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Simulation Modelling in Institutional Research

One of the most interesting aspects of the application of systems science to university administration is the use of simulation models in institutional research. This paper treats the benefits, implementation and prognosis of computer-assisted university administration with particular emphasis on university planning and cost simulation models. The point of view taken is that of a university office of institutional research, since the function and use of simulation models parallels the role of institutional research in university decision-making and planning.

Among the responsibilities of an office of institutional research is assisting the decision-making process by providing information needed to solve resource allocation problems. In both short and long range planning, the problem is the same. What distribution of scarce resources will best ensure that the university meets its institutional goals and objectives? To provide this information, the office must be aware of the costs (past allocations) of campus programs, university academic and financial policies, enrolment trends and the likely influence of any suggested distribution of resources or changes in campus programs, policies or enrolment patterns. Given the complex nature of university organizational structures, with a variation in one subsystem inducing changes in many other components of the organization, the institutional researcher has always had to think like any applied systems scientist. His model was either intuitive, back-of-the-envelope variety or, more recently for some, computer models which simulate internal institutional dynamics to varying degrees of approximation.

benefits

Given the state of the art of modelling in universities and current institutional experience with analytical management tools, immediate benefits will result more from model design and experimental implementation than from operational model use in decision making and planning. The modelling process leads to a better understanding of the institution. It provides a structured method for instruction of management and support people in the value and use of analytical management tools. It tends to make institutional self-examination a routine process rather than an epochal event. Management games with models give decision makers insight into the complicated relationships between costs, resource requirements and academic programs. Universities experimenting with simulation models are more susceptible to collateral developments in long range planning; management information systems; planning, programming and budgeting systems; and the coordinated evolution of other campus operating and planning systems. These institutions are also likely to have more success in grappling with the problems of formal and substantive accountability. In short, modelling encourages the growth of logical management processes throughout the campus.

Improvement in completeness, accuracy and consistency of the institutional administrative data base usually accompanies experimentation with models. Since compatibility of data elements in institutional files supporting the model is essential, efforts to improve these files yield sources of information which can be integrated for many management purposes. Planning models supported by institutional files with compatible data elements are an important medium for improving communications and hence trust among all levels and groups interested in the planning process. These are essential to the eventual productive integration of analytical tools and techniques into the normal campus operating and planning processes. Models can also be useful in isolating some of the technical problems of generating normative, comparable and compatible inter-institutional data. For many analysts and decision makers, modelling experience is like a short course in the institution's recent history which enhances participants' ability to define campus management problems and formulate "what if" questions for further analysis.

There are other benefits in modelling. Politically, model use

may convince granting agencies and legislators that institutions are seriously grappling with resource allocation problems. Moreover, the potential of models as teaching aids should not be overlooked in the training and orientation of new management staff, including academic department heads and administrative assistants. The effort to develop the model and its integrated data base may pay off by providing an effective way of generating many of the ad hoc and routine reports required by university management as well as by external agencies.

implementation

Many implementation problems of university simulation models are not generically different from those associated with the implementation of other analytical management tools and techniques. These are well rehearsed in the literature¹ so we will concentrate on those aspects of implementation that more particularly relate to modelling.

A university can design, develop and implement its own simulation model. The major ones available had their genesis at a particular university.² Experience at The University of Calgary supports the conclusion that experimentation with simple computer models has the advantage that analysts and managers involved gained a good deal of insight into their own university and appreciation of the art of modelling. However, it becomes evident quickly, like our experience with early computers, that a simple model generates an appetite it cannot satisfy. The development and programming costs necessary to build models comparable to, say, CAMPUS³ or RRPM⁴ are hard to justify on most campuses, thus, we will consider the implementation of an "off-the-shelf" model.

Since the general model has been designed for use at many types of institutions and for a wide spectrum of management purposes, it will not meet all the needs of any particular institution.⁵ Implementation will be time consuming and expensive. Model program classification structure and data element definitions will not match exactly the university structure or administrative practice. Existing data banks will need extensive modification to adequately support the model. Thus, since any non-custom model will need modification to simulate each unique campus, anticipated implementation problems should be important criteria in choosing the model.

In considering available models, one should bear in mind the following. An analog of a complicated system must incorporate simplifying assumptions with respect to internal dynamics of the system if it is to be a cost effective model. The disaggregation of detailed institutional information required as model output influences input data specifications and the precision with which the model imitates the real institution. The person evaluating contending models must decide whether the effective trade-off in this dimension by model designers is appropriate for his circumstance. In general, long range planning models can be more aggregated than models used for short range budgeting, operating or decision-making. Disaggregated models are more expensive in virtually all respects, including the expense of developing and maintaining support systems.

The following checklist of questions may be helpful to those considering implementation of a simulation model.

- (1) What data must be generated to support the model?
What are the minimum specifications of these data?
- (2) What are the minimum computer hardware requirements?
Are there any special software requirements?
- (3) What other resource requirements in terms of dollars, people and specific talents must be met?
- (4) What specific, practical improvements in which aspects of short and long range planning can be expected?
- (5) What secondary or spin-off benefits should be anticipated?
- (6) How does the present university commitment to and experience with analytical management tools affect these expectations?
- (7) What units of the institution should be included in the implementation team?
- (8) When and how should members of the faculty be involved with model implementation?

pace, barriers and prognosis

The pace of introduction of models for university administration in Canada is slow. However, within the institutions there is a growing realization that modern management procedures must be adapted to the universities if we are to meet society's demands within current fiscal constraints. Also, demands for information on institutional stewardship of public money will tend to quicken the pace but there are a number of bar-

riers to fast, widespread implementation of university planning and cost models.

The major barrier is the nature of university management and planning. These are Sisyphean tasks which are inherently perplexing because of the lack of measurable institutional goals, objectives and outputs. A nearly equally troublesome barrier is the decentralized nature of post-secondary education in Canada, which makes difficult the co-ordinated, or even co-operative, development of expensive university management tools, techniques and systems. There are two further barriers which slow the pace: one is the conservative attitude of university faculty toward change, particularly change that could influence the complicated political procedures by which internal university policy and planning decisions are taken traditionally; the other is the inherent complexity of the models and the maintenance costs of these and of associated support systems.

Thus, the prognosis is an estimate of the relative strengths of pressures to introduce more analytical management into higher education and the formidable barriers to effective implementation. It seems likely that the next five years will see a sharp rise in the use of analytical management tools both within the universities and systems of universities in response to the need for a more creditable formal accounting. The substantive impact of these tools on improved quality of services provided by universities is much more difficult to predict because of the apparent intransigent nature of the problems of quantification in university management and planning.

notes

1. John Minter and Ben Lawrence (eds.), *Management Information Systems: Their Development and Use in the Administration of Higher Education*, Boulder, Colorado: Western Interstate Commission on Higher Education [WICHE], 1969. See also: Charles B. Johnson and William G. Katzenmeyer (eds.), *Management Information Systems in Higher Education: The State of the Art*, Durham, North Carolina: Duke University Press, 1969.
2. Resource Requirements Prediction Model (RRPM) was evolved by W. W. Gulko and J. S. Martin of the National Center for Higher Education Management Systems at WICHE from the Cost Simulation Model developed at Berkeley. See: G. B. Weathersby, "Development and Application of a University Cost Simulation Model," unpublished monograph, Berkeley: University of

- California, Office of Analytical Studies, June 1967. The CAMPUS models grew out of initial work done in the Office of Institutional Research at the University of Toronto. See: Richard W. Judy and Jack B. Levine, *A New Tool for Educational Administrators*, Toronto: University of Toronto Press, 1965.
3. See, for example: *CAMPUS VII: College and University Resource Planning Model — General Description*, Toronto: Systems Research Group, 1972.
 4. *Resource Requirements Prediction Model (RRPM-1): Guide for the Project Manager*, NCHEMS Technical Report 20, Boulder, Colorado: National Center for Higher Educational Management Systems at WICHE, 1971.
 5. A good comparison of the major analytical models is given in George B. Weathersby and Milton C. Weinstein, "A Structural Comparison of Analytical Models for University Planning," Ford Foundation Research Program in University Administration Paper P-12, Berkeley: University of California, 1970.