Large Scale Library Systems

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AT A TIME when libraries are adopting systems analysis as an integral part of their management structure, systems analysts are voicing grave concern about their ability to deliver the kinds of systems libraries need. This ambivalance is not due to any loss of confidence in the power and precision of their methods, nor in the general usefulness of these methods to improve library operations. It is more a concern with a basic dichotomy between mechanical technique and human behavior. Systems are for people, and the systems impulse is towards a totality of involvement which encompasses all factors, including the human ones. Yet, the formal determinism of systems analysis as it is practiced today usually precludes human values, and tends to build systems which replace, compete with, or use men.

In the jargon of Marshall McLuhan, systems analysis is a hot medium which needs human participation to complete the message. How to do this is the major concern of a new breed of systems analysts who refer to their work as "large scale systems." In the search for "libraries of the future," they see how earlier theorists precipitated considerable hostility in library circles by their seemingly ruthless mathematical chauvinism. Today, there is more willingness to concede the field to the nonquantifiable aspects of systems design, and more concern that the wholesale use of deterministic approaches will create technical monstrosities.

THE MISUSE OF NUMBERS IN DECISION-MAKING

Roy, in his book *The Administrative Process,* observes how numbers tend to dominate managerial decision-making. They push aside intangible factors which can not be quantified, and they assume an aura of accuracy that can not be justified. Ideally, Roy says, "decisions should be made by: (1) maximizing the available precise information; (2) ac-

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cording to the quantitative elements only that degree of confidence merited by the numbers; (3) giving due and proper weight to all the other intangible non-quantifiable factors."[1] What usually happens, he says, is that steps (2) and (3) are ignored or abused by: "(2) according to *all* of the numbers complete and total confidence; (3) allowing the numbers to set aside, negate, and dominate the intangible elements, even when these are of overriding importance."[1] Numbers used in this way obviously are detrimental to sound decision-making.

Roy is clear, however, in his advocacy of the use of numbers for making decisions. For him, "the more numbers there are and the more accurate they are the better."[1] His concern about the misuse of numbers is shared widely by analysts, managers, and laymen alike, who are preoccupied with the societal and environmental impact of technology. This is not because of any fundamental change in belief in the technical power or logical validity of systems science. Rather, it is because of this power that there is such concern about how it will be used.

Science has provided powerful methods for solving operational problems which can be formulated as analogs of real human situations. By a detailed enumeration of all quantifiable factors, computers can be programmed to simulate decision-making processes and behave in an adaptive manner. In this way the problems associated with small scale situations sometimes can be resolved with a degree of scientific certitude that is out of proportion to the assumptions and conditions which made the formulation and solution possible in the first place. As this approach is extended to encompass situations of much larger scale and complexity, the analytic techniques begin to falter and the role of subjective judgment becomes more obvious in dealing with real man/technology situations.

In real man/technology situations, man must always be the dominant element. In the long run, man's capacity for learning and growth gives him the edge, while any given technological formulation becomes obsolete and eventually fails. In the short run, however, technology may dominate man and force him into self-destructive behavioral patterns. The ability to design man/technology systems that allow both man and technology to operate at their fullest potential is no mean feat. Obviously, to the extent that design concentrates on technical development only and on ways to coerce men into compliance with such developments, there is little chance of success. Today, more attention is being given to the study of the technical problems of human systems than to the human problems of technology. This is the large scale systems approach.

MATHEMATICAL LITERACY IN LIBRARIES

As libraries make more use of mathematical models and computers in their normal operations, they must necessarily change the level of knowledge about these techniques that is expected of the professional members of the organization. This is not to say that every librarian will eventually need extensive formal training in mathematics and computer science. It does mean that every librarian affected by the new methods needs to be made aware of the extent and source of this influence on his work. It is not possible to keep such knowledge confined to a small group of staff analysts.

All persons whose authority and responsibilities could be enhanced or compromised by the development of new systems within the organization must be given access to the planning processes governing these developments. This will necessitate an increase in their conversational literacy about numerical methods. Experience at Purdue University has shown that it is not difficult to achieve such awareness in a library staff if they are given a meaningful and regular opportunity to develop and practice such skills.

In the Purdue experiment, the staff met weekly with administrators and analysts in a series of presentations and critiques of systems analysis and operations research studies of library problems. Within a relatively short time, there was little difficulty in achieving meaningful open dialogue about fairly sophisticated systems concepts. The depth to which any one technique could be explored varied considerably, to be sure; but the significance of these techniques in a particular application could be freely explored at great length to the edification of all participants.

Because the top administrators of the organization attended these meetings regularly, there was little question about the importance of these discussions. It provided an opportunity for all persons to discuss common problems in a free and professional manner. The often oblique and sometimes naive arguments of the analysts had the beneficial effect of making room for other points of view. That this did not always lead to a convergence of arguments was more a measure of the complexity of the problems than the intransigence of their positions.

Mathematical and computer methods did not become a major stumbling block in these deliberations. In fact, there was little concern with limiting the range of sophisticated techniques that might be discussed. Always these were introduced from an applied or ad hoc viewpoint. Criticism was focused on the insights gained from the technique about the library problems under study, and not on the technique itself. The presence of other analysts and the side discussions among them gave sufficient attention to purely technical questions.

While this approach to systems analysis is not easy to start and maintain, there is good reason to believe it is absolutely essential to extensive system development in a library organization. Historically, it is a logical extension of the team concept in early operations research and systems analysis studies. This approach was justified initially by the need for interdisciplinary approaches and for the close involvement of analytic and operational viewpoints in developing promising alternatives to urgent problems. With the development of very large projects with clear technical missions—such as exploration of the moon—hierarchical staffs of systems specialists could be justified. Highly technical organizations can make good use of systems specialists in a selective, consultive manner; but, as systems methods are applied to situations with a high "human content," participative planning must be deliberately cultivated as a crucial element in systems development for the long run.

PARTICIPATIVE PLANNING IN SYSTEMS STUDIES

Ackoff points out that the benefits of systems planning are not derived by "following a plan" but by engaging directly in the planning process itself as an ongoing activity. "Effective planning cannot be done to or for an organization; it must be done by it," Ackoff says. "Therefore, the role of the professional planner is not to plan, but to provide everyone who can be affected by planning with an opportunity to participate in it, and to provide those engaged in it with information, instructions, questions, and answers that enable them to plan better than professional planners can alone."[2]

Because of the complexity in maintaining an effective planning activity, mathematical models and computer methods must be used extensively as a way of collecting, processing, storing, and retrieving the information needed for planning. These techniques can be helpful in the organization of the planning process itself which must be continuously updated, coordinated, interactive, integrated, and experimental. Computer-based information processing is the only feasible approach to the development of truly adaptive general purpose organizations of large size. As Bernal pointed out some years ago, effective communication takes the place of administration in organizations where persons act with a great deal of professional freedom and integrity.[3]

As an academic and theoretical question, the applicability of mathematical models to library operations is still highly debatable; i.e., there is a very limited body of organized scientific opinion to support the argument that certain library activities follow mathematical "laws." The number of people who are able to devote much of their time to such discoveries are very few, and probably will remain so as support for pure research dwindles. Basic research of this kind should be encouraged within the library profession, but it is not necessary for libraries to await such developments before engaging in serious systems development.

In the practical work of systems design, the goal is to find *better* methods for delivering library services—not finding *the one best method.* Optimization to the systems scientist has a very precise mathematical meaning, while to the systems practitioner it represents a general direction to aim for. It is more like a point of view. The validity of systems models in practical work is the degree of belief they muster in persons of authority, and not something to be demonstrated in a refereed journal. This is not to say that theory and practice are to be kept in airtight compartments, but that there should be recognition of the important difference in their viewpoint.

Operations research models used to process operational information for organizational purposes takes on a status similar to that of an accounting system in a business. Anyone familiar with accounting systems knows how inexact they are. In fact, accountancy is more a study of proper interpretations and the resolution of system conflicts than it is the precise mechanics of bookkeeping. The value of such information processing systems rests in their ability to give some limited sense of order to a highly complex situation by engaging the conditional belief of the persons involved.

SMALL AND LARGE SCALE SYSTEMS

Libraries make use of a considerable amount of financial resources. There is good reason to expect libraries to make as good an accounting of their use of these funds as is demanded of other institutions in society, and there is reason to believe this is not being done.[4] Mathematical modeling and information systems development in this area of application can be of considerable merit. Libraries also use valuable physical facilities and engage in extensive material handling operations. Such operations lend themselves naturally to technical treatment. The problems associated with physical systems can be readily formulated in a mathematical manner and solved in a systematic way. Information processing for clerical purposes is another aspect of library operations that can be readily systematized, providing that the time and energy is made available. A considerable amount of the human work done in libraries, including that of professionals, can be measured and organized in a systematic way. Opportunities such as these for starting library systems studies are of considerable practical value and do not present great technical bottlenecks calling for basic research. The amount of mathematical sophistication one could employ in such work is virtually unlimited, but whether it is worth it or not is questionable.

The kinds of applications referred to above properly can be called "small scale systems analysis." They are small because the work can be easily confined to limited areas of study, using well-tested methods, measuring a limited number of variables, employing self-evident measures of effectiveness, and causing little radical change to existing organizational structures. Studies which do not have these properties fall into a category called "large scale systems," for want of a better term. Here, too, mathematical sophistication is not the necessary ingredient, although it will not hurt to have some present. There is a class of mathematical programming problems called "large scale" and there is some overlap in significance. However, what is meant by the term in the more general sense derives from the orientation towards the structuring of human behavior in complex societal situations.

Libraries qualify as large scale systems on three major counts: scale, continuity, and complexity. Because of the impossibility of isolating any single modern library from the national and international environment in which it functions, the scale of any major innovation in library procedures is immediately very large. For example, the study of purchasing, classification, or reference operations quickly brings the analyst into confrontation with system constraints well beyond his control. The whole economic viability of the library system depends on such interactions among libraries.

Continuity is a fundamental condition of life in a library. Any significant tampering with storage and retrieval systems leads to problems of continuity with previous methods locally and elsewhere. Provision for future activities is an essential consideration in library systems development. Services are designed to accommodate all possible future contingencies of library use to the extent possible.

LIBRARY COMPLEXITY

Complexity is natural to the library environment because of its primary mission to meet basic human intellectual needs. What could be more complex? Licklider calls the library a "procognitive system."[5] Wilson points out that such systems are theoretically impossible to automate totally since they are concerned with all possible human uses of information.[6] Because of the essentially political nature of the human need for information, Wilson believes the problems of library systems design necessarily transcend technical and economic considerations.

Churchman argues along lines similar to those of Wilson when he puts down the presumption that library effectiveness could ever be measured in quantitative ways.[7] He says the true benefit of such systems must be in terms of the meaning of information for the system users in a moral and aesthetic sense. To the small scale systems analyst such arguments create a paralyzing dilemma as he seeks some kind of formal validation for his models. Churchman's purpose here is not to dissuade libraries from engaging in systems analysis. On the contrary, he encourages it, but insists on recognition of the severe handicap under which it must be pursued.

The recognition of libraries as large scale systems helps to clarify the role of systems analysis in such organizations. First, by recognizing the limitations of conventional systems studies from the outset, it is possible to be much more deliberate and efficient in such work. The level of technical sophistication can be kept more in line with the requirements of the study and the capabilities of the organization. The inherent hostility generated by such studies within an organization can be ameliorated by establishing firmer expectations and clearer limitations on the jurisdiction of such studies.

The second major benefit to be derived from the distinction between large and small scale systems is the understanding that large scale systems are "people systems." System development of this kind depends on the capacity of people to negotiate mutually beneficial agreements so as to engage in and to sustain creative and innovative efforts that affect everyone. System development becomes synonymous with human development as a continuous, interactive process of coordinated adaptation to a changing environment. While the full scientific validation of such developments will be a long time in coming, the principles for engaging in such an enterprise are not that difficult to come by. See for example, Maslow's description of the "slow revolution."[8]

Technique has an important place in large scale systems, but it is not to create the machine to end human work or the push-button for an easy future. Ackoff notes that: "We waste too much time trying to forecast the future. The future depends more on what we do between now and then than it does on what has happened up to now. The thing to do with the future is not to forecast it, but to create it."[2]

MODELING IN LARGE SCALE SYSTEMS

Mathematical models are needed in both large and small scale systems work to process factual information in an efficient manner. The formal, scientific rules remain the same for verifying the internal accuracy of such models and for manipulating them to show the kinds of relationships and properties they infer. What is most different about models in the large scale systems context is the emphasis on the limitations of models as "canned" substitutes for human activities, and on the value of the modeling process as a creative human activity.

Solberg, in a recent paper, offers the following principles for large scale systems modeling:

1. *A model should not be taken too literally.*
   The more elaborate and sophisticated a model is the less easy it is to be objective in evaluating its usefulness relative to its original intended purpose.
2. *Do not oversell any particular model.*
   "When a model is sold as a 'package of truth' rather than a 'package of plausible assumptions that lead to useful conclusions,' and it later turns out that the implied real world actions were somehow in error, we may suffer a backlash out of proportion to the error made."
3. *The deduction phase of modeling should be rigorous.*
   "If model deduction has not been carried out rigorously, we cannot distinguish between external errors in formulation and internal errors in logic."
4. *A model should not be pressed beyond the limits of its capability.*
   An example is the use of forecasting models to predict future events from irrelevant data.
5. *A model should not be criticized for failing to do what it was never intended to do.*
   "This principle is really a corollary to the preceding one. It is worth

starting separately because it is easy to attribute to someone else, one's own motives."

6. *Models should be validated.*
   Validation can be carried too far. One may reach a point where an enormous effort is required to increase one's confidence about the model just a little bit. Depending upon how important the model is, one may be wiser to tolerate a lower confidence level.
7. *Do not build a complicated model when a simple one will do.*
   (Occam's Razor revisited.) It is common practice in mathematical modeling to begin by introducing as many assumptions as are needed to make the mathematics tractable, and then begin to "enrich" the model by weakening the assumptions until the mathematics is no longer tractable. Such a procedure will produce the "strongest" model, but such strength has little to do with its usefulness. "This principle of building the strongest model one can is," in Solberg's opinion, "a useful principle in the training of model building, as a kind of academic exercise to keep that mental muscle strong," but he does not believe it should be a guiding principle in the actual practice of model construction. "To put the same point in the form of an analogy, lifting barbells may be a good thing to do insofar as it increases one's capacity to do useful work, but it is not in itself useful work and should not be thought of as such either by participants or observers."
8. *The medium of expression for a model should be selected according to its intended purpose.*
   Models should not be shaped to preselected solution techniques. Rather the problem should shape the model and the techniques.
9. *Some of the primary benefits of modeling are associated with the process of developing the model.*
   "Generally speaking, a model is never as useful to anyone else as it is to those who develop it. The model itself cannot contain the full knowledge and understanding of the real system that the builder must acquire in order to successfully model it, and there is no practical way to communicate this knowledge and understanding adequately."[9]

Solberg's principles focus on the shortcomings of mathematical models as a medium of communication in the design and development of large scale operational systems. Among analysts the model is the message. It is the accepted form for conveying information about new developments in the field. But, more than that, it is a form of creative expression of a particular kind and has its own rules of acceptance and qualities of elegance. Such forms of expression require some training on the part of those who would appreciate them.

SYSTEMS DEVELOPMENT IN THE FUTURE

The role of aesthetics in system modeling can be more easily seen in the use of computer programs. Programs are a more prosaic form of communication. Since they are written for robots, they are pure action statements that either work or fail. However, there is much opportunity for exhibiting human skills in the efficiency with which programs fulfill their appointed tasks. The user of computer outputs may have little appreciation for the elegance of the program used. Even if the patron is paying the bill for computer time, he has good reason to examine the trade-off in programming cost versus operating costs. Tests often fail to justify elegant programming. This kind of skill is important when it is necessary to make a computer operate at its maximum capability.

In a similar vein, as one attempts to model systems with attributes that seriously challenge the relevance of mathematical arguments, the ingenuity of the modeler becomes the crucial element. Linvill, in describing the changes in modeling required by large scale systems, notes that it is unlikely that the analyst can continue to rely on detailed quantitative analysis. "The future success of the system modeler," he says, "is probably more concerned with his ability to translate the concepts of modeling to the nonphysical situations which are becoming increasingly important in large scale systems analysis than with his ability simply to manipulate purely quantitative models."[10]

Linvill identifies four types of models that are of greatest importance in societal systems: (1) large scale mathematical programs for handling a large number of interacting variables in a simultaneous manner, (2) dynamic models which focus on system stability, rates of change and acceleration factors, (3) stochastic models which allow for uncertainties and risk taking in decision processes, and (4) logical models which can be used to structure multiple and hierarchical objectives and to lay out scheduling patterns.

The key idea in Linvill's paper is that "the center of gravity of activity in systems analysis has moved from mechanistic systems to humanistic systems; and, accordingly, there is an increasingly strong demand for including behavioral and social sciences as a background for the analytical modeling work, as well as the technological and quantitative concepts that have been applied up to now."[11]

Linvill also stated:

> Humanistic systems are living organisms and must be treated in a way fundamentally different from mechanistic systems. The system analyst must deal with human beings. He must develop agreements instead of controls, he must discover objectives rather than to set them, he must discover constraints and utilize freedom to an unusual degree. There must be a vital interactive humanity involved in humanistic system design. To be most useful these attributes must be added while the familiar characteristics of the mechanistic system analyst are not lost.[11]

These developments in the field of large scale systems are most important for libraries and information systems. Just as large libraries were important arenas for the development of operations research concepts at several universities during the 1950s and 1960s, there is now an opportunity for them to join in the perfection of these new approaches to societal problems. Because of their rich humanistic content and their commitment to intellectual service, libraries should stand to gain even more from these new developments than they have from past involvement in systems analysis efforts.

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