

A REVIEW OF MODELING AND SIMULATION IN
EDUCATION AND TRAINING

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ABSTRACT

This paper, as delivered, will provide an overview and survey of modeling and simulation in the field of education and training. It will consist mainly of brief descriptions and comparisons of some thirty representative models and/or simulations. Each one is presented in detail by one or more of the documents in the bibliography which also contains additional references to partial compendiums, critiques, and elaborations of some of these models and/or simulations.

I. SUMMARY AND CATEGORIZATION OF
EDUCATIONAL MODELS

Recent years have seen a number of educational systems models developed. Most of those which have been reduced to working computer simulations tend to be models of economic process, resource allocation, and various "costs" involved in managing a national education system, a school district, a university, or an industrial/vocational training activity. They tend to be:

a. Quantitative - treating in detail those aspects of education, such as enrollments, tuition, and facilities, most susceptible to "natural" and "objective" measurement.

b. Aggregated - treating "cohorts" of resources, blocks of students, and categories of support personnel rather than individual teachers, students, and classrooms. These models are generally intended to be used for gross predictions of the effects of alternative decisions by administrators

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and of variations in parameters not directly controllable. They vary as to the amount and precision of the information required as input or produced as output, as well as the degree of determinism or randomness they assume or permit. Typically, they deal with throughputs of students as a function of faculty, staff, physical plant, and other "costs" of the operation of a school or larger educational entity. For the purposes of this paper, all these will be characterized as "econometric" models.

A number of microcosmic, qualitative, functional models have also been proposed for the minute-to-minute process of learning and instruction. In general, these have not been reduced to computer simulations, mainly because of the unobservability of some of the functions postulated, and the difficulties inherent in dealing statistically with individual human decisions. These models are usually based on the principles of cybernetics, communication theory or one of the several schools of human psychology. Despite their tendency to vagueness and general lack of scientific validation, some of them have been found useful as tools for the design of programmed and/or computer-aided instruction packages. For lack of any better term, these will be called "instructional process" models of education and/or training.

BIBLIOGRAPHY

1. Boardman, Gerald R., et al. NEFP Decision Process: A Computer Simulation for Planning School Finance Programs. User Manual. National Education Finance Project, Gainesville, Fla., 1971.
2. Cogswell, J. F., Egbert, R. L., March, D. G., and Yett, Frank. Construction of School Simulation Vehicle. TM-1409, System Development Corp., Santa Monica, Calif., Aug. 6, 1963.

3. Carroll, T. Owen and Harrison, Shelly A. "The Objective-Based Education Model: Its Application in a School District." Proceedings of the 1972 International Conference on Cybernetics and Society, Washington, D. C., IEEE Systems, Man and Cybernetics Society, Oct. 9-12, 1972, pp. 499-502.
4. Dutton, John M. and Starbuck, William H. "Computer Simulation Models of Human Behavior: A History of an Intellectual Technology." IEEE Transactions on Systems, Man and Cybernetics, Vol. SMC-1, No. 2, Apr. 1971, pp. 128-171.
5. "The Cost-Ed Model: A New Economic Tool for the School Administrator." Washington, D. C., Sept. 1971.
6. Egbert, Robert L. and Cogswell, John F. System Analysis and Design in Schools. Santa Monica, Calif., System Development Corp., (SP-1141), Mar. 6, 1963.
7. Gage, N. L. "Paradigms for Research on Teaching." Handbook of Research on Teaching, Edited by N. L. Gage, Chicago, Rand-McNally & Co., 1963, pp. 94-141.
8. Gresford, G. B. "Systems Approach for Development." IEEE Transactions on Systems, Man and Cybernetics, Jul. 1972, Vol. SMC-2, No. 3, pp. 311-318.
9. Gulko, W. W. and Hussain, K. M. "A Resource Requirements Prediction Model (RRPM-1): An Introduction to the Model." TR19, NCHEMS, Oct. 1971.
10. Hulett, J. Edward, Jr. "A Symbolic Interactionist Model of Human Communication: Part One: The General Model of Social Behavior; The Message Generating Process." AV Communication Review, XIV, No. 1, 1966, pp. 5-33.
11. Levine, J. B. and Mowbrow, G. "The Development and Implementation of CAMPUS: A Computer-Based Planning and Budgeting System for Universities and Colleges." Educational Technology, New Jersey, 1971.
12. Luther, John P. "Toward a Functional, Multidisciplinary Conceptual Model of the Instructional Process." Unpublished Ph. D. Dissertation, The Catholic University of America, 1972.
13. McKelvey, J. "Plantran II: A Simulation System for Educational Planning." Midwest Research Institute Report, 1972.
14. Manser, Marilyn, Naylor, Thomas H., and Wertz, Kenneth. "Effects of Alternative Policies for Allocating Federal Aid for Education." Simulation and Games, I, Jun. 1970, pp. 134-154.
15. Organization for Economic Co-Operation and Development, Education and Development Report, Mathematical Models in Educational Planning. Paris, Directorate for Scientific Affairs of the Organization for Economic Co-Operation and Development, 1967.
16. Organization for Economic Co-Operation and Development, Education and Development Report, Econometric Models of Education, Some Applications. Paris, O.E.C.D., 1965.
17. Silvern, Leonard C. Systems Analysis and Synthesis Applied to Occupational Instruction in Secondary Schools. Los Angeles, Calif., Education and Training Consultants Co., 1967.
18. Silvern, Leonard C. Systems Engineering of Education IV: Systems Analysis and Synthesis Applied Quantitatively to Create an Instructional System. Los Angeles, Calif., Education and Training Consultants Co., 1965.
19. Smith, Robert G., Jr. The Design of Instructional Systems. Alexandria, Va., George Washington University Human Resources Research Office, 1966.
20. Stallard, Troy F. "A Computerized Systems Model of a Public School System." Center for Occupational Education, Tech. Paper No. 7, North Carolina State University, Raleigh, N. C., 1972.
21. Stolurow, Lawrence M. Teaching by Machine. Cooperative Research Monograph No. 6, OE-34010, Washington, D. C., Government Printing Office, 1961.
22. Struve, D. L. and Nelson, C. A. "SEARCH: A College Planning Model." Peat Marwick Mitchell & Co., Aug. 1972.
23. Taft, Martin I. "Design for Education: A Systems Approach." Proceedings of the Symposium: "Engineering: A Look Inward and a Reach Outward." Milwaukee, Wis., University of Wisconsin, Summer 1967.
24. Theodoris, George C. and Attinger, Ernst O. "Control Mechanisms in the Educational System." Proceedings of the International Conference on Cybernetics and Society, Washington, D. C., IEEE Systems, Man and Cybernetics Society, Oct. 9-12, 1972, pp. 494-498.
25. Travers, Robert M. W. Editor and principal investigator, Research and Theory Related to Audiovisual Information Transmission, Interim Report, Title VII, NDEA Project No. C977, Bureau of Educational Research, University of Utah, 1964.
26. Van Wijk, A. P. and Russell, R. S. "State of the Art in Educational Cost Modeling." Systems Research Group, Inc., Toronto, Canada, presented at: Atlantic City Joint Meeting ORSA, TIMS, & ATIE, Nov. 8, 1972.
27. Zemach, Rita. "A State-Space Model for Resource Allocation in Higher Education." IEEE Transactions on Systems Science and Cybernetics, Vol. SSC-4, pp. 108-118, Jul. 1968.