANEL AND TRANSNATIONAL.RELATIONS PANEL INTO SOCIAL.NEEDS.
         AND.TRANSNATIONAL.RELATIONS PANEL
     MERGE INFORMATION.EVOLUTION PANEL AND POLITICAL.AND.ECONOMIC.FUTURES PANEL
         INTO INFORMATION.AND.POLITICAL-ECONOMIC.FUTURES PANEL
     MERGE ARTS.AND.IMAGES PANEL, EVOLUTION.OF.HUMAN.VALUES PANEL AND SCIENCE.AND.
         UNEXPLAINED.PHENOMENA PANEL INTO ARTS.IMAGES.HUMAN.VALUES.AND.SCIENCE
         PANEL
     CREATE  PANEL COMMUNICATION STRUCTURES CALLED TECHNOLOGY.AND.ENVIRONMENT,
         PRODUCTION-GOVT,SOCIAL.NEEDS.AND.TRANSNATIONAL.RELATIONS, INFORMATION.
         AND.POLITICAL.ECONOMIC.FUTURES,ARTS.IMAGES.HUMAN.VALUES.AND.SCIENCE

  AT TIME.ALL.WALLS.COME.DOWN,
     DO
       FOR EVERY PANEL,SEND BLACKBOARD(PANEL) TO ALL AND DESTROY THIS PANEL
         COMMUNICATION STRUCTURE
```

```
            MERGE ALL PANELS INTO PLENARY PANEL
            CREATE A PANEL COMMUNICATION STRUCTURE CALLED PLENARY
        LOOP
      AT TIME.SYNCON.ENDS,
        SEND BLACKBOARD TO ALL
        SEND TEXT.MESSAGE(2) TO ALL
        STOP
END OF ENDOGENOUS GAME CONTROLLER
```

```
TEXT AREA
   TEXT.MESSAGE(1)  :  " GOOD MORNING, LADIES AND GENTLEMEN.  YOU ARE ABOUT TO PARTICIPATE
                        IN A UNIQUE COMMUNICATION PROCESS CALLED SYNCON.A.LA.SYNCOM.  EACH
                        OF YOU BELONGS TO A PANEL OF FELLOW INDIVIDUALS WHO SHARE YOUR
                        AREA OF EXPERTISE.  A TRAINED FACILITATOR WILL GUIDE YOUR PANEL
                        IN ARRIVING AT A POLICY FORMULATION FROM YOUR POINT OF VIEW.
                        FEEL FREE TO TYPE MESSAGES TO YOUR FELLOW PANEL MEMBERS AT ANY
                        TIME YOU DESIRE.  WHEN YOU LOG-ON, YOU WILL BE PROVIDED ALL
                        COMMUNICATIONS FROM YOUR FELLOW-PANEL MEMBERS.  IF YOU HAVE ANY
                        QUESTIONS AT ALL REGARDING THE PROCESS AND/OR METHODOLOGY, FEEL
                        FREE TO CONTACT PRIVATELY THE SYNCON.COORDINATOR.  THERE ARE OTHER
                        PANELS COMMUNICATING SIMULTANEOUSLY WITH YOUR PANEL.  YOU WILL
                        BE PERIODICALLY INFORMED OF THEIR VIEWPOINTS.  AT SOME LATER
                        POINT IN TIME, YOUR PANEL WILL BE 'MERGED' WITH ONE OF THE OTHER
                        PANELS, IN ORDER TO RESOLVE ANY MUTUAL DIFFERENCES AND AGREEMENTS
                        IN THE INDIVIDUAL POLICY FORMULATIONS.. FINALLY, ALL PANELS WILL
                        MERGE AT AN ANNOUNCED TIME INTO ONE BIG PLENARY SESSION.  O.K.
                        ENJOY..."
TEXT.MESSAGE(2)     :  "THANK YOU ALL FOR PARTICIPATING IN SYNCON.A.LA.ASYCOM.  WE HOPE
                        IT HAS BEEN A REWARDING EXPERIENCE FOR YOU.  OUR STATEMENT OF
                        POLICY RECOMMENDATIONS WILL BE GIVEN TO THE DECISION.MAKERS,
                        AND WILL HOPEFULLY RESULT IN POLICY IMPLEMENTATION AT AN
                        EARLY DATE."
END TEXT AREA
```

VIII. CONCLUSIONS AND RECOMMENDATIONS

The preceding chapters have presented numerous examples of the work of modelers, simulationists, and simulation-gamers. While each may have a different perspective and orientation, in commonality they all are studying systems and, ideally, are approaching their work based on an implicit recognition of the scientific method. Mihram (51), in his classic rebuttal of Ackoff's viewpoint that "Systems Science is not a Science," (52) argues that systemic scientists (i.e., scientists of systems, which includes modelers, simulationists and simulation-gamers) ought to be more concerned with the design and management aspects relating to their successful implementation of the scientific methods We present below Mihram's model of the scientific method.



As reiterated numerous times in preceding chapters, each arrow in this diagram can be considered (and even replaced) by a communication process amongst a specified group of modelers and reviewers. By failing to recognize the imbedded communication structures for the systemic scientists scientific method, we have never satisfactorily achieved a significant input from the confirmation level to the knowledge contribution level. The first three levels (extant knowledge, insight and hypothesis) have largely centered about individual efforts, with little communication amongst modelers. The Model Scrutiny and Confirmation aspects tend to be "potshot" affairs, with little organization and management. It is apparent from our discussions in earlier chapters that computerized conferencing is an ideal communication network for the assemblage of a modeling team.

If systemic scientists are to live up to their classifications as scientists, then it is necessary that we have a "working storage" or depository for our models, simulations and simulation-games. In essence, we feel that to provide a more significant "knowledge contribution" phase, we have to improve the "Model Scrutiny" and "Confirmation" stages with more organization and management. We fully agree with Mihram's (53) plan for the erection and maintenance of an "International Archives" where a (machine-readable) copy of each model whose report has been submitted for review would be deposited. Through a computerized conferencing network, the review team (which, theoretically, may be any subset of the population of modelers and other pertinent experts) would have direct access to the model for its scrutinization and for confirmation testing. The set of confirmed models residing in the International Archives could then become submodels for new hypothesized models. Potential users can then "remove" a model (or a simulation-game) and utilize it for a particular application, much like a chemist or physicist "removes" a journal article and bases his work on it.

As we have stated in this report, computerized conferencing has the potential to raise the "state-of-the-art" in simulation-gaming from the "toy" stage to a prominent position as both an educational as well as a research tool. Numerous communication structures in object systems can now be modeled more realistically via computerized conferencing. Humans can have their interaction with a simulation model (where some simulants in the model may be other humans) regulated by an "automated" intelligent capability, perhaps in the form of a microprocessor interface. Existing simulation-games can be adapted to computerized conferencing, but more importantly, new ones can be developed which capitalize on the interaction and communication features of conferencing, and incorporate such emerging methodologies as interpretive structural modeling and cross-impact paradigms.

The potential is here to accentuate the science aspect of systemic science. It is up to modelers, simulationists and simulation-gamers to tap this new tool - computerized conferencing.

EXCURSUS: A Conceptual Framework for Model Development Modularizations

In figure 1 below, we present a "top-down" structure of the modularization of the model development phase. The fundamental axiom upon which this is based in that any complex task in model development can be broken down into a set of N submodels, where some of the submodels could conceivably be interfaces between other models.

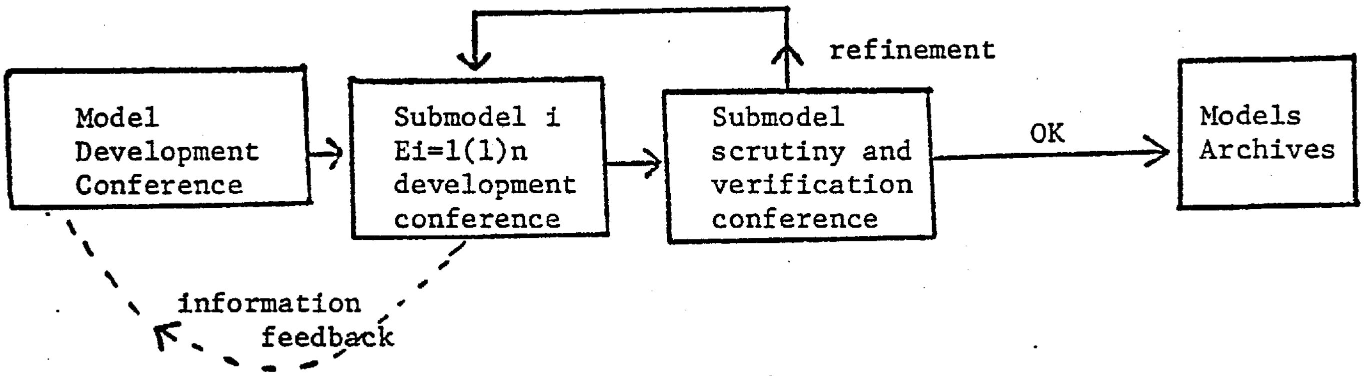


FIGURE 1

Since we are dealing with asynchronous communication processes, it is entirely possible that one individual could be a member of several Submodel Development Conferences, depending on his abilities and the requirements imposed by the Model Development Conference (the optimal structure of the Model Development Conference is an unanswered question at the moment -- should it start off with a "leadership set" of K individuals, who will seek other contributors to the Model Development Conference and guide the modularization into submodels, or should the "leadership set" be allowed to "emerge" from the general discussions? It is hoped that auxiliary efforts at NJIT which are critically examining the communication structures of "invisible colleges" using conferencing networks will shed some light on this).

The actual studies of a typical submodel development conference will be shortly examined in greater detail. The end result of the submodel development conference will be a candidate model for presentation to the Model Development Conference, as well as the Model Archives. The candidate model is then presented to the Model Scrutiny and Verification Conference which, in addition to the individuals (or some subset of them) of the appropriate Submodel Development Conference, will also consist of individuals known as Auditors. The goal of the Model Scrutiny and Verification Conference is to critically re-examine the assumptions, data bases, methodologies, etc., of the candidate model, and either send it back to the Submodel Conference for further refinement, or else accept it and place it in the Model Archives.

Our attention next turns to the inner workings and requirements for a typical Submodel Development Conference (the structure to be evolved, however, could also serve for the Model Scrutiny and Verification Conference). In Figure 2 below, we present a paradigm for such a conference structure.

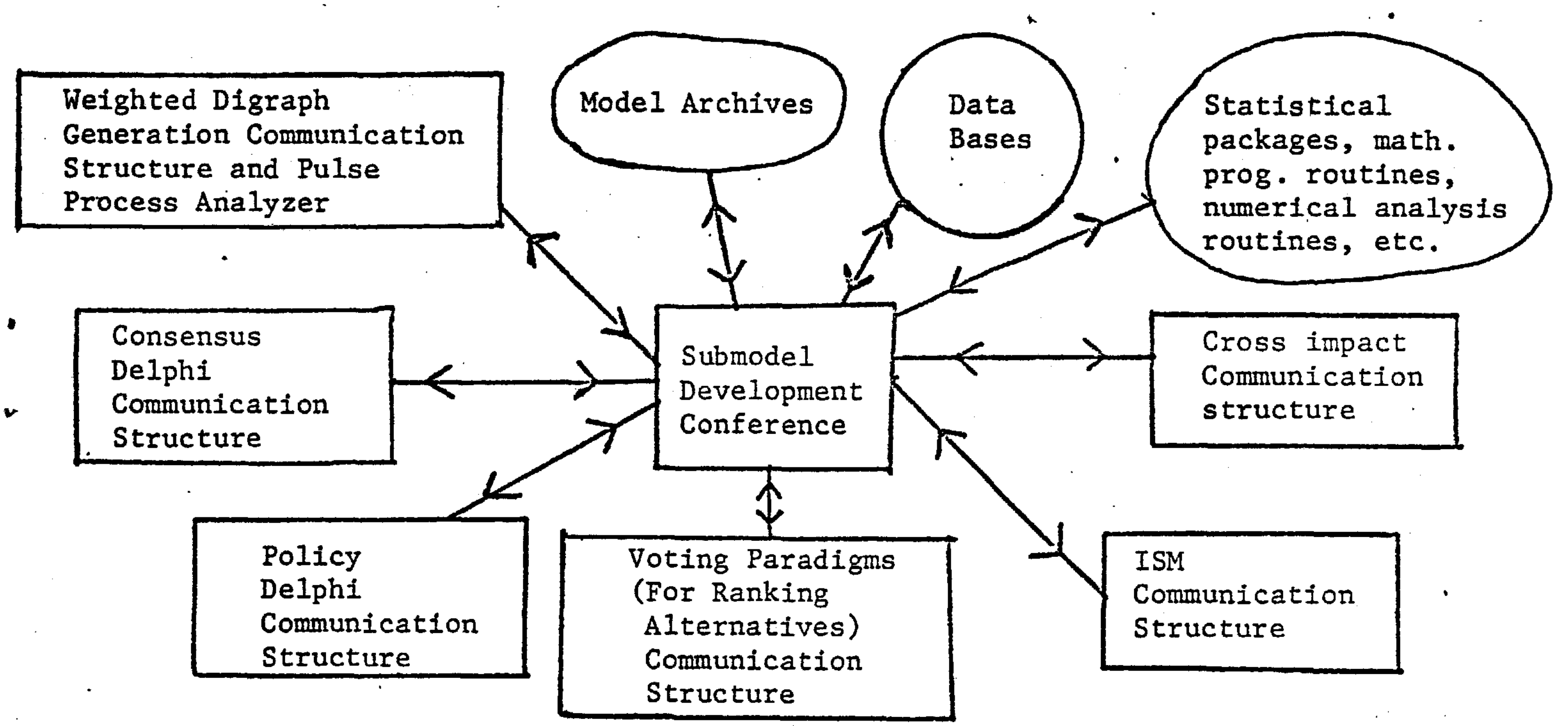


Figure 2

The square boxes denote various communication oriented modeling paradigms which may be invoked by the Submodel Development Conference. The circles, on the other hand, denote sources of existing information, such as models residing in the Model Archives, data bases, and auxiliary statistical packages. The Submodel Communication Structures (as well as any of the "square" communication structures) may invoke any (or all) of the modeling tools in the submodel development phase. Thus, the development stage of a typical submodel module will consist of a set of individuals, each of whom may be allocated to a number of modeling communication structures (depending on the assignments given by the "leadership set" in the Submodel Development Conference). The modeling paradigms we have presented denote a subset of possible communication-oriented methodologies available to a submodel development team. It should also be noted that each modeling paradigm, should have the flexibility to adapt to the various options under the paradigm heading - for instance, the various approaches to cross-impact analysis adapting and extending these methodologies.

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