A PARADIGM FOR GAME DESIGN

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During the decade of the seventies, there was a steady and increasing demand by real-world clients for serious operational gaming/simulation constructs to be used in actual policy formulation situations. These devices are still under increasingly widespread use, both here and abroad. They are usually employed in a predecision context by top administrative personnel in an effort to communicate more effectively with one another about the problem at hand.[1] The problem is typically a very complex real-world situation characterized by

(1) many variables in interaction;
(2) no realistic basis for quantification of variables or their interactions;
(3) no proven conceptual model or precedent on which to base action decisions;
(4) a sociopolitical context of decision-making where actions of the various "players" may be idiosyncratic or arational;

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(5) a "futures" context; that is, the decision is irrevocable and the results will not be understood until well into the future.

Each gamer develops an approach or paradigm used to guide the design of these gaming/simulation constructs. While these various approaches share some methodology, they also differ, dependent on both the client's objective and the gamer's philosophy. My own persepctive is that games lend themselves particularly to transmitting the character of complex reality;[2] consequently my approach to design is toward achieving that objective.[3] Below are the nine basic steps to game design which I pursue in a disciplined way each time I create a game for a client:

(1) develop written specifications for game design;
(2) develop a comprehensive schematic representation of the problem;
(3) select components of the problem to be gamed;
(4) plan the game with the Systems Component/Gaming Element Matrix;
(5) describe the content of each cell (above, 4) in writing;
(6) search my "repertoire of games" for ideas to represent each cell;
(7) build the game;
(8) evaluate the game (against the criteria of 1, above);
(9) test the game in the field, and modify.

These nine steps have evolved over two decades of using the technique in a wide variety of situations. The steps are described in more detail below.

STEP 1: SPECIFICATIONS FOR GAME DESIGN

This is the specific set of requirements, agreed to in advance by the game builders, describing the expectations and limitations of the game. Before game construction actually begins, the building team needs to determine the game's purpose—the messages to be communicated and the means of conveying it. Game architects need a blueprint composed of carefully delineated, detailed game specifications. At the outset, they need to conform to a plan, providing a clear, concise picture of the product to be created. This prevents unexpected, costly problems from arising later on in the process. There are two resulting advantages:

—*Time-saving.* Agreeing to specifications first tends to speed the design process along. Efficiency is increased, since unforeseen obstacles to progress have been eliminated.

—*Client approval.* The intentions of the client and game designers must correspond. By drawing up game specifications and giving the client something tangible to review, communication can ensue. This permits real differences in message interpretation, purpose, or content to be resolved at the start. These specifications serve, at the conclusion of the field trails of the exercise, as the basis for evaluation of the total effort.

STEP 2: COMPREHENSIVE SCHEMATIC OF SYSTEMS COMPONENTS

This is a specific description of the problem expressed in systems terminology. This is usually achieved through developing "snow cards"[4] by brainstorming, conducting a literature search, and interviewing experts; in turn, these snow cards are then organized into one or more convenient formats (sequential as in a table of contents, conceptual mapping wheel, three-dimensional construct, flow chart suitable for conversion of the system to a digital computer program, and so on).

STEP 3: SELECTION OF PROBLEM COMPONENTS TO BE GAMED

The purpose of gaming/simulation is to provide basis for organized communication about a complex topic. To achieve this objective it is necessary to abstract from the problem set or system those ideas or problem components which require further discussion. This process of abstraction must be guided in the particular by the specifications for game design described earlier. The process itself is quite simple and straightforward. Using one or more of the systems representations above (either the conceptual mapping wheel[5] or the flow chart, for example) and a colored marker pencil, the designer circles those aspects of the system which are considered essential for inclusion in the game.

While this is perhaps one of the most straightforward physical tasks of game design, it becomes one of the most critical in terms of the quality of the final product. There is a strong tendency to put too much detail in the game in recognition of the reality that all things are linked to all things. It is imperative for the team making these decisions to constantly review the "specifications for game design" to ensure a reasonable abstraction process. The specifications for game design serve as the basis or judgmental criteria for making the decision.

STEP 4: PLANNING TO INCLUDE SYSTEMS COMPONENTS IN THE GAME

Having decided *what* game in step 3, it is now necessary to plan *how* to game these systems components in terms of the basic elements of gaming/simulations. This step is achieved through the use of a "Systems Component Gaming Element Matrix." This matrix shows the specific way(s) in which a given systems component will be captured in the game design, game element by game element.

A game/simulation consists of twelve basic elements: (1) scenario, (2) pulse, (3) cycle sequence, (4) steps of play, (5) rules, (6) roles, (7) model, (8) decision sequence and linkage, (9) accounting system, (10) indicators, (11) symbology, and (12) paraphernalia. Any problem to be systematically conveyed through game design must specifically represent the problem components through one or another of these twelve gaming elements. (Sometimes a problem component will appear in several of the gaming elements.)

This process of "mapping" the problem systematically into a gaming element matrix achieves several results:

(1) First, it provides a record of the decisions that are made.
(2) It is a rigorous methodology which permits a deliberate evaluation of each of the components of the problem to ensure that it is considered in the game design phase.
(3) It forces consideration, at an early stage, of precisely how, in terms of the twelve gaming elements, each problem might possibly be represented in the game.
(4) Finally, it provides a blueprint for game design as described in step 5 below.

The twelve gaming elements are described below:

1. Scenario. A scenario is simply a text outlining the plot of the game. It outlines starting conditions and describes circumstances leading into play. It deals with all aspects—economic, social, and political—either presented by text or supplemented with diagrams and illustrations. Role descriptions might be considered a part of the scenario, but are normally offered in a separate section of the concept report. Role descriptions will normally establish initial points of reference and discussion for the players.

2. Pulse. A pulse (see note 3) is some event or problem introduced during the course of play to focus the players' attention on a single aspect of the problem. The pulse may be either designer-induced or player-induced. It may be predetermined, random, or triggered by a certain action in the game. A pulse is an organizational device, used to encourage "multilogue" (see note 3) by forcing players to focus on some shared phenomena. One pulse follows another in sequence (or in complex games, several are simultaneously initiated). Each represents an aspect of the conceptual map. During play of the gaming/simulation, these pulses become tangible handles which allow players to grasp the problem in detail and enter into and explore the gestalt of the total problem situation.

3. Cycle Sequence. Cycle sequence is a relatively simple, but very important, part of game design. There are both micro and macro cycle sequences that must be taken into account. The macro sequence takes into account preconditions to the game; the introductory cycle(s); the final cycle; and the evaluation process associated with the total exercise. The micro cycle takes into account the sequence of things that occur within each cycle, including the initiation, policy, action, and evaluation of each cycle.

4. Steps of Play. Steps of play are the explicit progression of activity in the game. There is a macro cycle in each cycle which includes the four steps, initiation, policy, action, and evaluation. During the initiation, the players read the scenario, take into a cycle any pulses/events/issues that have occurred, and consider any new data availabe to them as a result of the previous cycle. During the action cycle, players make specific decisions according to a given order. During the evaluation phase of the cycle, all play stops and an intellectual discussion ensues, under the direction of the game operation, which addresses two questions: (1) What are the results of the cycle just completed? (2) How does this experience relate to the real-world problem? The next step is always recycling, which proves especially critical—the success of gaming/simulation in conveying problem gestalt (see note 3) is largely derived from the interactive or cyclical nature of these exercises. Learning takes place through repetition of experience. Each cycle, then, reinforces the knowledge gained previously while additional details are introduced.

Steps of play provide the game basic guidelines of progress. Each sequence denotes another set of instructions, which signals some action(s) to occur. Player participation is directed, expected, and stimulated. Players move through the game one step at a time. This makes it easier for the player and the operator. The ultimate goal of the "steps of play" is to increase learning and to enrich knowledge of the system or problem being represented. During the design of a game, it is likely that these steps will be reevaluated and redesigned several times.

5. *Rules.* There are a variety of circumstances that might develop in a game, which go beyond the scope of the exercise. If these are anticipated, the designer can present rules that govern these cases. These should be made clear to the players at the outset, and any changes during play should be posted in a conspicuous way.

6. *Roles.* Roles are characters assigned to players with prescribed patterns of behavior. They are predicted on known real-world counterparts. Participants may play a role similar to their own "real-world" role, but generally it is better to permit the player to experience the game problem system from a position unknown to him/her in reality. Roles are always limited in number to those most central to the problem being studied. There are basically three kinds of roles that can be included within the game design—pseudo, gamed, or simulated.

—*Pseudo roles* are invented frequently on the spot to serve some immediate function. (Examples include judges and technical experts.) When the right situation arises, special participants with unique skills are employed on the spot. Psuedo roles remain unlinked to the basic rule structure, nor are they processed formally through the game's accouting system.

—*Gamed roles* are built into the gaming situation framework and played by real players whose decisions are processed by the game's accounting system.

—*Simulated roles* exist in the accounting system but not physically in the gameroom itself. Often they represent broad classes or categories of people (as in voting models and demographic models). It is often useful to have simulated roles in the gaming/simulation to generate output useful to the gamed or psuedo roles.

7. *Models.* Models are devices derived from the accounting system to keep track of logical processes. They may be simple or complex. They may be expressed in mathematical terms or illustrated graphically. Examples might include the representation of economic process or demographic reality. There are basically three types of models: (1) The heuristic, or homologue, model is

the least sophisticated and used most often. (2) Iconic models given the physical appearance of reality (they need not act like reality); board games serve as an example. (3) Analogue models parallel the real-world phenomena and correspond to the real-world counterparts they represent at least at some level of abstraction. Sophisticated simulation models are an example of the latter.

8. Decision Sequence and Linkages. The sequence of decisions and linkage between players' actions must be understood before the game is built. These represent the typical sequence of decisions that players can make during a normal cycle of play. Often these are developed through the use of a matrix: Across the top of the matrix are all of the gamed roles; down the left side are the steps of play. This schematic is intended to answer the question: *Who* is doing *what, when,* and *how*? It also provides data on information flows and feedbacks, role-to-role and role-to-accounting system. Generally, this matrix depicts the activity and intellectual process of each role during consecutive steps of play.

The purpose of this matrix is to assist the game designer in visualizing the sequence of play when the game is finished. The matrix helps to identify role linkages within the game framework, to chart the foreseen reactions of the participants to events during play, and to provide an initial analysis of all gamed, pseudo, and simulated role results before play begins.

When completed, this matrix gives some early insight into the totality of the game during play. In evaluating the contents of the matrix, the need will arise to adapt or change roles for one of several reasons. Players must be more or less equally loaded so that they are all more or less evenly occupied during the presentation. It is also necessary during an analysis of this chart to ensure that decisions are sequenced properly, one behind the other, so that necessary feedback takes place. Finally, the matrix can be used as an aid in explaining to others the sequence of events occurring during a typical game run.

9. Accounting System. The accounting system is a set of fixed procedures incorporated directly into the game to deal consistently with player decisions. These decisions—outcomes of steps of play—are processed, acted upon, and forwarded to some other game component, feeding back either into an indicator, model, role, or some combination of the above. An infinite variety of accounting systems exist. Game designers must develop a system suitable to the particular exercise. In the final analysis, the accounting system must be devised to deal in a rigorous and consistent way with all of the information contained in the cells of the Systems Component/Gaming Element Matrix described earlier in this article.

Having selected and defined the gaming elements from the Systems Component/Gaming Element Matrix, a procedure for their activation must be devised and implemented as an accounting system in the gaming/simulation. This accounting system may be simple or complex, it may maneuver players' responses through models, simulations, or very simple algorithms, and it may or may not use a computer. It will always be reported out to the players through various indicators which will be displayed on forms, wall charts, and playing boards. Whenever possible, it is desirable to have the players individually keep the accounting system. This gives them a better understanding of the problem being considered and saves a great deal of work for the operator.

Regardless of the format or the combinations employed, the accounting system will inevitably be sequential. This requires very sophisticated judgment by the builders of the exercise to ensure that the sequence of decisions, as represented by the systems of accounts, at least integrates into a larger system or gestalt experience.

10. Indicators. Indicators are those aspects of the accounting system that the operator chooses to emphasize for the participants. They report on the game's progress—the interaction of player's decisions as filtered through the accounting system and linked to the models.

11. Symbology. Symbology is the physical representation of indicators. These are visual aids comprising a set of characteristics about some gamed phenomenon. Symbology is game-specific in that the materials lose meaning outside of the playing arena. They are comprised of extemporaneous material like cardboard chips or wooden blocks, and are integrated into the game to portray some reality such as the land-use or building pattern. Symbology may be any tangible replication incorporated into play to embellish, as well as convey, meaning. Players are asked to focus their attention on these items. to address and manipulate them according to procedures.

During this stage of the design process, experimentation with the symbolic structure occurs. It must be the goal of the game builders to gain maximum clarity for the players. To minimize confusion during play, it is necessary to be parsimonious in the selection of these gamed materials.

12. Paraphernalia. Paraphernalia includes everything else required to successfully run the simulation exercise. The material ranges from the decision forms to the wall charts to colored pens and the game board itself.

STEP 5: SUMMARIZING THE CONTENT OF EACH GAMING ELEMENT

To build a gaming/simulation, then, it is necessary to define each gaming element along two dimensions: (1) its substantive content, and (2) the gaming mechanisms that are thought to be appropriate for representing this content in the game. To describe the *content* of each game element, one summarizes the notations from all cells for each column of the Systems Component/Game Element Matrix.

To obtain the first information; that is, the content which must be included under each of the indicated game elements, the game-building team simply makes a summary notation of all of the notations of each cell of the appropriate column for the Systems Component/Game Element Matrix developed under step 4. For example, under the column, "roles," the sundry rows of the matrix describing the problem in a systematic way will reveal those decision makers that have to be included. By listing all of those (going down the column) a complete list of roles that must be represented can then be included.

STEP 6: SELECTING GAMING MECHANISMS FROM ONE'S REPERTOIRE OF TECHNIQUES

Next, using ideas from his or her "repertoire of games," the game builder describes ideas about how each of the gaming elements will be represented. This is best done by going down the game element listing, point by point, as one lists the gaming technique which seems most effective.

STEP 7: GAME CONSTRUCTION AND TESTING

Game construction is an iterative process.[6] The experienced game designer will first attempt the design of the game at a very rudimentary level. These preliminary efforts are used primarily to help the game design team conceptualize the problem as it might be converted into gaming/simulation format. It is important to capture the design blueprint in a written concept report before game design begins in earnest. The concept report achieves three major objectives:

(1) It ensures that the game designers go through a deliberate process which takes into account the several steps noted above. This is more efficient and results in better game design than does a random process.
(2) It provides a very sharply delineated and documented basis for the client to review the expected product in its conceptualized stage. Gaming/simulation is a client-oriented tool and the concept report helps to ensure that the final product is useful to the client.
(3) Finally, the concept report serves as a blueprint or working document for the design team during the construction phase.

Actual construction is a trial-and-error process which progresses as follows: Each game element is built (designed, written, conceptualized). As the team progresses down the list of gaming elements, these are continually checked, one against the other, to ensure that they dovetail or "fit." When all gaming elements have been completed as initial, rudimentary, or trial efforts, a series of gaming "walkthroughs" are attempted. At this point, the "rule of ten" comes into play. The game builders must recognize that the early cycles or game runs will be full of difficulties. They will be pleasantly surprised, however, to discover that by the second, third, or fourth run, the form of the game will clearly emerge. To ensure that the final gaming/simulation product is reasonable, testing must be governed by the "rule of ten." That is, a game should be presented as complete only after it has been tested with appropriate audiences on ten separate occasions, the final three of which should require no further significant adjustment or modification to the gaming/simulation. The "rule of ten" goes through three more or less distinct phases:

—Trial construction or testing as an iterative process. In this, the design team "talks through" the game, considering various mock-ups and carrying the process through its logical processes.

—Pretesting corresponds to a "dress rehearsal." The entire product is tested with a small group of participants. Participants include the deisgn team and a few colleagues and interested volunteers.

—Formal testing ensues after most "bugs" have been eliminated. This entails more rigorous evaluation of the finalized version before it is turned over to the client.

The client, participants, and game designers must all recognize that many different runs may be required before the game is finally calibrated. In fact, there may never be a time when a "final" game exists. More likely, the users will find that continuous modification of the game is productive throughout the lifetime of its use.

STEP 8: GAME EVALUATION

After the game has been completed and turned over to the client for field use, it is necessary for the client to evaluate the product. The only logical basis for evaluation of the gaming/simulation is the original "specifications for game design" described earlier. These were the guidelines approved by the sponsor in advance, and they must serve as the basis for evaluating the product. At this point it becomes clear to both the game builders and the client that the more specific and plausible the original "specifications," the more clear-cut becomes the final game evaluation.

STEP 9: FIELD USE OF THE GAMING/SIMULATION

Once the gaming/simulation has been designed, tested, modified, and evaluated, it is time to put it into field use. Field use will normally require the training of appropriate game operators. This can be accomplished through holding workshops for those who intend to use the game, or by sending trained game operators into the field to assist in the actual use of the exercise. While the operation of the game may seem formidable to the neophyte, field experience with complex games like the F.A.O. gaming/simulation SNUS (Simulated Nutrition System; see Duke and Cary, 1975) indicates that it is not difficult to achieve adequate field use.

Finally, a distribution plan for the gaming/simulation is essential. Responsibility for distributing the game must rest clearly with an existing institution or commercial firm. This institution or firm should be authorized to duplicate the materials, train operators, and arrange for field use and demonstrations.

NOTES

1. A recent example is CONRAIL, the Consolidated Rail Corporation, which used a gaming/simulation to explore the probable impact of railroad deregulation on its operations. Participation in this exercise ranged from the various vice-presidents in charge of the several corporate function areas, to the board. Subsequently it has been used throughout the corporation, as well as with most competition and the regulatory agencies, to illustrate CONRAIL's thinking on the issue. The exercise, of course, changed considerably over the original six months of intensive use (see Duke and Cary, 1979).

2. *Complex reality:* a complex, interactive, and/or dynamic system, either abstract or concrete.

3. Gaming/simulation: a gestalt communication mode which contains a game-specific language, appropriate communication technologies, and the multilogue interaction pattern.

Gestalt: "a structure or configuration of physical, biological, or psychological phenomena so integrated as to constitute a functional unit with properties not derivable from its part in summation" (Webster's *Third New International Dictionary*).

Communication mode: a form of communication composed of a language, a pattern of interaction, and a communication technology.

Game-specific language: a symbol set and its conventions of use, unique to a given game.

Communication technology: a device for encoding, transmitting, and decoding a message.

Multilogue: multiple, simultaneous dialogue organized by pulse.

Pulse: a problem, issue, alternative, or information presented to the players through the game, used to trigger an exchange of messages between players.

These preceding definitions are derived from Duke, 1974. Section two of that work explains the communications approach to gaming in detail.

4. *Snow cards:* Small scraps of paper used to capture a single idea, concept subject, or concern of the participants trying to capture an image of a "complex reality" (see note 2, above).

5. For a complete description of the conceptual mapping technique, see Duke and Greenblat, 1979.

6. For a more complete description of the game design process, see Greenblat and Duke (1975: Part II).

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