
Systems Analysis as a Prelude to Library Automation

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OPINIONS on the scope of systems analysis vary from the very narrow one of covering only the present system through a much wider definition which includes design of a new system through the monitoring of its implementation. As a prelude to library automation it seems appropriate that systems analysis be considered as potentially including the design of a new system—if indeed the investigation and evaluation of the old system result in a recommendation to do so.

Chapman and St. Pierre defined system analysis as “the systematic and logical analysis of a problem and the design of a system to correct any of the inefficiencies or errors which exist in the current operations.”¹ They divided systems analysis into five steps: understanding current procedures, delineating requirements, determining the system’s inputs, evaluation of procedures currently used with respect to their fulfilling requirements, and finally, either design of a new system, proposal of modification of the existing system, or recommendation to accept the current system if it was evaluated as successfully meeting requirements.²

Systems analysis per se does not depend on the use of a computer. Robinson contended that only systems design, not systems analysis, can be discussed with a particular field in mind.³ However, as Becker pointed out in an early paper, if a library undergoing systems analysis has access to computers, the analyst will routinely consider their application.⁴ Adelson explained the interrelationship of the systems approach and the computer as stemming from the fact that usually the systems approach is applied to large problems and these are tied to

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computers because of the large amounts of information which are gathered, organized, and utilized.⁵

The scope of this article is restricted to applications of systems analysis to technical processing functions in libraries. George Hodowanec, in teaching technical processes at Drexel University, includes within the scope of technical processes those procedures within the circulation department such as charging systems, activities of the acquisition department and the serials department, the operations of the cataloging department and additional functions such as binding, mending, and repairing tasks.⁶ Technical processing, therefore, can be thought of as including traditional housekeeping activities and would include, circulation, reserves, ordering, processing, production of catalog cards, periodicals, serials, and binding. Such functions are good candidates for library automation. As Veaner points out the technical processes lend themselves to automation because they either involve repetitive tasks or are jobs which are deterministic and highly structured, with decisions, if any, that are repetitive and of a low order.⁷

In reviewing the literature relating to systems analysis preceding automation of technical processes as defined above, publications appear to be divided into two large segments: (1) those general in nature, i.e., not specifically related to the application of the technique at any individual institution or group of institutions; and (2) those articles which refer specifically to actual experiences in the use of systems analysis when automating one or more technical processing functions. While this division will be followed in this article, it should be realized that not all relevant papers are cited, due in part to the large number of publications which have some bearing on the topic. However, an attempt has been made to include papers which are representative and significant, while some are included because they emphasize points not made elsewhere.

Most authors divide systems analysis into several distinct phases which may, however, overlap in actual execution. Following are summaries of these phases as presented in several publications. Part of the differences encountered in the phases outlined from author to author depend upon each individual's definition of the scope of systems analysis.

GENERAL LITERATURE

Heiliger and Henderson see systems analysis efforts being directed

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to the selection of the best approach to reaching a given goal. They suggest the following five steps in the analysis phase.

1. Establishment of criteria recognizing requirements, restrictions, and objectives. There will be tangible criteria, possibly focusing on cost, as well as intangible criteria including values to be retained, factors of risk and delay, and the pace of progress which patrons and staff can sustain and accept.
2. Quantification of the system—identification of restrictions and demands outside the system. It is important to establish all interfaces with activities or organizations not within the system. At this point the authors consider it critical to make a distinction between physical objects and logical data.
3. Formulation of alternatives which can be aided by the use of models. They may be abstract, such as a flow diagram, or more tangible, as in the form of an operative diagram or simulation of a possible solution.
4. Selection of the alternative to be pursued, based upon the application of the evaluation criteria to the feasible alternatives. This should be based on consideration of both economics and practicality. The strengths and weaknesses of both humans and computers should also be considered.
5. Exposition of the specifications of the system. It is vital that all purposes are understood, that a sound approach is being used, and that targets are clear.⁸

Gechman, writing to heads of libraries with decision-making responsibilities in library automation projects, identified eleven steps followed at Information General, Inc., as leading to the implementation of an automated system.⁹ The first three steps fall within the scope of systems analysis. The first is establishing the goals and objectives of the system. Gechman identifies this as “the most important function of the whole effort.”¹⁰ The foundation of the system must be strong and requirements must be established clearly if the system is to meet the needs of its users. The second is systems analysis itself, in which the overall problem is defined within the context of a computer-aided environment. Here the most critical tasks are the determination and approval of descriptions of input and output data. After requirements and objectives are both known, specifications for a new system are prepared, along with descriptions of any present manual system. The third step, the specification manual, should cover requirements of the proposed new system and should be given to library management for approval.

Only after approval is granted at this point would work proceed on the other eight steps which cover design of the system in detail sufficient to permit programming and implementation.

A 1971 publication by the SPIRES/BALLOTS staff at Stanford University, "System Scope for Library Automation and Generalized Information Storage and Retrieval at Stanford University,"¹¹ presents a discussion and sequential presentation of how it sees the five major tasks in what it terms the preliminary phase of system development. The sequence of steps identified begins with determining the organization's general operating requirements, in terms of objectives, products and services. It is followed by the study and documentation of present operations. After the requirements are defined and the current system analyzed, a statement of limitations or inadequacies is delineated with the purpose of discovering those areas which could profit from manual improvement and/or computer support. Once the limitations are known, a long-range scope for the system should be established which clarifies areas in need of system development or research. Then, having outlined the whole system, the Stanford group recommends that a first area to be implemented be selected which provides "an optimal integration of computer and manual resources so that the areas in most need of computer help are aided and means for further research are provided."¹²

While not including systems analysis in those words, Bellomy in 1969 outlined a series of steps to be followed in development of a library system. He suggested: (1) formulation of module objectives, (2) documentation of existing operations including specific items and specific data elements, (3) analysis and summarization which should culminate with an informal summary of a module parameter, and (4) formulation of design concepts, a task which includes the identification of the widest conceivable range of alternatives. Step five is the preparation of detailed design specifications allowing for hardware constraints.¹³

In another paper, Bellomy and Jaccarino indicate that one of the most critical elements of the analysis preceding library automation is thorough consideration of all possible requirements which might be placed on the system.¹⁴ This is reinforced by Markuson, who adds another dimension by stating that prior to library automation a great deal must be known about the local setting.¹⁵ The most important elements therein are the library network, the parent institution, the user group, and the history of the library itself. Systems analysis would show that in some cases past decisions can influence future actions, in economic

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factor limitations if nothing else. For instance, she points out that the decision to set up new files cannot be taken lightly as data will be accessed for many years. Furthermore, in many library environments it is difficult to get accurate cost figures. Due to many exceptions encountered in library processing, only average figures are readily available for use.

In a 1967 article,¹⁶ Covill discussed phases through which a library automation project passes. Although he has a narrow definition of systems analysis, the first four phases he described fit within the framework of systems analysis as a prelude to library automation. The first phase, analysis and documentation of the present operating system, is considered by Covill to end with a problem statement covering the reasons the present system is inadequate and the course of action to be pursued to develop a solution. The problem statement would be accompanied by a picture of the library processes as existing at the time, expressed in words, diagrams, and charts. The next step would be establishment of the new system to be designed, followed by its design—the plan for which should be furnished, along with all files, reports and records generated, to the librarian for review. Covill lists as step four the making of decisions on equipment and storage to be used.

In discussing the work which must be done prior to programming an automation project, Kimber lists the following steps, not necessarily in sequence: gaining a clear understanding of the work to be done, knowledge of the available data, and desired results.¹⁷ He would reduce the requirements to a set of flow charts and written specifications for the purpose of clarifying the analyst's concepts, exposing omissions, and removing ambiguities. He rightly emphasizes that the whole task of job definition be thoroughly carried out in order that computer time, plus a great deal of effort, not be wasted later in making revisions in the system.

A paper presenting the sequence of steps in systems analysis with particular relationship to library automation is Pratt's contribution, "Systems: Components, Characteristics and Analysis."¹⁸ He states that understanding the present system is basic to designing and implementing any improved system, but particularly a mechanized one. Each decision, no matter how small, that is made in the normal course of duties must be known, and must be studied to be explicitly clarified. Pratt indicates that the sequence of steps proceeds to determination of the objectives of the present system. Then he specified the next step as one which many authors do not include under the heading of systems anal-

ysis—the determination of present costs. He indicates that knowing present costs is essential because decisions in selecting a new system will have to consider comparative costs. When considering the new system he recommends describing the environment in which it will operate, and determining its objectives. There will be alternative possible systems and they must be compared for the best possible overall selection. When an optimum design is reached it should be costed accurately and the system described in detail.¹⁹ To complete the task of systems analysis, a systematic plan for implementation of the new system should be developed, and, as part of the design of the system, there should be preparation of adequate documentation.

While not specifically presenting a series of procedures to be followed in systems analysis, Auld related some qualities it must have in order to prevent failure in library automation. He stressed the importance of good communication as part of good systems analysis. However, he pointed out that good systems analysis also requires an understanding by the analyst of the totality of that with which he is working, as well as establishing correctly the relationship of each part to all other parts.²⁰ Another view of what is needed to have a successful library automation program was presented by Waite.²¹ He believes that successful completion of the preliminary phases requires close communication among all participants including executive management, project management, operating librarians and systems engineers.

Cox, writing in terms of system design which occurs prior to automation in a university library, indicated four factors involved: analysis of the existing activity, establishment of the principles on which the system will be based, costing and functional evaluation of the proposed system, and finally, design of the system.²²

As can be deduced from the preceding discussion, there have been numerous publications dealing with the sequence of steps to be followed in performing systems analysis prior to automation within libraries. The different authors emphasize different aspects, but in general they present the need for an orderly, logical investigation of current operating systems with a clear presentation of positive and negative features of the alternative solutions. Harrison Bryan, an Australian who spent a good deal of time in the United States looking at examples of library automation, concluded that most failures and difficulties of library automation resulted from overly hasty planning and/or a lack of firm commitment to hardware.²³ To help insure success of an automation project, he recommends that the planning (analysis phase) be

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allowed twice the time originally scheduled because the preliminary planning is the most important aspect in the introduction of automation.

METHODS, TOOLS, TECHNIQUES

In addition to outlining a logical series of steps to be followed in systems analysis, many of the automation papers, especially those published in the 1960s, presented a discussion of methods to be followed along with various tools and techniques to be utilized. In general the techniques of systems analysis are equally applicable whether or not automation is a probable step. One of the most widely used techniques is flow charting. Flow charting can be used at least two ways within the context of systems analysis. The first is to set down each step followed in the existing manual system. A second means of utilizing flow charting is in designing new systems where proposed steps to be followed would be identified. Hammer mentions flow charts in the latter category where they "describe the hundreds or thousands of interrelated steps needed for the computer to accomplish the desired result."²⁴

Szeplaki presents lengthy instructions on how to prepare flow charts of existing library operations. In that situation a flow chart may be one of two types: step-by-step work flow chart or a document-by-document work flow chart. To accomplish a work flow chart Szeplaki recommends beginning by securing a job description from each individual staff member whose area is under study. Then, using the job descriptions as a base, draw preliminary flow charts. Next, interview each individual, without necessarily filling out a complicated interview form. Szeplaki does not give details on preparing a step-by-step flow chart, but he elaborates on preparing a document-by-document flow chart. He considers document-by-document charting to have several advantages over step-by-step, and should be consulted by individuals making decisions relating to the depth and type of flow charting to be pursued in the systems analysis of any probable library automation project.²⁵

Interviewing is listed by Robinson as one of the most obvious techniques of systems analysis.²⁶ Other techniques are less well known such as the construction of decision tables.

The early 1970s have witnessed a very significant development in the general field of library automation which includes ramifications for systems analysis. This is the publication of several major, comprehensive guides to library automation or, in any case, to library systems analysis. Thus, in contrast to the early years of library automation, in which in-

dividual papers would discuss steps or methods to be employed in systems analysis prior to automating, or perhaps staff implications involved, there are now available some important works which synthesize and consolidate knowledge regarding many aspects of data processing in libraries. While many of these aspects change rapidly, the techniques of systems analysis tend to have enduring applicability. In this regard, the sources discussed below should have value for a considerable length of time.

An absolutely invaluable source for anyone engaged in conducting systems analysis as a prelude to automation of technical processing functions is the 1972 publication by Markuson, *et al.*²⁷ It is extremely useful for its guidelines for decision-making in the early feasibility study stage, equipment and costing aspects, the steps and techniques of systems analysis, and for comparative information on automated projects as well as lists of most of the likely alternatives in automation of the various functions—whether acquisitions, cataloging, circulation, serials or other.

The steps for systems analysis presented by Markuson will not be reiterated in detail here. It is, however, worthwhile to mention a few points not emphasized so clearly in previously referred to papers. First, file analysis is a major part of analysis of the present operation and, secondly, conditions which might be imposed by outside environments such as agency, library community or other should be investigated.²⁸ This guidebook also includes a very comprehensive list of analytical techniques. These are discussed and explained in some detail with specific references to the advantages of each. As an example, decision tables which utilize “yes” and “no” information are singled out as valuable because they come close to simulating the logic used in computer programming.²⁹ Good guidelines are also included for systems cost analysis.

Another major publication covering an even wider scope is the 1970 tome by Hayes and Becker, *Handbook of Data Processing for Libraries*.³⁰ The information on the actual steps and techniques of systems analysis is very limited compared to Markuson. However, the Hayes and Becker effort is definitely a basic reference tool for library systems analysis. It is especially valuable, in the context of this article, for the descriptions of typical systems in the technical processing areas—including the data involved, the types of reports produced, and options of features which could be incorporated into these applications.

Not as encompassing in scope as the two efforts discussed above, but

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nevertheless invaluable to those individuals involved with systems analysis and design of automated library functions that involve conventional data processing, is *Library Systems Analysis Guidelines* by Chapman, *et al.*³¹ The nucleus of the information has appeared in several previous publications by one or more of the authors, but here it is brought together, updated and expanded. They emphasize that a systems study is an essential prerequisite to the design of a successful automated system. However, an automated system is not necessarily the result of such a study. It includes a look at the phases of analysis, detail on methods and techniques of analysis including job descriptions, worksheets for the survey of inputs, flow charts and others. Their section on preparing a report of findings should be useful to many. Included is a section on systems design with special considerations for design of a computer-based system.

PERSONNEL

A final area touched upon in many general papers pertinent to the topic of this section is personnel. Who should be the person(s) responsible for performing systems analysis in a library when a probable result is automation of one or more technical processing functions? Probably, the most frequent answer is that the analyst, or at least the project director, will be someone who is also a librarian with some training in programming. Some authors who recommend a combined librarian/analyst are Veaner,³² Szeplaki³³ and Lebowitz.³⁴ On the other hand, Hammer believes that a professional analyst is a requirement.³⁵ De Gennaro, writing at a time when trained and experienced library systems people were in short supply, did not care whether the person doing library automation was primarily a librarian in background or primarily a computer expert as long as he was dedicated to the purpose of library automation and took steps to acquire expertise in the areas he lacked.³⁶ Frequently the use of outside consultants is recommended for the systems development stages. Nevertheless, some in-house capability is required for maintenance.

Based on personal experience, it seems probable that librarianship is attracting, and will probably continue to attract, individuals with strong data processing backgrounds. These individuals, comfortable in both worlds, should be in a position to bring the two together harmoniously.

There have been many case histories of operational automated projects published as well as descriptive papers of planned or imple-

mented systems. Frequently they include comments on the methods or techniques of systems analysis followed. Following are representative references to some of the most informative or useful papers of this type.

SPECIFIC PROJECT LITERATURE

In the early days of library automation, there was often little formalized analysis. Many librarians were unaware of the desirability of careful planning and of sticking to projected schedules. Furthermore, in the early and middle 1960s not many librarians had had experience or training in systems analysis and design, or in programming. Dobb presents a useful, candid account of some early informal processes at Simon Fraser University in Burnaby, British Columbia, out of which evolved more systematic approaches including the recognition that there should be staff exclusively assigned to systems analysis and design.³⁷

Probably in the early 1960s many automated projects just evolved without any formal planning. Frequently these projects got off the ground because of the enthusiasm of one individual in a given institution. At the National Center for Atmospheric Research Library, after an initial decision that automation could work, the next decision was to produce an announcement bulletin that was currently prepared manually. After several experimental attempts a satisfactory product was achieved. McCormick explained that their approach to automation had been to begin with an analysis of a desired product and to work backwards to determine the input requirements, which were then coordinated with other sections of the system.³⁸

Thus, when both computers and library automation were in relative infancy, it can be seen that actions were frequently taken on a trial-and-error basis. As experience in the field began to demonstrate that increased positive results could be achieved with an initial systems analysis approach, and as more librarians achieved formal computer experience and/or training, the trial-and-error methods gave way, in most instances, to more systematic endeavors. Some specific examples of actual experiences in systems analysis which led to applications of automation to technical processes are presented below. It is intended as representative but not inclusive of the total publications pertinent to this topic.

Several authors are on record as beginning the analysis process with a feasibility study. These include Cage, whose feasibility study had the purpose of determining if it was practical to use the computer to pro-

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vide assistance to the acquisition department.³⁹ Crismond reported preliminary planning that was initiated with a survey to determine the needs of the San Francisco Public Library, and testing of the feasibility of new serials procedures.⁴⁰ Later, detailed planning at the San Francisco Public Library included determination of size and format of the catalog, the number of listings it would contain, the input forms required and data elements to be included on forms.

Lebowitz related the list of steps followed in the automation of serials at the Atomic Energy Commission. These included, as a first step, a study of the proposed mechanization in relation to the library as a whole. A feasibility study was conducted, followed by consideration of the proposed output and the available hardware.⁴¹

Another early experience was in the acquisitions area at the University of Michigan. It was initiated with a study to determine the feasibility of using a computer system in the book ordering process. Thomson and Muller described the series of steps they followed once the feasibility of such a system was considered favorably.⁴² The steps in sequence include: determination of what the system must accomplish; definition of the types of information contained in the system along with clarifying the necessary reports; definition of files; review of the proposed approach by a programmer; submission of the proposal to the director of libraries; and finally, after the approval of the proposal, design of the system in detail. Dunlap also commented on the University of Michigan's early experiences in automation of a technical processing function.⁴³ She indicated that once the preliminary proposal was drafted, cost and feasibility studies were made. A major factor in deciding favorably for automation of acquisitions was that while initial costs would be high, there would be long-range savings.

An interesting discussion of a feasibility workshop is presented by Epstein, *et al.*⁴⁴ It involved five colleges and universities in the San Francisco Bay area and was conducted by Stanford University for the purpose of exploring the feasibility of a regional library automation network based on Stanford's BALLOTS program and its support of technical processing. This study team produced a report which provided cost and benefit information, furnished to the director of each library, as a basis for decision-making.

The BALLOTS project at Stanford is well covered in the literature, including in *The LARC Reports*.⁴⁵ That report encompasses an extensive discussion of the history of the systems analysis and design phases. It began with such functions as the study of existing files, input and

output documents, and data elements. In the detailed analysis phase, requirements of the system were delineated in minute detail. Discussion of other stages of analysis and design are also included, making the Stanford experience a significant account of an actual experience in systems analysis preceding automation of technical processing functions.

Many authors mention the attention they paid to existing systems at other institutions. This can be done either by personal visits to the institutions, by a literature review, or both. Among the authors who discuss the value of comparison are Cowburn,⁴⁶ Wilkinson,⁴⁷ Miller and Hodges,⁴⁸ and Byrn.⁴⁹ The latter paper is particularly noteworthy because it provides a comparison between the middle 1960s and the early 1970s as to the relative abundance of literature detailing the experiences of various libraries in automation projects. Byrn indicated that the University of Oklahoma staff was so disappointed in the paucity of available literature of a nontheoretical nature, they initiated a questionnaire to survey 194 university libraries to determine which institutions had planned or implemented automated systems in their libraries.

It is clearly seen that in the last decade library automation has made great advances. More institutions have some and much more has been published, both by members of individual institutions and in large scale works covering the general state of the art. A valuable survey by the Information Science and Automation Division of the American Library Association, the American Society for Information Science, and the Special Libraries Association is currently underway. Its purpose is to compile data on all existing library automation programs and it will provide great detail concerning available sources of software.

At Eastern Illinois University the need for revising the circulation system led to informal discussions of alternatives by the librarians. The ensuing review resulted in a task force composed of representatives from the library, the data processing center and the administration. When the group recommended a computerized on-line circulation system as one possible solution, the administration authorized detailed analysis and the preparation of a design proposal. Rao and Szerenyi outlined the main considerations in the design of the BLOC (Booth Library On-line Circulation) system and emphasized that its aim was "a system that would provide the best possible service at the least cost in the long run."⁵⁰

Several publications by Kilgour⁵¹ discuss the systems analysis and

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design involved in the development of automation of the Ohio College Library Center (OCLC). Among the techniques of analysis used at OCLC was simulation. It was instrumental in the selection of hardware to be used, and in revealing that there was inadequate prior knowledge concerning the operation and efficient organization of a huge file in an on-line situation.

Additional examples of the use of the technique of systems analysis prior to implementing an automation program are, of course, covered in the literature. Many of these are "buried" in papers whose primary purpose is description of a particular system. Some of these will be mentioned in other papers in this issue of *Library Trends*. Several sources for locating addition literature exist, among which the *Annual Review of Information Science and Technology*, published by the American Society for Information Science, is particularly notable.

Along with attempting to review each year's literature, the *Annual Review* generally includes some synthesis of the various fields covered, including library automation. Some of the authors specifically discuss systems analysis and the latest trends in that area. Griffin, writing in 1968, covered the topic and emphasized systems planning and its necessity.⁵² Two years later, Parker, in reviewing the literature for 1969, commented on the abundance of articles dealing with the technique of systems analysis prior to planning for library automation.⁵³ At that time he noted the repetitious nature of many of these publications and cast doubt on the justification of their continued publication.

In 1972, Martin, in the seventh *Annual Review*, noted that the literature clearly reflects changes which have taken place in library systems analysis.⁵⁴ Recent publications tend to emphasize cost analysis, and the evaluation of variables which are difficult to quantify. In addition, she sees that the growth and development of networks is probably a reflection of a maturing field.

In general, maturation of library automation and the systems analysis which precedes its implementation is observed by this author. Some indicators of the increasing sophistication of the field are the publication of the guidebooks discussed previously, particularly Markuson *et al.*, Hayes and Becker, and Chapman, *et al.* These works are all the result of considerable experience in the field and for the most part are syntheses of existing bodies of knowledge rather than containing work original in these particular publications. Further, in the early 1960s there were a virtual handful of library automation papers produced

each year. A decade later the literature has expanded dramatically both in general papers and in published results or progress reports of specific efforts.

Another change noted from both the literature and from the author's personal experience relates to the availability of trained and experienced personnel. At first systems analysis was often only haphazardly employed when an automated project was considered. Frequently it had the form of informal discussions between a librarian with no computer experience and computer center staff with no library experience. Gradually, through trial and error for the most part, a small cadre of individuals experienced in library systems analysis and automation developed. In recent years the library schools have been able to provide considerable training for their graduates in automation principles and the techniques of systems analysis. In addition, as indicated previously, many individuals with prior experience in systems analysis and/or programming have been attracted to the library profession and have attained education and experience in both areas. At present there does not seem to be any serious shortage of individuals with experience or expertise in library systems analysis.

This increased availability of trained and experienced personnel should be reflected in a professional, thorough conduction of systems analysis and design in most instances. Many applications are now carried out in a routine manner, especially in smaller institutions. Furthermore, most staff members of libraries are now prepared to accept systems analysis and some computer applications as routine. They too have come to understand the process better and not to expect instant miracles. It is better understood that systems analysis is an iterative process where continuing feedback results in continuous analysis and redesign where appropriate.

Now that automation projects are successfully operational in many libraries, it is possible to do serious planning for joint ventures in which many institutions are involved. The rise of library networks, most with implemented or planned automation projects, is a definite sign of the increasing maturity of the field. Based on the confidence achieved with success in local situations, the phenomena of networks engaging in library automation should continue for some time to come.

Finally, in an overall appraisal of the utilization of systems analysis preceding library automation, it seems a fair conclusion that systems analysis is becoming routine in libraries, particularly in instances where automation is seriously considered or thought probable. Even when the

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use of the computer is not preconceived as a likely result, machine alternatives are routinely considered. As Cox states, automation in libraries is virtually inevitable due to increased demands for service.⁵⁵ Other factors including the large volume of materials handled and available technological aid in the form of computers are also contributing to the rapidly increasing number of applications of automation in library technical processes. In any case, systems analysis, as a prelude to library automation, is an inevitable commonplace fact of life in libraries.

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