Systems Analysis

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THERE SEEMS to be little doubt in anyone's mind that libraries are in trouble and have been for quite some time.[1] Opinion as to how critical the problem is varies. There are those who feel that it is a matter of survival,[2] while others maintain that it is simply a period of adjustment.[3] Greater diversity of opinion exists as to the primary cause or causes. In addition, a shift has occurred in the nature of the causes cited. During the 1960s, for example, the most frequently cited causes were:

1. The changing structure of knowledge and the rapid development of interdisciplinary fields of study;
2. The information explosion and the phenomenal growth in the amount and kind of material published; and
3. The proliferation of new libraries and the increase in size and complexity of older libraries.[4]

The 1970s, although still relatively young, have introduced a new set of causes, including:

1. Library management or, more precisely, the lack of librarians with basic management training;
2. The economic recession which has forced libraries to become conscious of such concepts as cost effectiveness and tight budgets;
3. The need to make libraries more immediately responsive to the changing needs of their users; and
4. The application of newly developing technologies such as computers, telecommunications, etc., to library procedures.[5]

All of the factors mentioned contribute to the problem; none, however, is the basic or primary cause. At best each is a symptom, and solutions that address themselves to symptoms, such as simply increasing library budgets to buy more books and hire more librarians, or using comput-

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ers to do what has been done in the past faster and more accurately, do not solve the problem.

The basic problem confronting libraries is the impact of rapidly accelerating change on an institution which has traditionally been slow moving and conservative. This problem is not unique to libraries; every sector of society has been affected. Any solution, therefore, must first attempt to understand the nature of change and then to develop a methodology to control and direct change.[6]

Systems analysis is a management tool that has proved valuable in analyzing complex organizations and has been used successfully in business, industry, government, and defense in identifying and solving problems resulting from organizations in conflict with an environment dominated by change and the uncertainty that inevitably accompanies change.[7] The use of systems analysis in libraries to date has been limited. Increasingly, however, as can be seen by the professional literature,[8] libraries are becoming aware of the potential usefulness of systems analysis to analyze and help solve their problems.[9]

Systems analysis is not a solution in itself. At best, it is a methodology, technique, or tool that has promise. If properly used, it can help librarians to identify the essential or real problems confronting libraries, to analyze pertinent factors, to develop alternative courses of action for consideration, and, finally, to implement more efficient systems.

WHAT IS SYSTEMS ANALYSIS?

A concise, generally accepted definition of systems analysis does not exist. Systems analysis is still emerging as a discipline. Aside from agreeing that systems analysis is related to management science and has borrowed heavily from several of its branches, there is little agreement among practitioners of systems analysis as to what it includes, where its boundaries should be drawn, or how it will develop. Perhaps the best way of understanding what systems analysis is, is to distinguish it from the closely related branches of management science from which it has developed. (See Additional References.)

Early in the twentieth century, the discipline of scientific management was developed. The primary purpose of scientific management was to determine faster and better methods of production. Little consideration was given, however, to the effect that these techniques had on workers or the effect that a specific operation might have on related operations, or the system as a whole. These limitations have proved

critical. During the past fifty years scientific management has spawned a number of related disciplines such as work measurement, methods research and work simplication, each of which suffers to some degree from the same limitations as management science—the emphasis on quantitative observation, and analysis of relatively isolated operations. Systems analysis employs many of the same techniques, such as time and motion studies, forms analysis and procedure charting, but uses the results for entirely different purposes and thereby avoids the inherent limitations of scientific management. Systems analysis is concerned with systematically analyzing a total system in context and in identifying and describing the interrelatedness of all the component parts or operations of the overall system. It attempts to measure not the effectiveness of a single operation or a narrowly focused set of operations, but the effectiveness of the system as a whole relative to the stated objectives and restraints of the parent organization.[10]

Another major and more recent field of study is operations research. For practical purposes, some maintain that operations research and systems analysis are synonymous, but differences do exist and are increasingly significant. Operations research is an art or technique which uses the scientific method to analyze operational problems, and then to develop abstract models to predict how a system or set of operations is affected by changed or changing circumstances. Operations research relies heavily on the use of advanced mathematical techniques and computer simulation. Its purpose is to provide management with a quantitative basis for making decisions. Operations research does not, however, attempt to implement decisions by developing new systems. Its purpose is primarily to analyze, forecast, and recommend alternatives to management. By contrast, one of the basic objectives of systems analysis is the design, implementation, and evaluation of new and more efficient systems.[10]

Systems analysis is not simply a collection of these older techniques, but rather is a discipline which is presently attempting to synthesize previous theories and branches of management science into a new discipline. The precise scope that this new discipline will take is still ambiguous. To the more enthusiastic, the direction is clearly towards subsuming all of management science within systems analysis; to the more conservative, the direction is towards defining systems analysis in terms of an attitude or approach appropriate for management to assume, enhanced by a corpus or repertoire of clearly defined and controlled analytical techniques.

ELEMENTS OF SYSTEMS ANALYSIS

Systems analysis represents a way of looking at and analyzing complex organizations and describing them in essentially quantitative terms.[11] Its first objective is to encompass the total system of operations, from management's stated objectives and the resources available (i.e., personnel, material, etc.) to achieve objectives, to the needs of users of the system and the environment in which the system exists. Once a systematic, quantitative picture of the total system has been achieved, systems analysis turns its attention to relating (but not evaluating) objectives and results. It does this initially in primarily quantitative terms (e.g., the unit cost of cataloging a book, the time lapse between placing an order and receiving a book) and then consults with management to determine system effectiveness and efficiency. The evaluative aspect of this effort is a shared responsibility of the technically-oriented systems analyst and management, and produces a qualitative evaluation of the system being considered.

If the system is judged inefficient and problems are identified (as is usually the case), management then may authorize the systems analyst to continue and to develop alternatives that might be more efficient. This is undertaken, however, only with the expressed instruction of management. The systems analyst designs alternative procedures which meet the requirements of the system and presents them to management for consideration. Management should then evaluate the alternatives and make a decision. If the decision is to accept one of the proposed alternatives, the systems analyst is instructed to design, test, and implement the new or revised system.

The role of the systems analyst is to work with management, not to replace or usurp management. It is critical during a systems study to be aware of the appropriate roles of management and systems personnel, and to distinguish between them. It is essential for management to embody a systems attitude or approach, but it is even more important for management to preserve intact its responsibility to control and decide. In contrast, the role of the systems analyst is to provide technical expertise and support. The failure to distinguish the roles of management and systems personnel can result in severe operational problems.[12]

USES OF SYSTEMS ANALYSIS

The uses to which systems analysis and the systems approach can be put in libraries are many and have yet to be fully identified or realized.

Following are several examples of how systems analysis can be of use to librarians. (See Additional References for literature dealing with application.)

Library Objectives—Librarians have often been accused of fuzzy, undisciplined thinking. The accusation, unfortunately, is too often true. The quantitative techniques used, the rigorous attention to detail, and the critical examination of facts, characteristic of systems analysis, encourage and enforce systematic, disciplined thinking about operations and organization. Such a critical, analytical attitude is fundamental to modern management and is an essential first step in understanding complex problems. For example, the objectives of an organization should be the starting point in the identification of problems and the evaluation of an organization. Objectives should be clearly stated and reflect a realistic attitude on the part of management. Too often library objectives are ambiguous, out of date, or unrealistic. Ask a librarian what he or she considers to be the objectives of the library and, too often, the reply is couched in platitudinous terms such as "providing service." Service to whom? Service of what sort? User requirements for libraries have changed radically during the past twenty years, and the importance of information in our society has increased enormously. Yet, library objectives, resources, and techniques have changed little.

Unless objectives are stated explicitly, it is impossible to develop measures of performance. Unless effective performance can be demonstrated, it is difficult to justify continued levels of financial support and impossible to argue for increased support to provide new or additional services. The ability to demonstrate effective performance assumes critical importance in a period of economic recession. Increasingly libraries are being forced to enter an unfamiliar area where funds are limited and competition for these funds is sharp.

Library Management—Undisciplined thinking is also reflected in many library operations. It is not uncommon to find that operations in libraries have no reason for continuing. They exist because no one has questioned or evaluated them. Continual evaluation and modification of procedures is required to reflect current, changing needs. This requires a querying, analytical attitude on the part of librarians at all levels. Similar problems exist in the areas of planning, control, and decision-making. As organizations grow, the number and kinds of decisions that must be made proliferate and the consequences of these decisions become more critical. For example, a seemingly simple decision about

what information to include on an acquisitions order form can have profound effect on cataloging operations. Unless a librarian can analyze the nature of a decision and have facts available in a form that he can understand and use, he is forced to rely on personal experience and intuition which is often insufficient to meet the needs of modern organizations. Decisions based on fact and proper analysis, coupled with intuition and experience, are inevitably more consistent, realistic, and reliable.

Modern Technology—The ability to analyze and understand problems is critical and important, but the solution to many current library problems is beyond the capability of simple manual techniques. The increasing requirements of volume of material and the growing diversity of operations in libraries require that libraries, if they hope to survive and continue to grow, must begin to adapt and use the new technologies that are available. The successful implementation and use of a new technology is complex and costly. The use of computers in libraries is a good case in point. Although libraries have been experimenting with the use of computers for more than fifteen years, the proper role of the computer in libraries is still not adequately understood or defined.

Library automation has demonstrated that libraries will need a great deal of special technical assistance in designing and planning systems using new technologies. This assistance can be provided in part by using trained technicians and specialists from other disciplines. Controlling and coordinating these nonlibrary specialists is difficult, but highly essential, because the system that will be developed will ultimately have to be taken over and operated by librarians. The need, therefore, for librarians to gain experience and some level of expertise in systems analysis to guide the design and development of automated systems and then to operate them is becoming increasingly critical.

In summary, the key to any approach for improving library systems is the acknowledgement that systems exist to attain objectives. Systems exist in a changing environment and must be responsive to the realities of that environment. Systems analysis is a methodology especially designed to facilitate the continuing adjustment of a system to its environment. It does this directly by providing techniques which help to define realistic objectives and evaluate operations; indirectly, it develops a systems attitude or approach in its practitioners which is the essential base of good management.

LIMITATIONS OF SYSTEMS ANALYSIS

Systems analysis has a great potential use in libraries. One should not, however, overlook its limitations. Following are several examples of the limitations of systems analysis. (See the Additional References for sources which discuss these limitations.)

Qualitative Factors—Systems analysis at present is an art based on rather gross, primarily quantitative techniques. Applying quantitative techniques to institutions which produce tangible products and profits is one thing; attempting to apply the same techniques to a service organization, such as a library, is quite different. Precise measures of public service activities are difficult, perhaps impossible, to develop. Until (or unless) these quantitative techniques are refined to a point where they can take into account subtle, qualitative factors, such as user satisfaction, quality of cataloging, and effectiveness of selection policies, the main use of systems analysis in libraries will be limited to areas of processing activities, such as ordering and receipt of materials, and physical aspects of cataloging.

Management—Systems analysis purports to be a rational, totally objective approach to the analysis of operations and problem solving. It is not. The systems analyst uses his judgment and intuition in deciding which facts to gather, how to interpret them, and what alternatives should be developed for consideration. Management must be aware of this and be prepared to deal with the problems that may result. Systems analysis does not make management's decision-making process easier; if anything, it makes the process more difficult. Systems analysis attempts to provide management with data to assist management in making better and more consistent decisions. It does not (or at least should not) assume management's prerogative for making decisions. Too often by default, the systems analyst is forced to fill a vacuum created by management's inability or unwillingness to make decisions. The proper role for the systems analyst is to advise and recommend, not to command and make management decisions.

Change—Ironically, systems analysis itself is affected adversely by change, the very force for which it was developed. A detailed, formal systems study will usually accumulate a great deal of data which often requires considerable time to assemble and analyze. The result of a systems effort is analogous to a snapshot which reflects or represents real-

ity at a point in time. Observations that are valid or correct at one point in time may be totally incorrect at a later date.

Cost—A full-scale, formal systems study is costly, often disruptive, and time-consuming. Unless there is sufficient promise that an effort will result in savings that are commensurate with the effort, a formal systems effort should probably not be undertaken. Unfortunately, it is difficult to know this in advance. The only factors that seem to be helpful in deciding whether to undertake a full systems study are scale and cost of operations. The larger and more costly an operation, the more likely that a systems study will prove beneficial. This should not be interpreted to mean that smaller operations cannot benefit from systems analysis. A staff experienced in the systems approach to operations and problems can do a great deal to increase the efficiency of their system.

WHAT IS DONE IN A SYSTEMS EFFORT

A full-scale, formal systems study will involve a variety of personnel, the number and type of which changes as the effort progresses. The actual work in a systems effort is normally done by a group of five or six technical specialists organized as a project team, headed by a project leader directly responsible to top-level management. Members of the project team are selected on the basis of anticipated needs of the project. If the object of the project is to explore the feasibility of using computers in cataloging, for example, the team would be made up of cataloging librarians, analysts, and computer programmers.

There are approximately six phases or steps in a systems study which can be distinguished, and in theory should be done in sequence; in fact, the process is iterative and overlapping. Usually, a specific problem or area of investigation is defined and becomes the focus of the project effort. However, the objective of an effort might be phrased in terms of the overall analysis of an organization to identify problem areas, each of which in turn would become the focus of a separate effort to be worked on in sequence or simultaneously, depending on priority and the number of personnel available.

The following section contains a brief description of the kinds of work done and the types of decisions necessary in each step of a systems study.

Preliminary Study—A formal systems effort begins with a decision by top management that a study is needed, followed by the selection and authorization of a person (or persons) to undertake the effort. Ideally,

the personnel selected should have experience with systems analysis techniques and some familiarity with the organization.

A primary purpose of the preliminary study is to get a broad overview of the entire organization, and this can be done in a variety of ways. One approach is to determine the objectives of the organization as phrased by top management, as interpreted and implemented by supervisors, and as understood by line personnel. This can be done by interviewing selected personnel at various levels and reviewing available documentation (e.g., annual reports, procedures manuals, etc.). Usually, revealing differences are uncovered between the objectives of top management and their actual implementation by line personnel.

The result of this overview should be a written report prepared by the analyst for top management which attempts to compare (or relate) management's objectives and systems performance, to identify major problem areas, and to formulate recommendations and priorities as to what should be done. Management then evaluates the report and decides on a course of action. If the decision is to go ahead, the analyst proceeds to define, plan, and estimate the requirements of the project effort for review and evaluation by management. Again, management must decide whether to accept, modify, or reject the analyst's project plan. If the decision is to proceed, management formally authorizes the project and approves the needed resources (i.e., money, personnel, space, etc.) to accomplish the project. The analyst is now ready to assemble a project team and initiate work.

The Descriptive Phase—The purpose of the descriptive phase is to gather data describing and measuring all aspects of current operations. There are a variety of techniques available to do this. Among the simpler and more effective are inventory and analysis of files, forms, and procedures, and flow charting of materials, data, and work flows. The descriptive phase is usually long and tedious, and produces a mass of raw data to be analyzed and used in later phases.

The Analysis Phase—The purpose of the analysis phase is to analyze the raw data that has been gathered, to assemble and display it in a useful form, and to begin to identify and compare alternate ways of accomplishing the same results. The techniques available to analyze raw, descriptive data are many and include, for example, sampling, linear programming and simulation. One of the more useful and easier to understand is modeling. A model is an abstract or symbolic representation of an operation or group of related operations. Models can be extremely sophisticated and use advanced mathematical theories and

computer simulation techniques, or they can be simple block diagrams which can be manipulated and evaluated manually. The purpose of a model is to predict how a set of procedures, real or proposed, works under varying conditions. Models are useful in evaluating a single system, predicting critical problem areas, and in comparing alternative systems designs.

Design and Development Phase—There are two purposes of this phase of work. The first is to prepare a detailed systems proposal, including work schedules, development and operating costs, equipment requirements, etc., of one or more alternate systems. The second is to develop, test, and document all aspects of a working system for implementation.

As a result of the analytical phase, the project team will recommend that the existing system be modified or, possibly, that a totally new system be designed. In either case, the team prepares a proposal documentating all aspects of the effort. If more than one solution or design is proposed, the same level of detailed documentation is required for each proposed alternative.

Management at this point reviews the project proposal and decides either to accept one of the proposed alternatives or to reject them all. If an alternative meets management's requirements and is selected, the project can then proceed with the development of a full-scale, working version of the proposed system. This will include writing and testing computer programs (if required), preparing detailed procedure documentation, ordering equipment, preparing position descriptions, etc. In addition to developing the new system, plans for phasing out the old system should also be developed. In certain situations, this can be almost as complex, time-consuming, and costly as the total effort expended to design a totally new system.

The Implementation Phase—Eventually, the new system will be ready to be implemented, or "turned on." Implementation planning is subtle, complex, and critical. Even an ideal system will falter and possibly fail if implemented improperly. The key to successful implementation is the creation of a hospitable environment. Unfortunately, there is no simple, infallible way of knowing if and when such an environment has been achieved. One of the more critical factors is staff attitude and acceptance. All staff should be trained, involved, and positively disposed to accepting and using the new system. This is done in part by conducting briefing and training sessions, which should be continued until

everyone understands not only how the new system works but what his particular responsibility or role in the new system is.

In addition, demonstrations of the new system should be undertaken. This is especially important if computer routines are being introduced. Systems demonstration is important in building confidence in new procedures and can take the form of a full-scale, parallel operation that may have to be continued for an extended period of time. Parallel operations are costly and cumbersome, but are necessary until everyone involved feels confident and familiar with the new system.

Other problems to be considered during the implementation phase include file conversion, if necessary, systematic phase-out of old procedures, site preparation, follow-up on training, updating of documentation, etc.

Evaluation and Feedback—A systems effort does not stop once implementation has been accomplished, regardless of how successful. Once implemented, a system must be monitored, evaluated, and modified. This is a continuing effort, especially if the new system is complex and uses computer processing to any degree.

Normally, the project team will initiate and carry out an overall evaluation of the new system, comparing performance with objectives. Depending on the complexity of the new system, extensive or minor modification of the new system may be made. Once completed, the full project team is no longer needed and can be disbanded. Responsibility for operating the new system now falls mainly on the operating staff.

In some instances, regular staff must be augmented by one or more technical systems persons. Computer-based systems, for example, may require that one or more programmers be employed on a continuing basis to modify applications programs to accommodate subsequent releases of computer-operating systems, to repair systems "bugs" and problems, etc. In less complex systems, the responsibility for systems evaluation and maintenance can take the form of a critical systems attitude on the part of the operating staff itself.

As can be inferred from the brief review of the various phases of a formal systems study, systems work is complex, dynamic, costly, and time-consuming, and results can never be guaranteed. (For more literature on this subject see the Additional References.) To date, most large scale systems studies in libraries have been done to develop and implement automated procedures.[13] This does not mean, however, that systems analysis can only be used to design and develop automated

systems. Systems analysis can and should be used in any situation where there is a need to measure performance and a reasonable possibility of being able to develop more efficient routines. Increasingly, systems analysis is being used by librarians in other areas of library activity, such as budgeting and management.

Systems analysis has already proved useful in libraries, first by fostering a critical, systems approach to operations and problems and, secondly, by providing libraries with new techniques useful in analyzing, evaluating, and understanding library operations. The future for systems analysis in libraries is promising, but will not be realized without effort on the part of librarians. Since systems analysis is an emerging discipline developed primarily for use in nonservice environments, the techniques currently available will have to be evaluated and adapted before they can be applied indiscriminately to libraries. This will take time and considerable effort.[14]

Perhaps the most useful contribution that systems analysis will make to libraries in the immediate future will be in the areas of management, organization, and adaptation to change. There is a potential danger, however, that librarians should be aware of. Systems analysis is a methodology which is very much involved with the management process. Its proper role should be that of assisting management to understand operations and to make decisions. It is a tool or extension of management and, therefore, must be controlled by management and not allowed to control or replace management.[15]

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