THE METHODOLOGY OF EDUCATIONAL SIMULATION AND DESIGN OF A SIMULATED INSTRUCTIONAL MODEL FOR OCCUPATIONAL EDUCATION

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ABSTRACT

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by

Omotosho Ogunniyi

The Problem

Although educational simulation has been widely used in civilian education within the past ten years, the theoretical principles undergirding the application of the technique in education are still obscure or at best fragmentary and scattered. Practitioners have no guiding principles for designing educational simulations and the teachers who use them possess no clear-cut criteria for planning, executing, and evaluating instructional simulation.

The problem, therefore, in this study was (1) to synthesize, analyze, and evaluate critically, all kinds of simulations: simulators, computerized games, in-basket simulation, for example, and (2) to derive integrative theoretical principles which explain and clarify the methodology of educational simulation, particularly as it relates to (a) the design and (b) instructional application of educational simulation, (c) the operational criteria for instructional simulation, and (d) the design of an instructional model for occupational education.

Methodology of the Study

The procedure for the research included an extensive and critical review of literature on educational simulation, observation of educational simulations, discussions with users, designers, and proponents of

educational simulation, and deductive abstraction. One educational simulation was observed under laboratory conditions during the learning and teaching situations. The literature on related psychological studies was reviewed also. Educational simulations (from computer to iconic models) were arbitrarily classified under four rationales: philosophical, mechanistic, psychological, and sociological.

From the analysis of the theoretical principles, six major criteria for administering a simulated instruction were derived and the extent to which five selected educational simulations conform with these criteria was investigated. These criteria are: (1) the selection of a model, (2) the orientation of students to the objectives and performance standard of the simulation, (3) simulated curriculum plan, (4) simulated instructional process, (5) simulated practice, and (6) simulated environment. The criteria were found to be operationally essential for simulated instruction but there was no agreement on evaluation procedure.

The six criteria were modified and a seven-process simulated instructional model for occupational education was designed. The functions of each of the processes were described and guidelines provided for utilizing the model and for rectifying dysfunctionality that may arise.

Major Findings

The study showed that the focus of all educational simulations, no matter the orientation of the designer, was the provision of realistic instruction. Simulation offers laboratory-type experience to the learner under conditions that replicate the operational situations of real-life. Gaming is a useful technique for indicating interactive processes but it is not the *sine qua non* of simulation.

As far as the design of educational simulation is concerned, a network of interrelationships color the methodology in design irrespective of the field of application. Transfer of training is the main criterion for deciding what to include in a simulation design. All simulations are represented by animated or synthetic materials to depict real-life characteristics. However, simulation devices are chosen by designers largely on the basis of the designer's sophistication, knowledge of the model, the resources available to him , and the suitability of the synthetic or animated materials for representing the abstracted characteristics. A simulation design needs to incorporate at least five criteria: a stimulus situation, a response situation, a consequence situation representing the interaction of stimulus-response, a feedback sequence, and a control. Thus the S-R theory is basic to all educational simulation designs. The importance of terms such as fidelity of simulation, degree of simulation, games, verisimilitude, simulated evaluation was clarified.

It was found that every simulated instruction is a pragmatic pedagogical approach which gives realism, meaningfulness, and utility to knowledge through the provision of participative experiences which are offered the students in the microcosm of the real-life. Simulated instruction can be described as learning by doing. It demands the application of integrated knowledge in meaningful and realistic exercises which test the application of procedure, motor-skills, identification, concepts, principles, and strategies, or the combination of any of these. In simulated instruction, terms like orientation, simulation objective, briefing, play, debriefing, feedback, simulated practice, transfer and simulated evaluation are relevant.

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Dedicated to my parents, Akebaje and Towobade, my uncles, Ola and Otunla, and my aunt, Mojirade, for their love and responsibilities for my early education.

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CHAPTER I

THE PROBLEM, OBJECTIVES, AND PROCEDURE

I. THE PROBLEM

Although educational simulation has been widely used in civilian education within the past ten years,[1] the theoretical principles undergirding the application of the technique in education are still obscure or at best fragmentary and scattered. Practitioners have no guiding principles for designing educational simulations and the teachers who use them possess no clear-cut principles for planning, executing, and evaluating instructional simulation.

The problem, therefore, in this study is (1) to synthesize, analyze, and critically evaluate all kinds of simulations: simulators, computerized games, in-basket simulation, role-playing simulation, and operational gaming, and (2) to derive integrative theoretical principles which explain and clarify the methodology of educational simulation, particularly as it relates to (a) the design and (b) instructional application of educational simulation, (c) the operational criteria for instructional simulation, and (d) the design of an instructional model for occupational education.

In order to present a clear understanding of the problem, it is

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[1]Increased popularity of simulation in civilian education began after Neumann and Morgenstern's Theory. C. J. Thomas, "The Genesis and Practice of Operational Gaming," Proceeding of the First Conference on Operational Research, Baltimore, ORSA, 1957, pp. 64-81. The American Management Association began the trend in business administration.

essential to provide an overview of the status of simulation in education and discuss briefly the dimension of the methodological problems. This overview will summarize the status of the field and the lack of theoretical rationale for its application. Also, the theoretical problems as they relate to design and utilization of instructional simulation will be reviewed.

The Status of the Simulation Art in Education: Educational simulation has ceased to be a super-science and has crossed the traditional boundary of military training, where it was once thought to be exclusive. Its application has now spread across all levels of education--elementary, secondary, college, business and industry. It is being used for training hospital administrators,[2] doctors,[3] and business executives.[4] Universities and teacher training institutions apply simulation to the training of teachers.[5] Urban planning educators see its usefulness in developing understanding of urban affairs concepts.[6] In political science, simulation has been found to be a useful technique for stimulating the learning of

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[2]Karl G. Bartscht. Hospital Administration Decision Simulation. (Ann Arbor: Department of Industrial Engineering, University of Michigan, June, 1962).

[3]The American Orthopaedic Association is using in-basket simulation as part of its total educational program for orthopaedic surgeons.

[4]Many Graduate Schools of Business, including Harvard, Cornell, Stanford, UCLA, MIT, NYU, and Carnegie Institute of Technology, to name a few, use simulation.

[5]The Oregon State System of Higher Education has developed a classroom simulator which is being used for training elementary school teachers. Also, Michigan State University has a brand called Professional Decision Simulator for training pre-service teachers.

[6]Cornell, Michigan State University, University of Michigan, and a few other universities use simulation in urban planning programs at graduate and undergraduate levels.

theoretical concepts associated with international relations.[7] Even in academic subjects the use of simulation in subjects like history, logic, mathematics and economics is becoming more and more popular.[8] A most recent application to an academic subject is the High School Geography Project (HSGP) sponsored by the Association of American Geographers. This simulation is being field-tested in 22 states and is drawing the attention of about 20,000 educators.[9] The non-school use of simulation is spreading also.[10]

This growing popularity has been accompanied by the lack of a clear and succint theoretical exposition of simulation technique which can guide instructional designers, teachers, and other users in the design and the application of instructional simulations. Also, despite the evidence of a number of studies pointing to the effectiveness of simulations in given instructional programs, the contribution of instructional simulation to total learning has been inconclusive.[11] Thus it would appear that simulation, as an instructional tool, in the absence of a clear enunciation

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[7]Northwestern University and Kansas State Teachers College pioneered the application of simulation in political science.

[8]See Appendix A for a listing of designers and distributors of these games.

[9]Education U.S.A. A Special Report on Educational Affairs, Washington, D. C., September 9, 1968, p. 7.

[10]Over 3,000 designs are available now. Twelker, Paul A.: "Simulation: Status of the Field." Paper presented at the Conference sponsored by the Commission of Educational Media for ASCD, NEA, Boston, October, 1968.

[11]Cleo H. Cherryholmes. "Some Current Research on Effectiveness of Educational Simulations: Implications for Alternative Strategies," American Behavioral Scientist, Vol. X, No. 2, October, 1966, pp. 4-7.

of its theoretical principles, has nothing to recommend it as a defensible pedagogical approach. Therefore, to have a defensible position for its judicious use in the classroom, there is a need to clarify the framework of its operation and evaluation.

There is a need to bridge the gap in the knowledge about simulation design and the process of optimizing instructional simulation. Because practice in this instructional approach is hitherto varied and complicated by divergences, there is a need to systematize and integrate the basic principles for educational simulation methodology.

Pronouncements by knowledgeable educators and psychologists support the belief that simulation is effective for professional development in many occupations.[12] While it is believed that simulation may not be the panacea to learning, it is believed that it has the potential of proving to be the most effective teaching technique of converting "knowledge" or "theory" into practical action in a situation which approximates real-life.[13] Therefore, there is a need for "developing a sound professional operational doctrine"[14] which could become an important part of the "trick of the trade" which educators can apply to solve some of the pressing

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[12] R. M. Gagne. "Simulators" in Robert Glaser (ed.). Training Research and Education, (New York: John Wiley & Sons, Inc., 1965), pp. 239-243; Paul A. Twelker, "Simulation: Status of the Field", op. cit.; James S. Coleman, "More Games Urged", Education U.S.A.: A Special Report on Educational Affairs, Washington, D.C., November 6, 1967, p. 57. Indeed simulations have been applied to professional development of teachers, nurses, dental and orthopaedic surgeons, and technicians. (Full references given in the bibliography).

[13] Gagne, op. cit., p. 241.

[14] Ibid.

problems of education, particularly of bringing relevance into the classroom learning.[15]

Methodological Problems of Educational Simulation

In order to understand the nature of methodological problems with which this study is concerned, it is essential to discuss at some length the crucial issues relative to the theoretical principles undergirding the design and utilization of educational simulation. This discourse represents an assessment of the nature of the problems as seen by leading proponents of educational simulation.

A. The Design Problem. Cherryholmes considers simulation design as one of the major problems in educational simulation. He specifically refers to the problem of constructing or designing a simulation and "building an explicit theory about a referent system."[16] He goes on to say that: "constructing a good simulation is not easy. . .The subject matter of the course must be arranged to present basic facts and features of the referent system. . ."[17] He suggests an alternative to designing good programs by advocating a strategy which enables the students to validate theory embedded in a simulation by a variety of comparisons with the real-life referent system. He is of the opinion that students should be encouraged to construct their own simulations. His view is supported by Herron who holds that students can learn a lot more about a subject if they are given an opportunity to have a close study and

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[15] Ibid.

[16] Cherryholmes, op. cit., p. 7.

[17] Ibid.

evaluate the design of the simulation.[18] Such a step will establish students' confidence in the objectivity of the simulation. Useful as these declarations are, their shortcoming lies in the lack of explicit clarification of the approach to the desirable objectives they advocate.

Guetzkow notes there is a need in giving the specification of educational simulation. In presenting some guideposts for constructing simulation models, he suggests: "Simulation must be grounded in explicit specification of a basic set of variables and programmed relations among them."[19] He argues that in constructing a simulation model in education there is a need to build into the design the "isomorphism of the environment", the "prototypic variables" and other "core variables" that undergird the nature of reality being simulated.[20]

Vance is concerned with <u>the problem of establishing procedure in simulation</u>.[21] He contends that establishing the procedure for simulation is a paramount desideratum if such a "make-belief" is to become a useful learning process. To Vance, certain "<u>strategic variables</u>" must be built into a simulation game before its conclusion can be valid. He suggests that <u>there must be basic planning in designing simulation</u> and ". . . in the <u>application of pertinent concepts and the requisite sequence</u>. . ." if the participants are to benefit in using simulation and games as "an extremely

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[18]Lowell W. Herron. <u>Executive Action Simulation</u>. (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1960), p. iv.

[19]Harold Guetzkow (ed.). <u>Simulation in International Relations</u>. (Englewood Cliffs: Prentice-Hall, Inc., 1963), pp. 104-106.

[20]<u>Ibid</u>.

[21]Stanley Vance. <u>Management Decision Simulation</u>, (New York: McGraw-Hill Book Co., Inc., 1960), p. 3.

useful workshop" in which they can gain experience in decision-making.[22]

B. The Problem of Utilization of Instructional Simulation. There is no agreement on when and how to use simulation for instructional purposes. Some educators believe that simulation is only a "blender" to learning. It is useful only after the learner has gone through some initial learning. Gagne argues that simulation is most useful for advanced learning, for consolidation of skill, and for maintenance of proficiency. He contends that "Simulation has its greatest and most obvious usefulness in application to second stage of the process of acquiring skill."[23] He thinks that application of simulation to initial stages of learning is both highly expensive and inefficient. To Gagne, the initial knowledge is the "raw materials" which simulated instruction uses to build performance knowledge.[24]

Some simulation designers consider the problem of class size in a simulated instruction. Both teachers and designers of simulation are concerned about clarifying the structure of learning and teaching in a simulated environment. Cohen, Cyert, Dill, Kuehn, Miller, Van Wormer, and Winters[25] stress the importance of the process of simulated instruction and emphasize the need to pay attention to such factors as team structure, time per move, spacing of moves, information flows, and stability of

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[22]Ibid., p. 7.

[23]Gagne, op. cit., pp. 233-243.

[24]Ibid., p. 235.

[25]K. J. Cohen, et al., 'The Carnegie Tech Management Games", in Harold Guetzkow (ed.), Simulation in Social Science: Readings. (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1962), pp. 118-121.

team membership in administering management simulation games.[26]

Inbar too has indicated that a crucial variable in instructional simulation is the size of the playing group. He observes that:

> In overcrowded groups the players learn the rules of the games less efficiently, interact less, are less interested in the session and participate less actively in it; as a consequence, they tend to play a lesser number of moves and the impact of the game is weaker.[27]

In using games in management decision simulation, Vance finds that an important step in playing a simulation game is setting out the fundamental objectives of the game and also providing "an organizational structure for each team" playing it. This reference points to the importance of setting the size of an ideal class for simulation instruction.[28]

Twelker poses a more fundamental problem in instructional simulation. He holds the position that educators cannot optimize the advantages inherent in instructional simulation unless they develop a philosophy of simulation which describes its nature in education and which systematizes the procedure for its application. He challenges educators to think in terms of bridging the gap between theory and practice in simulation. He calls upon them to give consideration to enunciating and elucidating "how simulation experience is utilized", "the quality of the instructor", the "debriefing", and also "the development of syllabus" for simulated

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[26] Ibid.

[27] Michael Inbar. "The Differential Impact of Game Simulating a Community Disaster". American Behavioral Scientist, 1966, 10(2), p. 26.

[28] Vance, op. cit., p. 7.

instruction.[29] What Twelker seems to be suggesting in this injunction is that it is no longer an intellectual question whether simulation can be used in education; it is now a question of how simulation can be used.

There has also been the question of the assessment of learning during simulation. Most simulations have involved practices described in various terms--"plays", "runs", "programs", "units"--through which the learner passes during the simulation experience. There are either weaknesses in evaluation or failure to evaluate pre-simulation entry-knowledge and post-simulation terminal knowledge. In many cases, simulation objectives are not clearly stated and whatever learning that takes place is hard to evaluate. Boocock notes that because there is no guiding theory, there has been very little empirical evidence supporting the effectiveness of simulation.[30] Carter thinks that we have to develop some reliable assessment for determining what has been learned and how it has been learned.[31] Criteria must be set up for assessing what has been learned in a simulation. He suggests that performance must be measured before the simulation and after it (several months after simulation experience).[32]

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[29] Paul A. Twelker. "Simulation: What is it? Why is it?" (Paper presented at the Conference, Simulation: Stimulation for Learning, sponsored by the Commission on Educational Media of the Association for Supervision and Curriculum Development, NEA, at San Diego, California, April, 1968.)

[30] S. S. Boocock and E. O. Schild (eds.). . Simulation Games in Learning, (Beverly Hills, California: Sage Publications, Inc., 1968), p. 14.

[31] In R. Glaser, op. cit., p. 422.

[32] Ibid., p. 424.

Carter also mentions the degree of transfer from the game to real-life situation. Gagne's position in this respect is persuasive. He does not consider that simulations are designed for the purpose of predicting performance in a real operational situation as an aptitude test.[33] He thinks it is an "illegitimate" question to ask whether assessment of performance in simulation will be valid in terms of performance in real-life. He argues that a simulation is not real-life; it is a representation of real-life. Therefore, the degree to which a simulation represents the real situation can certainly be measured in a direct manner in terms of the amount of transfer. "To the extent that the simulator is 'real' the performance is 'real' and one cannot define something which is 'more real'."[34]

From the foregoing it can be concluded that simulation has not acquired nor formalized its own techniques for educational purposes. In this regard it is unlike the conventional method of learning for which there are theories for research. Because the procedure for instructional simulation has neither been formalized nor clarified, there is a hiatus in our knowledge of the concept and its application. In civilian education, simulation has not enjoyed substantial adoption and there is the suspicion of it being another "methodological white elephant" in the classroom. Indeed, while progressive adminstrators may consider simulation "great", there are still many teachers at operational levels who believe its use to be the exclusive preserve of smart "master teachers" who belong

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[33] *Ibid.*, p. 237.

[34] *Ibid.*

to the "select family of simulation experts and enthusiasts".[35] Boocock observes[36], however, that while the mass media and television have popularized simulation in the classroom, there is still a considerable demand for information on how it can be used as a teaching tool.

In conclusion, if simulation, as applied in education, is not to become a casual technique in educational technology, a knowledge of its theoretical parameter is desirable.[37] To use Boocock and Schild's phrase, we require "explicit theoretical rationales" for simulation games in order to make a defensible use of it in the classroom. As Fattu observes, even though simulation has a great potential for improving educational practice, "whether simulation proves useful to education depends ultimately upon the standards set for such a practice by the profession, and upon the support it is able to obtain from the public".[38]

II. ASSUMPTIONS AND DEFINITION OF TERMS

A basic assumption in this study is that educational simulation (as defined below), is a phenomenon that can be observed and analyzed systematically as a set of instructional processes which are dynamically interrelated.

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[35]S. S. Boocock and E. O. Schild, op. cit., p. 14.

[36]Ibid., p. 14.

[37]Boocock and Schild put the blame for lack of theoretical foundation in simulation technology on simulation designers. They say: "To some degree, the designers of games are to blame for this situation. They. . . have been so fascinated with the possibility of really changing cognitions, attitudes, skills in real life, that they did not pause to undertake the particular type of experimentation needed to unravel the specific variables involved. . . .", Ibid., pp. 22-23.

[38]Nicholas A. Fattu. "An Introduction to Simulation" in Nicholas A. Fattu and Stanley Elam (eds.), Simulation Models for Education, (Bloomington, Indiana: Phi Delta Kappa, Inc., 1965), p. 24.

Simulation[39]: Simulation, when used without qualification, is used in its generic usage and is operationally defined as a dramatic activity, condition, or process that involves manipulative transaction or the interaction of abstracted elements of real-life with a motive to induce a phenomenal experience or state that replicates real-life.

Educational Simulation[40]: Educational simulation is defined to be any model, or process that is an abstraction of real-life used for instruction to provide educational experiences that elicit life-like behavioral responses.

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[39]The term "simulation" has been defined in many ways by many scholars in science and technology. Thus, there are many definitions of simulation. In spite of this, there is some consistency in its usage by people regardless of their academic orientation. There is, for example, an agreement that simulation is an "abstraction of real-life and not real-life itself". Since a number of scholars have reviewed the definitions of simulation, it is not necessary to duplicate this effort in this study. Harman (1961) perhaps does a better job than most reviewers in this connection. He offers that "perhaps the simplest and most direct definition of simulation is merely the act of representing some aspect of real world by numbers or symbols that can be easily manipulated in order to facilitate study". Harry H. Harman. Simulation: A Survey. Proceedings of the Western Joint Computer Conference, Los Angeles, California, 1961. McCormick is another person who has attempted to define somewhat precisely what simulation is. He says: "simulation consists of some type of reproduction or representation of an actual or conceptual physical object, system, process, or situation, or of a theoretical construct". E. J. McCormick., Human Factors in Engineering, (New York: McGraw-Hill, 1964). Thomas and Deemer have stated that "to simulate is to obtain the essence of, without the reality". C. J. Thomas and Deemer, Operational Research, January, 1957, pp. 1-27.

[40]The formulation of this operational definition of "educational simulation" is based on pioneering analysis of the nature of instructional simulation by Twelker, particularly his reflection on "Towards a Definition of 'Instructional Simulation'." Twelker argues, and this researcher agrees with his view, that instructional simulation may be a "model (physical, iconic, verbal, or mathematical) of some aspects of a real or proposed system, process, or environment". Paul A. Twelker., Simulation: An Overview, unpublished paper, Oregon State System of Higher Education, n/d, pp. 8-46.

Occupational Education: Occupational education is any formal education and training[41] (part-time or full-time) whose primary objective is to prepare the learner for a career role in any profession or employment.

III. OBJECTIVES OF THE STUDY

The major purpose of this study is to pull together what is known about the methodology of educational simulation and to synthesize this into an integrative theory which can be used to build a simulated instructional model for occupational education. Specifically, the purpose of the study is fourfold:

1. To analyze and synthesize theoretical principles underlying different types of educational simulation.
2. To develop an integrative theory for educational simulation which will explain (a) the theoretical principles underlying educational simulation designs; (b) the theoretical principles underlying instructional application of educational simulation.
3. To develop theoretical, operational criteria for instructional simulation strategy from the integrated theory and use these criteria to evaluate the practice of simulated instruction in

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[41]The term "education and training" is used advisedly. Although a distinction can be made between education and training, it is held that occupational education involves both. "Education" is seen as a process of awakening a student's intellectual understanding of why a method or procedure is carried out, or why an activity is performed. "Training" is seen as the application of teaching methods to the problem facing a student to enable him to understand how a method, process, or a complete activity is carried out. It includes also, imparting of a degree of skill and competence to the student in actual performance situations. ct. Gagne and Fleishman's definition of "training" as "the set of conditions employed to increase the level of performance of some human function by means of learning". R. M. Gagne and E. A. Fleishman , Psychology and Human Performance: An Introduction to Psychology. (New York: Henry Holt and Company, 1959), p. 394.

selected instructional simulations and to determine how the theoretical propositions operate in practice.

4. Based on the analysis, to develop an "optimum" simulated instructional model (SIM-INST Model) for planning, managing, executing, and evaluating simulated instruction for occupational education, and to provide guidelines for utilizing it.

Possible Outcomes

This study may be described as opening the "black box" of educational simulation methodology and the outcomes of the study may prove to be more far-reaching than suggested below:

1. Because the integrative theoretical principles will essentially be an inventory of "a priori" routes to simulation methodology in education, the systematic organization of the principles will lead to a development of a taxonomy of instructional simulation.
2. Success in such an effort will facilitate the refinement of the criteria of instructional simulation and the development of a more useful taxonomy of instructional simulation.
3. The study will provide guidelines for reconstruction and improvement of existing and future designs of educational simulations.
4. The guidelines provided will be useful in programming sequential learning units either to a definite or finite level according to the level and the needs of the learner since instructional simulation possesses much flexibility. This will be most useful for designing simulations for speedy development of any specific occupational role that may be critically needed by the society.
5. The principles set out in the study for instructional simulation

will be a useful "cookbook" for the design of "home made" simulations by teachers and students. The study will provide an enlightenment for instructional simulation designs and will uncover some of the pitfalls that characterize designs not rooted in clear-cut theoretical principles. In addition, it will draw the attention of curriculum designers to the importance of constructing simulated instructional objectives and the process of evaluation of simulated learning outcomes.

IV. PROCEDURE OF THE STUDY

The premise on which the procedure for this study is based is that the utilization of simulation as a viable learning methodology emerges from certain explicit or implicit rationales and assumptions that are embedded in educational simulations and are held by the designers and users of educational simulations. The nature of the theoretical structure undergirding educational simulations can be explained through critical examinations and observations of existing simulations used in classroom settings and by clarification of the principles adopted for the instructional procedure.

Therefore, for the purpose of deriving the general integrated theory of educational simulation, a general survey of simulation practices in education will be made, and a classificatory analysis of the typology of educational simulation will be presented. The functional criteria for all types of simulations will be described, and the underlying principles will be clarified. From these principles describing the operational criteria of educational simulation, an integrative theory of educational simulation will be formulated.

Five educational simulations, described below, are selected for study. Their operational criteria under instructional settings will be compared with the theoretical operational criteria, and differences and similarities will be discussed.

The five designs studied are:

1. Cornell Community Land Use Games (CLUG) for training and education of Urban Planners, developed by Allan G. Feldt.[42]
2. Integrated Simulation: An Interactive General Business Simulation for Management Education, developed by Smith, Estey, and Vines.[43]
3. Inter-Nations Simulation (INS) designed by Cherryholmes.[44]
4. Simulation in the Classroom, designed by Kersh for teacher education.[45]
5. Simulation for Vocational Office Education (VOB), designed by Michigan State University and Beverly Funk, for vocational education of office workers.[46]

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[42] Allan Feldt. The Community Land Use Game, (Ithaca, New York: Cornell University, 1966).

[43] W. Nye Smith, Elmer E. Estey, and Ellsworth F. Vines. Integrated Simulation: An Interactive General Business Simulation Designed for Flexible Application in Management Education, (Cincinnati: South-Western Publishing Company, 1968).

[44] Cleo H. Cherryholmes. "Simulation in Internation Relations: Development for High School Teaching". (Unpublished M.Sc. Thesis, Kansas State Teachers College, Emporia, Kansas, 1963).

[45] Bert Y. Kersh. Classroom Simulation: A New Dimension in Teacher Education. U. S. Office of Education, NDEA Title VII, Project No. 886. (Monmouth: Teaching Research Division, Oregon State of Higher Education, June, 1963).

[46] Michigan State University, Vocational Office Block, Project 201, Research and Development Program in Vocational-Technical Education, Michigan State University, East Lansing, 1967.

Appendix B gives brief information about each of the simulations.

Criteria for Selection: The criteria used for the selection of these simulations are:

1. All the selections fall within the framework of and satisfy the canons of the definitions of simulation as operationally used in this study.
2. The simulations selected are easily available and the materials for providing instructions with them exist.
3. The simulations are used for instructional purposes and therefore have passed the test of experimentation in either secondary or college or special education programs.
4. Each of the simulations has materials and guides that are specifically prescribed for the teacher and learner using the simulation.
5. The simulations are used in educational settings with the objectives of teaching certain specified rules, principles, and application of knowledge within specific disciplinary areas. Thus, educational goals are set in terms of the learner's expected behavior, action, response, and thought in consonance with specified real-life model.

METHODOLOGY:

The following methods of investigation were used for the purpose of deriving the undergirding theories of educational simulation:

1. Critical survey and review of research studies on simulated learning.
2. Laboratory observations of one simulated design through self-study

and exposure to the simulation in order to understand and identify the functional instructional criteria of the simulation.

3. Comparative review and analysis of the other four educational simulations. The theoretical criteria proposed were used for evaluating the functional criteria of the instructional processes adopted by the four simulations.
4. Personal communication and dialogues with proponents and designers of educational simulations.

The simulation which was observed under teaching and learning conditions was the CLUG. It was selected for study because of the accessibility of the instructional location to the researcher and the advantage of getting first-hand information from the designers and users.

METHOD OF ANALYSIS:

The general review of educational simulation practices was done by a broad classification of simulation rationales in education. Four schools of simulation rationale were identified: (1) the philosophical school, (2) the mechanistic school, (3) the psychological school, and (4) the sociological school. The features and principles underlying each of these schools were discussed. The theoretical principles were synthesized for (a) design, and (b) instructional application of educational simulation. These were proposed as an integrative theory of educational simulation. The nature of this theory is described in Chapter III.

Six operational criteria for administering an instructional simulation were derived from the theoretical principles. The practice of five selected simulations were evaluated with these criteria. The results of the analysis are discussed and tabulated in Chapter IV.

In order to design a model for occupational education, a number of assumptions were made about the nature of occupational educational and occupational instruction. Based on the theoretical structure of Chapter IV, a simulated instructional model (described as SIM-INST Model) for occupational education was designed comprising seven processes. The functions and relationships of these processes are discussed in Chapter V.

A flow chart describing diagramatically the research methodology for this study is contained in Figure 1, page 20.

V. DELIMITATIONS

In this study, the following delimitations are specified:

1. In developing the integrative theory and principles of instructional simulation, the sources of data used are limited to simulations used in the classroom setting for educational purposes. (See page 16 for some examples).
2. This study does not have as its purpose the development of simulated script and scenario, although general guidelines for designing simulated instructional materials will be given.
3. The SIM-INST Model designed for occupational education is not one of the models that calls for validation in the nature of stochastic, probablistic or deterministic model. It is a heuristic model for simulated instruction.[47] The model is

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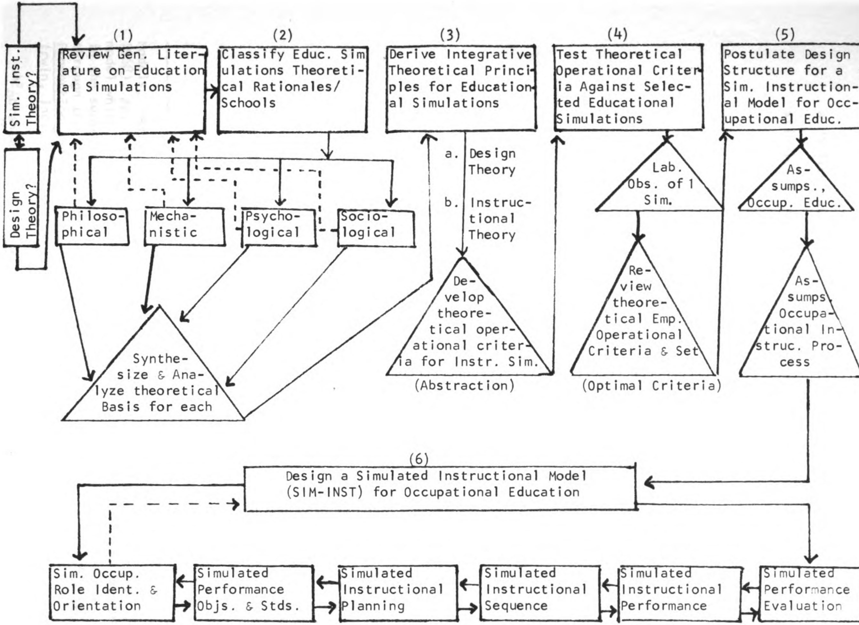
[47]Even if this is a stochastic model, most theoretical model scholars believe that "models are neither true nor false; their value is judged by the contribution they make to our understanding of the systems they represent". McMillan and Gonzales would argue that "the testing or validating of a model can be done by making further observations and measurements of the system, or by experimentation". If a model does not confirm the hypothesis implicit in it, it needs modification. See Claude McMillan and Richard Gonzales: <u>System Analysis: A Computer Approach to Decision-</u>



FLOW CHART OF RESEARCH METHODOLOGY
(Figure 1)

a "policy rather than a creed".[48] It serves to suggest, stimulate, and direct experimentation.

Models, (Homewood, Illinois: Richard D. Irwin, Inc., Revised edition, 1968), pp. 9-20. Compare also Bowman and Fetter's argument that "the model which usefully described a given situation is capable of prediction in the sense that changes in the situation can be logically followed through the model". Edward H. Bowman and Robert B. Fetter, Analysis for Production and Operations Management, (Homewood, Illinois: Richard D. Irwin, Inc., Third edition, 1967), p. 28.

[48]Abraham Kaplan, The Conduct of Inquiry: Methodology for Behavioral Science, (San Francisco: Chandler Publishing Company, 1964), p. 306.

CHAPTER II

THEORETICAL FOUNDATION OF EDUCATIONAL SIMULATION

This chapter provides a general review of the literature on educational simulation through a process of analysis and synthesis of undergirding simulation rationales. Attention is given to the two methodological problems posed in Chapter I, i.e., the problem of design and the problem of instructional application of educational simulation.

A survey of the literature on educational simulation suggests that proponents of simulation have different orientations in the design and process of simulation. The differences in orientation are not caused by differences in the subject-matter fields to which simulation is being applied. The central and major point of differences is methodological. Critical study of the approaches used by individuals and a search for explanation of their theoretical rationales lead to the conclusion that at least four schools of instructional simulation can be identified: (1) the philosophical school, (2) the mechanistic school, (3) the psychological school, and (4) the sociological school. The characteristic features of each of these schools, and their leading theoretical framework are discussed below. It must be said, however, that the classification into these schools is only a convenient way of clarifying the thought in this field that seems to be apparently divided on method, process, and practice.

I. THE PHILOSOPHICAL SCHOOL[1]

Educational simulation may be based on philosophical rationale. This school uses philosophical principles to support the instructional application of simulation in educational programs. The philosophical school argues that learning can be made meaningful to the individual if its contents are gamed so that the learning situation is somewhat a simplified representation of real-life. The main philosophical rationale of simulation for instruction seems to be based upon the premise that educational simulation is a "good" pedagogic technique because it simultaneously links the student with the outside world through the realistic participatory learning experiences in the classroom.

A. Game as the Theoretical Rationale of Educational Simulation

The use of games in education is not new. It began with Spencer and was continued by John Dewey. Dewey, particularly in his work, Human Nature and Conduct,[2] argues that play and game provide "fresh and deeper meaning to the usual activities of life". Indeed, Dewey's general philosophy of education contains most of the premises upon which simulation games are built. His philosophy emphasizes learning by discovery, active participation, and problem-solving[3]--all of which are epitomized in the objectives of simulation learning.

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[1]Sarane Boocock discusses this rather briefly in an article in Boocock and Schild (eds.), Simulation Games in Learning, (Beverly Hills, California: Sage Publishing, Inc., 1968), pp. 53-64.

[2]John Dewey, Human Nature and Conduct, (New Haven: Henry Holt, 1922), pp. 160-162.

[3]John Dewey, Democracy and Education, (New York: The Macmillan Company, 1916).

Dewey's concept of play and education is a usefulone in understanding instructional simulation. However, it is important to understand the conditions under which educational games can prove useful in education. Abt[4], an educational games designer, has recognized and stressed the conditions under which the advantages of educational games can be achieved. He observes that children are naturally strongly motivated towards play and that through mimetic process, they organize much adult behavior which when reinforced by their peers are incorporated as habits. Therefore, if the technique of design of educational games analogizes game activities according to student's interest and previous experience, the game approach can develop new habits. But in this approach, Abt warns that there is a danger of exaggerating the parameters of reality. In some cases the parameters of reality incorporated into the game are not explicit to the student. Sometimes essential elements of real life may be difficult, hazardous, or dangerous to be represented. These could be ignored. It is also possible that where the game focuses on elements that do not pay attention to the student's interest and previous experiences, learning outcomes of the game may be in conflict with the educational objectives. Abt notes:

> Most games provide for a uniformity of initial player resources--in real life it is seldom so. Most games have fixed uniform rules clearly known by the players. In real life, the rules of the "games" are continually (although often slowly) modified by the players, and there is often a game over the nature of the rules themselves. . . .Real life "rules", or constraints on behavior, are

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[4] Clark Abt, "Games for Learning". In Boocock, S. S., and E. O. Schild, op. cit., pp. 66-69.

> often tacit rather than explicit, and sometimes not even completely known to the player.[5]

Also, the assumptions which a designer may make about a game may relate to the student's capacity to understand the nature of the analytical model built into the simulation game. When this is an issue, the problem of how well the simulation design communicates effectively with the student becomes important. Abt gives very valuable suggestions in this respect and suggests:

> To communicate effectively with the student, the model must be translated into a social drama that involves the student's interest and enables him to experiment actively with the consequences of various "moves" or changes in the system under study. . . . To achieve an effective balance between analytical truth and dramatic communication some degree of simplification is needed to form the basic "plot" of this sociodrama or game. . . . Classroom time and student capacity for abstraction are the most common limiting factors.[6]

Some designers and users of educational simulation may disagree with Abt's prescription about simplification of the model because this can lead to watering down of the components of knowledge which will be taught. However, simplification need not lead to shallowness or superficiality of knowledge. A position such as Abt has taken in this instance, calls for some experimentation and points to the need for a theory of design of simulation games.[7] It might well mean that simplification of a complex

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[5]Abt, op. cit., p. 69.

[6]Ibid., p. 75.

[7]Kibbee also considers simplicity as one of the constraints in designing educational games. He suggests four facets of simplicity: (1) simplicity of participation, (2) simplicity of computation, (3) simplicity of administration, and (4) simplicity of construction. Simplicity of participation is a must in almost every game. Joel M. Kibbee , C. J. Craft, and Burt Nanus, Management Games, (New York: Reinhold Publishing Corporation, 1961), p. 61.

learning may, in the long run, be a desirable learning strategy which can be applied to cater for readiness and individual differences--a matter of uttermost psychological importance in sequencing learning.[8]

Abt recognizes that reality parameter and simplicity of the model may be horns of a dilemma to the educators and that opponents of simulation may exploit this situation. He suggests that when in conflict like this about the design of an educational game, the designer should consider the "various design trade-off decisions". He defines a trade-off as "a situation in which two or more characteristics interact competitively, and their optimum mix must be determined to assign them their weight in process".[9] Abt suggests the following trade-offs:[10]

<u>Realism</u>		<u>Simplification</u>
(at the cost of ease of playing)	vs.	(at the cost of intellectual validity)
<u>Concentration</u>		<u>Comprehensiveness</u>
(at the cost of topical coverage)	vs.	(at the cost of detail and realism)
<u>Melodramatic Motivation</u>		<u>Analytic "Calm"</u>
(at the cost of calm analysis)	vs.	(at the cost of reduced emotional involvement and reduced motivation)

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[8] J. S. Bruner, <u>Process of Education</u>, (New York: Vintage Books, 1960), pp. 33-54. Bruner will argue that initial simplicity may be a useful and honest strategy designed to cope with individual readiness and may be followed with more powerful sequence as the individual intellectually matures.

[9] Abt, <u>op. cit</u>., p. 75.

[10] <u>Ibid</u>., p. 76.

Abt's list may be extended to include other trade-offs not considered by him, for example:

Segmentation		Integration
(at the cost of sequential learning)	vs.	(at the cost of comprehensive meaningful learning)
Cost effectiveness		**Cheapness and frivolity**
(at the cost of inappropriateness)	vs.	(at the cost of teaching economy and relearning)

Other writers support the concept of games in educational simulation. Ray and Duke contend that the element of gaming is essential in simulation.[11] Coleman,[12] supporting the same position, argues that games offering opportunities to act out lifelike, decision-making roles in realistic settings, can offer students more motivation to learn than many current teaching devices. In another article, Coleman emphasizes:

> There are apparently certain aspects of games that especially facilitate learning, such as their ability to focus attention, their requirement for action rather than merely passive observation, their abstraction of simple elements from the complex confusion of reality, and the intrinsic rewards they hold for mastery. By the combination of these properties that games provide, they show remarkable consequences as devices for learning.[13]

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[11]Paul H. Ray, and Richard D. Duke, "The Environment of Decision-Making in Urban Gaming Simulations," in William D. Coplin (ed.), Simulation in the Study of Politics, (Chicago: Markham Publishing Co., 1968), pp. 152-160.

[12]Education U.S.A.: A Special Weekly Report on Educational Affairs, "More School Games Urged", November, 1967, p. 57.

[13]James S. Coleman, "Social Processes and Social Simulation Games" in S. S. Boocock and E. O. Schild, Simulation Games in Learning, (Beverly Hills, California: Sage Publications, Inc., 1968), p. 29.

The element of gaming suggests that educational simulation must involve the students in meaningful participation or competition that leads to measurable achievements. Thus there must be a role (competitive or participatory) to play and a standard of effectiveness that the learner will be taught to attain.

Another obiter dictum about educational games is that the game should be an accurate representation of the real-life model. This dictum has two implications. First, the reality parameter must be stated in specific terms. Second, there must be a true relationship between real-life and the situation being gamed.[14] It is implied that any educational games must have objectives and students playing them must be oriented to the objectives specified.

B. Problems in the Philosophical School of Simulation. Before some of the weaknesses in the philosophical rationale to educational simulation are discussed, one other philosophical principle often advanced to support educational simulation--teleological system[15]--should be discussed briefly. Rudner describes the teleological system as purposive and goal-directed behavior. It is suggested that this principle offers a persuasive argument for simulating instruction because it implies that simulation objectives should be goal-directed, purposive and functional. Whatever the philosophical problem in setting goals, an important implication for educational simulation methodology is that objectives for simulated instruction must be

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[14] Ibid., pp. 39-51. In this section, Coleman discusses the critical question in making a judgment about the kinds of social processes that can be simulated.

[15] Richard S. Rudner, Philosophy of Social Science, (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1966), pp. 84-111.

well-defined and must be relevant to the model of real-life of which it is a referent.

There are a number of weaknesses in the philosophical approach to simulation. One of these is the methodological process of validation. The philosophical approach is general and hard to verify. The ramifications of philosophical tenents--learning by experience, by participation, and the problem-solving approach--are not the exclusive domain of simulation as a method of instruction. Indeed, other teaching methods may equally be employed to achieve the same results.

Philosophical analyses are useful only when they are well-clarified and programmatic to the extent that each assumption made can constitute a verifiable theory. Arguing that simulation derives from philosophical rules without specifically indicating the nature of the theory and the phenomenon it tests does not say much.

There is yet another problem. The philosophical approach also seems to assume, if not ignore, the operation of psychological learning theory when conditions of play are assumed to be transferred automatically to real-life.[16] The assumption, if this is the case, is that the transfer to real-life or "make-belief" characteristics is automatic. From what is known of the operation of socio-psychological theory,[17] this assumption

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[16]For a critique of games as a pedagogic approach see Ivor Kraft, "Pedagogical Futility in Fun and Games?" National Education Association Journal, Vol. 56, 1967, pp. 71-72.

[17]In actual life some behaviors occur because they are reinforced, not necessarily because they are practised. In playing conditions, what is of consequence to learning is how habits under play are reinforced to become internalized behaviors.

is not quite true. If the case is one of ignoring the conditions of transfer, the theory is not a useful one because it does not specify the conditions under which learning and transfer will occur.

C. Some Examples of Simulation Designs Based on Philosophical Rationale

Based on the preceding exposition of the rationales behind the methodological approach to educational simulation, it will be fair to say that some games come under the category of the philosophical school. The Nova Academic Games Project in Fort Lauderdale, Florida, can be fairly described as falling into this category.[18] The development of "academic games", as the Nova Academic Games Project prefers to describe educational simulations, is based on the assumption that achievement of students in academic work can be enhanced if learning is structured to engender drives which spur from the need for "recognition and prestige" especially held in high esteem by peer groups. Games designed on this philosophy have been produced by the Nova Academic Project and have been used widely at elementary, secondary, and special education programs throughout the country. Examples of games produced by the Nova Academic Games Project include, The Game of Democracy, Life Career Game, Equations, The Game of Creative Mathematics, Onsets, The Game of Set Theory, WFF'N Proof, The Game of Modern Logic, Real Numbers, Propaganda Game, and Euro-Card, to name just a few.

D. Leading Theoretical Principles of the Philosophical School

In summary, the evidence in this analysis suggests that educational simulations based on philosophical rationale hinge upon the following principles:

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[18]Nova Academic Games Project, undated brochure published at Fort Lauderdale, Florida. The NAGP games are used in many states including Alabama and California, p. 3.

1. The reality parameter of the simulation model must be operationalized i.e., specified in definitive terms.
2. The creation of gaming situations must mirror real-life through the use of socio-drama which operationalizes specific role objectives.
3. When games are used, the competitive or cooperative objectives of the play must be specified.
4. Rules of the game must be pre-learned or be understood to facilitate the playing of the game, and the attainment of the stated objectives.
5. It is necessary that achievement in the gaming situation can be evaluated whether the situation gamed involves competition or cooperation. This element has a feedback effect and has some implication for transfer.
6. The games need to provide opportunities for adequate practice so that players can develop abilities to attain stated objectives. Also, the practice of make-belief in games leads to accumulation of meaningful experience which is organized in some way for solving future problems, when identical situations prevail.
7. Reproduction of what is to be learned and how it is to be learned under game conditions need to be goal-oriented and functional ("manifestly" or "latently").[19]

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[19]Manifest functions are those objective consequences contributing to the adjustment or adaption of a system which is intended and recognized by the participants in the system. Latent functions are those which are neither intended nor recognized. Rudner, op. cit., p. 110.

Finally, the question of "degree of simulation"[20] built into the games is the problem of good design. Simulation does not exist in vacuo. Therefore, the designer of the simulation must operationalize his variables within parameters that approximate the reality being modelled.

This discourse has helped in clarifying the undergirding philosophy of simulation that a make-belief phenomenon mirrors important elements of real-life and the responses an individual habitually elicits or emits under such a make-belief condition may be transferred to real-life. In addition, it can be inferred that the central idea behind the philosophical rationale of learning by experience, teleological system and functionalism, points to the essence of meaningful derivation of the objectives of educational simulation.

II. THE MECHANISTIC SCHOOL

In the mind of some people, educational simulation must in essence involve computers and machines. This school of thought can be described as mechanistic because the proponent of educational simulation based on this condition adhere to the necessity of applying technological devices to simulate abstracted elements of real-life models. At least two positions of the mechanistic school can be identified in instructional simulation. One relies on the application of computers to simulation of instruction;

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[20]Gagne defines "degree of simulation" as the "proportion of the total situation represented" in a simulation model. It is a rough judgment about what is adequate and sufficient to include or exclude. R. M. Gagne, "Simulators" in Robert Glaser, Training Research and Education, (New York: John Wiley and Sons, Inc., 1965), pp. 231-233.

the other relies on less sophisticated mechanical devices and media.[21] Any of these two positions can be regarded as a "simulator" depending on the degree and ramifications of the simulation.[22]

A. Computer simulation for learning

At least three types of computer simulations can be distinguished even though there is a close relationship in the design procedures and application of all three. The three general areas are: (1) simulation involving human cognitive processes, (2) computerized games involving environment and decision-making, and (3) operational game simulation. The operations of these three have implications for education and training as will be explained in this section.

In general there is a basic assumption, regardless of the type of simulation, that the computer, as a "giant brain", has an amazing capability to handle logically, multifarious problems with an alarming accuracy that cannot be parallelled by human efficiency, speed, and accuracy. Thus in dealing with complex learning involving thinking or decision-making, computers can be applied to simulate the decision-maker's internal cognitive mechanism. The inference is that if computer simulation programs can be

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[21]Twelker's distinction of categorizing simulations as either those that are "machine-ascendant" or "media-ascendant" is a useful one. Basically, there is no disagreement between the approach used here and that of Twelker. The main distinction is that this study has referred to both machine-ascendant simulation and media-ascendant simulation as mechanistic.

[22]The term "simulator as used in the literature does not necessarily always assume "the form of hard equipment". A simulator can be a partial or a total representation of a model. When a simulator represents only a small part of a total set of activities of real life, it is a partial simulator. Gagne defines a simulator as "a single set of equipment which can by itself represent a large portion of the system" being modelled. Gagne, op. cit., pp. 223-224.

designed to mirror the process of human thought, the same device can be used to teach man how to learn to think.

1. Cognitive Process Simulation

(a) Theoretical Principles Affecting Design: The major problem that faces the designer of computer simulations for cognitive processes is the specificity of the model, its characteristics, and the choice of appropriate medium for simulating the model. In this respect, the cognitive process of the model may be special, or general.[23] Once the model has been defined and delimited, computer simulation can be made to "behave" like the people it has modelled within the limits of the stated variables regarding the behavior of the model programmed. Thus, a computer simulation may connote the typical specified behavioral repertoire of a model (say a doctor carrying out a diagnosis) up to the degree of the model's behavioral protocols abstracted and represented in the simulation. In this sense, the simulation reproduces that real-life model. The abstracted elements can be manipulated and new programs about the model's behavior can be constructed for prediction. In every case, computer simulation program is expressed in either ordinary natural language, or in conventional mathematics or in specified computer language.[24]

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[23]Examples and designs of simulations of general and special models are described in Feigenbaum and Feldman (eds.), Computers and Thought, (New York: McGraw-Hill Book Co., 1963), pp. 269-325. A model is said to be general when the abstracted elements are common to all objects or phenomena having the same name. It is specialized when the elements of the abstracted characteristics are limited to a specified system or class. Ibid., pp. 274-275.

[24]The construction of computer simulation programs is greatly facilitated by the use of computer language. One of the most powerful developments in this area is the algebraic language such as the FORTRAN and the various dialects of ALGOL. Feigenbaum and Feldman describe a second class of computer languages--IPL, FLPL, LIST, and COMIT, which are "list processing languages commonly used in simulation of cognitive processes". Ibid., pp. 271-272.

(b) Theoretical Principles Affecting Instructional Application: As far as instruction goes, computer simulation has great implications for learning. The immediate feedback that is an important structural feature of the computer simulation has an enormous resemblance to the familiar learning paradigm. Computer problems are solved through explicit logical steps (choice, categorization, and computation), which are printed and can be learned and verified by the student. The feedback which the computer gives after the data has been processed is automatic and can be assessed in terms of expected outcome. Because of the reliability of the results, generally expressed in binary form, the contingencies observed, once verified, can be generalized for identical situations in the future.

In addition, computer simulation programs can be made flexible. Programs can be sequenced as desired. Sequence is an important feature of instruction because it relates to the structure of the learning task, the amount of time available for learning, the learning conditions, the order of presentation, and the student who is to benefit from the instruction.[25] Also, because feedback in computer simulation is automatic, the contingencies of reinforcement[26] is immediate and knowledge of results is communicated to the learner at once. Additionally, since the machine does not threaten the learner, particularly when reinforcement is negative, the learner does learn more comfortably because the venon of the admonition

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[25] Leslie J. Briggs, Sequencing of Instruction in Relation to Hierarchies of Competence, (Pittsburgh, American Institutes for Research, 1968).

[26] B. F. Skinner, The Technology of Teaching, (New York: Appleton-Century-Crofts, 1968), pp. 4 & 8.

of the real-life model does not prevail. Thus, in general, it may be said that computer simulations allow students to solve their learning problems in a non-threatening condition and without allowing them to experience the agony of failure of real-life.

(c) Some Examples of Computer Simulation of Cognitive Processes

There are many examples of simulations in the literature concerned with the rationale discussed above. Some of these are designed for instruction, some for development, and some for research. Depending on the designer's objective, a computer simulation can do all three. When designed for instruction, however, the computer simulation can be applied to a wide range of subjects. Some of the well-known computer simulations of cognitive processes are those of Newell and Simon, Clarkson, Feldman, Hovland and Feignbaum, which deal purely with cognitive and verbal learning.[27] These popular models are known as the General Problem Solver (GPS). There is also the sophisticated problem-solving program, The Elementary Perceiver and Memorizer (EPAM), based on a pair-associates presentation for simulating human thinking processes.[28] The EPAM model can "sound" in the "mind's ear" what it "sees" in the "mind's eyes".[29] The GPS has been used for teaching symbolic logic through a simulation program which uses the digital computer. Simulation models have also been designed at the IBM Research Center in New York by Gelernter and Rochester to solve geometrical problems and

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[27]Feigenbaum & Feldman, op. cit., pp. 265-325.

[28]Ibid., pp. 297-309.

[29]Ibid., p. 309.

theorems.[30] A program called SAINT, an acronym for "Symbolic Automatic Integrator", has been developed for solving symbolic integration problems in Freshman Calculus.[31]

2. Computerized Games for Decision-making

(a) Theoretical Principles Affecting Design: Computer simulation may be designed to simulate the environment and decision-making process. Figure 2 represents a flow-chart which illustrates the theoretical design procedure of this type of complex computer simulation. Usually, the simulation designer begins with some presumptions about a system which may be anything ranging from a marketing system to an international relation. His perception of this system depends a great deal upon his knowledge of the system. Assumptions are made about the environment. These include assumptions about the value of the relevant internal and external factors that affect the system state and functions. Similar assumptions are made about an idealized decision-maker's cognitive processes. These are combined to represent the parameters of the simulation. The relevancy and/or irrelevancy of elements abstracted will represent the degree of simulation.[32] These variables are then sequenced and programmed

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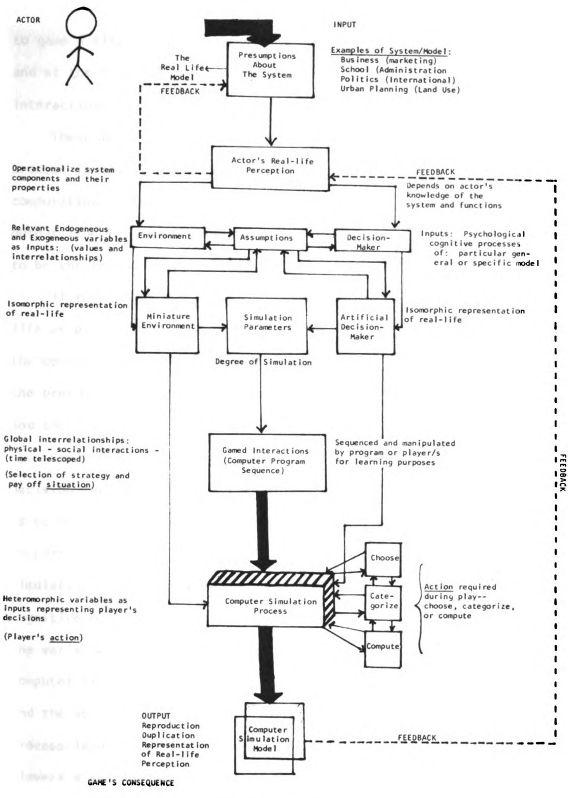
[30] Gelernter gives a concise description of this model in an article entitled "Realization of a Geometry-Theorem Proving Machine". Ibid., pp. 134-152.

[31] James R. Slagle, "A Heuristic Program that Solves Symbolic Integration Problems in Freshman Calculus". Ibid., pp. 191-203.

[32] Designing a game continually involves compromises, deciding what to include and what to leave out. "A game is a model of some segment of reality and a model implies abstraction: the inclusion of relevant items and the omission of irrelevant details". Joel M. Kibbe, C. J. Craft, and Burt Nanus. Management Games. (New York: Reinhold Publishing Corporation, 1961), pp. 94-95.



A COMPUTER SIMULATION GAME DESIGN PROCEDURE
(Figure 2)

to game a situation, while the programmer or actor determines the strategy and at the same time makes some predictions about the consequences of the interactions of the variables fed into the computer.

These multifarious variables are processed by the computer. The process involves some action arising in the choice, categorization, and computation of the variables as may be deemed fit by the computer. The output from the computer represents the game interactions and is taken to be the reproduction or duplication of the real-life gamed.

If the computer simulation model (the output) differs from the real-life as evidenced by the results of the program, there is a need to modify the computer simulation model. This will involve shifting the bases of the presumptions and assumptions about the internal and external factors and their variables as well as those about the decision-maker.

Ray and Duke point out that computer simulation designed to model decision-making process need to involve gaming.[33] They argue that this is so because when computer simulation involves gaming, it has an advantage of portraying real-life because, not only does it interface two strategies--simulation of the relevant environment and simulation of the internal cognitive mechanism of the decision-maker--but because it also shows that the variables fed into the computer reflect gamed interactions. Thus, the computer simulation game consequently becomes the nexus of two models--man and the abstracted elements of real world brought together. This gaming process leads to an involvement and psychologically imposes upon the players a subtle "appearance of realism" described by Kibbee and his

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[33]Paul H. Ray and Richard D. Duke, "The Environment of Decision-Making in Urban Gaming Simulations," in William D. Coplin (ed.), Simulation in the Study of Politics, (Chicago: Markham Publishing Co., 1968), pp. 153-157.

associates as "verisimilitude".[34] This is an important concept because this "illusion of reality can sometimes be more convincing than reality itself".[35]

(b) Theoretical Principles Affecting Instructional Application: A typical simulation game used for instruction ideally would have three major parts: (1) the briefing, (2) the play, and (3) the debriefing.

Briefing: The purpose of briefing is to put the educational objectives of the simulation game into proper perspective. The quality of briefing generally determines the success of the game in attaining the stated objectives. Typically, a part of the briefing session in management games will involve a description of the organization, a description of the economic environment, the nature of the products to be produced, scope of authority of players, decisions to be made, information pertinent to the organization, and the mechanics of the play. Another part of briefing deals with the purpose of the simulation exercises and how it relates to the entire educational program for which the game is designed. In addition, the briefing period lays down the rules of the game and spells out the game strategy and how the objectives set can be attained.

The Play: The simulation game requires players. Usually these players organize themselves into groups with a common objective or goal. This provides a forum for the interactions in the game for the purposes of competition or cooperation that may be built into the game. Once the rules of the game have been espoused and learned by the players, they are ready to begin practice. Usually the play emphasizes the time dimension

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[34]Kibbee, Craft, and Nanus, op. cit., p. 12.

[35]Ibid., p. 100.

which is made to analogize the "real time" in "real-life". Thus the playing time in simulation game is "simulated time", an approximation of time which is a compressed period designed to telescope real time. One run or a period of play may thus represent a week, a month, a quarter, or a year, according to the design of the game. The play offers opportunities for practice of the learned rules, and requires, for the purpose of making moves, insights and judgement based on previous knowledge of the process of interactions among the players. Feedback is spontaneously received for actions taken, and players are able to feel the consequences of their decisions as their actions affect the strategies of other participants in the game. Learning in simulation, therefore, is largely self-discovery. The play time offers great opportunities to safely put theory into practice to test the validity of assumptions, hypothesis, and transfer (learning integration).

The Debriefing: A typical "good" computer simulation game has a debriefing or critique session. This post-game session is a very important feature of a simulation game because it affords an opportunity for students to evaluate their performances. Twelker describes this as an evaluation period which affords an opportunity for "cross-fertilization of ideas".[36]

The debriefing period has many advantages. It serves a corrective purpose because it puts the programmed relations of the game into proper perspectives. The fact that the simulation is "an appearance of reality" and not reality can be re-emphasized during the debriefing so as to caution

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[36]Twelker, "Simulation: Status of the Field", Paper presented at the Conference of the Commission of Educational Media of the Association for Supervision and Curriculum Development, National Education Association, October, 1968. (mimeo)

what might otherwise result in a bigoted internalization of game experiences. Also, the instructor's comments on other strategies that could have been used, can enrich student's learning. This session presents an appropriate and valuable learning opportunity which combines the experience of the teacher (as an experienced administrator) and the experiences of the students who are the neophytes in business decision-making skill. Sometimes, the advantage can be mutually beneficial because students may often come up with ideas that do not occur to the teacher who is the umpire in the simulation exercise.

The debriefing brings a new dimension into learning through game and it is an essential feature of simulation games.

(c) Some Examples of Decision-making Games: In civilian education, it was the American Management Association which in 1956[37] first adapted the Neumann-Morgenstern Game Theory[38] to the design of the "Top Management Decision Simulation Games".[39] This led to greater popularity and wider interests in other disciplines--political science, psychology, sociology, urban planning and economics.[40]

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[37]Richard D. Duke, Gaming Simulation in Urban Research, (East Lansing, Michigan: Institute for Community Development and Services, CES, MSU, 1964), p. 10.

[38]John Von Neumann and Oskar Morgenstern. Theory of Games and Economic Behavior, (Princeton, New Jersey: Princeton University Press, 1947).

[39]For an excellent review of these games and others used in military operation and business management and an evaluation of their strengths and weaknesses, see Kalman J. Cohen and Erick Rheuman, "The Role of Management Games in Education and Research", Management Science, Vol. VII, (1961), pp. 131-166. See also Elizabeth Martin (ed.). Top Management Decision Simulation. (New York: American Management Association, 1957).

[40]Guetzkow has put up a volume which presents an excellent coverage of application of simulation in social science. This volume presents articles on application of simulation in psychology, sociology, political science, economics and business, education, industrial engineering, and military operations. See: H. Guetzkow, Simulation in Social Science: Readings. (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1962).

Guetzkow has described the methodology of simulation model in international relations. He develops simulations for international relations for instruction, development and research. His simulations have been used at Northwestern University for graduate and undergraduate courses. It has been reported that the results are satisfactory.[41] Cherryholmes and Guetzkow have also produced a simulation in international relations which has the high school as its target audience, although the simulation can be used at any level of education.[42]

In the field of urban planning, Duke has produced the Metropolis Simulation (M.E.T.R.O.) which is an excellent example of simulation gaming in urban affairs.[43] M.E.T.R.O. has been used at Michigan State University and the University of Michigan. At MSU it has been used to supplement requirements in graduate courses in Urban Planning and Urban Sociology.[44] This simulation program has attracted also professional urban planners, politicians and laymen.

Cohen and others give the descriptions of the design and application of the Carnegie Tech Management Games used in management education.[45]

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[41] H. Guetzkow, Simulation in International Relations: Development for Research and Teaching. (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1963), pp. 24-37. See also Coplin, op. cit., pp. 2-27.

[42] Cleo H. Cherryholmes, and Harold Guetzkow. Inter-Nation Simulation Kit. (Chicago: Science Research Associates, 1966).

[43] Duke describes the design and purposes of this simulation in his Ph.D. dissertation, University of Michigan, Ann Arbor, 1964, and in a monograph, Gaming Simulation in Urban Research, op. cit., pp. 13-42.

[44] Discussion with Richard Anderson, Assistant Professor, Department of Urban Planning, Michigan State University.

[45] K. J. Cohen, et al. In Harold Guetzkow (ed.), Simulation in Social Science: Readings, op. cit., pp. 104-123.

Balderston and Hoggart discuss the problem of models in business administration simulations and describe an approach they adopted for constructing a simulation model for the United States West Coast Lumber Trade.[46] Kibbee, Craft, and Nanus give a comprehensive review of gaming as applied to the business world. The issues they discuss are useful for simulation game designs generally. These include theory and practice of simulation games, the administration of simulation games, and game design. A part of this work is also devoted to case studies of selected business games used in business education training programs in colleges and industry.[47]

3. Operational Game Simulation

(a) Theoretical Principles Affecting Design: A third type of computer-based simulation is referred to as the operational game simulation. Twelker describes this type of simulation as a simulator representing a "sophistication of man-machine adaptive and responsive environment".[48] This type of design is "purely mechanistic simulation"[49] which calls for a computer-controlled programmed operation that integrates a number of parameters analogous to real-life.[50] The designer of this kind of simulation

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[46] A. C. Hoggart and F. E. Balderston. Symposium on Simulation Models and Applications to the Behavioral Sciences. (Cincinnati: South-Western Publishing Co., 1963), pp. 182-191.

[47] Kibbee, Craft, and Nanus, op. cit. Note pp. 315-336 which contain "A Directory of Management Games".

[48] Twelker, op. cit.

[49] Kibbee, Craft and Nanus, op. cit., p. 255.

[50] Cushen defines operational gaming as a "model of reality....designed to meet as exactly as required the characteristics of an actual situation". "Operational Gaming in Industry", in Operations Research for Management, Vol. II, J. F. McCloskey and J. M. Coppinger (eds.). (Baltimore: The John Hopkins Press, 1956), pp. 361.

usually spends ample time in the field to gain a really adequate knowledge of, and insight into, the operations to be modelled. In addition, he studies the environmental conditions and abstracts, feasible aspects of the environment, as may be relevant to the operations. It is important that the abstracted elements be adequate to produce that empathy and contextual response from the operators as would be expected in real life. Thus, in studying the environment, valid response patterns that are associated with the operations must be abstracted and should be represented in the design. Operational game simulations are often complex and difficult to design.

The Simutech trainer, described by Kristy,[51] is an example of this kind of sophisticated design. Simutech trainer is used for training Air Force electronic technicians. Operational gaming design has also been applied to management education. Robinson describes an operational simulation game called "ASCOT" (Analogue Simulation of Competitive Operational Tactics) which is designed to simulate the operations of five service stations.[52] The simulation provides a game which illustrates the competitive interactions of the service stations in selected service station operations. The design includes a set of instructions for the participants, numerous photographs of the equipment and facilities of the service stations, as well as rules for the game. Most of these details are computer-controlled.

(b) Theoretical Principles Affecting Instructional Application: A

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[51] Norton F. Kristy, "The Simutech Trainer for Technical and Vocational Training". In Werner Z. Hirsch, et al., Inventing Education for the Future. (San Francisco: Chandler Publishing Co., 1967), pp. 114-122.

[52] "ASCOT" is fully described in Kibbee, Craft and Nanus, op. cit., pp. 259-273.

brief description of the features of Simutech is pertinent because this device provides tutorial teaching realistically as though it were on-the-job. The simulator has the following features:

(1) A component of video-instruction on the basics of electronics.

(2) A component consisting of the clarification of instruction and reinforcement from the computer-controlled programmed instruction console.

(3) A practice unit providing performance learning by means of the simulated hardware.

(4) A component providing remedial help when the student needs it, or when the computer deems it necessary.

(5) An evaluation segment where the student can be quizzed on his progress.

The program is highly flexible and can be sequenced to suit the individual's pace. The instructor can monitor it to receive information about his student's progress and/or learning difficulties at any time.

4. Issues and Problems in Computer Simulation for Learning

Balogh and Purdman point out, computer assisted instruction is no panacea for all ills that afflict the learning process.[53] There are still several types of subject matter areas to which the computer simulation is unsuited according to our present knowledge of the technique.

Feigenbaum and Feldman believe that there are at least two major unsolved problems in simulation of cognitive processes.[54] The first they

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[53]R. L. Balogh and D. L. Purdman, Computer Assisted Instruction: Feasibility Study. (Texas: Philco-Ford Corporation, NASA Contractor Report 917, 1968), pp. 2-2 & 2-3.

[54]Feigenbaum and Feldman, op. cit., pp. 275-276.

call "the substantive problem" dealing with the areas of human cognitive knowledge about which very little is known. Obviously, if the knowledge of a system is limited, the simulation model will be a poor representation of the real-life being simulated. The second problem relates to the "procedural or methodological problem" which reflects three sets of problems within it, namely: (1) the problem of testing models and estimating reality parameters, (2) the problem of experimentation, and (3) the problems of program organization and representation.[55]

Indeed, the fidelity of simulation has been a perennial problem in simulation designs.[56] Very often the characteristics of the model being simulated is oversimplified in order to accommodate the quantification of the data that are fed into the computer. This sometimes leads to unfortunate compromises which affect the fidelity of the model in some essential respects. Some computer simulations, instead of being oversimplified, are complex and unmanageable. There are diversities in the author's languages, some of which may be ambiguous if not explained.[57]

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[55] Ibid.

[56] For a good review of research studies on fidelity of simulation see Jack A. Adam in Guetzkow, (ed.), op. cit., pp. 37-38. Adams concluded that "high fidelity simulation is not necessary for transfer". Kersh has also reached a more positive conclusion: "Although it is an inherent requirement that simulation be realistic, all stimulus properties of real situation may not be relevant and need not be represented". Bert Y. Kersh Classroom Simulation: A New Dimension in Teacher Education. (Monmouth: Teaching Research Division, Oregon State System of Higher Education, June, 1963, U.S. Office of Education, NDEA Title VII, Project No. 886), p. 8.

[57] Balogh and Purdum define "author's languages" as "special software programs which enable the course author to enter curricular materials into a central processing unit and program the sequence in which it will be represented". Balogh and Purdum, op. cit., p. 2-11.

The critical issue in computer simulated instruction is not often answered by the design. Computer simulation instruction, like any other instruction, requires planning and preparation. Selections of subject materials, sequencing, validation and evaluation are often neglected in some designs. Also, the procedures for using instructional computer simulation ought to accompany the simulation exercises as an essential handbook for the users. Along this line, there is the need to specify in the instructional plan the terminal behavior that the instruction will develop.

It would appear, however, that the limitation of computer simulation for learning will not be limited by the capacity of the computer to faithfully reproduce some aspects of reality, but will be limited by man's inability to abstract the relevant elements of the real world that the computer is required to simulate. Where man's knowledge of his real world is limited, computers can hardly do anything. The fidelity of computer simulation depends very much upon the fidelity of the data fed into it. Information fed into the computer forms the basis of the data processed and the decision made; colloquially it is said, "garbage in, garbage out." Postley puts it appropriately: "Failure to introduce good data into the calculation can result in the more rapid reproduction of worthless results."[58] But he also adds that "quality in, quality out."[59]

It is believed by systems engineers and educators that a good deal of prospects abound in computer simulation of academic subjects.[60] When

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[58] John A. Postley, <u>Computer and People</u> (New York: McGraw-Hill Book Company, Inc., 1957), p. 111.

[59] <u>Ibid</u>.

[60] Don D. Bushnell, <u>The Automation of School Information Systems</u> (Washington, D.C.: Department of Audio-Visual Instruction of MEA, 1964). See particularly Part V, pp. 93-110.

the potential is tapped, computers will be used for teaching subjects like fine arts (music, drawing and art), mathematics, physics and economics.[61]

B. Non-computer mechanistic simulation

1. Theoretical Principles Affecting Design

The application of media and machine devices, which have inherent capacity to reproduce the isomorphism of a specific aspect of real-life or the iconic form of a model, has dominated the orientation of a number of educational simulation designers. The design specification often involves the use of machines, gadgets, and other man-made devices. Recent technological breakthroughs culminating in the invention of media, like the filmstrips, motion pictures, phonograph records, stereophonic recordings, magnetic tapes, tape recorders, ratio, TV, CCTV, video tape, and other iconic models, have greatly influenced the trend toward the simulation of instruction. It must be pointed out, however, that simulated instruction does not necessarily apply unless the design embodies the elements of the model and the medium selected is appropriate to represent or reproduce the elements abstracted. The impact of media in providing specified learning experience is a concurrent requirement. This is imperative because it is the basis of evaluation of the effectiveness of learning that takes place. For example, if a video-tape were to be used to model the behavioral repertoires of a skillful cash register operator, all the relevant features of the model's behavior, essential for effective performance on the cash register, must be reproduced on the video-tape simulation if it is to become an effective simulation media.

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[61]Education, U.S.A.: A Special Weekly Report on Educational Affairs, November 27, 1967, p. 78.

2. Theoretical Principles Affecting Instructional Application

Like the computer simulation, non-computer mechanistic simulation, when used for instruction, has essential structural features that are instrumental to effective learning. These are stimulus perception, response, vicarious experience, involvement, feedback and transfer of learning which the use of the devices produces in instructional setting. Media-ascendant simulations, as Twelker describes them, have much commonality with the psychological school theory because the use of simulation for instruction is essentially rooted in psychological learning theory.[62]

The selection of an appropriate media for simulation design requires a thorough understanding of the capacity of media to simulate what. Bruner has classified the various instructional media into three categories, which it is argued here should provide guidelines for the utilization of media for simulation. Bruner's three categories are audio-visual instructional materials that can: (1) model, (2) dramatize, and (3) automatize.[63] He describes model devices as the whole range of "aids from the laboratory exercise through the mathematical blocks to programmed sequence."[64] The dramatizing devices are such instructional aids as films and other devices that can recreate a phenomenon or an idea. Machines which respond immediately, like the teaching machines, will represent the automatizing instructional aids. Bruner argues that: "What one teaches and how one teaches

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[62] Twelker, op. cit.

[63] J. S. Bruner, The Process of Education (New York: Vintage Books, 1960), pp. 82-84.

[64] Ibid., p. 83.

it with the aid of such devices depends upon the skill and wisdom that goes into the construction of a program of problem.[65] Therefore, when any of these devices are used in designing simulations, adequate care needs to be taken in the choice of a medium.

3. Some Examples of Non-computer Mechanistic Simulation

It is an understatement to say that all simulations use one form of media or another. Simulations in their own right are media. Nevertheless, simulations differ in the extent to which the media used actually simulate the model. The guiding rule is: the media should fit the objectives of the simulation, and not the objectives, the media.[66]

Kersh designed a simulation for teacher education based on the media-ascendant simulation theory. In simulating classroom management problems, Kersh uses motion picture films and printed materials. His design includes an orientation to the simulation facility and to the procedure. The instructional sequence in the simulation is composed of filmed problem sequences of actual classroom situations to which the student-teacher is supposed to enact a response. Feedback is provided through the same device. The unique thing about Kersh's design is the building into the simulation design a pre-test and a post-test sequence. This feature makes possible the evaluation of learning that has taken place within the simulation program.[67]

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[65] *Ibid.*, p. 83.

[66] D. K. Stewart, "A Learning-Systems Concept as Applied to Courses in Education and Training." In R. V. Wiman and W. C. Meierhenry (eds.), *Educational Media: Theory into Practice* (Columbus, Ohio: Charles E. Merrill Publishing Company, 1969), p. 160.

[67] Bert Y. Kersh, *op. cit.*

Another example of non-computer base media-ascendant simulation is the Michigan State University Professional Decision Simulation (PDS-I). The PDS-I is based on a theory that combines visual and audio devices for the purposes of bringing realism into learning that involves the development of teacher competence in responding promptly to classroom problems as they arise in the classroom. Like the Kersh model, the MSU model has a feedback sequence. Its distinctive feature is the creation of what has been described as three essentials of simulation, namely: situation, action, and consequences.[68]

The overriding point about man-machine simulation is not the gadgetry but the effectiveness of the machine in contributing to the learning process. Quality is important in mechanistic simulation, and this can be controlled by isolating irrelevant elements from what is being programmed into the machine. In determining the most effective approach, the objectives of the simulation should guide the designer in what and how the machine can be used to simulate abstracted elements of real-life. The purpose for which one wishes to use a simulation plays a determinant role in what and how of the simulation.

4. Factors Guiding the Choice of Mechanistic Devices for Simulation

It has been noted that the choice of mechanistic simulation device is not an easy one. This review, however, has highlighted at least four factors that should govern the choice of mechanistic device for simulation:

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[68]Professional Decision Simulator, Michigan State University, East Lansing, Michigan, 1965. (Pamphlet). Dr. Ted Ward, Director of Human Learning Research Institute, explained the theoretical basis of the design to the researcher and other students in a graduate seminar on Educational Simulation (ED 982) at Michigan State University in Winter, 1969.

1. The characteristic of the model which is to be simulated; the operationalization of the elements that characterize the model, and the specificity of the variables to be reproduced or duplicated.
2. The characteristics of the medium used for simulating the abstracted elements of the model, and appropriateness and ease with which the medium can represent, reproduce, or duplicate these elements.
3. The resources of the model designer in terms of human and materials support for the design work.
4. The knowledge possessed by the simulation designer about the system which is being modelled. The designer must be able to give satisfactory explanations of the phenomena that characterize the model.

C. Leading Theoretical Principles of the Mechanistic School

The features of the methodology of mechanistic school to simulation can be summarized as follows:

1. The model to be simulated must be defined in specific phenomenal terms.
2. Before the simulation is created, critical observation of the real-life model must be focused on the environment, functions, and operations of the model.
3. The model that is constructed must resemble in form and functions the real-life model. There is a need to have adequate opportunity to predict or evaluate the consequences of the variables simulated.
4. Feedback sequence is an important feature of mechanistic simulation. It is a self-regulatory control for evaluating the achievement of stated objectives.

5. Transfer of training is another feature which is consequential to feedback and leads to generalization about the contingencies of feedbacks.

6. The employment of the mechanistic simulation for instruction is relatively costly in some cases. The choice of an alternative medium of simulation depends to a great extent upon the characteristics of the model being simulated, and the appropriateness and suitability of mechanistic devices to represent the abstracted elements of real-life being simulated.[69]

7. Fidelity of simulation is only important when the "reality parameter" is a most important issue in the purpose of the simulation and when the exclusion of an element may lead to negative transfer.[70]

8. When the mechanistic simulation is used, detailed and clear instruction on utilizing the simulation is needed by the user. Three features of this type of guideline are essential: the briefing, the play, and the debriefing. When used for instruction, simulations must have these three features.

9. The simulation model designer must possess adequate knowledge about the system and the phenomena that characterize it before a defensible simulation can be designed. Satisfactory explanations

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[69]Suitability for learning, and not gadgetry sophistication is the primary rationale of mechanistic simulation. It is not a "purely mechanistic synthesis" that is the object of the design. Kibbee, op. cit., p. 256.

[70]Studies have shown that fairly radical departures from physical similarity still produce high degrees of transfer from a simulated to an actual task. Gagne, op. cit., p. 232.

of all elements included in the simulation must be given and their justifications based on their contribution to transfer of training.

10. When used for instruction, mechanistic simulation presupposes, on the part of the learner, a certain level of initial knowledge or learning about the nature and relationships of the elements which are built into the simulation.

A good deal of advantages can be derived from the mechanistic simulation theory. Many of the principles explained above are meaningful instructionally. The instructional process under this method too can be made fairly straight-forward since the learning materials are all "programmed". Providing the elements which represent the inputs of the simulation are reliable, mechanistic simulation can be valid. It has been found out that most of the programs built into the mechanistic simulations assume some initial learning on the part of the learner either about the nature of the elements or about their inter-relationships. So, in mechanistic simulation, attention is given to sequence of structure. The programs can be manipulated according to the learner's capacity. The assessment of learning in mechanistic simulation is not problematic since it is facilitated by mechanical devices which serve not only as reinforcers but as motivators to the learner. The learner who uses mechanistic simulation is motivated through spontaneous knowledge of results provided by the feedback sequence of the device. Correct responses are reinforced. At the same time, diagnosis of learning difficulties is easier as learning errors can be spontaneously located and corrected either by the teacher or the learner himself.

III. THE PSYCHOLOGICAL SCHOOL

Anyone interested in educational simulation cannot escape the implications of psychological learning theories. Either on the basis of design or on the basis of instructional application, every educational simulation embodies certain psychological learning theories such as the law of contiguity, the law of effect, the law of exercise, and several other laws that have proved empirically relevant to human learning.[71] However, there is no empirical evidence in the literature to support the significance of these laws specifically for simulation, but the implication which they have for stimulating and facilitating learning are too obvious to be denied. In this section, the ramifications of psychological principles for design and instructional application of educational simulation will be evaluated.

A. Framework of Psychological Rationale of Educational Simulation

Three important points are considered to be the pivot of simulations based on psychological rationale. These are: (1) a theory of learning for the design, (2) simulation representation, and (3) adequacy of representation.

1. A Theory of Learning for the Design.

The design of educational simulation may be based on any specified

[71]Greenlaw, Herron and Rawdon discuss the implications of some of these laws on business games. P. S. Greenlaw, L. W. Herron, and R. H. Rawdon, Business Simulation in Industrial and University Education, (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1962), pp. 32-67.

psychological learning theory.[72] This point can be illustrated with at least two examples. Firstly, a design may be based on the principles of the S-R theory. In this case, the selection of the inputs into the simulation design will be based on representation of those elements which are relevant stimuli that can produce the responses which are relatably relevant to specified operational situations in real-life. The whole design thus becomes a representation which generates responses that are contextually relevant to the specified situations. Secondly, a design may be based on cognitive theory. In this case, cognitive principles that relate to perceptual or mental organization as well as cognitive activities, will govern the representation adopted for the simulation model. The manner in which the cognitive structure is represented provides the concrete prop which elicits the relevant responses in terms of specified operational situations.

2. Simulation Representation

All simulation designs are represented by some devices. These may be animated or synthetic materials. Two major issues of psychological importance are worthy of note in simulation representation: (1) the medium of representation, and (2) the objective of representation. A model can be represented in three ways: (a) enactive representation in which the medium is action-oriented; (b) iconic representation in which the imagery or the picture becomes the stimulus; and (c) symbolic representation in which words and other forms of languages become the

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[72]Auto-instructional simulation devices are based on "operant conditioning" theory developed by Skinner and others. Symbolic stimuli simulation devices are based on the S-R theory developed by Gagne and other behaviorists. Theoretically, all simulations can be classified under one learning theory or the other.

dominant media of communicating with the learner.[73] Enactive representation often connotes action, i.e., representation by doing. Iconic representation presents the image or picture of what the situation is. Symbolic representation focuses on symbolization through any form of language which can be overtly or coverly understood to represent the situation. In considering the objective of representation, it is important that the anticipated response should occur as a result of the presentation of the stimulus. However, it is recognized that whether this condition occurs or not depends on a number of factors, one of which is reinforcement. For this reason, it must be pointed out that a positive orientation to simulation is a necessary precursor of simulated instruction.

3. Adequacy of Representation in Simulation

The adequacy of representation is the degree to which the medium of representation guarantees the occurrence of the expected behavior. It is an underlying assumption within the psychological school that unless the representation is adequate the contiguity of results will not occur. There are two dimensions of adequacy of representation: one is physical and the other is mental. On the one hand, adequacy of representation is a matter of representing essential elements which accurately replicate the important characteristics of the real-life being simulated. This may be referred to as physical fidelity. On the other hand, there is the representation of aspects of the real-life which a self-critical individual will judge adequate representation regardless of whether the representation reflects any physical fidelity or similarity with the

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[73]J. S. Bruner, et al. Studies in Cognitive Growth, (New York: John Wiley and Sons, Inc., 1966), pp. 6-29.

real-life being simulated. This may be referred to as psychological fidelity. Psychological fidelity is a function of individual differences, cognitive maturity, sex, social and cultural background, intellectual ability and psychological idiosyncracy. The representational meaning which the stimulus acquires comes from the learner's point of view, and may have its own peculiar behavioral effect.[74] A critical study of the methodology of designs shows that designers of educational simulations are more apt to be concerned with physical fidelity of simulation than they are concerned with the psychological fidelity. In fact, there is no guideline on how to design for psychological fidelity for people of varying ages, experience, and intellectual ability. Thus, there remains a number of unanswered questions on simulation designs for all age groups and it seems that we should turn to psychological principles for answers. Some of the questions that relate to adequacy of simulation to which answers should be sought include:[75]

1. Will there be differences in representations for adults and children? What will be adequate representation for each group?
2. Will the differences in perceptual functions of adult and children affect representation and ability to reconstruct a model even with isolated details? What conditions of preception will be necessary to meet each group?
3. Will differences in intellectual abilities justify differences

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[74] David P. Ausubel, The Psychology of Meaningful Verbal Learning, (New York: Grune and Stratton, Inc., 1963), pp. 35-36.

[75] Bruner provides the theoretical foundation upon which these questions are raised. See Bruner, et al., Studies in Cognitive Growth, (New York: John Wiley and Sons, Inc., 1966), pp. 1-85.

in representation: Should one simulation model be simplified and the other complex?

Empirical findings in these directions are lacking at the moment on educational simulation.

It can be said that the design of any educational simulation based on psychological rationale can be viewed as the provision of instructional media which provide enactive, iconic, and symbolic stimuli for realistic learning. In this respect, the simulation design should incorporate: (1) symbolic, enactive or iconic stimuli which give the learner a feeling of "realness" (psychological fidelity), and (2) enactive, iconic, and symbolic stimuli (words, machines, visuals, models, artifacts in the nature of physical representation), which aid the learner's memory and monitor his responses so that there is a climate of realism of action, performance, and consequences.

It is argued that the efficiency of educational simulations based on psychological rationale can be judged on the generalizability of the learnings that take place when the habits inculcated by the simulations are transferred to new situations resembling the real-life types modelled. It is a moot question that any design *per se* should, on psychological ground, fulfill any motivational function since creating motivation is not the purpose of the design. If the design is good and the elements of real-life on which it is constructed are valid, the use of the design for instructional purposes should motivate the learner. An educational simulation does not have as its purpose the fulfillment of aesthetic satisfaction. Rather, the design is judged by what it teaches and not by its imposing structure.

B. Psychological Rationales for Simulation Design

Gagne and Twelker provide what seem to be the most logical and consistent theoretical principles to support the design of educational simulations on psychological rationales.[76] Simulation as a learning device can be regarded as any form of stimulus (machine, model, artifact, visuals, word, etc.) designed to elicit from the learner responses that are typical of real-life situations.

Gagne provides some useful guidelines for the design of simulations. He suggests that specificity of purposes and functions are crucial to good simulation designs. He points out: ". . .the purposes of simulation are of the utmost importance, not only in determining the ways in which simulators are used, but also in establishing the criteria for their design".[77] Gagne considers that a designer must first settle the question of the purpose of the simulation. He identifies three purposes for which a simulation may be designed, viz, training, assessment, and development, all or some of which may be served by one design if preferred.[78] The

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[76]Gagne, op. cit., In R. Glaser, Training Research and Education, (New York: John Wiley and Sons, Inc., 1965), pp. 223-246; Twelker, op. cit., See also Instructional Simulation Newsletters, Vol. I, No. 3, November, 1968, and Vol. 2, No. 1, February, 1969, published at Monmouth by Teaching Research, Oregon State System of Higher Education, Monmouth, Oregon.

[77]Gagne, op. cit., p. 227.

[78]The most obvious usefulness and implication of simulation for education, argues Gagne, is for training purposes. He does not regard training as merely being the development of psycho-motor skills but rather as comprising of development involving: procedural skills, psychomotor skills, identification skills, conceptual skills, team functions, or a combination of any of the five. Ibid., p. 225.

designer must be explicit about his choice of purpose or purposes.[79]

Once the function of the simulation has been defined, the operational situation which is to be represented must be specified. This will necessitate defining the learning functions in specific operational task terms, i.e., in terms of general types of human performance they characterize--operation, concept, identification, attitude, strategies, and the like.

In specifying the operational situation and task, the set of events in which a man or men interact with the machines or with their environment must again be considered.[80] The designer has to identify the situation stimuli that are pertinent to the relevant tasks to be included in the simulation design. The situational stimuli need not be replica of real life. Equivalent stimuli will suffice. It has been empirically proved that a stimulus equivalence like a photograph or drawing produces high degree of transfer from simulation to real task.[81]

Gagne recognizes that the question of what to omit is a vexing problem to designers, but he grants that the omission of certain elements of the operational situation may be justifiable when it is considered by the designer that such inclusion will either be dangerous, or inimical to the learner, or that such inclusion is non-feasible, expensive or unprofitable. Most designers of educational simulation agree on this

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[79]When used for training, the function of simulation may be any or a combination of the six functions specified in foot-note 78 above.

[80]Gagne, op. cit., p. 230.

[81]Ibid., p. 232.

point.[82] It is generally agreed that there is no justification for loading up a design with variables that are not originally considered as part of the learning functions to be fulfilled by the simulation.

Twelker agrees with Gagne that it is futile to base a design upon an exact physical duplication because this does not necessarily guarantee maximum positive transfer of learning. A few empirical studies point to the fact that the greatest element influencing transfer is psychological fidelity.[83] In supporting this notion, Twelker contends:

> If there exists a "credibility gap" between instruction and the operational world, then the learner is at a disadvantage when it comes to either performing in the real world, or understanding what the real world is like.[84]

Like Gagne, Twelker refers to the question of stimulus situation representation. He developed the notion of contextual stimulus and contextual response as being important in determining the relevancy of the elements to be represented in the design. Perhaps the greatest contribution of Twelker to the theory of the design of educational simulation is the criteria which he developed for educational simulation. He considers that an instructional simulation must embody a <u>situation</u>, a <u>stimulus</u>, a <u>response</u>, and a <u>feedback sequence</u> which interprets the consequences of action that has taken place. Put in a different way, it may be said that every educational simulation design must answer the following questions:

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[82]Simulation designs developed by such proponents of simulation as Guetzkow, Cherryholmes, Duke, Feldman, Herron, Kersh, Gagne, Dill, Babbs and Eisgruber, to mention just a few, evidently omitted some elements of real-life. Limitation of designers knowledge about the whole system may also account for the omission.

[83]Twelker, <u>op. cit</u>.

[84]<u>Ibid</u>.

1. Does the design employ appropriate symbolic stimulus for representing the realistic situations simulated? Is the stimulus contextually relevant?
2. Does the design specify the context of the stimulus and response?
3. Does the design provide situations demanding life-like responses from the learner?
4. Does the design provide appropriate feedback sequence to the learner in terms of the learning outcomes?
5. Does the design provide for evaluation and control of learning that it offers? Can it be controlled or re-designed?

Other relevant questions may be asked about the design.

C. Psychological Rationales for Instructional Application of Simulation

An analysis of how people learn from simulation exercises, suggest Dill and Doppelt, may provide some clues to improving the design and use of simulation games.[85] In general, those who are familiar with the application of simulation games in the classroom know that a great deal of psychological principles surround the pedagogical practice. There are research findings now supporting the psychological implications arising from the use of simulations in the classroom.[86] Some of these implications are reviewed.

Most educational simulations provide practice for the learner. On a psychological basis, the sequencing of learning under instructional

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[85] William R. Dill and N. Doppelt, "Acquisition of Experience in a Complex Management Game". In Nicholas Fattu (ed.), Simulation Models for Education. (Bloomington, Phi Delta Kappa, Inc., 1965), pp. 71-103.

[86] J. R. Jackson. "Learning from Experience in Business Games", California Management Review, Winter 1959. J. L. McKenney, "An Evaluation of a Decision Simulation as a Learning Environment", Management Technology, May, 1963. Babbs and Eisgruber, op. cit., Chapters IX-XII, pp. 125-158. See also Dill and Doppelt, op. cit.

simulation must have regard for the student's level of knowledge and relevance to the student's needs. This affects both the degree of interest and motivation the student brings into the simulated instruction. Initially acquired knowledge and the degree to which the simulation integrates newly acquired knowledges will determine the performance of the student under simulated learning environment. Learning provided by simulated instruction needs to be meaningful to the learner and must, above all, be realistic.

A good simulation design provides both a briefing session and a critique session. The critique session is an occasion when both the individual and the group engaged in the learning activity can discover more about their successes, failures, and inadequacies in preceeding simulated exercises. The significance of simulated learning lies in the opportunity for transfer of learning to other problem situations identical to real-life.

D. Some Examples of Educational Simulation Based on Psychological Rationales

For the reasons given at the beginning of this section, it appears that either by design or accident any educational simulation will have one or two types of affinity with psychological learning theories. But, if Twelker's four criteria of educational simulation are applied in evaluating educational simulation based on psychological theory, perhaps most designs will fall short of the requirements for educational simulation. If a more liberal psychological criterion were used, however, all educational simulations will qualify either because of the principles underlying their designs or because of their instructional application. Thus, it can be generalized that if any educational simulation is a symbolic, iconic, or concrete stimulus representation of real-life and if it is used for instruction, it has embedded in it psychological learning theories.

E. Leading Theoretical Principles of Psychological School

In summary, the features of educational simulation based on psychological learning theories can be briefly stated as follows:

1. Symbolic, iconic, or enacted stimulus may be used for eliciting responses typical of real-life.
2. The aspects of real-life modelled by the simulation are specified and defined in operational task terms that describe the nature of human performance and the interactions that are involved.
3. Only relevant situational stimuli are represented.
4. The representation of the stimuli is equivalent.
5. Five criteria must be satisfied by the design:
   (a) a stimulus situation
   (b) a response situation
   (c) a consequence situation representing the interaction of the stimulus and response
   (d) a feedback sequence, and
   (e) a control and evaluation sequence.

It can be concluded therefore that the S-R theory is basic to all simulation designs.

6. Transfer of training is the main criterion for deciding what to include in the simulation. If an element of an operation will not be relevant to a stimulus situation that produces a response that can be transferred to real-life, that stimulus is contextually irrelevant.
7. Omission of dangerous, inimical, non-feasible, expensive, and

non-profitable elements of the situation is permissible. So are the omissions of elements that are irrelevant to the purposes of the simulation.

8. When used for instruction, simulation based on psychological learning theories give adequate consideration to:
   (a) the level of knowledge of the learner and his interest
   (b) the sequencing of his learning experiences
   (c) the provision of an orientation for the instructional objectives
   (d) the provision of adequate practice and feedback
   (e) evaluation of learning outcomes in terms of real-life standard or criterion.

IV. THE SOCIOLOGICAL SCHOOL

To a number of people the most plausible rationale for simulation is a role theory. This is so because educational simulation is perceived as a planned strategy which enables the individual learner to mimic the roles of real-life model through realistic practices which enables the individual learner to "act" and internalize the roles depicted by the simulation regardless of the true personality of the learner. Therefore, simulations are construed to have as their central feature the development of specific roles and attitudes that replicate those of a real-life model. Learning to act these roles are maintained by definite social constraints or rules which condition the learner to play the roles and internalize them. Thus, under instructional simulation, the individual learns to perform the identified roles built into the simulation through practice of a series of learning activities programmed to depict cooperative and/or competitive interactions provided by the simulation. The transaction in the simulation is regulated by some rules which are known to the players.

The role theory of simulation therefore hinges upon the premise that the referent point for constructing a simulation should be the role for which the individual is being groomed. Thus, it is argued that simulations for instructional purposes, regardless of the field, should reflect the roles which the learner will be required to perform in real-life, except that the opportunity to perform is under instructional conditions.

A. Framework of Simulations Based on Sociological Rationales

Any simulation based on a sociological rationale is characterized by a depiction of phenomena that represent a microcosm of the social system. The simulation represents a series of identifiable purposive components of behavior repertoires. Man is the main "actor". The main elements of social simulation design have been discussed by Coleman[87] and Garvey.[88] The "microcosm of the social system" has its own process of socializing the individual and of molding him according to social standard through a process of reward and punishment, sanction, reinforcement, and approval as in real-life. Even though there may be no adequate explanation for all the theoretical questions that may arise on social simulation games,[89] it is proposed to clarify certain basic points in the design of simulations relying on role theory.

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[87] J. S. Coleman, "Social Processes and Social Simulation Games" in Boocock and Schild, op. cit., pp. 29-51.

[88] D. L. Garvey, Simulation, Role-Playing and Social-Drama in Social Studies, The Emporia State Research Studies, Vol. XVI, No. 2, December, 1967, see particularly pp. 12-17.

[89] Coleman, loc. cit., p. 37.

1. Theoretical Principles Affecting Design

The design must show at least three major structures: (1) the act, (2) the actor or actors, i.e., the roles which are being simulated, and (3) the environment consisting of other people, groups, and things in the organization. These three structures together constitute a systemic unit with a common goal orientation or purpose. The components of each of these and the problems involved in determining what is to be abstracted will be discussed next.

The Act and Actor: The act describes the situation "played". It describes the role type that is depicted by the simulation. The person who performs the role is the actor. His action may involve active participation that results in interactive relationships with others in the organization. It is often difficult to separate the act from the actor.

The determination of the elements of role to be included in the simulation design is always a difficult task. It is practically impossible for a simulation to contain all the sets of "role behavior"[90] of an incumbent of a position. Therefore, some research focusing on a specific model or system is necessary to ensure that valid role behavior sets are used for the construction of a simulation. It must also be noted that there are several forces in the society and the environment that may alter roles. The incidence which technology may play in the role of a person should be taken into consideration. In education, this becomes important, because a simulation which derives from the estimation of roles of yesterday

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[90]Gross, et al. define role behavior as "an actual performance of an incumbent of a position which can be referred to an expectation for an incumbent of that position". N. Gross, W. S. Mason and A. W. McEachern, Explorations in Role Analysis, (New York: John Wiley and Sons, Inc., 1965), p. 64.

may not be appropriate for training technicians and other personnel needed for tomorrow.

2. Methods of Derivation of Roles

Several approaches have been used to determine the role behavior sets that must be included in the simulation design. Some of these are discussed.

(a) Theoretical Roles: Simulations of role behavior can be theoretically determined. Before the theoretically derived roles can be valid, they have to be tested and proved to be generalizable. Political science simulation roles derive from theoretical constructs.[91] The specific system to be modelled is operationalized, e.g. simulation of international relationship, bargaining, or election.

(b) Critical Incidents: Some roles are derived from a "critical incidents analysis".[92] The elements derived are then thrown into the simulation model. In this respect, the critical incident is considered to be the criterion upon which the model is designed. Critical analysis as the basis of derivation of referents for a simulation role model has been used in the military operations and has a lot to recommend it.[93]

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[91]Garvey, op. cit., p. 11; Coleman, op. cit., p. 35; Waltz, "Realities, Assumptions, and Simulation" in Coplin, op. cit., pp. 105-111.

[92]Flanagan pioneers the use of critical incident approach for developing educational objectives. See J. C. Flanagan, "The Critical Requirements Approach to Educational Objectives", School and Society, Vol. 71, 1950, pp. 321-324; also Flanagan, "The Critical Incident Technique", Psychological Bulletin, Vol. 51, 1954, pp. 327-358.

[93]Edwin A. Fleishman (ed.), Studies in Personnel and Industrial Psychology, (Homewood, Illinois: The Dorsey Press, 1967), pp. 84-85.

The American Orthopaedic Surgeons have also used the critical incident approach.[94]

(c) Functional Approach: Role elements to be included in a simulation design may be based on the functional requirements of the job position. The use of functional scales developed for the Dictionary of Occupational Titles[95] may be the source of the elements abstracted for the design. The Michigan State University Vocational Office Block Simulation is based on this type of derivation.[96]

(d) Employers' Requirements: A check-list of employers' requirements for specific positions in an organization may be the basis of the elements of the role to be abstracted for a simulation design. Usually, this type of check-list or requirements will also provide estimates of physical demands, working conditions, and other types of approximations, required for the job.

Other methods can be used for the derivation of role objectives of a simulation, such as the competency approach, and the cluster-of-jobs approach. Regardless of the method used, there are some problems that plague designers of role simulation. First, the designer is faced with

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[94] J. Michael Blum and Robert Fitzpatrick, Critical Performance Requirements for Orthopaedic Surgery - Part I, Method I. (Pittsburgh, Pennsylvania: American Institute for Research, 1965).

[95] U.S. Department of Labor, Manpower Administration, Dictionary of Occupational Titles, Volume I - Definitions of Titles, and Volume II - Occupational Classification and Industry Index, (Washington, D.C.: U.S. Government Printing Office, 1965 (3rd edition).

[96] Personal knowledge as a Research Assistant at Michigan State University in the Research and Development Program in Vocational-Technical Education, and discussion with the Project Director, Dr. Peter G. Haines.

the problem or the danger of concentrating on behavior or effects of behavior.[97] Second, the designer may face the problem of neglecting the structure that molds the character and shapes the behavior. Sometimes the situations give rise to behavior that may be ambiguous because of the stimulus-messages they emit, in which case the designer is at a loss of what to represent. Often the focus may be on the individual role player when his response or action may have been determined or influenced by a set of other persons in the organization or by the environment and this may not be adequately represented by the design.[98]

Even though the problems discussed above are valid, the role theory does not offer a solution to the problems. It seems we have to rely on the psychological theory--the notion of contextual stimulus suggested by Twelker--for an answer to the problems.

The Environment: The purpose of representing the environment in a simulation is to ensure that an artificial environment reflects the resemblance of the real-world and that the physical place of decision-making is brought within the perception of the learner. The ecology of the environment may provide the constraints and stimuli that play a vital role in the behavioral response.

In social simulation, it is not essential that the physical place be represented in all its entirety. In certain cases, when it is possible

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[97]For example, a compulsive teacher-educator may consider the teacher's "appropriate" classroom dress as an important element to be simulated because it affects students learning rate or attention span in the class. This may or may not be true significantly to make such a simulation absolutely essential.

[98]Problems of this nature will fall into the affective domain and may include such aspects as attitude, mood, and personality, difficult to abstract from behavior.

to represent every aspect of the environment, it is always a very expensive proposition. Garvey has suggested that often a verbal description of the environment may be adequate in some respects.[99] Moore stipulates broader but tighter requirements for simulating organizational environment.[100] He contends that an innumerable number of elements (exogeneous and endogeneous) form a total environment of which only a few are relevant in specific cases. Only the sum total of all the variables that initiate response-stimuli will constitute the relevant environment. He terms some kinds of elements of the environment as "substantive". These are those environmental factors that may affect operations (e.g. lighting). Time is another aspect that is an element of the environment considered by Moore. He argues that knowledge of the past often affects the actions of the moment, or those of the future. Resources for acquiring information is another factor. In decision-making situations, the facilities for obtaining information or their lack must be taken into consideration. He sums up by stating that above all, the major objective in simulation of the environment is to develop an artificial environment that will be as realistic as possible to elicit a real-life response.[101] He finally suggests that the way to test the degree of realism of environment is to use real-life practitioners as players in the simulation. It should be possible from their responses to determine whether there are errors of omission or commission in the environmental simulation.

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[99] Garvey, op. cit., p. 16.

[100] Charles G. Moore, "Simulation of Organizational Decision-making: A Survey", in William D. Coplin, Simulation in the Study of Politics, (Chicago: Markham Publishing Co., 1968), pp. 191-198.

[101] Ibid., p. 195.

Whether maximum or optimal environmental simulation is what makes a simulation effective has not been resolved. There is reason to believe, however, that verisimilitude of the model is psychologically adequate and is all that is essential.[102]

3. Some Examples of "Role" Simulations

Many simulations have been designed upon a rationale that relies on the development of role competence through role simulation. Simulations of this nature have professional education and training overtones and their major objective is the inculcation of identified performance objectives--skills, habits, concepts, attitudes--exhibited by individuals occupying specific roles in real-life. The goal of such simulations, therefore, is to develop the skills, concepts, and insights needed for the job.[103] These simulations consider not only the development of the behavioral repertoires of the model, but they also consider the situational settings in which such behavioral repertoires occur. This is important because of the need to impart knowledge in circumstances that take cognizance of the environment that will facilitate transfer to future on-the-job situations.

The gaming concept again features prominently as an important element of sociological simulation but it is not necessarily the rule. There is a need for the simulation to show gamed roles and social interaction to illustrate the ways in which the roles, the rules, the relationships, the reward and penalty structure of the simulated model truly operate. Babb

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102This position is very much supported by the psychological and the mechanistic schools, particularly by Gagne and Kibbee, respectively.

103Note that often the learner or role-player in such a situation is often not well-informed or experienced about the role he is called upon to play.

and Eisgruber observe that the term game is deeply entrenched in social science vocabulary. It connotes the concept of rules, strategies, and maximization which help to orient the participants.[104]

Unfortunately, the construction of a competitive strategy in social studies is somewhat difficult because most of the social interactions involve cooperation. For learning purposes, however, simulation games need to be constructed such that they combine the interactive relationships. Designers have approached this problem in different ways, and two examples of role simulations are described below.

A. Role-Playing Simulation:

Garvey defines role-playing as the practice or experience of being someone else.[105] It is a symbolic model designed to enable a person to understand the situation of the model by casting the learner in the model's situation and requiring him to solve some specified problems which the model faces. Role-playing is an extension of the case method of teaching, but it goes further than it, because it involves the dramatization of the roles being depicted by the participant. Thus role-playing is not just talking about a role, it is playing it out. The following features, when present in the design, make role-playing an effective educational simulation:

1. when there is a model whose role can be simulated,
2. when the problems posed by the design are presented in life-like settings,
3. when the participants roles in the role-play design actively

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[104]E. M. Babb and L. M. Eisgruber, Management Games for Teaching and Research, (Chicago: Educational Methods, Inc., 1966), p. 16.

[105]Garvey, op. cit., p. 8.

involve them emotionally in providing solutions to the problems of the role-playing simulation,

4. when the role-playing provides an opportunity for the development of interpersonal skills through practice that offers occasions to test ideas and hypothesis about the solutions to the problems, and

5. when feedback is continuous.

Liveright notes that certain shortcomings are inherent in role-playing.[106] Participants may resent it on the pretext that it is childish. Also because the model of behavior to be role-played is not standardized, the player may overdramatize and overact. This changes the objective of instruction from being problem-solving to pure dramatization and entertainment. Some participants prefer "playing to the gallary" to solving the problems posed by the simulation. Reinforcement is always a problem in role-playing. Bass and Vaughan argue:

> The players receive immediate feedback on the effects of their behavior from each other and the trainee observer. The problem arises when this feedback is in the form of approval, and the approval is for "acting" rather than for insight into the problem.[107]

The importance of the instructor's "stage-setting" remarks[108] are crucial in the application of role playing. Wikstrom suggests that in order to attain the objectives, the instructor must constantly monitor the program,

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[106]A. A. Liveright, "Role-playing in Leadership Training", <u>Personnel Journal</u>, 1951, Vol. XIX, pp. 412-416.

[107]B. M. Bass and J. A. Vaughan, <u>The Psychology of Learning for Managers</u>, American Foundation for Management Research, Inc., 1965, pp. 86-87.

[108]W. A. Wikstrom, <u>Developing Managerial Competence: Changing Concepts, Emerging Practices</u>, (New York: National Industrial Conference Board, Inc., 1964), p. 82.

and manipulate or control the role-playing course, otherwise it may be difficult to attain the training objectives.[109]

Cohen mentions an important limitation in effectiveness of role-playing simulation. He refers to the concept of the "knowledge gap" which the student suffers from about the "role types" of the real-life counterpart. He doubts whether acting out necessarily implies internalization of roles. He argues: "Even if a player knows the role he is playing...the probability that he will behave in a manner that is indicated by the role is rather low".[110]

The knowledge gap concept relates to the level of entry knowledge which the role-player brings into the role-play and the degree of knowledge required for effective performance of the role in real life. When students do not have appropriate knowledge or experience about the role they have to play, role-playing simulation has a drawback. This drawback can be off-set if the design incorporates a coaching unit. On point of fact, a good role-playing simulation can teach the roles and at the same time assess performance. This makes assessment of transfer possible. Many role-playing simulations now in use do not perform these two functions. They emphasize human relations training mainly.

1. Theoretical Principles Affecting Role-Playing Design

Maier, Solem, and Maier offer excellent suggestions in considering

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[109] Ibid., p. 82.

[110] Bernard C. Cohen, "Political Gaming in the Classroom", Journal of Politics, Vol. XXIV, 1962, p. 376.

the construction of role-playing designs for instruction.[111] It is, however, considered that any role-play which strictly will qualify as a simulation should encompass the following features:

(a) The referents for the role-playing design must be demonstrated and proven items that do represent conditions of a life situation.

(b) The design should be a simple representation of the model, yet clear and accurate with minimum amount of detail.

(c) The role playing simulation design must typify a broad range of problems requiring the application of integrated principles and knowledges relevant to the problems simulated.

(d) Problems illustrated by the design must have interest value and the type of challenge which will produce conflict and varied viewpoints among the participants. If it is otherwise, boredom may set in as participants will not be involved emotionally.

(e) Irrelevant and extraneous facts must be purged out of role-play design as these will disrupt the progress and focus of discussion.

(f) Feedback, objectively provided during and after the simulation exercise, makes role-playing effective and controllable.

(g) An evaluation of the role played is essential for developing the proper perspective in generalizations which can be transferred to problem-solving situations later. An evaluation control is desirable, and this is effectively given by the teacher who acts as the arbitrator.

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[111] N. R. F. Maier, A. R. Solem, and A. A. Maier, <u>Supervisory and Executive Development: A Manual for Role-Playing</u>. (New York: John Wiley and Sons, Inc., 1964), pp. 4-5.

2. Theoretical Principles Affecting Instructional Application of Role Simulation

Maier, Solem and Maier suggest four important theoretical principles for instructional application of role-playing.[112] These are discussed briefly.

(a) Focusing the Problem. This is an introductory section and a general description of the problem illustrated in the simulation. The educational objectives of the role-playing simulation must be stated. It is helpful if the level of skill which the participants are required to develop is specified.

(b) Role-Playing Procedure. This represents the step by step description of the role-playing scene. Questions relevant to the problems as well as suggested method of analysis need to be highlighted. It is absolutely essential that participants familiarize themselves with the procedure.

(c) Material Presentation. It is essential that all relevant background information on the role-playing problem be given beforehand to the participants. The roles to be played by each individual should be clarified. At the same time, specific instruction to each participant about the situations described in the role play must be given.

(d) Comments and Implications. This aspect of the instructional program is designed to serve as the "post mortem" analysis of the roles played. However, the instructor must be prepared

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[112] Ibid., pp. 6-8.

to interrupt the procedure of the session particularly at a time when the role-playing simulation is moving away from the stated objectives. One of the major purposes served by this session is to offer a critique of what has transpired during the role-playing session. It should therefore be focused towards the development of generalizations that can be transferred to new situations rather than violent criticism of the parts played by individuals in the role-play.

B. In-Basket Simulation:

Little has been written on the methodology of designing in-basket simulation,[113] although there is in the literature, a fairly extensive description of the technique as a training tool.[114] The attempt by Frederiksen, Saunders and Wand,[115] however, represent the first step at grappling with the methodological problem in designing, administering and evaluating in-basket simulation. Their pioneering work has influenced

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[113] Frederiksen, Saunders and Wand note: "In-basket testing presents a novel approach to a measurement problem, and little recorded experience was available to guide the development of the test and scoring procedure". N. Frederiksen, D. R. Saunders, and Barbara Wand, In-basket Tests, Psychological Monographs, Vol. 71, No. 9, Whole No. 438, 1957, p. 22.

[114] Ibid. Also J. Hemphill, D. Griffiths, and N. Frederiksen, Administrative Performance and Personality, (New York: Teachers College, Columbia University, Bureau of Publications, 1962); N. Frederiksen, Factors in In-basket Performance, Psychological Monographs, Vol. 76, No. 22, Whole No. 541, 1962; University Council for Educational Administration, Simulation in Administrative Training, (Columbus, Ohio, 1960), B. M. Bass and J. A. Vaughan, Training in Industry: The Management of Learning, (Belmont, California: Wadsworth Publishing Co., Inc., 1966), Charles Kepner and Benjamin Tregoe, "Developing Decision Makers", Harvard Business Review, September-October, 1960, and W. S. Wikstrom, Developing Managerial Competence: Changing Concepts, Emerging Practices, (New York: National Industrial Conference Board, Inc., 1964).

[115] Frederiksen, Saunders and Wand, loc. cit.

the trend towards the application of the device as a viable and profitable educational tool which has a great promise for training evaluation, personnel selection, placement, guidance, and for instructional purposes.[116]

1. Framework of In-basket Simulation

In-basket items are collectively described as in-basket tests or simulation because they represent the components of the work which constitute the content of the daily work of an administrator's In-basket. Thus, it is a prototype of an instruction used for training a student to assume the role of the administrator whose role is simulated. It puts the individual in a representative realistic situation which demands that he acts the role of the administrator.

The materials for in-basket simulation consist of written items covering aspects of the role of a personnel within an organization setting. The simulation could represent one role or several roles. For example, a business organization can represent in-basket items for the General Manager, Business Manager, Advertising Manager, Controller, and even an office boy. The materials are either fictionalized events about the organization and its people or they may represent hypothetical models of a real-life situation.

2. Purpose of In-basket Simulation

In-basket simulations are concerned with situational performance. Therefore, it can be said that its major purpose is assessment of performances that are characteristics of the holder of a position. However, in-basket simulation can be used also for the assessment of instructional effectiveness, specifically, how well the instructions given in the classroom are meeting the curriculum objectives.

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[116] Ibid., pp. 1, 21-23.

In-basket simulation, when used for performance assessment, has been applied for assessment of complex skills including: (1) ability to organize discrete pieces of information, (2) ability to discover problems implicit in a situation, (3) ability to anticipate events which may arise, and (4) ability to offer solutions based on a number of considerations.[117]

3. Features of In-basket Simulation Tests

In-basket simulations vary in their complexity of models. In general, they represent a paper-and-pencil affair in which a typical role performer finds himself in the day to day role of a real-life model. In an attempt to represent a realistic model, in-basket simulations typically represent items of varying complexity. Some items are easy and can be solved outright or be ignored temporarily after a cursory glance. Some are complex items difficult to solve and may require detailed study and reflective and considerative processes. The urgency of some items, inspite of their complexity, may also exert pressure on the decision maker and therefore demand a top and immediate priority.

Frederiksen and associates have suggested that the best way to structure in-basket items will be to clarify them by situations and categorize them by functions.[118] When classified by situations, the problems are identified as to whether they characterize problems involving interactive behavior. The former will involve inactive interaction, and the latter interactive interactions. In categorizing the problems into functions, any of the following may be taken into consideration:

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[117] Ibid., pp. 2-5.

[118] Ibid.

(1) routinized functions, (2) flexible function, requiring adaptability and willingness to innovate, (3) foresight requiring resourceful anticipation of developments, and (4) data evaluation requiring judgment about what is pertinent and what is not.

4. Theoretical Principles Affecting Design of In-basket Tests

The important design features of in-basket simulation have not been researched to warrant any generalization. Proponents of in-basket simulation recognize however, that the design of in-basket simulation raises many problems among which can be mentioned the problems of modelling, specifying objectives, devicing scorable tests for evaluation of performance and many others.[119] Also, attempts have been made to devise models which can eliminate some of the complaints which examinees have, especially when inadequate background information is given on in-basket problems. Based on the works of pioneers in this field, the following is suggested as the elements of the design of an in-basket simulation:

(a) Choose a model and clarify its purpose. Identify and specify the roles of the incumbent. Examination of past records, observations, interviews, and opinion survey about the scope of the roles of model are useful sources of information about the nature and characteristics of the model. Be specific on the choice of model: state whether general or special. Provide a verbal or iconic description of the model and its environment. Be brief.

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[119]Frederiksen and his colleagues at the Educational Testing Service have been concerned with development of a design which will have a scoring device for assessment of performance. Ibid.

(b) Develop some concept about basic situations in which the functions are to be performed, and determine which functions require individual behaviors primarily and which require interactive behaviors.

(c) Focus on specific problems that relate to specific functions and develop series of problems connected with specific situations involving conflicts or complexities requiring solutions. Use essays in constructing the problems stating what has arisen, how, and what has been done or remains to be done.

(d) Experienced administrators who know about the roles may be asked to describe or construct typical problems. Test for reliability and validate. Arrange in-basket items in a manner that they are scorable. Validate correct answers by asking several persons who know about the system to say what they will do.

(e) Any supporting documents representing a description of the operational situation may be written or presented in some other composite explanatory formats. This information must be available to those taking the in-basket tests.

(f) Provide a feedback sequence,[120] and set a criterion for evaluation.

5. <u>Theoretical Principles Affecting Instructional Application of In-basket Tests</u>

When used for instruction, a great deal of effort is made to give in-basket simulation the highest realism possible. This requires elaborate preparation about the physical arrangements of the decision-maker. In order to give the participants a definitive air of realism, background materials

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[120] This is a tenuous problem for both design and instruction.

relative to the in-basket items must be given. The particulars provided may include a written, recorded, or verbal description of the organization, artifacts, charts, and models which are pertinent to the in-basket items either directly or indirectly. These particulars orient the participants to the problems of the simulation. In addition, the participant is placed in a "simulated situation" which represents his own "office" which is the replica of the real-life model's.

In-basket simulation used instructionally provides the participant an opportunity to play actively the role being modelled. However, the approach as now designed by some proponents, does not include all relatively important features which may increase realism. Interactive relationships are not included in some in-basket simulations. Feedback sequence is a peculiar problems. One proponent has combined a computer program with in-basket simulation for feedback purposes. This approach described by Bessent is used for requesting information.[121]

Wikstrom, among other things, makes the following suggestions that are unique as his own contribution. He suggests that the solution to the items must "permit a variety of approaches if the purpose is to explore concepts".[122] At the same time, if the purpose is to train in standard procedure, the in-basket items must highlight "the one 'right' way".[123] He also refers to the critique session as an important feature

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[121] Twelker, "Simulation: Status of the Field", op. cit. Twelker briefly describes Bessent's model in this paper. (mimeo)

[122] Wikstrom, op. cit., p. 88.

[123] Ibid.

of in-basket simulation. This session is used, as described in the previous examples, for the purpose of supplying new information to the student on the approaches which could have been taken if other assumptions were made.

Frederiksen and his colleagues are concerned about scoring simulation items in in-basket tests. They suggest that the scorer must be given a great freedom in awarding or subtracting points for exceptionally good or poor performances. This means that students' responses to in-basket items must be weighed on the basis of the competences which the tests emphasize and according to the judgment of the scorer. This does not mean that a standard procedure will be hard to establish. Scoring in-basket tests improves the reliability of the test but this is achieved through homogeneity of items which constitute the tests. High reliability implies high homogeneity of items.

The proponents also suggest that the homogeneous parts of the tests should be introduced sequentially and be followed by critiques of students' performances. They mention other uses of in-basket simulation and suggest that for instructional application, in-basket simulation can be used to assess the quality or effectiveness of teaching, the strength and weakness of students, and the determination of an appropriate level for beginning instruction.[124]

In-basket simulation, properly designed and utilized, is a valuable laboratory for development and application of skills and for accumulation of realistic experience in role performance. It must be remembered that the items need to be revised from time to time.

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[124]Frederiksen, Saunders and Wand, op. cit., pp. 21-22.

C. Leading Theoretical Principles--Sociological School

The theoretical principles underlying role theory to simulation design may be briefly summarized as follows:

1. There must be a model that epitomizes the roles simulated, e.g. an occupation, a system, or a person.
2. The role types built into the simulation design must be valid prototypes of the model. The derivation of roles must be based on some systematic observation of behavioral characteristics of the model in his environment. The roles must be proven before they can represent those of the model.
3. Inasmuch as the environment is part of what determines the individual behavior or group behavior, the relevant substantive elements of the environment need to be represented in the simulation design in order to give effect to active and interactive responses of the model.
4. When used for instructional purposes, the simulation must involve life-like activities which provide practices (plays) of the roles of the model.
5. Individuals who are to play these roles must be oriented realistically to the objectives of the roles and be appraised of the acceptable standard of performance essential for effectiveness.
6. Life-like situations need to be provided for the practice, so that the reward and punishment constraints of real-life can be brought to play.
7. Rules and constraints must be stipulated to condition the role behavior of the learner when he is engaged in the practice

(play) thereby leading to the enforcement and internalization of the values imposed by the rules of the game.

8. The social interactions or actions represented in the simulation may be man-machine or man-man operations manually controlled or computer-controlled.

SUMMARY

It has been suggested and supported by examples from the literature that educational simulation is characterized by four rationales--philosophical, mechanistic, psychological and sociological. The philosophical position emphasizes the realistic, pragmatic, functional, goal-directed, participatory aspects of learning in which the learner plays the dominant role. The mechanistic position supports the utilization of technological devices, (synthetic and animated), for faithfully representing real-life. The devices facilitate learning. The psychological school regards the physical and psychological fidelity of the operational situations as important issues which engender realistic responses on the part of the learner. Such considerations facilitate transfer to real-life situations under practice conditions. The sociological position emanates from the abstraction of relevant human and physical environment relatable to the role sets of the real-life model. Role behavior is inculcated through a process of normative practice.

It is clear from the exploration of each theoretical position that the focus of all educational simulation is for instruction of a realistic type which presents laboratory-type experiences to the learner under conditions that replicate the operational situations of real-life. This representation is not real-life itself. Gaming is a useful concept in most educational simulations but it is not the sine qua non of simulation.

As far as the design of educational simulation is concerned, it has been noted that the main difference that arises in each of the schools is basically one of approach. The goal is the same. It can be said, therefore, that any variation noted in the instructional approach is caused by the main difference in approach to design. Indeed, it has been found out that a network of interrelationships color the methodology in design and application for instructional purposes. Terms like games, fidelity of simulation, feedback, verisimilitude, practice, play, actor, sequence appear in almost every section throughout the review. These findings strongly support the position that is taken, that an integrative theory[125] can be proposed for educational simulation regardless of the orientation of the designer.

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[125]Theory as used here is in its simplest sense--as a set of logical principles or propositions which provide explanations that lead to an understanding of a complex phenomenon. As Kaplan suggests, theory is an explanation which "sets forth some ideas of the rules of the game, by which the moves become intelligible." It is an effort "to make sense of what would otherwise be inscrutable or unmeaning empirical findings". Kaplan, op. cit., p. 302.

CHAPTER III

AN INTEGRATIVE THEORY OF EDUCATIONAL SIMULATION

The classificatory approach used in Chapter II in reviewing the theoretical rationales underlying educational simulation is only a convenient rubric for investigating the nature of the phenomenon. It has been seen that none of the four classes of educational simulation has theoretical principles which are mutually exclusive. From the analyses of the four categories, it is clear that a network of objective theoretical relationships exist between the different schools, both in design postulates and in the application of simulation for instructional purposes.

In this section, an endeavor will be made to synthesize the principles that have been identified as common to the four schools and are considered as those theoretical principles which give significance to educational simulation as a phenomenal knowledge. It is hoped that the integration of the theoretical principles will serve as a connecting bridge between the four rationales, and that a unified basis will be found for interpreting and criticizing established principles on educational simulation. At the same time, the integrative theory can serve as a useful device for generating and modifying new principles which may be discovered for more powerful generalizations about educational simulation.[1]

In order to relate this analysis to the problems posed by this study, the theoretical principles unravelled will be discussed under two headings: (1) theoretical principles related to educational simulation design, and (2) theoretical principles related to instructional application of educational simulation. These integrated principles will be presented as tentative theoretical principles that bind together all educational simulations.

I. THEORETICAL PRINCIPLES FOR THE DESIGN OF EDUCATIONAL SIMULATION

A. Nature of Simulation. There is a general agreement that simulation is a model of reality and not reality itself. It is not the aim of educational simulation, therefore, to reproduce reality in all its complexity, but only to select certain essential elements that are adequate to afford an understanding, prediction, or control of the real-life situation. However, a real-life model needs to reflect the essential internal and external variables that are substantively relevant contextually to the model.

B. Fidelity of Simulation Model. All the four schools are concerned with fidelity of simulation model but with varying degrees of preoccupation.

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[1]This approach can be regarded as a step towards a theory of educational simulation. Kaplan argues that "a theory is a way of making sense of a disturbing situation so as to allow us most effectively to bring to bear our repertoire of habits, and even more important, to modify habits or discard them altogether, replacing them by new ones as the situation demands. . . Theory will appear as the device for interpreting, criticizing, and unifying established laws, modifying them to fit data unanticipated in their formulation, and guiding the enterprise of discovering new and more powerful generalization". Kaplan, op. cit., p. 295.

Fidelity of simulation may be physical or psychological. Physical fidelity is the representation of essential elements of a real-life model which accurately replicate the important characteristics of the real-life being simulated. It is the approximation of the real-life model through a process of selective omission of irrelevant elements and the inclusion of relevant elements that provide stimulus equivalence that elicits life-like responses transferrable to real-life. Psychological fidelity is a mental process which leaves a self-critical individual in a feeling of "realness" whether or not there is a physical similarity between the real-life model and the simulation model. The fidelity of a simulation design is not affected if the designer omits dangerous, inimical, and non-feasible features of the real-life model. Fidelity of simulation is not attained by physical duplication of the model alone, but also by verisimilitude, a psychological state which gives an appearance of reality. However, fidelity could be in a continuum (high or low) to reflect the degree of realism of simulation. Simulation can also be partial or total.[2]

C. Simulation and Game. These two terms are used sometimes interchangeably by designers and users of educational simulation. Computer simulations are generally oriented towards games when used for instruction, as in management or business games.

Although simulation and game are both useful terms in educational

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[2]When a simulation does not represent all the task elements of an operational simulation, it is partial simulation. When it represents all the referent task elements important for successful outcomes, it is total simulation. Jack A. Adams, "Some considerations in the design and use of dynamic flights simulators". In Harold Guetzkow, Simulation in Social Science: Readings, (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1962), p. 35.

simulation, they do not always mean the same thing.[3] Shubik's distinction clarifies the application of the two terms. He suggests:

> Gaming is an experimental, operational, or training technique which may or may not make use of simulated environment but is invariably concerned with studying human behavior or teaching individuals. In simulation, the behavior of the components is taken as given. The actual presence of individuals is not necessary to a simulation, but it is to a gaming exercise.[4]

It is important to clarify the usage of the term "game" as applied to educational simulation. There are two possible technical uses of the word in educational simulation. The first, and the more common usage is the notion of game as an instructional approach in a manner suggested by Shubik. In this respect, game is used as a device which provides mimicry and interactiveness between man and other men, between man and machines, or between man and his environment or between all of these. The purpose is to dramatize conflict, competition, or interaction between variables that represent real-life. When gaming involves men, participation results. Thus, simulation game sessions are exercises which provide realism by depiction of interactions in real-life. A simulation device which utilizes the game strategy is effective for generating involvement and motivation on the part of the learner and it is the degree of verisimilitude more than anything else which gives the participants a feeling of realism. In this sense, game is a means of providing "clinical experience" about a model's behavior.

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[3]Cherryholmes argues that all games are not simulations nor are all simulations games. A game becomes a simulation when it attempts to model a referent system. Cleo H. Cherryholmes, "Simulating Inter-Nation Relations in the Classroom", in Becker and Mehlinger (eds.), <u>Inter-Nation Dimensions in Social Studies</u>. 38th Yearbook, National Council for Social Studies, Washington, D.C., 1968, p. 176.

[4]Martin Shubik (ed.), <u>Game Theory and Related Approaches to Social Behavior</u>, (New York: John Wiley and Sons, 1964), p. 71.

It must be pointed out, however, that gaming is not the _sine qua non_ of educational simulation.[5] Some types of simulated instruction are not based on game theory because competitive or conflicting strategies are not illustrated conspicuously in the learning exercises. Such simulation exercises provide activities of the "non-zero-sum" type where there is no winner or loser in the learning "game". Yet the exercises provided are the prototypes of the real-life model, but it is only the individual that reacts to the situation by himself, or cooperatively with other group members (when this is part of the design).

For gaming, the computer is used when the operational strategy is complex and requires the manipulation of heteromorphic variables. This facilitates computation and provides feedback. The computer has no rival when the model designed requires multiple responses of either deterministic or stochastic model.

The second usage of game is concerned with the implication of game theory as the rationale of modelling a referent system. Shubik mentions the importance of games in social science process.[6] In real life, no individual is in complete control of the processes in his environment because of the influences of various elements. Certain variables related to social interactions therefore can be selected and gamed to depict

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[5]Robinson has, however, reported that "games may prove superior to other methods of instruction". See J. Robinson, "A Research Design for Comparing Simulation with Case Studies and Problem Papers in Teaching Political Science". Jackson and Sweeney (eds.), _Proceedings of the Conference on Business Games as Teaching Devices_, School of Business Administration, Tulane University, 1962, pp. 123-129.

[6]Shubik, _op. cit._, pp. 8-9.

problems involving conflict, contest, or cooperation in real-life in order to simulate a set of situations about human processes, be it politics, psychology, sociology, or economics. Thus the elements of game theory, as developed by Neumann and Morgenstern,[7] are useful for building simulation games that attempt to model real-life.

It will be necessary to summarize the characteristics of games when used for instructional purposes:

1. Players are oriented towards the educational objectives of the game. It is the explicit statement of educational objectives of simulation games, and the specificity of the model, that distinguish educational games from parlor games.
2. Games are used primarily for training purposes, but they may also be used for research and development. Usually they are simpler than the model they represent.
3. They always involve man-machine operations (generally computers) requiring sometimes rigid or flexible rules controlled by an umpire or programmer. Some games may be manually operated or scored.
4. Time is always simulated, i.e., "real time" is compressed under basic assumptions of the program, e.g. one cycle of play may represent a three months operation or a year.
5. A simulated environment is always designed either symbolically by a representation of those relevant aspects of real-life or through verisimilitude representation which gives a cognitive appearance of real-life.

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[7]John Von Neumann and Oskar Morgenstern, Theory of Games and Economic Behavior, (Princeton: Princeton University Press, 1947).

6. Games progress on the basis of "plays", "runs", or "cycles", each representing a sequence and period of real-life operational situation.

7. Every participant in the game has a role in the play demanding the exercise of decision or judgment as required by the cycles of the game.

D. Objectives of Educational Simulation. In the four categories of simulation rationale, it has been found out that designers are concerned with objectives of simulations. Sometimes these objectives are stated explicitly in the design. In some cases they are not quite spelled out.

An important stage in the design of educational simulation is the specification of the learning objectives that the simulation will provide. The learning objectives must be stated in specific observable behavioral terms, and the operational situation under which the behavior will occur must be specified.

In determining the parameters of the objectives of any simulation, attention needs to be given to specific aspects of the real-life model. When performance is the major objective of the educational simulation, the referents for simulation objectives need to be valid in terms of the operational roles of that model. Also, the behavior of the model in his environment must be considered. In general, behaviors may be characterized by their relationships--whether they are primarily individual behavior without interaction with other people, or whether they are interactive behavior. The notion of endogeneous and exogeneous variables, which may affect the nature of the operational situations, is very useful. For example, time may be an important variable in a situation, or action, or consequence of an operational task simulated. Substantive elements that affect the time factor need to be represented in the simulation. Invariably, time is drastically compressed in a simulation: a month's activity of real-life may be compressed into thirty minutes of simulated instruction.

E. Representations in Simulation Designs. In every type of simulation, theoretically, it is the nature of the model and the simulation objectives that dictate the choice of symbolic representation of the model. To some extent this rule has guided some designers. The selection of appropriate media should be based on the suitability for the model and its educational objectives. Certain devices, or media can model, dramatize, or automate, but a simulation design may adopt the integration of many media for the purposes of a design. Generally it is the objectives and not the media that determines the choice of modelling devices. By the same token, it is not the gadgetry of simulation but the efficiency of the simulation model for instructional purposes that matters. Machines may be the most appropriate in representing some elements in the model, e.g. no verbal description of a model's voice is as real as the tape-recorder's voice. Sometimes machines are most effective for providing feedback, e.g. there is nothing better than the contingency of reward as provided through a teaching machine.

F. Steps in Designing Educational Simulation. The mechanistic school and the psychological school are concerned with the need to systematize design steps. However, their methodology breaks down when they are applied to design of instructional simulation. Validation and experimentation with designs are often not done with some models. For example, no one knows a procedure for evaluating a design of role-playing simulation.

It is crucial that a simulation design which is to be used for instructional purposes be a valid model of the real-life it represents. All designers of educational simulation zealously watch this. The need for a systematic approach in developing simulation games for education is all the more critical because of the need to provide quality and content for the learner.[8] Indeed, there is no evidence in the literature as reviewed in this study to reflect the existence of any clear-cut systematic guidelines for designing and validating education simulations.[9] It is therefore considered essential in this section to provide some general guidelines for designing and validating educational simulation. The flow-chart that is presented in Figure 3, summarizes fourteen steps involved in the development of a simulation device from the time it is conceptualized until it is ready to be used for instructional simulation.

G. Simulation Design Evaluation Criteria. Abt has made several

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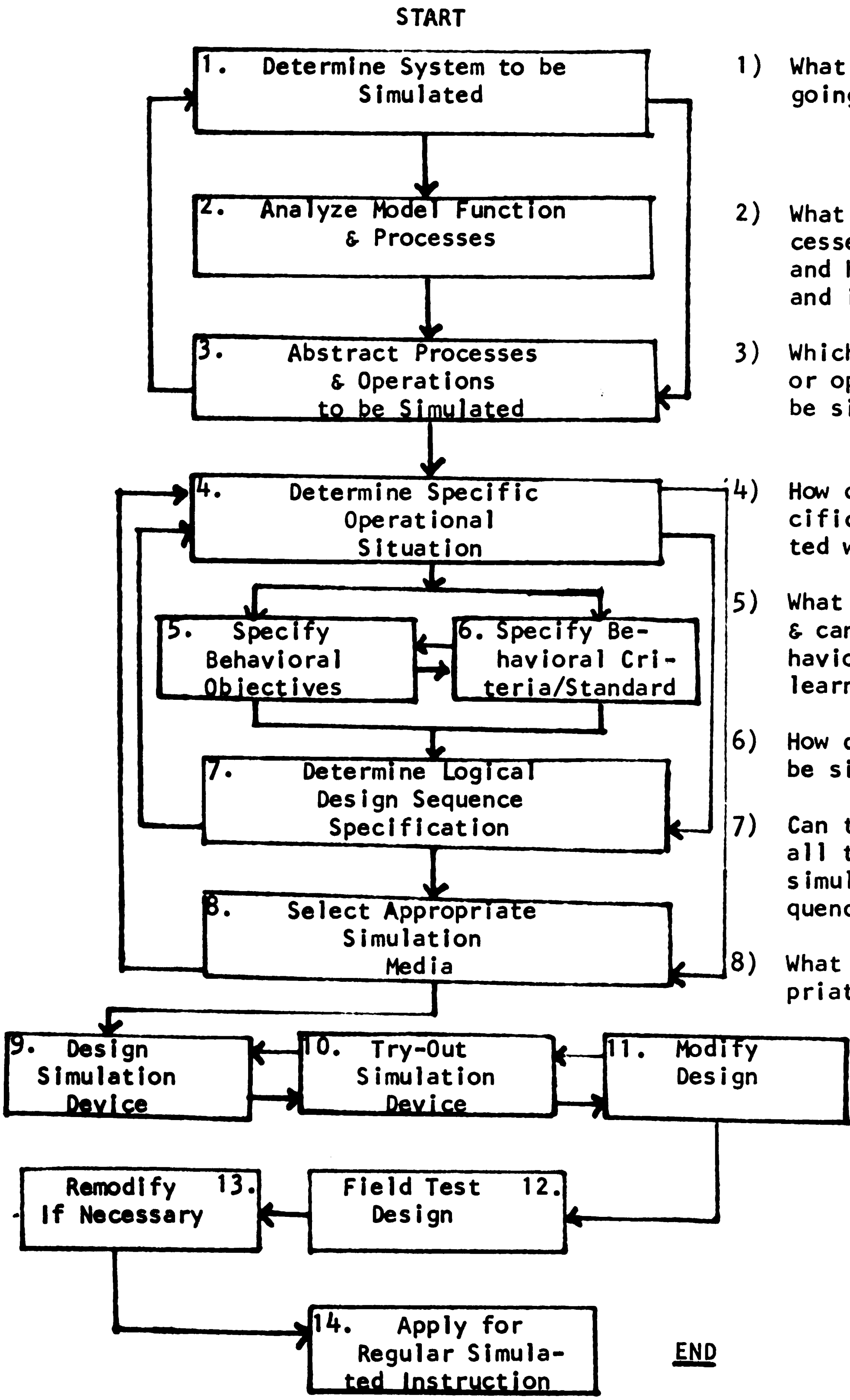
[8]But this concern is too often a mere sacred cow that is wantonly defiled by most designers. Business games, however, have enjoyed the tradition of extensive field testing before widespread instructional application.

[9]The first comprehensive attempt to present any clear basic rules for designing educational simulation is now being carried out by Crawford and Twelker of the Oregon System of Higher Education. The authors prescribe a 13-step approach in designing "instructional simulation". See Appendix C for a chart summarizing these 13 steps. Twelker, Instructional Simulation Newsletter, Oregon State System of Higher Education, Vol. 2, No. 1, February, 1969.



1) What is the simulation going to model?

2) What are the major processes in this system and how do they function and interrelate?

3) Which of the functions or operations are to be simulated?

4) How does each of the specific operations abstracted work?

5) What are the sim. objs. & can the specific behavioral objectives be learned by simulation?

6) How can the behavior to be simulated be measured?

7) Can the design represent all the objectives to be simulated in logical sequences?

8) What will be the appropriate simulated media for this design?

9, 10, 11, 12) Has the model been validated?

The simulation needs to be modified from time to time.

FLOW-CHART ILLUSTRATING AN APPROACH TO DESIGNING EDUCATIONAL SIMULATION (Figure 3) suggestions about quality of design in education simulation,[10] but it is desirable that all these and other suggestions made by other proponents be pulled together as criteria for simulation designs.

It has been discovered that the strongest common heritage of educational simulation is the fact that all designs represent a real-life model. But, this criterion alone is *not* adequate for evaluating educational simulation for instruction. It has been reported that the mechanistic school and the psychological school give consideration to certain elements like response, feedback, and control. It is believed that these are some of the logical criteria for evaluating any simulation design. But, in order to establish a more comprehensive basis for evaluating simulation designs, it is proposed that all educational simulations should answer the following six design questions:

1. Does the design represent a real-life model? What kind--special or general?
2. Does the design serve specified functions? Which?
3. Does the design employ suitable synthetic or animated media for representation and integration of selected operational situations that characterize the model? Which?
4. Does the design provide the sequential context of life-like active or interactive processes within the system modelled? In what way?
5. Does the design provide appropriate feedbacks to the learner in terms of stated learning experiences simulated? How?

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[10]Abt, *op. cit.*

6. Does the design provide for evaluation and control of learning that it offers in terms of the real-life model?

There are other relevant questions that may be asked. The question of whether or not the design should be simple or complex depends on a number of factors, one of which may be the nature of the simulated real-life. The question of cost-effectiveness may be an important consideration for which no dogmatic answer can be given.*

Finally, it has been seen that the psychological S-R theory is basic to all simulation designs. While synthetic or animated devices may be utilized in construction of the simulation model, it is important that the simulation design incorporates five features: a stimulus situation, a response situation, a consequence situation, a feedback sequence and a control.

II. THEORETICAL PRINCIPLES IN INSTRUCTIONAL APPLICATION OF EDUCATIONAL SIMULATION

It can be inferred from the evidence contained in the review of the theoretical foundation of educational simulation, that instructional simulation, no matter the orientation of its proponent or user, has as its main objective the creation of a learning laboratory which provides clinical experiences for a learner in order to bridge the gap between theoretical bookwork and actual practice.[11]

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[11]Jones says: "The use of the term'laboratory' as an instructional organization denotes a situation in which each leaner has the opportunity to pursue investigations and study according to his own particular interests--to try out previous learnings on his own--to derive conclusions based on his own particular style of study of a problem". Adaline Jones, "The Engimatic Intensive Office Laboratory". The Balance Sheet, Vol. XLIX, April, 1968, p. 344.

*See pages 26 and 27 for a detailed discussion of other considerations termed "design trade-off decisions".

From the review of the literature, it has been noted that there is a trend towards systematization of learning processes in instructional simulation although no consistent methodology has yet emerged. Some of the evidences that support this assertion may be reiterated. Designers of computer simulations, particularly those for business games, have regarded briefing and debriefing essential elements of instructional simulation process. Practice features in every simulated instruction. Also the importance of sequence of instruction has been underscored by various designers in varying terms: play, runs, units, sequence, and the like. Evaluation of simulated instructional outcome is considered an unquestioned process in instructional simulation although it is somewhat treated as a supererogatory obligation in some respects since this is often times done perfunctorily or not at all because of lack of clear-cut evaluation instruments.

A. Instructional Simulation as Laboratory Learning. Instructional simulation is a pragmatic pedagogic approach, directed towards a goal that gives realism, meaningfulness and utility to knowledge. It is the integration of initial and new knowledge in a purposeful, relevant, and functional manner that is goal-directed. Instructional simulation is not "talking about" but learning by doing. It is an instructional approach which helps students to have a "feel" of reality in using the knowledge acquired in a practical manner that gives credence to integration and sequencing of knowledges and skills so that participants in this learning experience, are forced to apply integrated knowledge in problem-solving situations, which may involve one but does not exclude any of the following:

1. realistic <u>routine functions</u> that relate to specific operational situations;
2. realistic <u>flexible functions</u> that require adaptability and insights on specific operational situations;
3. realistic functions requiring <u>foresight</u> and resourceful anticipation about specific operational situations;
4. realistic functions involving data <u>evaluation and adjudication</u> about specific operational situations; and
5. realistic functions involving any combination of the above.

To this extent, simulated instruction is problem-solving in the microcosm of real-life environment. It is providing realistic problems which could be solved by integration of knowledge and it requires the application of procedural skills, motor skills, identification skills, conceptual skills, principles and strategies.[12]

Instructional simulation begins with the specification of learning objectives. The learning environment must give realism to the students and the goals must be objectivized in behavioral terms that specify the type of <u>action</u> or <u>interaction</u> that the simulated instruction will fulfill.

B. <u>Features of Instructional Simulation</u>. It is therefore logical to conclude that to this extent an instructional simulation design should incorporate the following features:

1. The identification of simulation learning objectives and an orientation of learners to these objectives as well as the specific outcomes of the educational experience.

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[12]Robert M. Gagne, "Simulators." In R. Glaser, <u>Training Research and Education</u>, (New York: John Wiley and Sons, Inc., 1965), pp. 230-231.

2. The identification and integration of knowledge, skills and attitude and the creation of simulated learning problems which call for integrated application of knowledge.
3. The planning of simulated learning sequence and the provision of appropriate and adequate simulated practices to test the application and transfer of acquired learning to identical situations.
4. The clarification of the nature of simulated instructional process, the identification of the learner's and instructor's tasks in the process, the briefing and debriefing on purposes and goal of simulation instruction, and the evaluation of simulated practices.
5. Simulated evaluation of the total simulated instructional objectives through the administration of situational tests.

C. Criteria of Instructional Simulation Model. In general, every instructional simulation design or model must answer the following relevant theoretical questions:

1. Does the instructional model present adequate introductory materials relevant to the real-life model in a manner that will motivate the students?
2. Does the instructional simulation have objectives that aim at the development of specific behavioral repertoires of a model?
3. Does the simulated instructional model set out relevant experiences which must be mastered by the student in a logical sequence? What is the measure of effectiveness?
4. Does it provide learning sequence which integrates the whole

behavior repertoires of the learner--his attitude, skills, and ability about an operational situation?

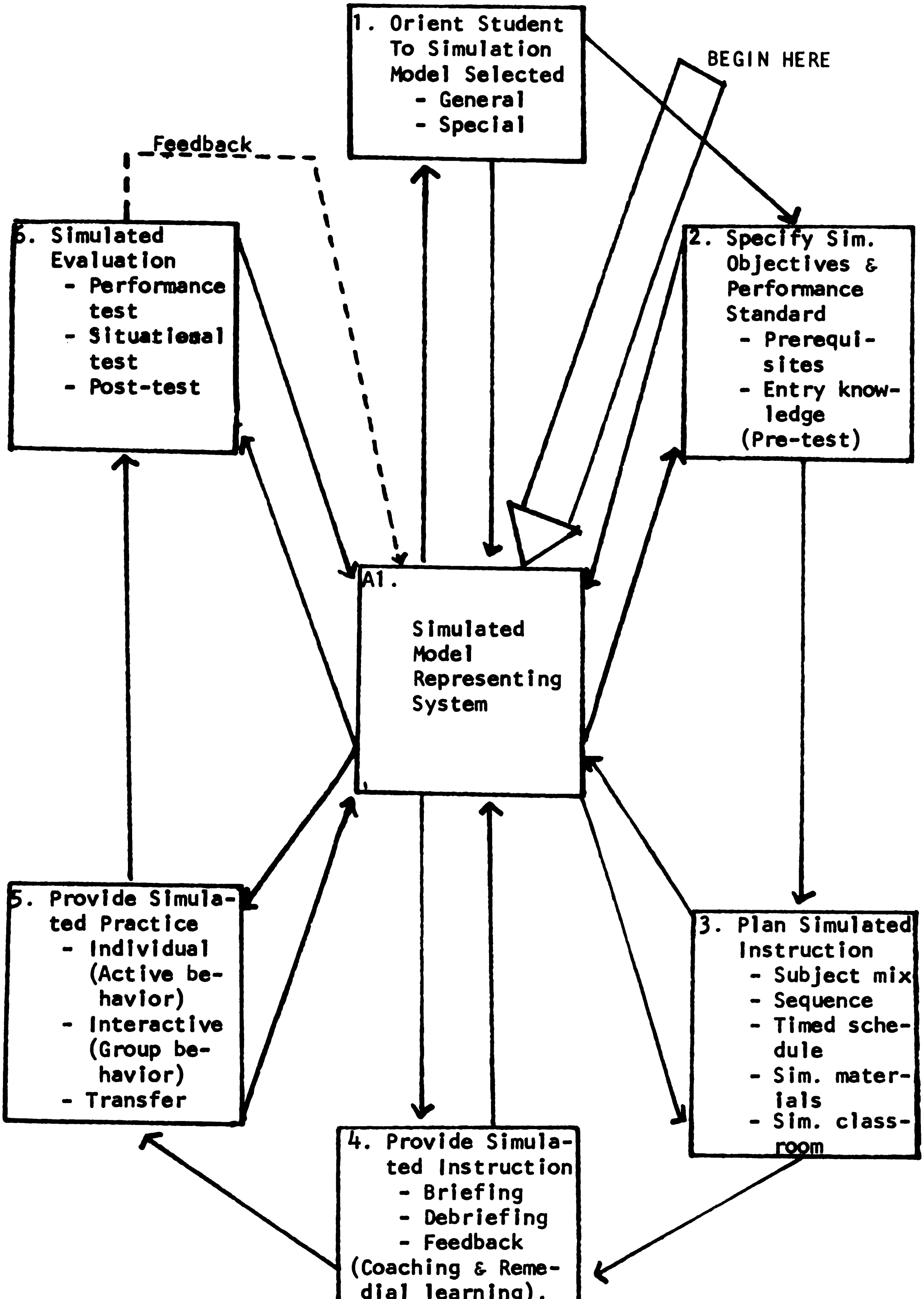
5. Is the simulated learning process carried out in a manner that evokes a feeling of realism on the part of the students physically and psychologically? Can students practice their learning habits in a laboratory setting?

6. Is the simulated learning outcome evaluated in a realistic manner that replicates real-life standards? Who is controlling the learning and monitoring the progress--the teacher, the student, or the device, or all of these?

The question often asked about the simulated instruction is what its evaluation evaluates. Simulated instruction is not a reproduction of, nor is it an evaluation of the on-the-job performance. It is an evaluation of a representation of on-the-job performance. The effect of simulated instruction, however, can be tested by an investigation of how it has helped students to adjust to their educational goal. The flow chart on page 106, Figure 4, summarizes the theoretical processes of simulated instruction.

SUMMARY

It is logically defensible to propose an integrative theory of educational simulation because all educational simulations have the same goal orientation: they all tend to evolve a pragmatic pedagogic approach which gives realism, meaningfulness and utility to knowledge by providing the participants experiences in an environment which is a microcosm of the real-life. The goal of simulation in education is the provision of laboratory experiences which offer the students participatory practices which are transferrable to real-life.



A SIMULATED INSTRUCTIONAL MODEL (Figure 4)

Theoretical principles on designs of educational simulation, the nature of simulation, fidelity of simulation, degree of simulation, game representations in simulation designs, and the criteria of simulation designs, are discussed. It is found out that while synthetic or animated devices may be utilized in building a simulation model, it is important that every educational simulation design should incorporate five features: (1) a stimulus situation, (2) a response situation, (3) a consequence situation representing the interaction of stimulus-response, (4) a feedback sequence, and (5) a control. This indicates that the S-R theory is basic to all educational simulation designs.

Gaming is a useful concept in education but it is not the _sine qua non_ of educational simulation. Educational games are used for training purposes but they can also be used for development and research. In general, the distinction between educational games and parlor games is that educational games have educational objectives to which the students are oriented. Briefing and debriefing are unique features of educational games.

Simulated instruction is described as learning by doing. It demands application of integrated knowledge in meaningful and realistic exercises. Simulated instruction, therefore, is problem-solving, demanding application of procedures, motor skills, identification, concepts, principles, and strategies or the combination of any of these. There are a number of principles such as orientation, briefing, debriefing, simulated practice, and simulated evaluation which are theoretically important for instructional simulation. All of these principles may be pulled together to calibrate what may be regarded as a tentative theory of educational simulation.

CHAPTER IV

THEORY AND PRACTICE OF INSTRUCTIONAL SIMULATION

While it may be feasible to design a simulated instructional model on the integrated theoretical principles espoused in Chapter III, it has been discovered that simulated instructions do not follow the same step-by-step pattern of instructional procedures. There are three practical considerations to explain this condition. First, all instructional procedures must be flexible. Secondly, some educational simulation designs impose their own procedures through "the rules of the game" stipulated by the simulation model. In this case, the handbook which accompanies the simulation package becomes the instructional cookbook. Thirdly, instructional simulation procedures, when not stipulated by the designer, are to a large extent, affected by other instructional factors which may or may not have anything to do with simulation theory. Constraints of this nature fall into the category of sound pedagogic or psychological concepts. These concepts may include such factors as the student's ability and capacity, his entry or initial knowledge, his social and cultural background, his motivational disposition; the teacher's teaching style, his motivational strategies and contingencies of rewards; the instructional environment, scheduling, instructional facilities and the like. These are not irrelevant to instructional simulation but they could not be branded a general simulated instruction theory.

However, it has been found from the review of the literature, that in spite of these considerations, instructional simulation procedures converge on certain principles which can be said to represent what may be called the operational criteria of simulated instruction. It is, therefore, proposed in this chapter: (1) to outline these principles in some detail, and (2) to examine them in relation with the operational criteria of selected simulations that have been reviewed or observed in teaching and learning situations.

I. OPERATIONAL CRITERIA FOR INSTRUCTIONAL SIMULATION

At least six major operational criteria are considered theoretically essential in administering a simulated instruction: (1) the selection of the educational simulation model, (2) the orientation of students to the objectives and standards of the simulation, (3) simulated curriculum plan, (4) simulated instructional process, (5) simulated instructional practice, and (6) simulated instructional evaluation. Each of these is described briefly below:

A. Selection of the Educational Simulation Model. The choice of education simulation design to be used for instruction depends on the purpose and objectives of the instruction. For example, if the simulated instruction is geared towards training general accounts clerks, the model should reflect the generalized functions of accounts clerks in every sector of the industry. If the specific objective is to train insurance clerks for a particular company, e.g. the United Brothers' Insurance Company, the simulation should reflect the office functions within that specified company. Some simulation designs are intended to provide all-purpose knowledge. In any case, the choice of the simulation package to be used for instruction must be taken into consideration in determining the strategy of instruction.

B. Orientation of Participants to Simulation Objectives. Participants in instructional simulation must be oriented towards the curriculum objectives and the standard of performance anticipated from the instruction. The skills, knowledge, and attitude to be developed by the simulated instruction must be stated and intimated to the students. This is done primarily for motivational reasons. It is a matter of bringing congruity of perception about the learning objectives. This serves the purpose of generating the participant's interests in the learning enterprise.

Several methods can be used to orient students to the simulated instructional objectives. These include the use of artifacts, symbolic models, photographs, films, recordings, video-tapes, written descriptions of background information, and sometimes a verbal description by the teacher just before the beginning of the simulated instruction.

C. Simulated Instructional Plan. In using simulated instruction in the classroom, a considerable amount of instructional programming is involved. A simulated instructional plan includes each of the following instructional activities:

1. Determining the prerequisites for the simulated instruction in terms of student's entry knowledge and ability and the instructional goal.
2. Determining the subject mix for the simulated instruction, i.e. what types of subject matter mastery are required for the integrated simulation. It has been said that simulated instruction is blending together of previously acquired knowledge.

3. Determining the sequence and integration of subject mix.
4. Timing and scheduling the instruction, i.e. determining when new subject matters are to be introduced, reviewed, or relearned.
5. Determining the simulated instructional facilities, e.g. appropriate simulated environment, simulated materials, equipment and kits.
6. Determining what extra-classroom knowledge will be required for the simulation, e.g. field trips, assignments, outside lectures, projects, and the like.

In some cases, these activities may be embodied in the design. When they are not, there is a need to synchronize classroom instruction, lectures and reviews, with the sequence of instructional simulation. For example, the student's experience in a simulated practice may be frustrating if the enabling knowledge that will provide a meaningful and rewarding simulated practice has not been taught or provided. However, some simulation models deliberately do this to enable the student to discover the knowledge himself. The economy of this approach is debatable.

D. <u>Simulated Instructional Process</u>. It is essential that simulated instructional procedures remove learning roadblocks as much as possible if simulated instruction is to be maximized. This is done through a motivational instructional process which involves:

1. systematic orientation of the learner towards the learning objectives according to the sequences of the simulation;
2. appropriate briefing and debriefing on simulated learning experience. The procedure for these have been elaborated

upon in several sections in Chapter II. (Compare procedure for instructional simulation under computerized games, pages 40 to 43).

3. Provision of feedback. The contingencies of reward must be given adequate attention. This has been touched upon earlier.

The need to sequentially present learning units according to the levels of difficulty of the units cannot be over-emphasized.

E. Simulated Instructional Practice. Students must be given the opportunity to perform in laboratory-type situations, operations which involve active and interactive activities so that they are exposed to situational dynamics which provide them "clinical" experiences to:

1. apply integrated knowledge by doing,
2. practice integrated knowledge to acquire mastery,
3. evaluate performance to validate the mastery of acquired, fragmentized and integrated knowledges.

The simulated practice is carried out in a situation which replicates the microcosm of the real-life environment. This facilitates transfer of learning.

It must be remembered that simulated practice should be preceded by a briefing session and a debriefing session. The rules of the game imposed by the simulation are learned by the participants before the simulation practice begins. Usually, the teacher serves as the umpire or game administrator, who makes decisions about the reward and punishment system (according to the rules of the game).

F. Simulated Instructional Evaluation. The major purpose of the evaluation is the assessment of the degree to which the simulated learning objectives have been achieved. This is a vital part of the instructional process. The evaluation of any simulated instruction needs to be a simulated evaluation. That is to say, the evaluation of the knowledge that has come out of the simulated learning must be realistically evaluated in terms of real-life standards. This is often overlooked in simulated instruction. Therefore, this means that using any other method is defeating the objective of instructional simulation. To meet simulated evaluation requirements, simulated instruction must be evaluated through either or both of the following, depending on the purpose of the evaluation:

1. Administering of situational tests. This may be the appropriate test at the end of the simulated instruction and it may be the terminal test upon which the final grade is given. The situational test is analogous to performance requirement on the job.
2. Administering the performance tests which are designed only to cover primarily the contents of the instruction presented during the simulation. This test helps in testing transfer of previously learned materials, rules, concepts and attitudes.

It is feasible that the two tests could be combined to award the final grade for the course. New York University offers a Business Games simulation sequence which graduate students in the MBA program may take in lieu of a thesis requirement.[1]

Another method of evaluation adopted by some teachers is report writing. At the end of the simulation exercise, the students are required

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[1]New York Times, Sunday, November 24, 1968, "Students Play Management In a Computerized Game". Story by Robert A. Wright.

to write a comprehensive report of what has happened to them during the simulation and the contents of the course they feel they have learned or not learned. This is a salutory practice.

The six propositions summarized above, represent the tradition of simulated instruction. It will, therefore, be used to analyze the operational features of selected simulations discussed below. It must be emphasized, that the purpose of this analysis is not to criticize any practice on the ground that it does not conform to a theory. Rather, the purpose of the analysis is to see how the theory works in action, and to see how those who hold to a theoretical concept select and manipulate their principles for designing experiments that endeavor to present, interpret, and analyze a phenomenon that is epitomized by the concept.[2]

II. ANALYSIS OF OPERATIONAL CRITERIA OF SPECIFIC SIMULATED INSTRUCTIONS

In order to understand how the theoretical positions described in Section I above operate in practice, the researcher observed one instructional simulation under teaching and learning conditions. Because a detailed description of this simulation will be outside the scope of this study, only the findings which are pertinent to the theoretical principles outlined herein will be presented in a general descriptive manner. The simulation observed was the Community Land Use Game (CLUG), developed by Allan Feldt.[3] Other simulations whose literature were

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[2]Kaplan, *op. cit.*, pp. 294-326.

[3]Allan Feldt, *op. cit.*

reviewed and which will be included in the tabulated findings are: (1) Vocational Office Block Simulation, Research and Development Program in Vocational-Technical Education, Michigan State University[4], which was designed by Beverly Funk[5], (2) Inter-Nations Simulation (INS) designed by Cleo Cherryholmes[6], (3) Simulation in the Classroom, designed by Kersh for teacher education[7]; and (4) Integrated Simulation developed by Smith, Estey, and Vines.[8] Only the CLUG was observed under laboratory conditions in teaching and learning situations.

A. The Community Land Use Game (CLUG). This simulation was developed by Allan G. Feldt of Cornell University. Michigan State University developed the accompanying video-tape and single concept film to present it as an educational kit. The information which was contained in these devices was considered by the participants as adequate introductory background for the game.

1. Objective of the simulation: The CLUG was used to supplement instruction in a graduate course on Research Methods (Urban Planning 820)[9] in the school of Urban Planning at Michigan State University. The game was used to enable students to understand the application in realistic

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[4]Michigan State University, R & D Program, op. cit.

[5]Beverly Funk was one of the Research Associates connected with the Michigan State University R & D Program project in the Vocational Office Block. At the time of the project she was a teacher at Mount-Lake Terrace Senior High, Mount-Lake, Washington.

[6]Cleo Cherryholmes, op. cit.

[7]Bert Kersh, op. cit.

[8]W. N. Smith, E. E. Estey and E. F. Vines, op. cit.

[9]CLUG is also being used for the course, Urban Planning 812: Application of Social Sciences to Urban Planning, at Michigan State University.

situations, of concepts such as urbanization, land use, housing, business facilities, industrial development, traffic, recreation, and other critical aspects of community structure.

2. Students: Students enrolled for this course had similar career objectives. They were all master's degree candidates preparing for professional careers in urban planning.

3. Level of previous learning and knowledge: The students had taken several related courses in urban planning, either at undergraduate or graduate levels, during the master's program and before involvement in the CLUG simulation. They were presumed to have the same level of knowledge (for practical purposes) at the time they enrolled for the Urban Planning 820 course. However, no tests were administered to assess their entry or pre-simulation knowledge.

4. Lecture: Before the students entered the CLUG simulation they received a series of lectures on transportation, urbanization, land use, housing, business facilities, industrial development, traffic, recreation and other community facilities.

5. Orientation: In addition to viewing individually the single concept film and the video-tape, the students were collectively given a thorough step-by-step introduction to the game, its components, the parameter of reality, and other operational details.

6. The game: The game was played by three teams of at least three persons per team. The game began by providing situations which required students to demonstrate application of knowledge and skills about the concepts covered in the course particularly as they related to urbanization, transportation, and land use. Students determined their own strategies in the game, aiming at beating opposing teams by careful calculations in

situations requiring decisions about land use, locations of industrial facilities, business and housing. Decisions involving a variety of concepts were built into the simulation, and the game administrator always directed the game in the direction of the concepts to be mastered by the students.

There were six cycles of the game. The materials of each cycle were carefully sequenced and tied to the next one to present a total picture that was analogous to real-life. Each circle of the simulation corresponded to one year of urban development for the community in real-life.

7. The game administrator: The instructor was an important agent in the game. His role was one of an observer, although he was the person who directed the manner in which things were to go in the game. He followed the handbook of the game, and sometimes had to use his discretion to ensure that things did not get out of hand. For example, the administrator usually decided what the borrowing rate from the bank should be whenever a financial crisis arose among the players.

8. Motivation and feedback: Token money was used in playing the game. Money and competition between the groups appeared to be the substantial motivational factors in this game. The "winner" in the game was defined as that group or team that: (a) generated the highest net income from their selection and arrangement of land use types, (b) had the "best" configuration of land use activities in terms of sound accepted urban planning principles and practices, and (c) contributed more substantially to the financial welfare of the community. The game administrator made decisions on these issues.

Typically, there was an intensive competition among the groups. Sometimes alliances were freely entered into and broken. When a particular cooperation did not "pay off" with one group, alliances would be shifted. Sometimes students got so carried away with their involvement in the game that they preferred to forego their meals.

9. Evaluation: The debriefing session was used for evaluation of performance in the game. No final grade was given on the basis of the simulation. One method which the instructor used for evaluating the extent of transfer of and mastery of the concepts was to have students play the game several times. Students' performances at different sessions were recorded and compared with previous performances. It was then possible to notice favorable improvement and progress in understanding planning concepts on the part of the students.

10. Conclusion:[10] The operational criteria adopted for the CLUG simulation included a large proportion of the elements of the theoretical principles discussed earlier in Section I of this Chapter.[11] This is shown clearly in the table on pages 121 and 122.

In addition, the following points stand out in this example:

(a) Determination of the concepts to be taught within the abstracted parameters of reality of urban affairs.

(b) Determination of who should be taught and for what specific function.

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[10] From the researcher's observations and discussions with the Professor in charge of the simulation, and from the participants' comments, it can be said that the simulation was effective.

[11] See pages 108 to 113.

(c) Determination of, or assumption about, the level of pre-simulation knowledge.

(d) A further learning process for additional knowledge to be tested through a self-discovery approach.

(e) Integrated application of knowledge, attitudes, skills, newly or previously learned.

(f) Dramatic involvement of students during the simulated practices.

(g) Students were made to engage in meaningful activities for which they received feedback.

(h) A mental state of reality was generated in every student during the simulation runs, so that there was a transfer of attitudes and/or emotions that typify real world situations. In one of the games observed, it was reported that two good friends refused to talk to each other for a period of two weeks because of a "ruthless strategy" that one had employed against the other in achieving an advantage in the game.

B. Other Simulations. In order to evaluate the degree of conformity of selected instructional simulations with the theoretical criteria discussed here, the research reports or texts which contain empirical findings or general information on four other simulations, were reviewed. Only the findings pertinent to the theoretical criteria will be presented. These are summarized in Table I on pages 121 and 122 to offer comparative analysis with others.

Summary of Findings:

The analysis contained in Table I, page 121, shows how each of the simulations fared when evaluated on the basis of the criteria discussed in this chapter. All the five simulations consider the six criteria relevant to their instructional strategies. Each one of the five simulations give considerations to (1) the choice of a model, (2) determination of instructional process, (3) the provision of simulated practice, and (4) the need for simulated evaluation. The criterion that relates to instructional plan is weak for the CLUG, and INT. This may be an error in judgment on the part of the researcher, but there is no other evidence available to him to reach a different decision from the one summarized in the table. Simulated evaluation is somewhat weak for CLUG and INTEGRATED SIMULATION on the basis of available information. Every three or four weeks there are ratings for students on INTEGRATED SIMULATION. Oral reports are also given.[12] (Both the VOB Simulation and Kersh's classroom simulation rate very well on all the criteria.)

However, it has been found out that generally the evaluation of educational simulation is a tenuous problem. One of the major problems in evaluating the effectiveness of educational simulation is lack of appropriate instruments for the measurement of simulated instruction. Because the purpose of educational simulation is realistic life-like performance, an evaluation of simulation instruction should be nothing short of simulated assessment of performance. This will require the construction of appropriate tests designed to measure terminal behavior

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[12] W. Nye Smith, "Objectives in Educational Simulation", Collegiate News and Views, Vol. XXII, 1968, p. 23.

TABLE I

AN EVALUATION OF SIMULATION CRITERIA
IN FIVE SELECTED INSTRUCTIONAL SIMULATIONS

Theoretical Instructional Operation Criteria	CONFORMITY OF SELECTED EDUCATIONAL SIMULATIONS WITH THEORETICAL CRITERIA				
	CLUG*	VOB*	INT*	CLASS-ROOM*	INTEGRA-TED*
1. Simulation Model:	Yes	Yes	Yes	Yes	Yes
Generalized	X		X		X
Specialized		X		X	
2. Orientation:	Yes	Yes	Yes	Yes	Yes
Curriculum Objectives	X	X	X	X	X
Performance Standard		X		X	
Introductory & Back-ground Information	X	X	X	X	X
3. Simulated Instruction Plan:	Not specified	Yes	Yes	Yes	Yes
Prerequisites	X	X	?	X	X
Subject Mix	X	X	?	X	X
Sequence	?	X	?	X	X
Timing & Scheduling	X	X	X	X	X
Simulated Facilities and Materials	X	X	X	X	X
Simulated Classroom (Microcosm of real-life)	?	X	?	X	X
Extra-curricular activities	?	X	X	?	X
4. Simulated Instructional Process:	Yes	Yes	Yes	Yes	Yes
Briefing	X	X	X	X	X
Debriefing	X	X	X	X	X
Feedback	X	X	X	X	X

	CLUG	VOB	INT	CLASS-ROOM	INTEGRA-TED
5. Simulated Instructional Practice:	Yes	Yes	Yes	Yes	Yes
Active behavior	?	X	X	X	X
Interactive behavior	X	?	X	?	X
Integration (transfer)	X	X	X	X	X
6. Simulated Evaluation:	Yes	Yes	Yes	Yes	Yes
Pre-test	No	?	X	X	?
Situational Test	No	X	No	X	X
Performance Test	No	X	X	X	X
Post-test	No	?	X	X	?

*CLUG means Community Land Use Game designed by Allan Feldt; VOB means Vocational Office Education; INT means International Simulation designed by Cleo Cherryholmes; CLASSROOM means classroom simulation for elementary teacher education, designed by Bert Kersh; and INTEGRATED means Integrated Simulation for management education, designed by Nye Smith and associates.

after the simulated instruction. Educational simulation designers do not give attention to the construction of this type of test, although there are some kinds of simulation like the In-basket simulations which are specifically designed to measure performance.

The proponents or users of the simulation designs reviewed in this section, however, have all regarded evaluation an important process in instructional simulation. Perhaps, it is fair to expect that the objectives of the simulation should dictate the type of test to be administered. However, it is the opinion of the researcher that all users of instructional simulation are committed to administer a situational test. If this is done, the other types of tests (if the user believe in the efficacy of these tests) like essay tests (recommended by Cherryholmes), simulation reports (adhered to by many users of business games) may also be used.

The unanswered question is what grade should be given for a simulated learning? Should only winners of games be given A's and losers - what? How about games where there are no losers? The results of the review in this study do not provide answers to these questions. It seem that the expediency of the situation should be taken into consideration in resolving the problem. It is the opinion of the researcher that everyone who goes through a simulated instruction learns something and should never have a failing grade in that course. The teacher who is in charge of the simulation should have the freedom of assigning students grades based on his judgment of their performance in the simulation.

Teachers as Designers or Vice Versa. It has been noted that four of the simulations reviewed in this section have been used by their designers in instructional situations upon which these analyses are made.

There may be much to be said in favor of designers being also users of their simulation designs. One advantage is that the designer can bridge the "credibility gap" when errors of omission or commission are found in the simulation design and when assumptions made by the design are far-fetched to be acceptable to the students. The designer can easily and more readily correct these errors without allowing students' fussiness to disorganize the instructional process. If the designer is excessively defensive about the flaws discovered from the design, some students may get disappointed and apathetic. This can destroy simulated instruction.

As Cherryholmes points out, whoever uses the design for instruction, it is important that meaningful learning should come out of it, and this will be derived only if the events of simulation are discussed, interpreted and related to principles and concepts used in the study.[13]

SUMMARY

In this chapter, the six operational criteria essential for administering a simulated instruction have been proposed: (1) the selection of a model, (2) the orientation of students to the objectives and performance standards of the simulation, (3) simulated curriculum plan, (4) simulated instructional process, (5) simulated instructional practice, and (6) simulated instructional evaluation.

One instructional simulation (CLUG) is observed under learning and teaching conditions, and it is concluded that the simulated

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[13]Cleo H. Cherryholmes, "Simulation in International Relations: Development for High School Teaching". (Unpublished M.Sc. Thesis, Kansas State Teachers College, Emporia, Kansas, 1963).

instructional approach adopted for its instructional strategy conforms in essential details with the operational criteria proposed.

When four other simulations are evaluated on the same basis, it is also found out that each of them has the same basic concepts but they all differ in some essential details as specified by each criterion. The five simulations all have evaluation as one of the criteria for instructional simulation but their procedural practices differ.

It can be concluded that the six criteria are operationally essential for simulated instruction. While it is logical to expect differences to occur in evaluation process (as this is largely dictated by simulated instructional objectives), there is an obvious commitment that all simulated instruction should consider a situational test as "simulation warranty".

CHAPTER V

A SIMULATED INSTRUCTIONAL MODEL FOR OCCUPATIONAL EDUCATION

It is essential in a study like this to demonstrate how theoretical propositions can have a practical utility in real-life education. Therefore, in this chapter, the theoretical principles and the criteria of simulated instruction developed in Chapters III and IV will be applied to one of society's pressing problems, namely, occupational education.[1] After a brief description of design methodology in occupational education, a simulated instructional model, called SIM-INST, will be designed[2] and guidelines will be provided for its use.

As an introduction, however, it is necessary to clarify what is meant by occupational education and to present some basic assumptions that are made about it as a system. Occupational education is any formal education and training* (part-time or full-time) whose primary objective

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[1]Robert M. Gagne, "Simulators" in Robert Glaser, Training Research and Education, (New York: John Wiley and Sons, 1965), p. 242.

[2]It must be understood from the beginning that designing a model is not necessarily normalizing a practice. Designs are not formula. They result from inventiveness and innovation relative to identifying some functions or activities to be performed by a system and then inventing procedures or strategies to accomplish these functions or activities. R. B. Miller, "Task Description and Analysis". In R. M. Gagne (ed.), Psychological Principles in System Development. (New York: Holt, Rinehart and Winston, 1965), p. 189.

*See footnote on page 13 , Chapter I.

is to prepare the learner for a career role in any profession or employment. Therefore, any career that has "specific vocational preparation"[3] plan will qualify. By "specific vocational preparation" is meant any education and training acquired in a school, work, or avocational environment, requiring an amount of time for learning the techniques, acquire information, and develop facility needed to average performance in specific job-worker situation. It may also come from experience and self-study.[4]

I. Assumptions about Occupational Education

A. Occupational education includes a study of the occupation and the occupational environment.

B. Occupational education is the integration of general education with technical and specialized education.[5] General education is education of a general academic nature, ordinarily obtained in elementary school, high school, or college, which does NOT have a recognized, fairly specific occupational objective even though it may have application in an occupation. Technical and specialized education includes specific knowledge of theory and knowledge of practice required for a specific occupation.

C. The basic goals of occupational education are:

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[4]Ibid., p. 77.

[5]Towers, Lux, and Ray will describe "technical and specialized education" in one word--"praxiology" - meaning "knowledge of theory and knowledge of practice" - two essential elements for occupational education. New Dimensions in Industrial Arts Curriculum Development. (Industrial Arts Curriculum Project, Ohio State University, Columbus, Ohio), pp. 7-8.

1. To develop specific skills, concepts, and insights needed for the performance of job roles.
2. To develop individual characteristics as a human to desirable levels that satisfy self-concept, self-respect, self-fulfillment, aspiration, social and occupational adjustment.

II. Assumptions about Occupational Instruction

A. The goal of occupational instruction is the development of acceptable performance proficiency. Employability is the objective.

B. Occupational instruction involves practice that is indicative of the specific tasks and jobs of an identifiable position for which the occupational instruction is given. The instructional practices[6] consist of:

1. A feature that specifies the experiences which must be effectively imparted to the learner in a manner that motivates.
2. A feature that integrates the essential knowledges--skills, principles, concepts, and attitudes in a manner that is meaningfully related to jobs, tasks, or other relationships within the occupational environment.

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[6]The four points that follow are adapted from Bruner's theory of instruction. See J. S. Bruner, Toward A Theory of Instruction, (Cambridge, Massachusetts: Harvard University Press, 1966), pp. 37-53.

3. A feature that presents the simulation sequence in a manner dictated by the nature of instructional task and student's learning capacity.
4. A feature of instructional motivation with appropriate sequencing of rewards and punishment in learning-teaching process.

III. SIMULATION DESIGN FOR OCCUPATIONAL EDUCATION

Designing a simulation for occupational education is an act which involves the identification of the functions and activities of occupational education and the invention or selection of procedures and strategies which will accomplish these functions and activities. It is not an easy task because it is an inventive, creative, and innovative act, and not all people are all of these. Besides, the design of a simulation for occupational education is a task that is confronted with many dynamic variables including changes in jobs, functions, persons, activities, and even the occupational environment itself. All these changes can be represented in mathematic symbols but not the design.[7] Therefore, one cannot impose a rigid or rigorous procedure about the design of occupational education. A rule of the thumb, however, may be given: an occupational education design must prove effective for its functions. Since the functions of a simulation design for an occupational education and a simulated instruction are inextricably linked, and since more is known about the conditions under which learning

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[7]See Robert B. Miller, "Task Description and Analysis". In R. M. Gagne and Arthur M. Melton, Psychological Principles in System Development, (New York: Holt, Rinehart, and Winston, 1965), pp. 118-202. In this section Miller discusses the problem, mechanics and objectification of system designs.

is effective than is known of the laws that make a design effective, it is more defensible to design a simulated instructional model that can be validated than to design an occupational education simulation whose validation may not only prove expensive, but sometimes prove non-feasible. Therefore, this chapter will be primarily concerned with the methodology of applying simulated instruction in occupational education. In this respect, the simulation design is assumed to be an input into occupational education instruction. The primary objective of the simulated instructional model is to invent strategies (based on proven psychological theories) which will accomplish the functions of occupational education instructional goals.

IV. THE DESIGN OF SIMULATED INSTRUCTIONAL MODEL FOR OCCUPATIONAL EDUCATION

Chapter IV supplies the theoretical framework for the design of a simulated instructional model. However, the six operational criteria are considered inadequate for the design of an instructional model for occupational education. Therefore the following seven features of the design are proposed:

A. Occupational System Analysis

B. Selection of a Simulated Occupational Model

C. Orientation to Specific Occupational Objectives and Performance Standards

D. Simulated Occupation Curriculum Plan

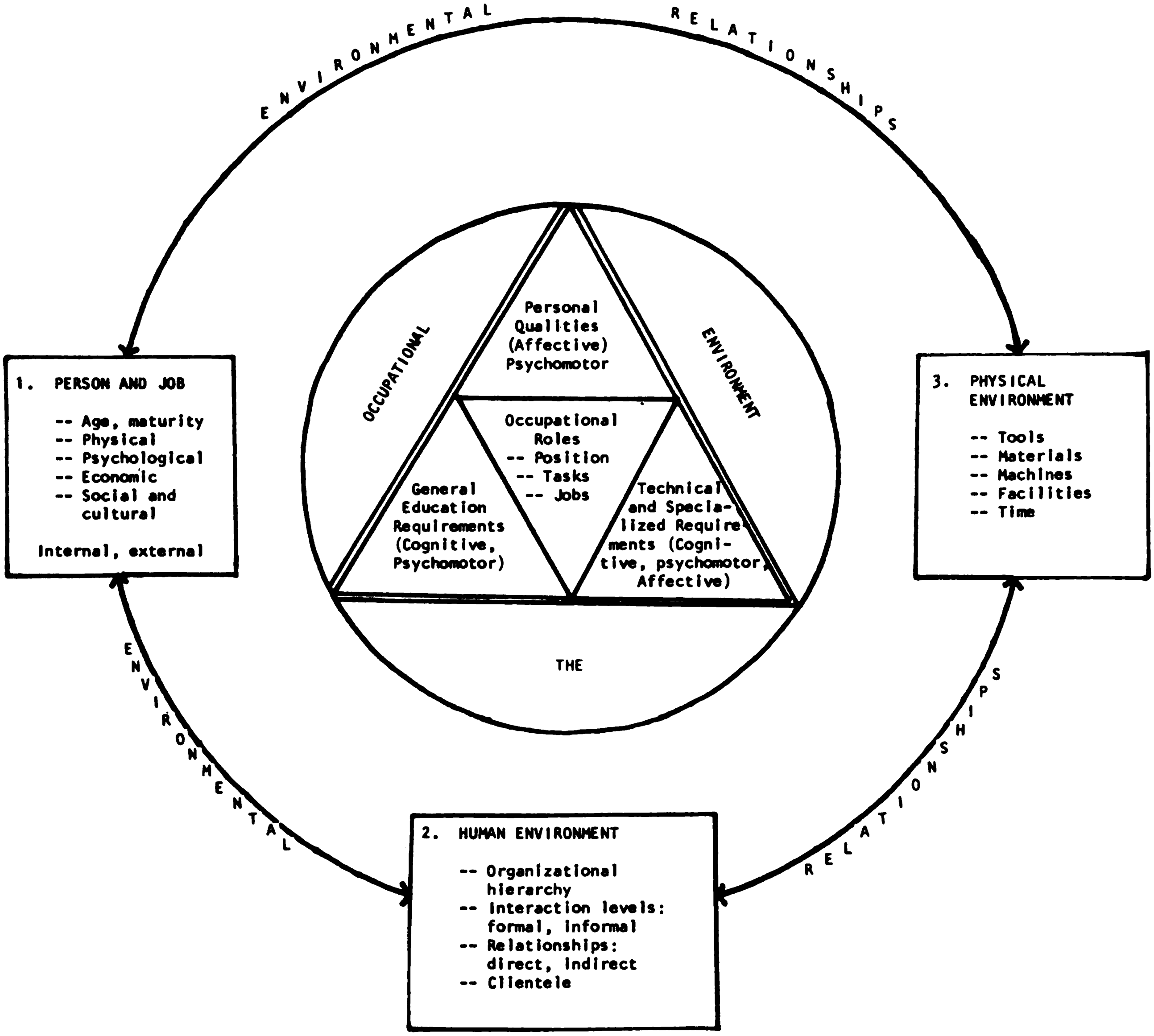
E. Simulated Instructional Process

F. Simulated Occupational Practice

G. Simulated Evaluation

A. Occupational System Analysis

A necessary starting point in the design of a simulated instruction model for occupational education is an analysis of the occupational environment and the familiarization of students with the characteristics and functions of the various components of the environment. This is important in order to attain congruity between what the occupation is in reality and what students think it is. There are three major factors of an occupational environment: (1) the individual and his occupational roles, (2) the human environment of the occupation, and (3) the physical environment. An understanding of the characteristics of these three factors facilitates an intelligent appreciation of the importance of functional interactions which exist within the organization. Analyzing the occupation system also includes the determination of the characteristics of the occupation and the essential hardware and human components that characterize it. The situational stimuli of the operational tasks, i.e., relevant elements of the environment that give context to actions, should be analyzed. The chart, Figure 5, on page 132 summarizes some of the essential elements of the three factors of the occupational environment. Needless to emphasize that these factors have their internal and external counterparts. Sometimes the factors show up in formal and informal forms. For example, one relevant internal physical environment of an employee may be his office within a departmental organization; part of his external but relevant environment is his home and family relations. As part of occupational education, students must understand their relationships, as job-holders, with other relevant environments of the occupation like the human environment, (organizational hierarchy, interactions and relationships), and the physical environment (tools, materials, machines and facilities) with which they have to come in contact in the course of the performance of their jobs. Regardless of the occupational simulation



NOTE: The big triangle represents the occupation with the small triangles as its components. The two square shapes and the rectangular one represent the environmental factors. The arrows show the interrelationships between these environmental factors.

THE STRUCTURE OF OCCUPATIONAL ENVIRONMENT
(Figure 5)

model, these matters should be communicated to the students in a realistic manner. This part of the simulated instruction is not attained in a day. In fact, this is sequenced along with other instructional components. The point that is being made is that somewhere along the line, these aspects must be communicated to the students before the end of the occupational education. The intensity or relevance of these factors will vary in accordance with students' level of knowledge of the occupational environment.

Methods of familiarizing students with the Occupational Environment:

Several methods can be used to broaden students' knowledge of the occupational environment among which may be field-trips, guest-speakers from the occupation, exhibitions, films, slides, work observation, and work-study. A "feeling" of what the occupation is like is the main goal of this type of activity.

Evaluation: Without a doubt, the level of students' knowledge about the occupational environment can be evaluated if there is some specificity about the essential things which students must know about the occupational environment. It must be pointed out, however, that it is unrealistic to attempt to familiarize students with every element of the occupational environment. In actual fact, the teacher does not possess all the essential knowledge. Nor do the students. Knowledges that are simulated are subject to constant changes having regard for the dynamic nature of the occupation. Therefore, at best, what should be aimed at is acquaintanceship with the characteristics of the environment and the consequences that inhere in such characteristics.

B. Selection of a Simulated Occupational Model

The specificity of the occupational model is an important matter in focusing the goal of the educational program. A simulation model for occupational education can be specialized or general. A general simulation model is one that aims at developing occupational competency of a general nature for a broad field. For example, a simulated occupational education may seek to provide simulated experiences for marketing majors of an MBA program, generally. In this case the simulation will be an integration of general competencies that presumably make competent marketing managers. On the other hand, the simulated experience may seek to provide a specialized simulation in which case the objective may be, for example, to prepare a marketing executive in the detergent industry. In this case, the particular firm that specializes in this field may be fictionalized.

1. Representing the Model: The choice of a model is as important as the selection or representation of the compentencies to be developed through the simulated experience. Some of the ways in which a valid representation or selection of model competencies are achieved may be reiterated.

2. Functional Criterion: A checklist of the functions of an idealized model may be constructed. Thus the total items on the checklist represent the model being selected and therefore the simulated instructional objective.

3. Competency Criterion: A norm-based competency criterion may be used in modelling. In this case the competency criterion contains a list of proficiencies that are anticipated at the end of simulated instruction. This criterion generally is derived from performance evaluation of persons within the occupation and the norm of the employees is used as the model. These become the focus of the simulated instruction.

4. Dictionary of Occupational Terms Criterion: The Dictionary of Occupational Terms criterion can be used as the model.[8] To a great extent this model is reliable because of its national validity and therefore may be considered a suitable model for public education. Other models can arise from the critical incident analysis, the training needs evaluation, and the behavioral objectives criteria.[9]

C. Orientation to Specific Occupational Objectives and Performance Standards

One of the main purposes of orientation,is motivational. It is designed to give the student more specific information about the particular occupation for which he is being educated. Part of the information comes from the initial introduction to the occupational environment, if this is considered part of the picture. The student is oriented to the conditions under which he is to respond realistically. He is informed of the types of equipment, materials, informational sources, and other matters that are germane to the specific occupation for which he is being trained. The information is simulated. Assuming that the simulation design takes cognizance of this need, there will be no problem of the order in which the items of information suggested above is presented to the student. Some information may be withheld temporarily for the student to discover himself. Some are so self-evident that no real orientation is required.

1. Objectives: However, when a simulation unit is designed to develop

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[8] U. S. Department of Labor, Manpower Administration, op. cit.

[9] See B. S. Bloom (ed.), Taxonomy of Educational Objectives: A Handbook I: Cognitive Domain, (New York: McKay, 1956).

a new skill, knowledge, or attitude, it is essential for the students to be oriented towards the curriculum objectives.

Although there are many approaches in derivation of instructional objectives, the objectives of occupational education are better described in tasks taxonomy because this method describes task behaviors in a manner that is "standardized, efficient, directly teachable and reliable".[10] The taxonomy of performance is concerned with activities in terms of whether they are jobs, or tasks, and whether the performance can be described in behavior of an individual or that of a team or group.

2. Pre-test: Another purpose of orientation to simulated instructional objectives is to assess students' readiness for the learning experience. Students entry-knowledge must be evaluated in terms of the prerequisites set for the simulated experience. Students with inadequate preparation must be given remedial coaching which will enable them to derive an optimum advantage from the simulated learning.

Homogeneous vs. heterogeneous grouping: Ideally it is preferable and more efficient to have students with the same ability level enter a simulated instruction. However, this is not usually possible. Yet it must be said that heterogeneous composition of a class is not ideal for

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[10]Miller, who has done an extensive work on job analysis in military and industrial settings, considers this approach as being ideal. To paraphrase him, a job is a component of activities that make up the roles of a position. A task is a component of a job mutually related to it because of a common purpose. A task therefore is a series of activities that are part of a job-cycle. Miller, *op. cit.*, pp. 198-202. Examples: One of the items of the Job Description of a lawyer may be "To prepare a brief to defend a client". This is a *job*. One of the task components of this job is: Referring to the statutory requirement in the statute book. *Activities* involved in this includes referring to the index, turning over the pages, etc., while the appropriate reference is found and the brief is written.

a simulation in which the development of team behavior is an objective. Unless the simulated learning affords individualized tutoring, it may be advisable to group the class according to their levels of ability so that there is no great disparity in ability grouping and achievement.

3. Specificity of simulated instructional functions: A simulated instruction can be designed to train in procedural ability, psychomotor skills, concepts, insights, judgment, synthesis, or a combination of any of these. The specific occupational proficiency to be achieved by the simulation must be specified in behavior or performance taxonomy. For example, one of the functions of a vocational business education program may be: To provide instruction which will enable the students to transcribe a mailable letter dictated at a speed of 100 words a minute.

4. Standard of performance: In some performance objectives where the performance can be quantified, there may be no problem in specifying what the performance standard will be. "Students will be able to transcribe a mailable letter dictated at a speed of 100 words a minute" is a goal at least broadly measurable. When there is an objective in which performance is not easily quantifiable, measures need to be devised for assessing performance. If it is critical to have just "one right way" of performance, the determination of this standard must be based on the opinion of experts in the occupation. Sometimes it is unrealistic to have just one right answer, in which case a series of alternatives will have to be specified in which the answer given will be acceptable. For example, performance requiring decision-making may be rated: (1) excellent, (2) good, (3) effective, (4) ineffective, and (5) poor. Each of these can now be quantified by assigning points for the responses. A pre-simulation evaluation of where the student is in relation to instruction objective

will facilitate measurement of effects of simulated instruction. To facilitate total evaluation of simulation experience, a pre-test is a desideratum. At the end of the simulated instruction, a post-test is administered to measure the achievement of students during the simulated instruction. More of this will be discussed under simulated evaluation.

D. Simulated Occupation Curriculum Plan

Simulated occupation curriculum plan involves making detailed plans on what has to be learned in a simulation, when it has to be learned, where, how, and by whom. Therefore, this process is the programming, managing and coordinating simulated instructional activities. The components of the activities include, determining the structure of subject matter mix essential in the development of skills, attitudes and concepts for carrying out specific activities such as jobs and position of an occupation. This is logically sequencing materials with the following important issues in mind: (1) time required for simulated learning by an average student, (2) the relative difficulty of topics to be covered, (3) the optimum order of subject matter, and (4) the allocation of time for practice, drill, testing, and review, and (5) individual differences of the students.[11]

1. Simulated Environment: The motivational techniques that will be used for this process should be dictated by what is known about the students' needs, the nature of the occupation, and the incentives, and reward patterns that characterize it. For example, "promotion" and

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[11]M. P. Crawford. "Concept of Training" in R. M. Gagne and Arthur W. Melton, Psychological Principles in System Development. (New York: Holt, Rinehart and Winston, 1965), p. 333.

salary raises may be appropriate rewards in a program training secretaries. Since it is required that the learning situation should have an appearance of real-life situation, the need to have a simulated learning environment is important. In occupational education, the need for realism of the environment cannot be over-emphasized. The important point is that the stimulus situation created must be such that it is contextually similar to the real-life so that positive transfer occurs after the training or in the process of using or integrating learning to solve similar problems encountered in learning situations.

2. Simulated Materials: An essential, and no doubt the most important instructional plan decision to be made by the teacher, is the development or use of simulated materials. If an occupational education uses an existing simulated model, probably the simulated materials will come with the package. If the instructor has to develop these materials for himself, then a problem of greater dimension occurs. In this respect, the simulated materials developed should be the prototype of real-life materials. For example, if exercises in decision-making are to be given, the materials developed for these exercises must be realistic. In this respect, the relevance of the materials as the equivalence of the real-life is important. Tools, machines, work space and other equipment essential for simulated instruction must be provided. The physical learning conditions--lights, sitting arrangements--need to be appropriate and be, as far as possible, the prototypes of real-life models.

The fidelity of the learning environment is essential only to the degree that it is environmentally or physically relevant and adequate to elicit the life-like response that can be transferred to real-life. Exact duplication of real-life conditions is not essential. Thus, a model office is not absolutely essential for training secretaries and office managers. The contribution of realism should be made clear: it stimulates interest which facilitates acquisition of knowledge and skill.

E. Simulated Occupational Practice

An important element of "learning by doing" is practice. Thus, simulated practice should provide laboratory experience in the occupation. It is impossible for mastery of a performance to occur without practice, because it is practice that enables assessments to be made between stimulation and response. The theoretical principle underlying practice and habit formation should guide the teacher in arranging simulated practice. It is accepted as a truism that "practice makes perfect". Since the goal of simulated instruction in occupational education is development of effectiveness in a chosen occupation, it is important that the simulated practice should develop occupational effectiveness and efficiency. Several factors will determine the effectiveness of practice in a simulation. Some of these may be mentioned.

1. Speed and Accuracy: The teacher in charge of a simulated instruction should consider the importance of speed and accuracy of practice according to the nature of operational situation being simulated. In some real-life situations, time and accuracy are correlated with the execution of an operational task. For example, in training cash register operators, speed and accuracy are important. However, it can be said that, in general, time is a critical element in every task performance. Therefore simulated practice should take cognizance of speed and accuracy. The emphasis of one over the other should be based absolutely on the nature of the operation as seen in the market place. It has been shown

in several practical examples that speed will come after repetitive practice. Accuracy should be stressed not as an alternative to speed but as an element of what goes with it.

2. Simulated Practice Continuum: Practice in occupational training has a natural division. Assuming that the initial learning is effective and efficient, simulation in occupational education may be planned in a continuum. Thus, the first part of the simulated practice will deal with simulation of tasks; and when these have been thoroughly mastered, simulated practice of job may be added, and then lastly, a simulation of position. To illustrate how this may be done, this example will suffice. Suppose one of the items in the job description of an accounts clerk is: "To prepare employees monthly salaries from time card record." This job is composed of these tasks: (a) checking employees lists by section, (b) calculating time card hours, (c) multiplying this by rate per hour per employees, etc., until the form, and check is prepared. The practice continuum process will break down practice into all the activities sequentially until the whole job activities are simulated.

The complexity of the task or job and the logic of activity flow should determine the sequencing of practice. Simulated practices should be distributed properly to cover the proportion of interactive and active behaviors associated with the operational tasks. The nature of the occupation should determine how these are balanced. For example, if the temperament of a job is self-centered, self-centered activities should predominate in the simulated practice.

3. Recycling of practice is essential for two purposes: (1) correct response building for effective response generalization, and (2) opportunity to integrate or transfer previously acquired generalizations.

4. Flexibility in practice: A number of variables may dictate what type of practice and what method should be used by the teacher. In some cases, the teacher has no choice on what the practice should be. For example, if a simulated game is to be used, the simulated practice is already written up. It is a question of the teacher following and adopting the practice procedures specified. It can be said, however, that in general, simulated practice needs to be meaningful. Active responses by the students to a stimulus situation is important. The same material need not be used over and over again for practice (except when the goal is to over-learn). Thus, it is necessary to vary stimulus materials. Immediate knowledge of results (KOR) is important as it is related to the rate of learning and motivational drive. The instructor must be around to give guidance.

5. Progress Records: Progress of students during simulated practice needs to be kept. It is wise to chart this if the learning involves measurable psychomotor skills. A lot of information about the student and the effectiveness of practice and/or instruction could be gotten from records of students' progress kept.

F. Simulated Instructional Process

This process is the stage at which the teacher's function is primarily that of a "back-seat driver". The teacher may not come in at all if the simulation design includes a debriefing program. The students are involved in the action. The teacher simply gives direction. This process is linked with the proceeding process of simulated practice. The two processes actually function together. Three instructional activities are involved in simulated instruction method: (1) briefing, (2) directing, and (3) debriefing.

1. Briefing: The briefing session for a simulation exercise intimates the students with the objectives of the simulated practice. It provides some useful directions that can make the practice meaningful and effective. This is extremely important in occupational education. The explicit purpose of each practice and the method of practice need to be clarified to the student.

2. Directing: This is the intentional coaching which the simulation process may demand, particularly when the directions given for conducting the practice is not followed by students or when wrong responses are made all the way. The amount of guidance will depend on the needs of each student. In auto-instruction simulation, the student may be branched to a coaching track when wrong responses are made. The simulation program in such a case prescribes appropriate remedial instruction. In some cases, this may require outside reading, projects, and other activities. The instructional plan, it is possible, may program activities like these in such a way that they supplement student's knowledge at the appropriate times and at such levels that will enable him to function or respond more effectively and efficiently.

3. Debriefing: The debriefing session relates to the conduct of a review and a summary of post-practice session. It deals with removing any misconception about the situations that may have arisen during the practice. Also new ideas which the student may not have thought about are given. It can be summarized that debriefing accomplished one important objective: it puts the simulated practice in proper perspective by under-scoring important points that might have been overlooked or overemphasized unnecessarily. It might be said also that the debriefing session is an evaluation session: it offers an opportunity to assess

the extent to which the stated objective, as expressed during briefing, has been achieved. An analysis of students' weak points should guide the teacher in programming any subsequent practice and coaching.

In occupational education, the articulation of the teacher in motivating students occupationally is very important. The effect which this has on the process of instruction is evidenced by the type of behavior which the students cultivate. If the teacher is not professional in the manner he handles the simulation process, he can hardly sensitize the students to be. The goal of simulated instructional process should be (1) to develop the potentiality of the student as completely as possible, and (2) to promote desirable personal-group relationships, and an awareness of the welfare of others.

G. Simulated Evaluation

The evaluation of simulation learning has been beset with a number of problems chief among which is the question of qualitative and quantitative evaluation. Evaluation of occupational education may become a complex task if there is no clear-cut procedure for translating the observable behavior of persons in job situations to numerical scales. The major problem is that the bulk of behavior repertoires in occupational education result in performances that are describable more accurately as qualitative than quantitative.

The first step in approaching this problem is a definition of the behavior to be evaluated. Two approaches are possible under an instructional setting: (1) the behavior to be evaluated may be defined in terms of a norm-reference, in which case the norm of a group is the standard of evaluation. This is grading on a curve. (2) The behavior may be evaluated in terms of a market place criterion-reference, e.g. "At the end of the simulated instruction, student will be able to transcribe from shorthand notes at the rate of 100 words a minute." Thus, every student is graded on this criterion-reference. This approach is preferred because it can show what progress, if any, that is being made in terms of an "absolute" standard.

In occupational education, a logical standard of assessment is competency assessment. Evaluation of this nature is based on the occurrence of desired response. This may be expressed in terms of degree of accuracy or the speed at which the function is performed or the behavior is exhibited.

1. Types of Simulated Evaluation: In any program of occupational education, at least two categories of evaluation are relevant. The first is concerned with evaluation during the process of simulation. The second type of evaluation is correlated-behavior measure which is post-simulation evaluation.

(a) Simulated Evaluation: The fundamental criterion for evaluating a simulation-based instruction is the extent of transfer to life situation.[12] Thus, simulated evaluation is a logical process in evaluation of occupational education. Simulated evaluation relates to any type of test or measurement that is given in a job-like situation which contrives the effects of real-life environment. It is a test given in the microcosm of the job-situation. Types of these tests may be discussed.[13]

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[12]Willian C. Biel, "Training Programs and Devices", in R. M. Gagne, and Arthur W. Melton, (eds.) Psychological Principles in System Development, (New York: Holt, Rinehard and Winston, 1965), pp.377-378.

[13]Glaser and Klaus refer to these tests as "Simulated Performance Measures". Glaser and Klaus, "Proficiency Measurement: Assessment of Human Performance". Ibid., pp.457-460.

(i) Situational Tests: These are tests which "stage" job situation problems. Students act the roles of job-holders depicted by the test. A situational problem, for example, in medical education may relate to a specific problem, say, in diagnosis which doctors face in real life.

(ii) Equipment Operation Measure: In some occupational tasks the use of machines and equipment is inextricably linked with efficiency and effectiveness on the job. The proficiency of a typist, for example, may be evaluated by having her manipulate the typewriter to accomplish a set of tasks in display, or letter-style.

(iii) In-basket Tests: In-basket test simulation is an excellent performance test which evaluates the student's ability to cope with problems that are representative of those faced by real-life counter-part. In-basket simulation items may focus on specific functional roles, e.g. discipline problems in the classroom.

(iv) Role-play simulation: Role-play simulation can be used as a method of evaluating the simulated occupational instruction. Role-play then becomes the test. To be effectively used, the role-play simulation must contain elements of problems that characterize the occupational role within the parameters of the instructional objectives. A check list of behavior or responses expected must be part of the evaluation tool. Also, a rating scale showing the record of performance must be prepared. Group discussion can be used in the same way.

(v) Simulation Game: Games may be used to evaluate performance. To be effective, a record of performance during the game situation must be kept by using a rating scale and a check list for the behavior repertoires expected or unbecoming.

(vi) Reports, committee assignment and task force are other kinds of simulated evaluations that can be used.

2. Grade assignment: Grades may be assigned in accordance with the rating scales adopted by the teacher. As discussed earlier, this may be norm-referenced, or criterion-referenced. The teacher should have absolute freedom in assigning grades. No one can usurp this responsibility but she has also the professional obligation of ensuring that the standards used are realistically defensible.

3. Correlated-behavior Measures: Correlated-behavior measures are measurement of related events in the sense that the post-simulation events suggest a relationship between the events that occur and the incidence of simulated instruction. Thus if there are immediate promotions, salary raises, and increased responsibilities for the graduates of a simulated program, in recognition of skill levels attained in their work, these events may be regarded as correlated-behavior measures. However, before any such a claim is made, there must be adequate evidence to support it. This may be done by comparing the graduates of simulated program with those of non-simulated program. It is recognized, however, that the relationship between job performance proficiency and associated events is not always clear.

In occupational education, a correlated-behavior evaluation can be conducted through a follow-up study of graduates. Such a survey should measure occupational mobility, promotability, job knowledge, occupational adjustment and job behavior (e.g. punctuality, absenteeism, occupational housekeeping), and the extent to which the simulated instruction can be said to have helped the student to attain all or any of these. The results of these may not be evident in a one-shot study. Therefore, a longitudinal study, covering, say a period of five years may be desirable.

Other examples of correlated-behavior measures that can be used are: (1) objective observation on-the-job, and (2) verbal or paper-and-pencil test on technical knowledge. Results from both the situational tests and the correlated-behavior measures can provide some feedback on the effectiveness or ineffectiveness of the simulated instruction.

H. Redesign

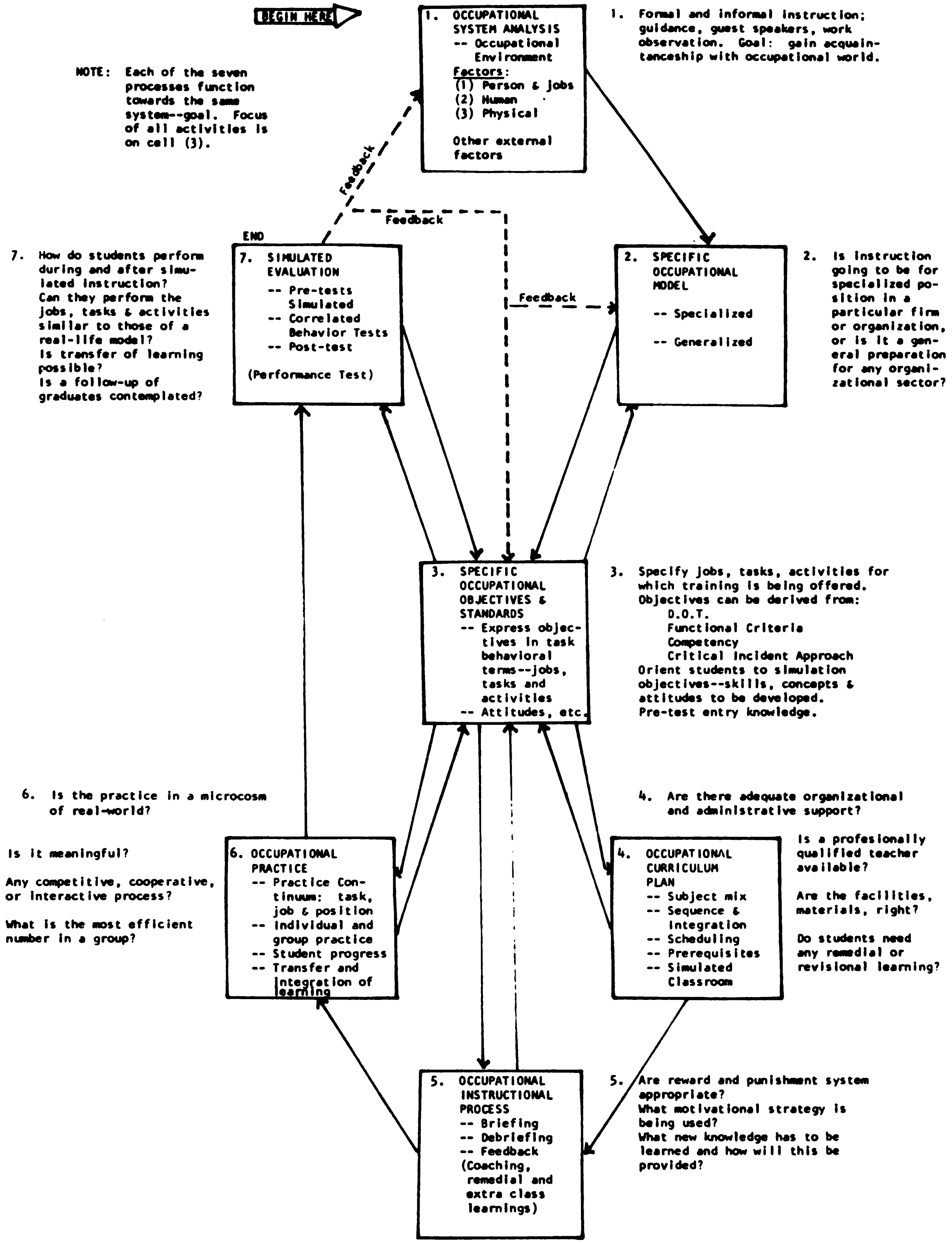
If the objectives of simulation are not attained, several factors may be responsible. Two probable causes in the dysfunctionality of the model may be suggested. First, the assumptions made about the simulation model may be wrong, in which case the inputs of the simulation design are either inadequate or are invalid. Secondly, there may be dysfunctional coordinations in the processes of the model. Errors in functional process may be located if this is the case. Thus, in such a case, the correction of the errors, and not the re-design of the whole simulation model, will be the logical action. In any case, the model should be reviewed from time to time to make it functional for whatever the simulated occupational objectives may be.

V. GUIDELINES FOR THE USE OF SIMULATED INSTRUCTIONAL MODEL

Figure 6, page 149, summarizes the procedures for the simulated instructional model, described herein as SIM-INST Model. The figure also describes the processes and essential guidelines for the teacher. At the risk of repeating some of what has been included in the flow chart, the following additional guidelines are given:

A. Design Guideline: Choose an occupation model and identify specific occupational goal.

1. Determine what type of model to use--generalized or specialized.



A SIMULATED INSTRUCTIONAL MODEL (SIM-INST) FOR OCCUPATIONAL EDUCATION
(Figure 6)

2. Is a suitable commercialized simulation available? Or can a "home-made" model be designed to do the same job?

B. <u>Administrative Guideline</u>: Obtain institutional commitment and support for running the simulated occupational program.

1. Can the simulation be financed?
2. Can scheduling be arranged without disrupting other school hours?
3. Is the administration favorable to its use?
4. Are simulated facilities available?
5. Is an occupationally competent teacher available to conduct the simulated instruction?

C. <u>Professional Guideline</u>: Be professionally prepared to conduct the simulated instructional program.

1. For what group of students is the simulated instruction designed? (Heterogeneity of student input may be a burden on the instructional process. State prerequisites for the simulation).
2. Determine other instructional inputs for the simulation: What are the objectives of the simulated instruction? Are objectives stated in task behavioral terms--job, task, and position? What attitudes, skills, concepts are to be developed?

   (a) Subject mix; (b) lesson plans; (c) texts required; (d) Manuals for the simulation; (e) simulated package and materials--Are these tried out before? (f) Extra-curricular activities required, e.g. projects, field trips, assignments, etc.; (g) simulated environment.

3. Determine instructional process: (a) Are remedial learning essential for any student? (b) What kinds of practices should the student have--individual or group? (c) Do problems reflect integrated knowledge? (d) Are students briefed for simulation exercises? Are they debriefed? (e) What additional coaching is necessary?
4. How are students to be motivated?

D. Evaluation Guidelines: Determine how the simulated instruction is to be evaluated.

1. How will the simulation be evaluated--norm-referenced or criterion-referenced?
2. Pre-test to evaluate entry knowledge.
3. Performance test--evaluate instructional objectives. This may be used as post-test.
4. Situational tests--simulated evaluation administration.
5. Correlated-behavior measures, e.g. conduct a follow-up study.

SUMMARY

In this chapter, the nature of occupational education has been discussed. Assumptions are made also about the objectives of occupational instruction. A seven-process simulated instructional model is designed to meet these objectives. The seven processes are (1) occupational system analysis, (2) selection of a simulated occupational model, (3) orientation to specific occupational objectives and performance standards, (4) a simulated occupational curriculum plan, (5) a simulated instructional process, (6) a simulated occupational practice, and (7) a simulated evaluation. The activities of each of the seven processes are discussed. Guidelines for using the model and rectifying any dysfunctionality are provided.

CHAPTER VI

SUMMARY AND CONCLUSIONS

I. SUMMARY OF THE STUDY

This study was a venture to derive some thoeretical generalizations about the methodology of educational simulation, particularly on design and methods of instructional simulation. It attempted to open the "black box" of educational simulation and unfold the theoretical principles that undergird the practice in all kinds of simulations used for educational purposes including simulators, computerized and non-computerized games, operational gaming, in-basket simulation, and role-play simulation. Specifically, the study was concerned with the synthesis, analysis, and critical evaluation of all kinds of theoretical rationales on educational simulation in order to derive an integrative theory which explained and clarified the methodology as it related to: (1) the design of educational simulation, (2) the instructional application of educational simulation, (3) the operational criteria for instructional simulation, and (4) the method of designing an instructional model for occupational education.

The procedure of the research included an extensive review and critical analysis of literature, observation of educational simulations in classrooms, discussions with users, designers, and proponents of educational simulation, and deductive abstraction.

The literature of educational simulation and related psychological rationales were reviewed. From this broad view, four schools of simulation rationales were identified. These were: the philosophical, mechanistic, psychological and sociological schools. The simulations reviewed covered all types of presentations including computer and non-computer simulation games, in-basket simulation, role-playing simulations, simulators, and other iconic models.

The classificatory approach adopted in investigating the methodology of educational simulation. although arbitrary, was used to analyze the theoretical principles relative to the design and application of instructional simulation.

An integrative theory which covered all the theoretical principles analyzed was proposed and criteria were developed for the design of educational simulations. Also, six major operational criteria for administering instructional simulation were derived.

The extent to which the theory conformed with practice was evaluated by comparing the operational criteria of five selected simulation designs used for instructional purposes with the six theoretical instructional criteria derived. One of the simulations, Community Land Use Game, was observed under laboratory conditions.

In order to design a simulated instructional model for occupational education, some basic assumptions were made about the nature of occupational education and occupational instruction.[1] The six operational criteria of instructional simulation were modified because of their inadequacies for occupational education. A seven-process simulated

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[1]See pages 127 and 128.

instructional model called the SIM-INST Model[2] was derived. The functions of each of the seven processes of the SIM-INST Model were described and guidelines were developed for utilizing the model and for rectifying any dysfunctionality that might arise.

II. MAJOR FINDINGS

The major findings of the study are discussed under four headings: (1) the nature and rationale of educational simulation, (2) theoretical instructional simulation criteria, (3) theoretical principles affecting the design of educational simulation, and (4) theoretical principles affecting instructional application of educational simulation.

A. The Nature and Rationale of Educational Simulation

The following major findings are pertinent to the nature and rationale of educational simulation:

1. The focus of all educational simulations is the provision of realistic instruction. This approach relies on laboratory-type experiences which are provided the learner under conditions that replicate the operational situations of real-life. The simulated environment in which the laboratory experience is given is a microcosm of the real-life situation. Simulation therefore bridges the gap between theoretical bookwork and practical application of knowledge in real-life situations.

2. The classificatory approach, philosophical, psychological, mechanistic and sociological, used in analyzing all types of educational

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[2]SIM-INST is an acronym for the author's model for simulated Occupational Simulation proposed in Chapter V. See pages 130 to 151.

simulation are useful rubrics for investigating and understanding the rationale of educational simulation.

a) The philosophical position emphasizes the realistic, pragmatic, functional, goal-directed, and participatory aspects of learning in which the learner plays the dominate role.

b) The mechanistic position supports the utilization of technological devices (synthetic and animated) for faithfully representing real-life. The devices facilitate representation of abstracted elements of real-life and make presentation of realistic instruction understandable and meaningful.

c) The psychological school regards the physical and psychological fidelity of the operational situations as important issues which engender realistic responses on the part of the learner. Such considerations facilitate transfer to real-life situations if they are accompanied with reinforced goal-directed practices.

d) The sociological position emanates from abstraction of elements of human and physical environment relatable to the role sets of the real-life model. Role behavior is inculcated through a process of reinforced normative practice.

However, it was noted that in spite of these different classifications, a network of interrelationships in methodology of design and instructional application exist within the schools. For example, it was noted that all the schools of educational simulation had to make specific assumptions about the characteristics of the real-life model which was being simulated. The four schools of educational simulation use synthetic or animated devices for representing simulation models. However, it was concluded that the differences in method of representation could be explained by differences in levels of sophistication of designers. A sophisticated designer might prefer the computer for simulating abstracted elements of real-life model while a less sophisticated designer might prefer a simpler artifact, symbol, or iconic representation.

3. Contrary to existing opinion which some people have that simulation is useful only for developing psychomotor skills, it was determined that simulation could be used for all types of learnings and subject-matter fields. Simulations are being designed and found effective for traditionally "hard" subjects like mathematics, logic, economics, as well as for subjects like political science, geography, and vocational subjects. It was found out that whether a simulation is computerized or non-computerized, the function of educational simulation is to integrate knowledges which an individual may possess and to put these knowledges into meaningful forms by presenting the learner with problem-solving situations which require the application of procedures, principles, concepts, psychomotor skills, identification, and strategies or a combination of any of these. This learning experience is a synthesis of the cognitive, affective and psychomotor knowledges which an individual has previously acquired or may acquire during the simulation.

4. Gaming and simulation are two terms used in educational simulation. The game concept is a useful one, but it is not a _sine qua non_ of educational simulation. The two terms are sometimes used interchangeably by some designers and users. Computer simulations are generally oriented towards games, as in management games. The game concept as used in educational simulation means a model which provides stimulating mimetic practice for students about gamed situations of real-life. What distinguishes an educational game from a parlor game is that an educational game has

specific instructional objectives to which the student must be oriented at the beginning of the game. Also educational games end with debriefing.

a) The purpose of gaming is to illustrate in mimetic manner the social or physical interactions that occur in real-life and to provide a miniature of real-life in which participants can practice and respond realistically. Games illustrate the application of concepts, rules and principles in specific situations.

b) The rationale behind the use of games in education is to motivate the learner by providing him learning experiences that will stimulate his drives to attain standards that are normatively rewarded by the rules of the game. Games always have built-in motivation. Rewards in games are assured and because of contingencies of rewards with behavioral responses, it is assumed that the process of reinforcement which exists in a game will enhance the internalization and transfer of learning.

B. Instructional Simulation Criteria

The following major findings are noted:

1. The five selected instructional simulations conformed in essential details with the six theoretical operational criteria for administering simulated instruction, namely, (a) the selection of a model, (b) the orientation of the student to the objectives and performance standards of the simulation, (c) simulated curriculum plan, (d) simulated instructional process, (e) simulated instructional practice, and (f) simulated instructional evaluation. However, it was discovered that there was no agreement in the procedural practices on simulated evaluation. Some have pre-test and post-test. Some have none of these.

2. In general, evaluation of simulated instruction proved to be a tenuous operation. Consequently, it was considered desirable to establish

a systematic process of evaluation comprising a pre-test, a post-test, and finally a situational test. The situational test is a prototype of situational problem which a person faces in a real-life situation and its major objective is the assessment of the amount of transfer of training. Performance test, which may assess mastery of important concepts, rules, and application, may also be administered if considered essential.

3. The assignment of a grade for simulated instruction was in cases studied not based on any consistent principle. It was concluded that generally the final responsibility for assigning a final grade should rest with the instructor who should take cognizance of the student's performance in simulated practices and the levels of improvement and progress he has made over a reasonable trial period during the simulated instruction. The objectives of the simulation should determine the weight given to any criteria of evaluation that might be adopted.

C. Theoretical Principles Affecting Design of Educational Simulation

As far as the theoretical principles affecting designs of educational simulations are concerned, the following findings are considered major:

1. While synthetic and animated devices have been utilized in constructing simulation models, every simulation design should incorporate five features: (a) a stimulus situation, (b) a response situation, (c) a consequence situation representing the interaction of stimulus-response, (d) a feedback sequence, and (e) a control. The nature of these criteria suggests that the S-R theory is basic to all educational simulation designs.

2. Simulation devices are chosen by designers largely on the basis of their own sophistication, knowledge of the model, the resources available to the designers, and the suitability of the synthetic or

animated devices for representing the abstracted characteristics of the model. Thus, even though there were different types of simulations, such as those utilizing cybernetics and "giant brains" in computerized games, and those using simple non-mechanistic devices as in role-playing simulations, all simulations accomplish the same objective, i.e., the provision of laboratory-type education in which the learner is actively involved.

3. The concept of simulation does not imply exact <u>duplication</u> of real-life but rather is a <u>representation</u> of real-life based on the individual designer's presumptions and assumptions of the state and characteristics of that real-life.

4. Fidelity of simulation is important in design because it incorporates the degree of realism the designer has represented. Fidelity can be physical or mental or both. Physical fidelity applies when the representation is based on physical resemblence between the real-life model and the simulation model. Mental fidelity is a psychological state of perception. It makes the user of a simulation acquire a feeling of "realness" because of the verisimilitude of the model. The ultimate test of fidelity is the extent to which the representation leads to the elicitation of responses that are transferrable positively to real-life situations. <u>Fidelity of simulation</u> is (a) omission of situational stimuli that are irrelevant to contextual responses, and (b) the inclusion of those stimuli that are relevant and at the same time vital to positive transfer and integration.

5. <u>Degree of realism</u> relates to the extent to which operational situational stimuli of real-life model are represented in the simulation model in a way which stimulates positive responses. In the final analysis,

the extent to which the degree of realism stimulates learning is the important touchstone. The degree of realism may be psychological or physical. Degree of simulation can also be total or partial. It is not essential to have absolute realism if a minimal-response type of stimulus representation will lead to the inculcation of desirable behavior that is transferrable to real-life.

6. Omission of elements which are relevant but dangerous, inimical, non-feasible, expensive, and non-profitable, is permissible and does not do any violence to the validity of a simulation model. In this way, irrelevant elements (those that are not vital and situational stimulus-response elements) may be omitted.

7. What counts most in representation is the contribution of simulation designs to educational objectives in terms of suitability for development of transferrable behaviors. Sophisticated gadgetry is a minor item.

8. Transfer of training is the main criterion for deciding what to include in the simulation. Thus, an element which does not produce a positive response which can be transferred to real-life is contextually irrelevant and must be omitted.

9. The specificity of the model being simulated is the first step towards the development of a good simulation. The objectives of the simulation must be consistent with the characteristics of the real-life model.

10. Educational simulation designers do not give sufficient attention to the construction of <u>realistic achievement tests</u>, particularly <u>realistic situational tests</u>. With the exception of the in-basket simulation in which

Frederiksen's pioneering work offered grassroot guidelines for designing a type of a simulated test, the procedures for constructing and validating simulated tests are not clearly known.

D. Theoretical Principles Affecting Instructional Application of Educational Simulation

The following findings are considered major:

1. Instructional simulation procedures in all kinds of educational simulation are to a great extent similar.

2. Initial learning is a necessary "raw material" for instructional simulation. It is the initial knowledges which simulation integrates to develop performance skills.

3. The instructional objectives of any simulated instruction should be stated in performance terms, i.e., in behavioral goals. The standard of acceptable performance which reflects acceptable real-life performance standard should be clearly specified.

4. The sequencing of learning under instructional simulation must have regard for the student's level of knowledge and relevance to his needs. It is not clear from this study how designers and users should determine what this level should be.

5. Realism and meaningfulness of practice stimulate learning and involvement in simulated exercises. This is achieved by simulated environment and the use of simulated materials.

6. Orientation, briefing, and debriefing sessions need to be conducted in such a way that brings congruity of learning objectives with the perspectives of the simulated instruction. Debriefing sessions are sometimes omitted in some simulations. They should be regarded as

problem-solving sessions in which the group uses the occasion for diagnosing difficulties and for exploring new procedures for solving problems.

7. Feedback is essential for effective learning through simulations and must be prompt, relevant, accurate, unambiguous as well as given so that association with antecedent actions can be formed without difficulty. Contingency of reward is motivating and leads to internalization of values.

8. Evaluation in simulation must include situational tests. The basic criterion for evaluating a simulation-based educational program is the extent of transfer of training to the life situation.

9. In simulated instruction, time is usually altered. "Simulated time" may telescope the events of real time so that an hour of instruction may represent a period of one month or even a quarter in real-life; or "simulated time" may allow a momentary real-life task to be expanded into a long series of events.

III. IMPLICATIONS OF THE STUDY

The findings of this study support three major implications for education: (1) the implication for general education, (2) the implications for occupational education, and (3) the implications for instructional technology.

A. Implications for General Education

1. Theoretical exposition of educational simulation has revealed that simulated learning is learning by doing; it is a chain of meaningful deliberations which offer realistic practices to the student. This may well be the technique which will assist in breaking the passive reaction to learning that occurs under non-simulated instruction. Simulation may be a major answer for motivating those who find puzzlement and threat in learning without action.

2. Theory for simulated instruction emphasizes the importance of immediacy of feedback and its implies that the instructional application of designs with appropriate feedback sequences may remove the present conventional reliance on the teacher for reinforcement and may satisy the student's motivational needs in terms of contingency of rewards which the teacher typically is unable to match.

3. Clarification of the theoretical principles on design and application of instructional simulation opens the door widely for possible experimentation in many subject-matter fields that may wish to develop educational simulations for instruction. Innovation in this direction may emerge.

B. <u>Implications for Occupational Education</u>

1. The concept of occupational system and environment as part of the total program of simulated occupational education (as proposed in this study) can affect the structure of occupational education by bringing a new approach to occupational curriculum design.

2. The description of instructional objectives in occupational education in terms of a task taxonomy, i.e., task and job behaviors, can be a meaningful and appropriate approach for occupational education because the concept naturally fits into the simulation practice continuum, whereby practice is progressively sequenced for task, job, and position.

3. The simulation model designed through this study may assist in providing a better evaluation of simulated instruction than the non-simulated approach conventionally used in occupational education. The assessment of simulated learning through situational test administration and correlated-behavior assessments, e.g. follow-up study, is a responsible approach to evaluating the outcomes of occupational education.

4. The simulated instructional model for occupational education safeguards the installation of quality occupational education program that can serve specific needs because it offers a systematic approach to instructional design.

C. Implications for Instructional Technology

1. Clarification of the theoretical principles on design and instructional application of educational simulation can lead to better understanding of the nature of design decisions that designers may have to make, and hopefully, this can lead to quality in production of educational simulation designs in every area of learning.

2. Persuasive interest in simulation among all concerned with educational enterprise can result in the emergence of a class of instructional technologists who may probably prefer to be referred to as "simulationists". The individuals probably can champion the cause of "evolution of this deviant form of academic enterprise"[3] and protect "fair standard and quality in simulation". Some of these individuals may be known as "computer simulationists", "physical simulationists" and "media simulationists" as the market becomes diversified. Simulation technology may be a big instructional market, particularly in vocational-technical education.

IV. RECOMMENDATIONS

This study was an attempt to arrive at a systematic theory-building in educational simulation and as such, it supports at least six recommendations that are pertinent to this study as follows:

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[3]Allan Feldt, op. cit., "Introduction", (mimeo).

A. Future research in this area should concentrate on the refinement of the theoretical principles discussed in chapters III, IV, and V of this study and on development of testable hypotheses based on these principles. As an example, one of the questions that may be considered is what effect will pre-learning level of knowledge have on simulated learning competence? Is pre-learning really an essential step in instructional simulation?

B. The extent to which the theoretical SIM-INST Model is usable for instructional purposes in occupational education should be investigated through clinical testing in classrooms, and the extent to which the model can be refined after several years of testing in practice, should be reported.

C. The effectiveness of simulated learning using simulated instructional materials (e.g. in-basket simulation), developed according to the design criteria suggested in this study, should be compared with learning effectiveness of any other non-simulated instruction.

D. Where "good" simulation designs are available for use in any professional or vocational-technical education programs, a comparison of the effectiveness of simulated design should be made with other methods of instruction. For example, in the high school cooperative occupational training program, comparative study of simulation with cooperative programs and/or the project laboratory methods, should be undertaken.

E. There is a need to do additional work on the psychological factors affecting the design and use of educational simulation. For example, what psychological factors will determine what is an adequate representation of a simulation design for adults and children, or for people from different socio-economic backgrounds?

F. There is a need to devote research efforts to the mechanism of construction and validation of simulated achievement tests including situational tests and/or performance tests. It is suggested that every simulation designed for educational purposes should have accompanying it specific simulated performance tests and/or simulated situational tests appropriate for the simulation objectives.

V. GENERAL CONCLUSION

The importance of sound theoretical principles for designing and applying educational simulation cannot be over-emphasized. The aura of technology that surrounds the society, and the breakthrough in space exploration, tell the success story of simulation in industrial and military science (as in the training of the astronauts that circled the moon) and educators and other scholars should be reminded that the breakthrough of educational simulation in civilian education, (particularly public K-14 schools) may not arrive until the theoretical relationships between the technique and learning are clarified and tested in the crucible of the classroom.

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APPENDIX A

A LIST OF MAJOR DESIGNERS/DISTRIBUTORS OF EDUCATIONAL SIMULATION

DESIGNER/DISTRIBUTORS	ADDRESS	MAJOR INTEREST AREA
1. Abt Associates, Inc.	55 Wheeler Street Cambridge, Massachusetts 02138	Games of all descriptions for elementary levels, junior and senior high, college students: graduate and undergraduate.
2. Board of Cooperative Educational Services	Center for Educational Services and Research 845 Fox Meadow Road Yorktown Heights, New York 10598	Development of computerized games for individual instruction.
3. Carnegie Tech Management Game	Carnegie Institute of Technology, Graduate School of Industrial Administration Schenley Park, Pittsburgh, Pennsylvania 15213	Computer simulation games for business administration curriculum (graduate level).
4. John Hopkins University	Department of Social Relations, Charles and 34th Street Baltimore, Maryland 21218	Social studies simulation games in areas such as career, parent-child, economic systems, etc., for high school level; also suitable for adults and younger people.
5. Northwestern University International Relations Program	Department of Political Science, Northwestern University Evanston, Illinois.	Computerized and non-computerized games in political science.
6. Nova Academic Games	Academic Games Director Nova High School 3600 Southwest 70th Ave. Fort Lauderdale, Florida 33314	Variety of academic games for all levels including special games for disadvantaged and special educational programs.
7. Project SIMILE Western Behavioral Sciences Institute	1150 Silverado La Jolla, California 92037	Clearing House for all types of educational simulations; research and development.

APPENDIX B

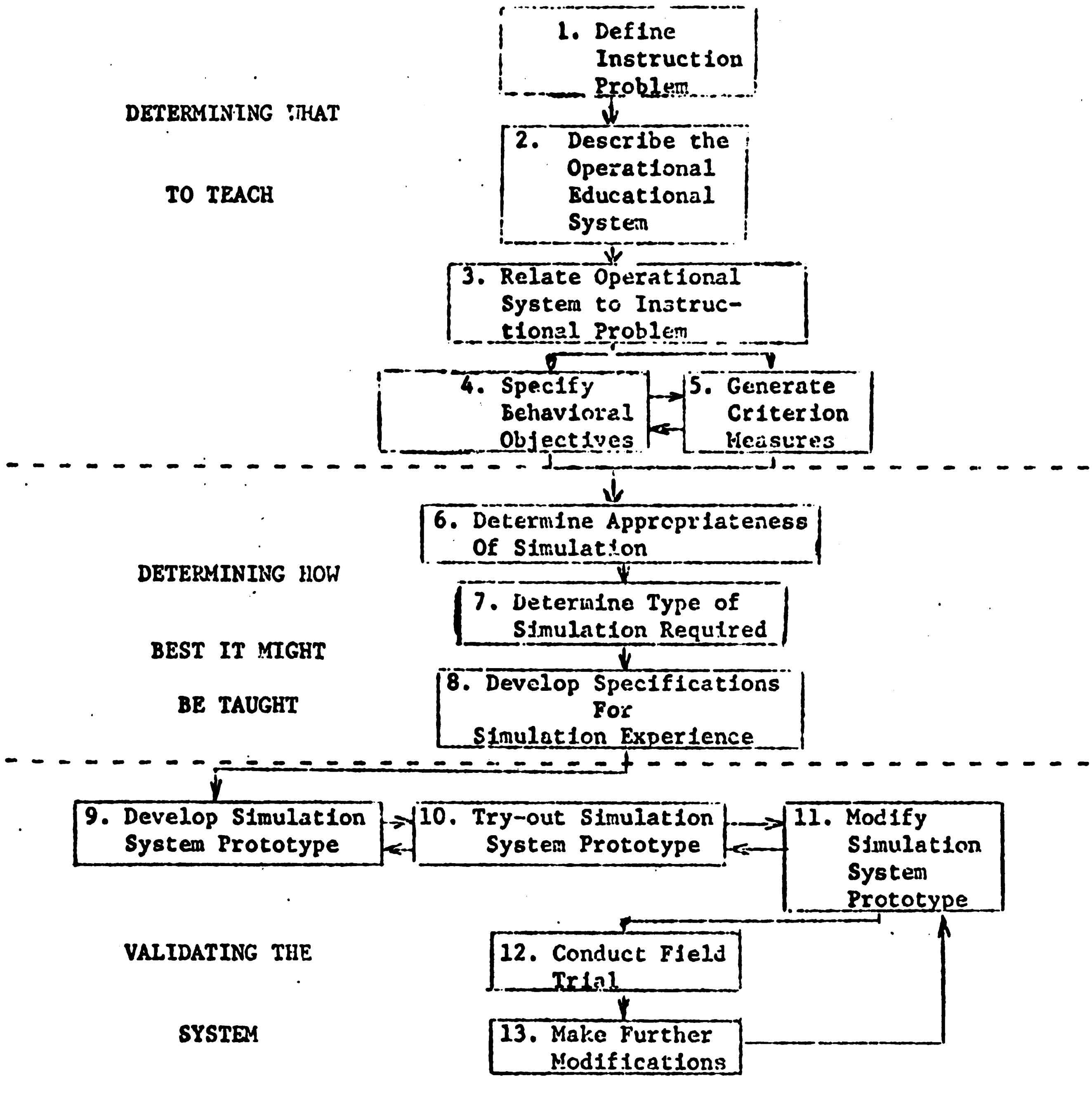
BRIEF PARTICULARS ON SELECTED SIMULATIONS ANALYZED IN CHAPTER IV (pages 119 to 122)

Description of Simulation	Focus of Simulation	Designer	Publisher	Type of Representation	Level of Program at Which Used and Name of Institution	Basis of Evaluation of the Analysis
1. Community Land Use Game (CLUG)	Urban Planning	Allan G. Feldt	Cornell University Ithaca, New York	Artifacts and models; could be computerized on IBM 1130	Graduate and undergraduate Urban Planning	Laboratory observations, analysis of research reports, and discussion with the users of the simulation/students and professor
2. Vocational Office Block Simulation (VOB)	Vocational Office education for insurance clerks	Michigan State University Research and Development Program in Vocational-Technical Education modified by Beverly Funk	R & D Program in Vocational Technical Education, M.S.U., East Lansing, Michigan	Model (Model Office); in-basket simulation	Senior High 12th Grade; Mount-Lake Terrace Senior High, Mount-Lake, Washington	Personal connection with program as Research Assistant; discussions with designers; evaluation of available records; discussion with user

Description of Simulation	Focus of Simulation	Designer	Publisher	Type of Representation	Level of Program at Which Used and Name of Institution	Basis of Evaluation of the Analysis
3. International Simulation (St. Lawrence Game)	International relations (part of American Government course)	Cleo Cherryholmes	Experimental not published at the time but see: INS published by Science Research Assoc., Chicago	Symbolic representation; mathematical values assigned to variables, scenario, written background information	Senior High 12th Grade St. Lawrence High School, Kansas	Empirical Research by Cleo Cherryholmes--M.Sc. Thesis 1963, discussion with Dr. Cherryholmes
4. Classroom Simulation	Elementary Teacher Education Classroom Management Problems	Bert Y. Kersh	Experimental not offered for commercial sale	Iconic representation; sound and still film	College; pre-service teachers, Oregon State University (Fictitious Mr. Land's Class)	Research report analysis on the experimental study. Study completed by Oregon State System of Higher Education, Teaching Research
5. Integrated Simulation In Management Education	Integration of business management disciplines, marketing, production, accounting or finance (General business simulation)	W. Nye Smith, Elmer E. Estey, and Ellsworth F. Vines	South-Western Publishing Company, Cincinnati	Computerized Simulation	College level; School of Business Administration, Clarkson College of Technology, Potsdam, New York	W. Nye Smith's published report; exchange of communication with publisher, evaluation of simulation kits and handbook

APPENDIX C

OREGON STATE SYSTEM OF HIGHER EDUCATION MODEL



Steps in the Design of an Instructional Simulation System

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