MANAGEMENT PLANNING FOR LIBRARY SYSTEMS DEVELOPMENT

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This paper deals with the application to library systems development programs of planning techniques which long ago proved their usefulness in business, military, and aerospace developments. The significant features of PERT (Program Evaluation and Review Technique), WBS (Work Breakdown Structure), planning diagrams, statements of work, cost/time estimates, schedules, manpower loading, and cost phasing are related through an example to the management requirements of a major systems development program at a large university library. The practical aspects of planning are treated in preference to the more theoretical.

One seldom finds the sense of urgency characteristic of aerospace and military programs influencing the development of new library systems. This, of course, has both advantages and disadvantages. Compared to military programs, the level of risk demanded by the urgency of the requirements may be considerably lower. Development periods may be relatively longer and resource allocations can be spread out over a longer period of time, also. Fewer people need to be involved in the development at any one time, but the problem of retaining individuals with a technical knowledge of the program throughout its life is greatly increased. The development of a total library system could require twenty to fifty man-years of effort and, depending on the number of people assigned to the program, it could span a period of a decade or more. Nevertheless, the requirements of a major library systems development program and those of a major aerospace or defense project are more similar than different. It is appropriate, therefore, to expect that planning techniques perfected for aerospace programs might be useful in planning major library programs. It is the purpose of this article to show how these principles are even now being applied in some library systems development programs.

IS PLANNING NECESSARY?

The question is rhetorical, for every program manager uses some technique of planning in his work. As often as not, however, he attacks problems individually without an overriding concern about the effect a particular solution may have on other aspects of the library's operation. This approach to solving problems, while obviously not an optimum one from the long-range point of view, may be the only available alternative at times. Even the most ardent proponents of the total systems approach admit the possibility of critical problems requiring "quick and dirty" solutions (1). Many of the steps to be outlined here for planning and implementing a total library system would, undoubtedly, be omitted where a solution was urgently needed to satisfy a small set of relatively simple objectives and where few external constraints and resource limitations were imposed. Furthermore, not all systems designers agree that a library should even attempt to develop a "total system" in the beginning — arguing that man must crawl before he learns to walk (2). In practice, any library will find it necessary to apply a combination of approaches, but must plan from the very beginning for a total system. Even where the "fire fighting" approach must be adopted it is helpful to have a knowledge of procedures to be followed were solutions approachable in an ideal manner.

A planning technique, regardless of the degree of sophistication, is only a tool and can never be expected to serve as a substitute for effective management. Furthermore, such a tool must be viewed as an integral part of the entire management process. The management process has been evolving as much through the process of trial and error as through design for a long time now (3). Many knowledgeable people have written about the process and not all of the descriptions agree (4,5,6). There does seem to be general agreement, however, on some of the fundamental operations which constitute a management cycle. These are diagrammed in Figure 1. Although phrased variously by writers the management process is usually defined to include: 1) the determination of objectives for an organization, 2) the preparation of plans for achieving the objectives, including the development of compatible cost and time schedules based on the plans, 3) the authorization of the required work, 4) the monitoring and evaluation of progress towards the objectives, and 5) the identification of alternate corrective action as problems develop.

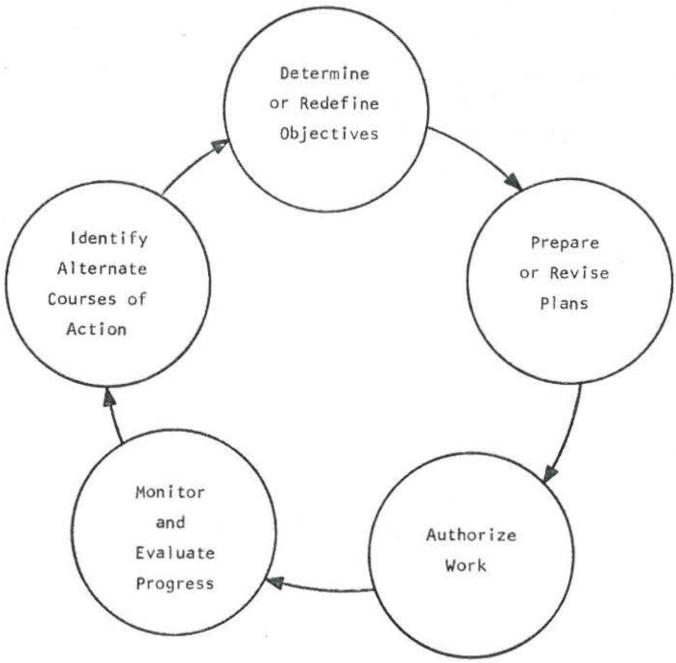


Fig. 1. The Generalized Management Cycle.

It is an unfortunate fact that too many major development programs in libraries are begun without prior establishment of objectives, prepared plans or developed schedules. Too often, discussion has been begun with the unwarranted assumption that everyone concerned has a clear and identical understanding of objectives that have not been explicitly stated.

During the past three years the author has had occasion to study, first hand, library automation projects underway at a large number of institutions: University of California - San Diego, University of California - Irvine, University of California - Riverside, University of California - Los Angeles, University of California - Santa Barbara, University of California - Santa Cruz, University of California - San Francisco, University of California - Davis, University of California - Berkeley, Stanford University, IBM - Los Gatos, Washington State University, Texas A & M, Florida Atlantic University, Southern Illinois University, Massachusetts Institute of Technology, Yale University, University of Maryland, Harvard University, University of Missouri, Michigan State University, University of Chicago, University of Illinois - Chicago, University of Pittsburg, Ohio State University, Rensselaer Polytechnic Institute, Johns Hopkins University, State University of New York - Albany, State University of New York - Buffalo, Honnold Library - Claremont, New York Public Library, National Library of Medicine, Library of Congress.

In some of the major systems programs studied, planning had progressed not much beyond the identification of the initial steps which were required in the program, with tentative discussions of the immediate resources which were needed to implement the first steps. Several of the managers reported that adequate funding for automated library systems development was hard to obtain before a technical capability had been demonstrated. Others were of the opinion that a greater degree of library automation was inevitable and that although everyone knew that the first steps would be costly and relatively ineffective, a start had to be made sometime. In retrospect it is very clear that such arguments, while undoubtedly expedient in the short run, are not in an institution's best interest in the long run and, after all, as one associate put it, libraries are designed to last a millennium.

PREREQUISITES TO PLANNING

Resources

The total systems approach implies the deployment of a team of professional people possessing diverse capabilities and backgrounds. One library administrator maintains that the development of a total library system requires the skills of scientific managers, philosophers, all categories of analysts, systems engineers, many categories of design engineers, computer programmers, and others in addition to library scientists. It is improbable that any one library would have on its staff personnel possessing the full range of capabilities required to pursue a successful systems development program. In some cases dedicated, full-time staff members will be able to learn the new skills which are needed; however, not all of the jobs requiring special skills need to be performed by full-time staff members. In some cases it will be feasible, and perhaps even desirable, to employ on a consulting basis individuals from outside organizations (including equipment manufacturers). It may even be advantageous to contract with an experienced outside organization to perform an entire segment of a complex systems development program.

In addition to individuals with specialized skills the systems development team should include key individuals from all of the existing library operations likely to be affected by the new systems. First, these people can provide the necessary insight into their organization's operations that only an insider can develop, and second, these people will stand as strong evidence that their organization's special interests are being considered, so that the new systems will have a much better chance of being accepted once they are implemented.

Above all, the early identification of one individual responsible for directing the entire development program is essential. This individual must have great skill in eliciting cooperation among people with diverse backgrounds, for systems work, like management, is partially a "people art" (7,8).

While it is imperative that a library systems program be adequately staffed it is equally important to insure adequate funding for the project. Serious funding difficulties may result from a library's attempt to develop a major new system out of its existing operating budget.

When a library administration commits itself to a comprehensive systems study, it must be willing to accept the risk that the results of the study may indicate that existing systems are adequate; that no new major systems development is required. If a library administration is dedicated to change for change' sake or if it has decided to undertake a research project as distinguished from the development of operational systems, much of what is being said here must be viewed from a considerably different perspective.

The process of analyzing existing systems is itself valuable (9). Libraries which have subjected themselves to systems analysis know that problems or inconsistencies within existing systems discovered during the analysis ordinarily will be followed by some immediate corrective action. Few administrators consciously intend to maintain useless duplicate records or to prepare reports which serve no purpose.

Techniques applied by effective program managers vary widely from one individual to another and from one situation to another (10). Aside from personal preference, factors which affect the approach taken include the complexity or scope of the objectives, the urgency of the requirements, and the risks the individual manager is willing to take. While objectives should be made explicit, they may be sketched out broadly or documented in great detail.

Similarly, plans should include consideration of every major activity required to achieve the objectives, but the level of detail may vary widely here, also. Plans should, either implicitly or explicitly, specify the contingency relationships among all of the tasks identified in the plan. It should go without saying that schedules must be based on plans. However, there are undoubtedly countless instances where schedules have been conjured up out of thin air to meet artificial deadlines, or worse, where no schedules at all have been specified. The latter is more characteristic of dozens of small library programs now in progress, and it may be suspected that the former characterizes too many of the major library programs.

Objectives

The reasons for undertaking a program must be determined by management in advance. A library administration begins the process of developing objectives for a modernization program by reviewing existing library policies, both generally understood and documented. Because program objectives must be compatible with library policies, this is an essential first step. It will likely be necessary to develop a few new policies and to document many previously undocumented ones.

The preliminary decision to undertake a modernization program may

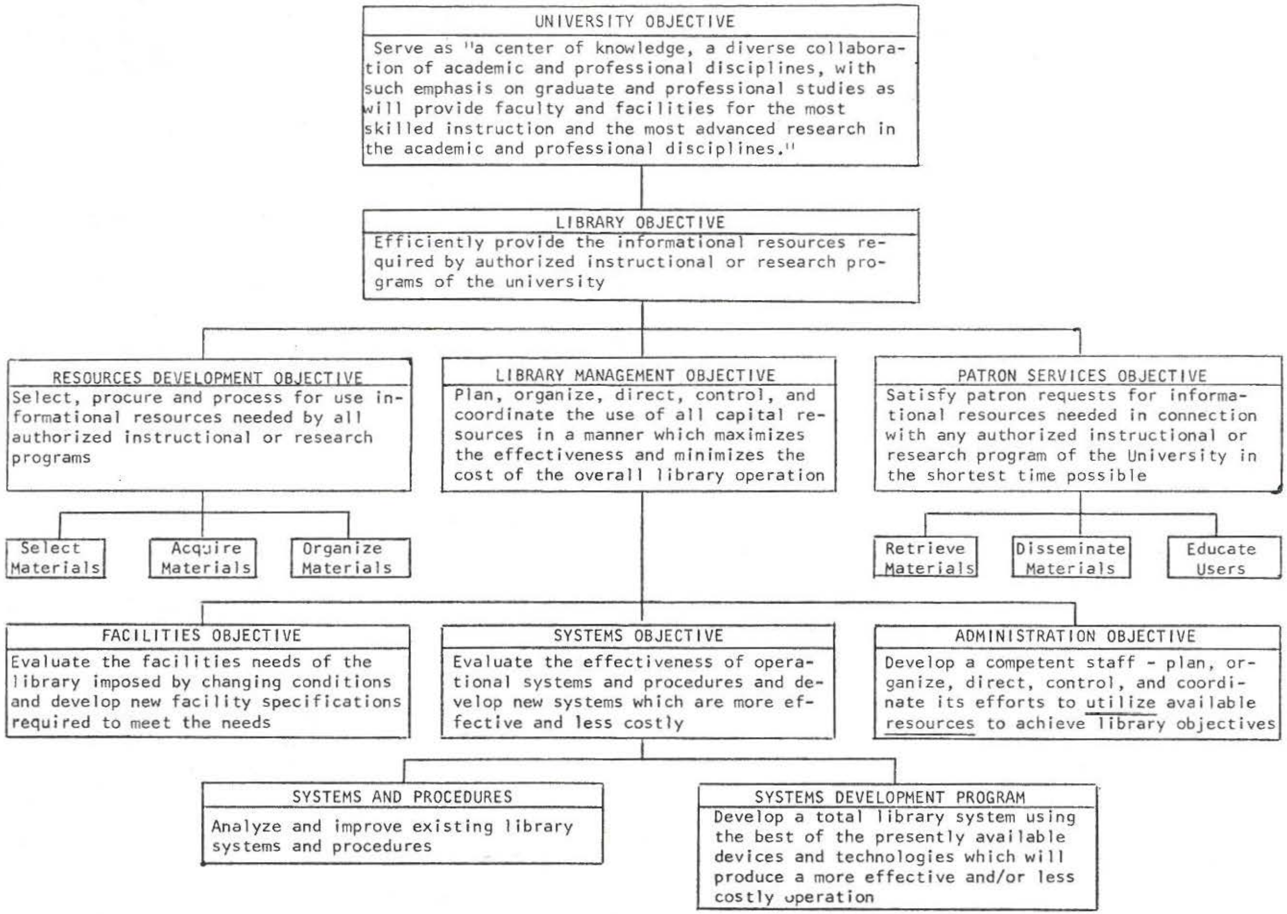


Fig. 2. Library Objectives Hierarchy.

have resulted from demands for change by higher governing bodies; requirements for new services in response to changing conditions; increasing backlogs; or inadequate budgets, staff or building space. In any case, program objectives will need to be established that reflect existing library policies and current or anticipated needs. If the library is a part of an institution that utilizes the Planning-Programming-Budgeting System (PPBS), this step already may have been taken.

In the case of an essential support activity like a library, the process of identifying objectives is complicated by the fact that the operation tends to be self justifying. That is, it is an integral part of the stated objectives of the higher-level organization of which it is a part. Thus, in order for a library to examine its full range of responsibilities it must first secure an approved statement of objectives for its parent organization. The purpose or objective of any organization depends on the perspective from which its functions are viewed. Thus, even at the highest levels of abstraction, concerned individuals arrive at widely varying statements of objectives. In a university this process is further complicated by the general lack of concurrence on any subject, a situation which seems to be peculiarly characteristic of an academic community.

In attempting to program the operations of a library, it is absolutely essential that the statement of objectives for the library, in some sense, be correlated with some reasonably authoritative and reasonably widely accepted statement of objectives for the parent organization. No statement of the library's objective will satisfy everyone concerned, but it must reflect the administration's official attitude.

Just as the library's objectives must contribute to the achievement of the objectives of the parent organization, so too must the objectives of the major library programs contribute to the achievement of the overall library objective. When objectives for program elements are identified, these in turn must contribute to the objectives of the programs, and so forth on down to the lowest level of activity in the program. In other words, there is a hierarchy of objectives, although they are seldom discussed in these terms. A portion of this hierarchy for a university library is shown in Figure 2.

The main purpose of Figure 2 is to show how the objectives of a systems development program contribute to achieving all of the objectives at successively higher levels in the hierarchy. The systems activity is divided, in this example, into two major areas of work: systems and procedures work, and major systems development projects. The systems and procedures work is directed at obtaining relatively short-term gains while the major systems projects have comparatively long-range goals.

The systems and procedures work in the example is considered to be a continuing administrative function directed at improving the general efficiency of the existing operation. Much of this work is carried on by the individual supervisors themselves, with central coordination being provided. Systems and procedures tasks include: organization planning and analysis; systems analysis and design; management audits; policy, procedures, and bulletin maintenance; forms analysis and design; reports analysis; records management; work measurement; office equipment selection; office layout; systems implementation; and related research (11). Most libraries need to give this aspect of professional systems work greatly increased emphasis.

The main objective of the systems development program cited in the example is to "develop a total library system using the best of the presently available devices and technologies which will produce a more effective and/or less costly total library operation."

Specific objectives could include such things as faster processing of new book orders, better control over technical processing routines, availability of more comprehensive statistics, better management information, reduction in routines performed by clerical staff, availability of better bibliographic descriptions of the collection, more effective utilization of professional staff, improved reference services, better control over the physical collection, reduction of patron involvement in the charging transaction, better circulation control, etc. Naturally, no two libraries' general or specific objectives are going to match these exactly.

Selecting the First Project

The steps which are usually taken when preparing a set of program plans will be discussed in terms of a relatively typical example. Let it be assumed that a systems analysis has shown that a total library system should be defined to consist of the following thirteen interrelated modules: materials selection, order processing, cataloging, materials preparation, library accounting, personnel control, systems and procedures, management information, inventory control, circulation, information retrieval, reference, and user education. Also, let it be assumed that every routine function performed by the library will support one of its stated objectives and will be subsumed within one of these thirteen modules.

The library system itself will be defined to be concerned only with the operational objectives, however. Special, single-end-item projects, like facilities development, objectives or policy formulation, major systems projects (i.e. the development of a new module), etc., are a part of the management apparatus of the system. It will be convenient to isolate these aspects of the undertaking from the operational segments of the system.

While it is reasonably clear that the formulation of a total system concept has to precede the development of any of the identified modules, it is much less clear in just what order the development of individual modules should be undertaken. A study of even some of the more obvious dependencies among thirteen such modules reveals a very complex set of contingency relationships. In a few cases these contingency factors will definitely constrain the order in which modules must be developed. Usually, however, these considerations will be much less demanding and it will appear that the choice of implementation priorities will be, for all practical purposes, arbitrary.

An evaluation of factors influencing the choice of implementation priorities will include: the nature of the interfaces among the defined boundaries of all the modules, an evaluation of the relative value of the payoffs to be expected from developing each of the modules, an evaluation of imminent changes in the state of the art affecting the development of a new module, and the political advantages to be gained from the development of a particular module. Thus, the library's management must take these and other factors (including technical) into consideration when they make their initial selection of implementation priority.

For the example program a set of hypothetical contingency relationships have been evaluated. They are diagrammed in Figure 3, which shows how the sequence of implementation will be constrained by the various design contingencies which have been identified. The diagram says that the formulation of the total systems concept precedes development of any module. It must be the first major activity to be undertaken. Further, it says that once the total systems concept has been formulated the development of any one of five modules can be initiated. The selection of a par-

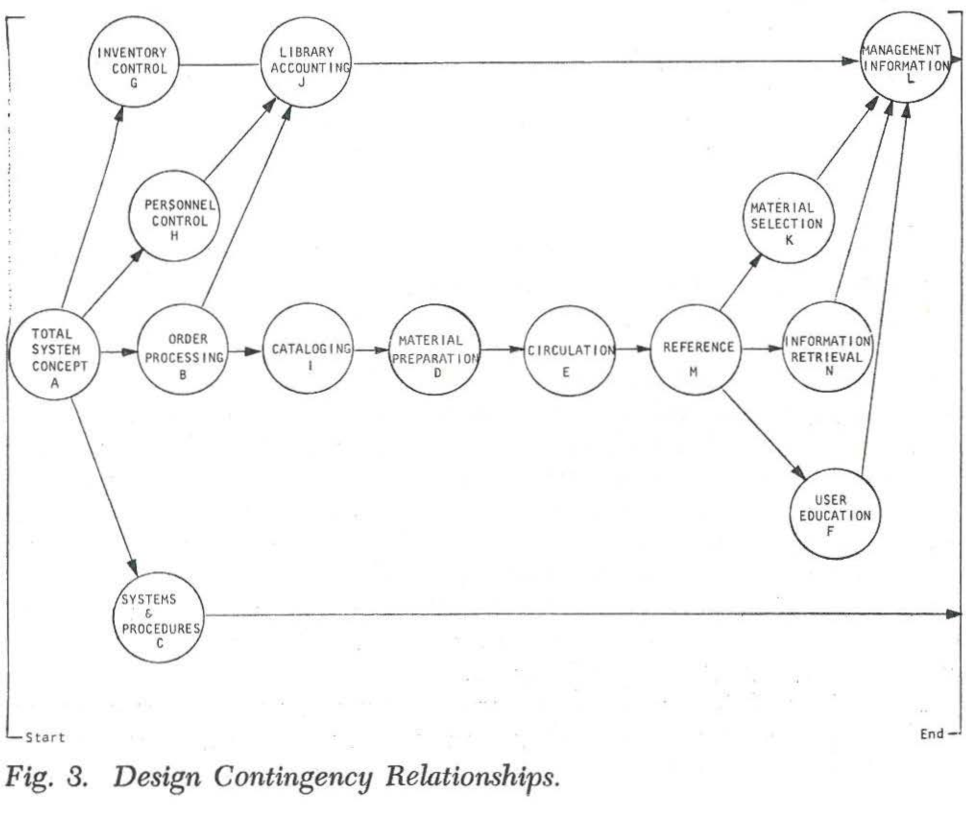


Fig. 3. Design Contingency Relationships.

ticular implementation priority is indicated by the letters associated with each block. That is, work implied by block "A" is completed first, then block "B", then block "C", then block "D", etc., each module being completed before the next is begun. Under these circumstances there would be little justification for identifying much more than the obvious contingency relationships already discussed. For more rapid development of the total library system, a much more complex planning effort would need to be undertaken. Several of the major efforts shown to occur sequentially in Figure 3 could, in fact, overlap significantly. Some of the tasks involved in developing the cataloging module, for example, can be undertaken while the development of the order processing module is still in progress. Where minimizing development time is an important program objective and where all necessary resources are made available as needed, a carefully formulated and detailed program plan is warranted—indeed it is essential.

The Work Breakdown Structure

The work breakdown structure (WBS) displays two different kinds of information. First, it shows how the system itself is subdivided into successively smaller sub-components. Second, it shows how all program activities making demands on available resources are related to the achievement of program objectives (12).

The development of a work breakdown structure can be undertaken as soon as the system is conceptualized. Furthermore, it should be available before an attempt is made to identify specific program tasks and the sequence in which they should be done (PERT Programing).

The work breakdown structure is a useful means of showing the components of a major program in successively greater detail. While there is, naturally, no limit to the number of levels of subdivision which can be used, four or five should satisfy the requirements of most library system development programs. The development of the work breakdown structure proceeds from the top to the bottom, showing how the total program is first subdivided into major program elements (or activities) and then how each of these in turn is successively subdivided into tasks and finally work packages. This relationship is shown generally in Figure 4.

A well developed work breakdown structure provides a basis for effective program planning and insures that no major program activity is overlooked during the planning phase of the program. It provides an excellent graphic representation of the interrelationship of the various components of a complex program, and shows how all aspects are related to the achievement of stated program objectives. Finally, the work breakdown structure chart can be used as a convenient means for displaying progress towards achieving the objectives of a program.

The details of the work breakdown structure developed for a project are heavily dependent on a number of factors. These include: the complexity, cost, and time span of the project; the relationship among the organi-

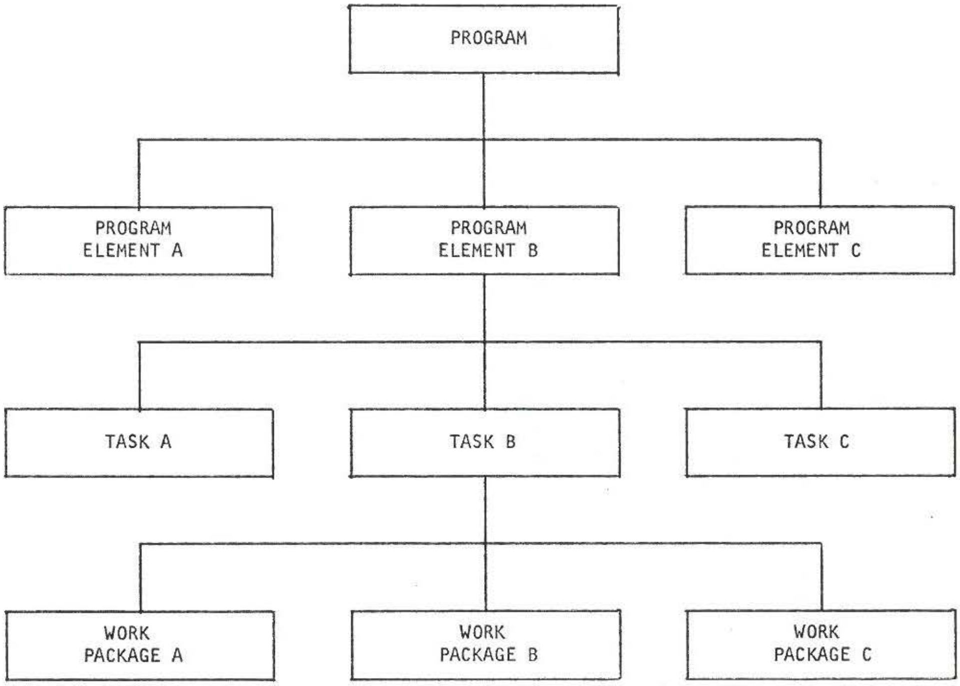


Fig. 4. Work Breakdown Diagram.

zational units directly involved in the project; the objectives of the project; and externally imposed program constraints.

An example of an actual work breakdown structure is presented in Figure 5 and illustrates the important features of such a diagram. It shows how a typical major development program at a large research library might be dissected into its successively more detailed component parts. In this example, the Systems Development Program is subdivided into four major subsystems developments and a general program activity. These are represented by the five blocks in the second level of the diagram (program elements). Each of these five program elements is then further subdivided into more detailed tasks. Tasks are divided into work packages so that the bottommost elements on the chart represent work assignments of a manageable size for program control. This is just an example, of course. In actual practice a similar structure would be developed for each project in the program. The order processing module, for example, would be divided into sub-modules, etc.

An integral part of the planning function involves the budgeting of available funds (or the estimation of required funding) among the various program activities. A common technique for accomplishing this makes use of the use of the work breakdown structure. During later stages in the planning, all of the specific activities required to accomplish program ob-

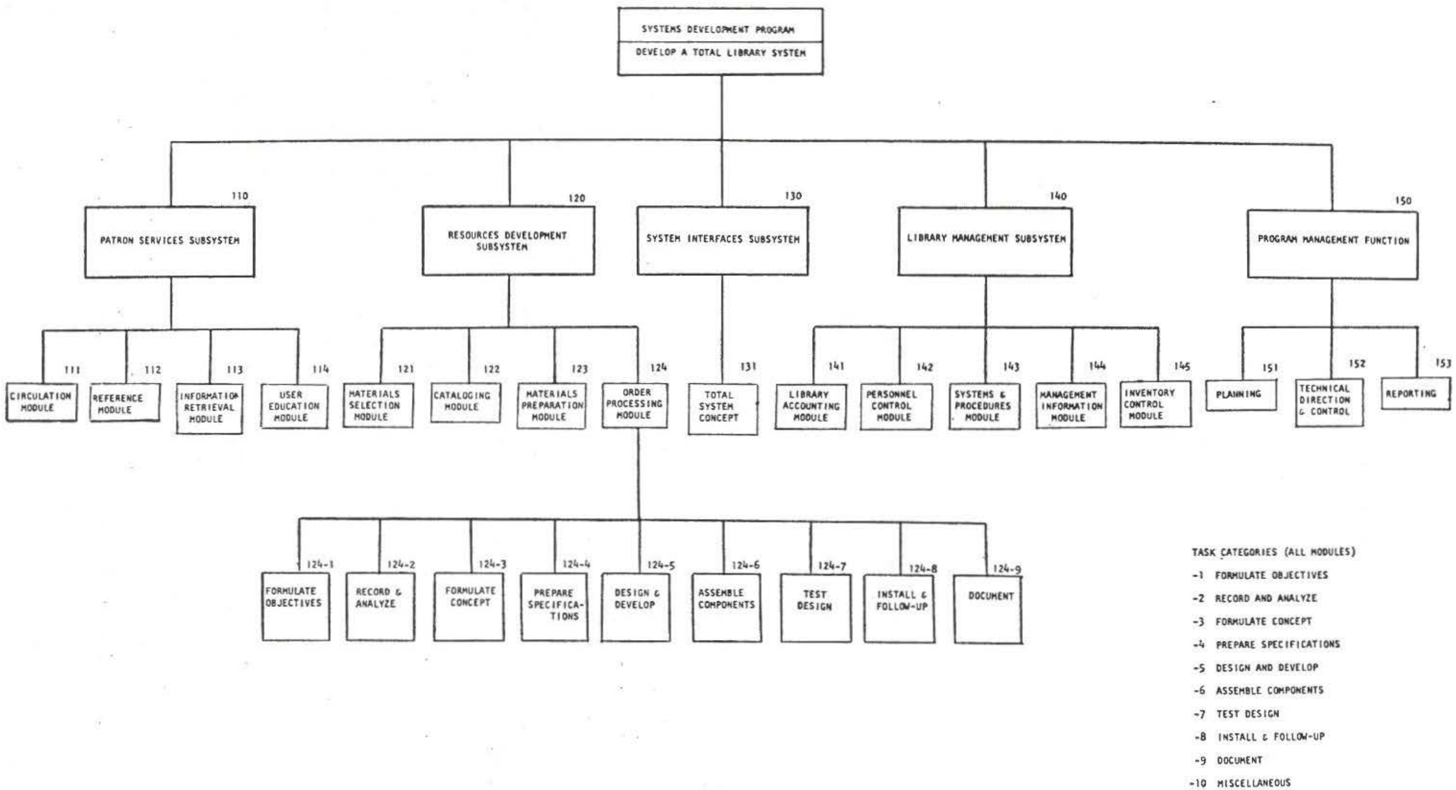


Fig. 5. Library Systems Development Program Work Breakdown Structure.

jectives will fall under individual blocks in the work breakdown structure. The lowest level blocks, it will be recalled, represent work packages. Each of these work packages may in turn be assigned a cost account number for which funds may be budgeted. The work breakdown structure may also be used to establish summary budgets.

While fund numbers may be assigned arbitrarily, coding is helpful. One workable technique is illustrated in Figure 5. Blocks of numbers are established for activities at each level within a structure on the diagram. One digit usually suffices at any particular level within a structure.

Responsibility for Planning

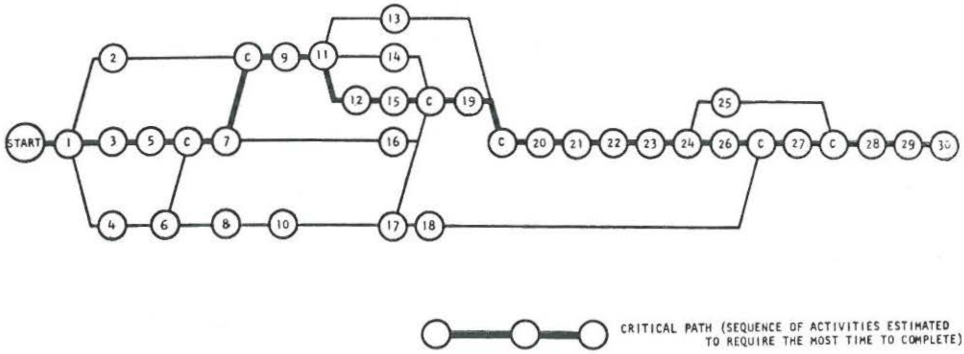
While it is probably better to assign responsibility for the preliminary planning activity to a single individual, it is imperative that plans eventually reflect the intentions of those who will actually be responsible for doing the work. These individuals will require certain guidelines before they can complete detailed planning activities. First, they must understand the program objectives. Second, they must understand the basic organization of the program and the fundamental planning philosophies adopted by the program manager. Third, they must understand that no plan is ever final, and should, therefore, propose every task which they believe necessary for a high probability of success.

There are many advantages of drawing people responsible for major areas of work into the detailed planning activities of a program. A program plan developed in this way becomes their plan; it is one which reflects their intentions and which records their commitments. When schedules are finally developed from the plan they are much more likely to understand the significance of the completion dates and the consequence of slipping schedules or over-running budgets. It is well known that when an individual commits himself to a particular task completion date, he is more likely to meet that date than when he is directed to do so.

PROGRAM EVALUATION AND REVIEW TECHNIQUE (PERT)

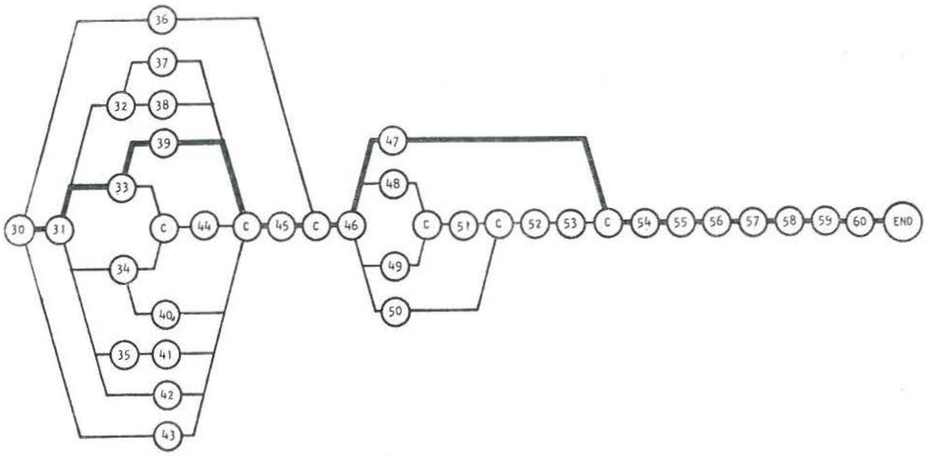
Planning Factors

While the work breakdown structure provides a logical means of displaying the interrelationship among the various system components and program activities, it does not necessarily show all of the essential jobs which must be undertaken during the program. All such tasks are either implied or assumed during the preparation of the work breakdown structure, but they must be enumerated in greater detail before an attempt is made to prepare a comprehensive program plan. Examples of implied tasks might include: the selection of personnel to be assigned to the program, the procurement of funding, the survey and evaluation of manufacturer's equipment, program review conferences, system design evaluations, etc. A comprehensive list of such planning factors is another invaluable tool for use during the planning phase of the program.



1. AUTHORIZATION TO START PROGRAM
2. PATRON INFORMATION NEEDS VERIFIED
3. TOTAL SYSTEM CONCEPT FORMULATED
4. AVAILABLE DOCUMENTATION ASSEMBLED
5. ORDER PROCESSING MODULE DESIGN CONCEPT FORMULATED
6. SUMMARY FLOW CHART OF PRESENT OPERATION PREPARED
7. MODULE INTERFACES STUDIED
8. MEASURABLE PROCESSING PARAMETERS IDENTIFIED
9. PROBLEMS DOCUMENTED AND STUDIED
10. PARAMETER MEASUREMENT EXPERIMENTS DESIGNED
11. ORDER PROCESSING OBJECTIVES ANALYZED
12. PROCESSING POLICIES DOCUMENTED
13. CURRENT COSTS MEASURED BY FUNCTION
14. NEW PROCESSING OBJEC-TIVES "BRAINSTORMING" COMPLETE
15. PROCESSING INFORMATION NEEDS STUDIED
16. PROCESSING CONSTRAINTS IDENTIFIED
17. PROCESSING PARAMETERS MEASURED
18. PRESENT COSTS PER UNITS OF WORK CALCULATED
19. PROCESSING FREQUENCY REQUIREMENTS STUDIED
20. BASIC SYSTEMS ALTERNATIVES IDENTIFIED
21. DESIGN TRADE-OFF STUDIES COMPLETE
22. COMPLETE REVIEW AND REFINEMENT OF MODULE DESIGN CONCEPT
23. COMPLETE REVIEW AND REFINEMENT OF TOTAL SYSTEMS CONCEPT
24. MANAGEMENT APPROVAL OF CONCEPTS
25. EFFECTIVENESS OF OLD AND NEW DESIGNS COMPARED
26. COST TO DEVELOP AND OPERATE NEW SYSTEM ESTIMATED
27. OPERATING COSTS FOR OLD AND NEW DESIGNS COMPARED
28. COST/EFFECTIVENESS TRADE-OFF STUDY COMPLETE
29. MANAGEMENT APPROVAL TO IMPLEMENT
30. GENERAL SYSTEMS SPECIFICATIONS PREPARED

Fig. 6. System Development Program (PERT) Planning Diagram.



(30) GENERAL SYSTEMS SPECIFICATIONS PREPARED

(31) DETAILED TRADE-OFF STUDIES FOR SYSTEMS COMPONENTS COMPLETED

(32) RECORD AND FILE SPECIFICATIONS PREPARED

(33) MACHINE PROGRAM SPECIFICATIONS PREPARED

(34) INPUT/OUT SPECIFICATIONS PREPARED

(35) EQUIPMENT SPECIFICATIONS PREPARED

(36) MODULE IMPLEMENTATION PLANS PREPARED

(37) RECORD FORMATS DESIGNED

(38) FILE STRUCTURES DESIGNED

(39) MACHINE PROGRAMS CODED

(40) INPUT AND OUTPUT FORMS DESIGNED

(41) EQUIPMENT SELECTED

(42) OFFICE LAYOUT DESIGNED

(43) ORGANIZATIONAL STRUCTURES FORMULATED

(44) DETAILED PROCESSING PROCEDURES DEVELOPED

(45) COMPLETE EVALUATION AND REFINEMENT OF MODULE DESIGNS

(46) MANAGEMENT APPROVAL TO IMPLEMENT

(47) EXISTING MANUAL FILES CONVERTED

(48) DATA COMMUNICATION LINKS INSTALLED

(49) EQUIPMENT PROCURED

(50) OPERATION INSTRUCTIONS PREPARED

(51) ASSEMBLY AND TEST OF HARDWARE COMPLETE

(52) OPERATING PERSONNEL TRAINED

(53) MODULE ELEMENTS TESTED

(54) NEW MODULE INSTALLED

(55) SHAKE DOWN RUN COMPLETED

(56) RELEASE MODULE TO OPERATING UNIT

(57) FOLLOW-UP EVALUATION COMPLETE

(58) MODULE DESIGN FINALIZED

(59) MODULE DESIGN DOCUMENTED

(60) PUBLISH ALL SYSTEM DOCUMENTATION

(C) INITIATION OF NEXT TASK CONSTRAINED BY COMPLETION OF SEVERAL PRIOR TASKS

Fig. 6 Continued.

Sometimes good lists of planning factors can be developed by reviewing other programs of a similar nature. While no list of planning factors developed by other organizations or individuals will prove entirely satisfactory in a new undertaking, it seems wise to take advantage, where possible, of others' experiences.

Sequencing Activities

The axiom, "The best place to begin is at the beginning," is probably less true of program planning activities than any of life's other endeavors. Planning should begin with the important program goals (the major program objectives as specified by the library's chief executive). This is an alien approach to many, for it seems more "natural" to assess one's present situation and then to ask "where do we go from here?" There are fewer unknowns associated with planning activity for the near future than for the far. Conditions can change radically during the course of a program. Assumptions may be discovered to be poor or false. After having been caught up in such situations a number of times, everyone finds it more natural to say "I'll cross that bridge when I come to it." But some people responsible for funding major library development programs are not "natural" thinkers. They often want assurances of specific accomplishments within specified periods of time in return for a specified amount of funds. It is not unusual for them to get very "unreasonable" when a request for funds is not accompanied by these kinds of "justifications." Thus, program managers must approach the initial planning activity in an unnatural way. Difficulties must be anticipated and contingencies identified. Above all, the plans must include recognition of every essential major activity. When plans are developed with reference to a carefully formulated work breakdown structure, the chance of inadvertently omitting an important activity is greatly reduced.

An example of a typical planning diagram is presented as Figure 6. Such a plan is developed by first selecting a primary project objective. Then, moving backwards in time, each task required to achieve the objective is determined in sequence (13, 14, 15, 16, 17, 18). The process of charting tasks in this manner to show their contingency relationships continues backward in time until a task contingent upon nothing other than authorization to proceed with the program is reached.

As a practical matter, when a task has been identified that is contingent upon the completion of several other tasks, it is probably advisable to enumerate all of these tasks before selecting one to trace on back to the beginning of the program. Naturally, all of the tasks will have to be traced back before the charting process is complete.

Preparation of the initial charts is an iterative process and assumes that a number of reviews will be made by knowledgeable individuals and their comments reflected in subsequent drafts of the preliminary chart.

During this preliminary planning stage an effort should be made to have the diagram reflect all tasks that everyone thinks essential. Furthermore, wherever tasks ideally should be conducted sequentially, they should be shown as sequential on the chart. When this procedure ultimately reveals schedule conflicts, compromises can be made. The logic adopted initially will likely be modified a number of times before even the first preliminary draft of the chart has been completed. Arrangements that seemed logical initially will be discovered to be inconsistent as the plan develops, and new approaches and subdivisions of activities will be required.

Every good program planner knows that no amount of careful thought and foresight will result in the identification of all problem areas that will interfere with progress once the program is underway. Consequently, he will either explicitly or implicitly build into the program plan contingency factors. In some cases there will be sequences of activities that can be completed ahead of the time when contingent tasks begin. In these cases the waiting time and contingency factors can be identical and the problem is solved automatically, so to speak. In the critical path (that sequence of activities which will take the most elapsed time to complete) there will be no waiting times so that contingency factors must be interjected into this sequence of activities. They may be explicitly identified as contingency time or they may be implicitly imbedded in other tasks in the program. For example, management reviews or evaluations can be "padded" with the additional contingency time required for a viable program plan.

The best program plan will result when the final preliminary draft of the planning diagram reflects the understanding of all the individuals responsible for executing portions of the program plan. Their backgrounds and experiences will permit them to see discrepancies and inadequacies in the plan which any single man could not possibly see. In particular, they will tend to view the plan from their own organization's point of view and can be expected to scrutinize critically those areas for which they will have some responsibility. Some of their comments will not be compatible with the overall program philosophy or with the requirements of other organizations involved in the planing process. Someone will need to arbitrate the special interests of individuals reviewing the plan. It is important, however, to attain a degree of concurrence among all individuals before the planning diagram is finalized. Each of the involved individuals should consider the plan to be his plan, reflecting his judgment of what must be done to achieve the stated program objectives. The program manager, who is responsible for the overall direction of the program, must be a primary participant in these negotiations, naturally.

Not every program will require such detailed planning. The process of periodically reviewing and revising the detailed plans is time consuming and may be completely unwarranted where the pressures of time do not force the performance of many tasks simultaneously. Where all major program activities can be scheduled for performance sequentially the process of planning is greatly simplified. Referring to Figure 3, again, it will be noted that the first major undertaking in the example is the formulation of a total system concept. The second major undertaking is the development of an order processing module. The third is the development of a systems and procedures module, and so on for the rest of the thirteen modules in the example. It is assumed that the development of each module is substantially completed before initiating the development of the next.

Using the less detailed planning approach the interrelationship among the several major activities that could be undertaken in formulation of a total system concept are summarized in Figure 7. It will be seen that the second, third, and fourth activities could be scheduled to occur simultaneously, if the necessary personnel to undertake them were available. However, there is no reason why they could not be performed sequentially.

Taking the same gross planning approach the interrelationship among the various activities that might be undertaken to develop one of the modules are summarized in Figure 8. This generalized planning network could apply equally well to any of the modules.

Statement of Work

Those responsible for estimating the magnitude of work to be performed in each activity will require some knowledge of the scope of each activity. A generalized statement of work for the development of any one of the modules (Figure 8) might look as follows:

1) Formulate Module Objectives

The objective of the module must contribute to achieving the objectives at all higher levels in the objectives hierarchy (Figure 2). In addition to a generalized statement of objectives for the module, a comprehensive list of specific objectives needs to be formulated, in particular, what functions the module must perform; in other words, what products the module must produce. In performing this task attention needs to be paid both to the generalized objectives of the parent organization as well as to the present activities of the existing operations which imply objectives themselves. The design concepts finally adopted will reflect these objectives.

2) Document Existing Operations

In the process of formulating a total systems concept a great deal of documentation will have been assembled for all operations of the library. However, the emphasis there was on interfaces among operating units of the library. In executing the present task the emphasis is on detailed inputs, outputs, external constraints, processing information needs, resource requirements, and detailed procedures. This task must be concerned not only with specific items, such as books or forms, but also with specific data elements utilized or generated within the operation.

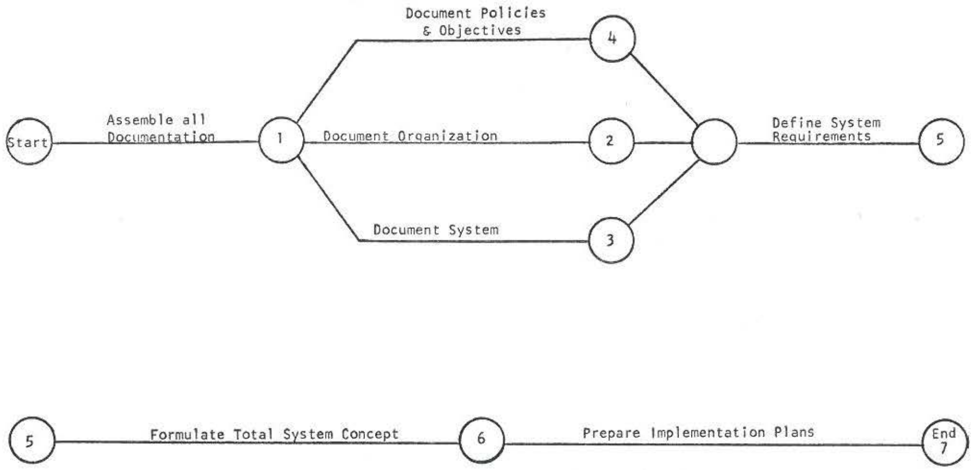


Fig. 7. Total System Concept Formulation Planning Network.

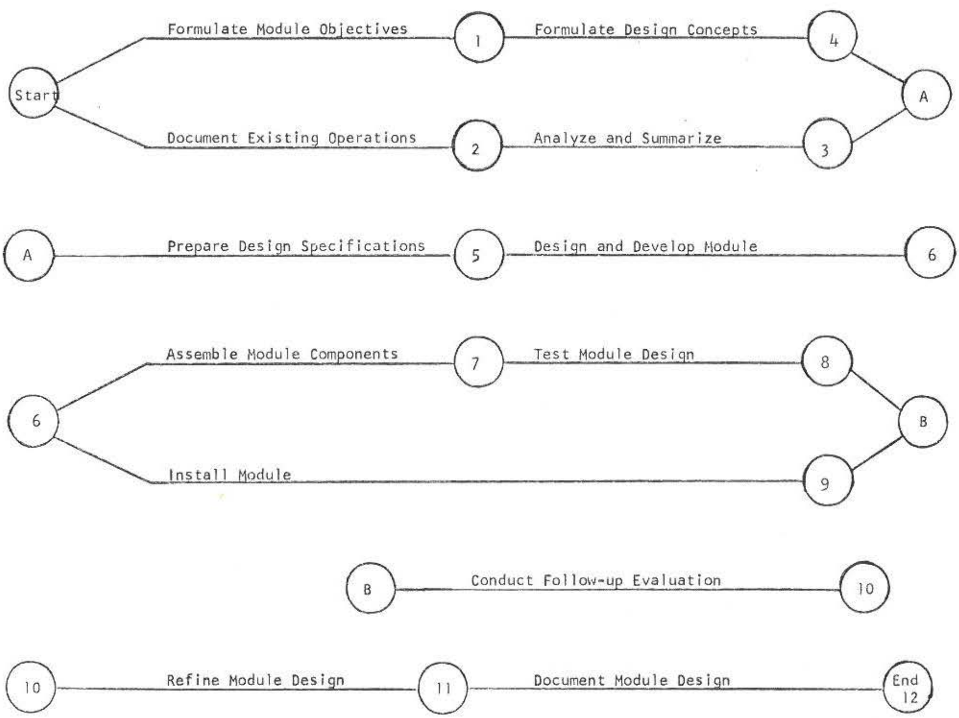


Fig. 8. Generalized Module Development Planning Network.

3) Analyze and Summarize

The previous task provided the data necessary for putting together a comprehensive picture of the existing operation. The mass of data and materials which were collected need to be summarized, in a way which presents a concise display of the significant characteristics of the operation. All significant measurable parameters need to be identified. Those capable of succinctly characterizing the operation must then be measured under carefully controlled, typical operating conditions to provide an accurate picture of current costs and effectiveness of the operation. This task should culminate with the informal publication of a module parameter summary.

4) Formulate Design Concepts

Once the module objectives have been formulated, various alternate means for achieving these objectives can commence to be discussed. One important objective of this particular task is the identification of as many alternate approaches to satisfying the objectives as can be conceived. In this regard "brainstorming" sessions are useful (19,20). The fullest range of techniques and devices available should be explored for possible use in the implementation of the system module. During early stages in the development of a design concept little concern is paid to even the obvious design constraints. Eventually, of course, a system concept must be postulated which satisfies these contraints, but initially even impossible approaches may suggest others which are possible, so that all alternatives will be considered in the beginning. Before a design concept is finalized the result of the systems analysis of the existing operations should be evaluated. When a single set of concepts is finally selected, estimates of development and operating costs for a new module based on the concept, together with its projected effectiveness, should be made and compared with those of the existing operation. The design concept document should describe all functions to be performed by the module, as well as special techniques or items of equipment which will be used.

5) Prepare Design Specifications

Based on the generalized descriptions in the design concept document, detailed specifications for the module are prepared. These specifications include such considerations as: the numbers, kinds, output formats, accessibility, and frequency of various management reports; the number of processing stations of various kinds; a comprehensive list of record contents; a description of all files required by the module; descriptions of all forms required by the module; personnel requirements and organizational descriptions; office layout; data processing machine software; equipment to be procured; timing of processes; and special module interface features. The documented design specifications should be circulated widely among operating personnel for comment and possible modification based on this comment.

6) Design and Develop Module

This task includes the development of detailed procedures for transforming the module inputs into all of the required module outputs. Machine programs must be written, forms designs finalized, file structures and record formats optimized, detailed operating instructions and procedures written, equipment interfaces confirmed, and personnel training programs developed, to name most of the more important undertakings. While no attempt should have been made at this point in the development of a system module to prepare final formalized documentation, enough background material should have been assembled to permit the preparation of such documentation.

7) Assemble Module Components

Special equipment must be procured. Interfaces between the library and a remotely located electronic data processing system must be established. Existing personnel must be retrained and new personnel recruited. New communication links, if required, must be installed.

8) Test Module Design

Every segment of the module design should be tested prior to its installation. New items of equipment or communication channels should be tested through many cycles to verify their operating characteristics, as well as to familiarize a few members of the staff with their operation. If a pilot operation of the module is possible, it should be undertaken. During the testing phase a continuing effort should be made to detect serious design deficiencies. The module should be exercised through several processing cycles, utilizing as many different variations of input data and output requirements as possible. Such a testing phase should evaluate the adequacy of the various forms and reports, as well as provide some preliminary information about the accuracy of the predicted operating costs for the new module.

9) Install Module

The first element of this task is the preparation of an installation plan. During the preparation of the installation plan early consideration needs to be given to the installation approach (phased, parallel, all at once) to be followed (21). During the changeover period special attention will need to be paid to operational problems as they develop. No system design is perfect and during the installation period major design deficiencies may become apparent. The major file conversion efforts are included in this task. This task culminates with turning the new module over to the operating personnel.

10) Conduct Follow-up Evaluation

During the new system's shakedown period it will have been forced to operate as intended by the designers and the department supervisor.

However, the real test of the workability of the system comes after this initial period when the system is "released" to run without any special attention being paid to it. After the system has been in operation for a period of time an evaluation of its effectiveness and the actual operating costs should be undertaken. Because no system is ever perfect, even a brand-new system may be significantly improved as a result of this follow-up evaluation.

11) Refine Module Design

If the follow-up evaluation has disclosed any design deficiencies, a modification of the original module design is undertaken where the cost of correcting the deficiency is not greater than the value of the improved operation.

12) Document Module Design

After warranted modifications to the module design have been made as the result of the follow-up evaluation, the module design and operating instructions should be formally documented and released. Until about this point in time the module design parameters may have been undergoing a process of gradual evolution, so that formal documentation of them may not have been justifiable. Full and careful documentation of the new module design completes the module development project.

Estimating

Once the preliminary plan has been completed and approved, estimates of manpower, equipment, and materials requirements can be made. Some people find it convenient to mark the various estimates on the PERT planning diagram itself, using different colors for each of the estimators. This has the advantage of displaying all previous estimates to each individual attempting to provide estimates for other activities in the program. However, this approach results in estimates being made on the spot without the careful deliberation and evaluation which they deserve and, therefore, probably is not advisable.

The use of estimation worksheets can be effective. A worksheet that has been prepared for the example program is presented as Figure 9. (Note that a task breakdown has been included for illustrative purposes in the first two program elements, only.) Each planned activity is entered on the form, where activities have been numbered in their general order of occurence. Enough copies of these forms are then made so that each organization can have its own full set to use for estimating.

The responsible individual in each organization provides estimates of required manpower, elapsed time, materials costs, and special equipment or facilities based on his understanding of the job. Estimates of manpower requirements are made by category of manpower, except where a specific individual must be applied to a specific task. In such cases this individual

No.	PROGRAM ELEMENTS	MONTHS ELAPSED TIME	EQUIPMENT	SERVICES & MATERIALS	MAN HOURS BY CATEGORY* 1	2	3	4	5
A	TOTAL SYSTEM CONCEPT	18	0	0	1800	1500	1600	--	--
1	Assemble Documentation	5	--	--	200	200	100	--	--
2	Document Organization	2	--	--	100	100	200	--	--
3	Document System	10	--	--	1000	1000	800	--	--
4	Policies and Objectives	5	--	--	100	100	200	--	--
5	Define System Requirements	1	--	--	200	--	100	--	--
6	Total System Concept	1	--	--	100	50	100	--	--
7	Implementation Plan	2	--	--	100	50	100	--	--
B	ORDER PROCESSING MODULE	26	$25,000	$23,000	1500	1600	2000	3000	800
1	Formulate Objectives	3	--	--	100	10	10	--	--
2	Document Operations	4	--	--	100	50	200	--	200
3	Analyze and Summarize	3	--	--	100	50	200	--	100
4	Design Concepts	1	--	--	50	50	100	100	--
5	Design Specifications	1	--	--	50	10	90	100	--
6	Design and Develop	12	--	$18,000	600	200	600	1500	100
7	Assemble Components	1	$22,000	--	50	10	100	--	--
8	Test Design	1	--	$ 3,000	50	--	90	150	--
9	Install Module	2	$ 2,000	$ 1,000	100	1000	100	150	400
10	Follow-up Evaluation	1	--	--	50	20	100	200	--
11	Refine Design	1	$ 1,000	$ 1,000	50	50	100	300	--
12	Document Design	3	--	--	200	150	300	500	--
C	SYSTEMS & PROCEDURE MODULE	18	$ 1,000	$ 3,000	4000	3000	700	200	500
D	MATERIAL PREPARATION MODULE	6	$ 1,000	$10,000	200	200	500	500	--
E	CIRCULATION MODULE	18	$41,000	$15,000	2000	2000	2000	3000	2000
F	USER EDUCATION MODULE	18	$10,000	$10,000	1000	400	500	2000	--
G	INVENTORY CONTROL MODULE	6	$ 2,000	$ 6,000	100	300	500	300	--
H	PERSONNEL CONTROL MODULE	12	$ 1,000	$10,000	1000	500	1000	700	--
I	CATALOGING MODULE	24	$35,000	$30,000	4000	1000	3000	4000	--
J	LIBRARY ACCOUNTING MODULE	12	$ 2,000	$10,000	1000	500	1000	2000	
K	MATERIALS SELECTION MODULE	12	$ 7,000	$ 6,000	1000	200	1000	1000	--
L	MANAGEMENT INFORMATION MODULE	18	$ 8,000	$10,000	1000	300	2000	1000	--
M	REFERENCE MODULE	24	$10,000	$15,000	2000	2000	3000	3000	--
N	INFORMATION RETRIEVAL MODULE	36	$50,000	$30,000	4000	2000	4000	5000	--

* (1) Librarian, (2) Clerk-Typist, (3) Analyst, (4) Programmer, (5) General Assistance

Fig. 9. Cost/Time Estimates.

is identified as a separate category of manpower and estimates are made separately for him. When all estimates have been completed, the costs are summarized by funding categories, as has been done for the example in Figure 10, and the elapsed time estimates are marked onto the planning diagram.

Scheduling

An elapsed time analysis is performed to determine the estimated time of completion for every event in the program. This is accomplished by adding together all the estimated elapsed times in a sequence of activities, and indicating at each event marker the cumulated elapsed time to that point. Where several sequences of activities converge on a single

NO.	PROGRAM ELEMENTS	GENERAL ASSIST-ANCE	ACADEMIC SALARIES	NON-ACADEMIC SALARIES	SUPPLIES & EXPENSES	EQUIPMENT & FACILITIES	TOTAL COSTS
A	TOTAL SYSTEM CONCEPT	$ --	$ 10,500	$ 16,050	$ 2,000	$ --	$ 28,550
1	Assemble Documentation						
2	Document Organization						
3	Document System						
4	Policies and Objectives						
5	Define System Requirements						
6	Total System Concepts						
7	Implementation Plan						
B	ORDER PROCESSING MODULE	2,200	8,700	19,320	39,050	25,000	94,270
1	Formulate Objectives						
2	Document Operations						
3	Analyze and Summarize						
4	Design Concepts						
5	Design Specifications						
6	Design and Develop						
7	Assemble Components						
8	Test Design						
9	Install Module						
0	Follow-Up Evaluation						
1	Refine Design						
2	Document Design						
C	SYSTEMS & PROCEDURE MODULE	1,375	23,200	13,350	4,070	1,000	42,995
D	MATERIAL PREPARATION MODULE	--	1,160	4,290	12,675	1,000	19,125
E	CIRCULATION MODULE	5,500	11,600	20,400	31,050	41,000	109,550
F	USER EDUCATION MODULE	--	5,800	5,230	20,700	10,000	41,730
G	INVENTORY CONTROL MODULE	--	580	4,560	7,600	2,000	14,740
H	PERSONNEL CONTROL MODULE	--	5,800	8,850	13,750	1,000	29,400
I	CATALOGING MODULE	--	23,200	25,200	51,400	35,000	134,800
J	LIBRARY ACCOUNTING MODULE	--	5,800	8,850	20,700	2,000	37,350
K	MATERIALS SELECTION MODULE	--	5,800	8,040	11,350	7,000	32,190
L	MANAGEMENT INFORMATION MODULE	--	5,800	15,810	15,350	8,000	44,960
M	REFERENCE MODULE	--	11,600	27,900	31,050	10,000	80,550
N	INFORMATION RETRIEVAL MODULE	--	23,200	35,400	56,750	50,000	165,350
	TOTALS	$ 9,075	$142,740	$213,250	$317,495	$193,000	$875,560

Fig. 10. Costs by Budget Category.

event marker, that sequence requiring the longest period of time determines the cumulative elapsed time to reach that event.

Those sequences which require less time will have slack time (waiting time) built into them and this can be used for adjusting schedules to minimize peak manpower, equipment, or facilities loading. When the cumulative elapsed times for each event have been determined for the entire program the preliminary scheduling activity can commence. It is convenient to use tenth's of forty-hour-work weeks in expressing elapsed times because 1/10th of a week equals a half day, which often seems to be a good minimum unit of time for estimating purposes.

When the elapsed time analysis is complete it may be determined that the total elapsed time estimated for the program is incompatible with the required program completion date. If this happens, it will be necessary to reinspect the program logic in an effort to identify activities originally planned to occur in sequence which can, in fact, be performed in parallel. Such a change in the plan, however, will almost always imply increased risks. Sometimes it will be possible to compensate for the increased risk by additional backup efforts, or by assigning the same activity to two different groups for simultaneous parallel performance. Upon closer scrutiny it may be found that some of the activities originally thought essential are, in fact, merely desirable and can be eliminated from the plan entirely. Eventually, this strategy will force the planned program elapsed time to be compatible with the program completion date specified by the program manager.

In establishing schedules for activities, it is always best to leave any available slack at the end of a sequence of activities rather than at an earlier time in the sequence. Because the above approach to scheduling may produce undesirable manpower peaks or unreasonable work schedules for individuals, early drafts of the schedule likely will need to be modified significantly before the draft can be finalized. A preliminary schedule is prepared by charting on a graph the earliest beginning and ending time for each activity identified in the plan. In Figure 11 such a schedule has been graphed. Tasks which are not contingent upon anything other than the start of the program (Tasks 1 and 2 in Figure 8) can be scheduled to commence on the first day of the program and be scheduled for completion in the estimated elapsed time for each one. For example, if Task 1 had been estimated to require an elapsed time of three months the graph would show a bar starting at the beginning of the program and running out to the third month. Some of the tasks (Tasks 3 and 4) depend on the completion of earlier tasks. Thus, Task 4 (in Figure 8) could not commence until the third month. Then, if the elapsed time to complete that task had been estimated at one month, the bar for that task would begin at the third month and end on the fourth month. Similarly, all tasks are scheduled in this way for the entire program.

Utilizing the other estimations (See Figure 9) and making reasonable assumptions about how the man-hours are distributed in time for each task, the total number of man-hours by category can be calculated for any week in the program. If it were assumed, for example, that the expenditure of personnel time was evenly distributed throughout each of the tasks, and if two tasks were scheduled during the same week, with an average of 15 hours per week for one task and 25 hours per week for the second, a total of 40 man-hours of labor of that particular category would be estimated to be expended during the week in question. This sort of analysis is continued until the estimates of man-hour expenditures by category are available for each week of the program.

Now it is possible to analyze any period of activity in the planned program to determine what level of each category of manpower or special

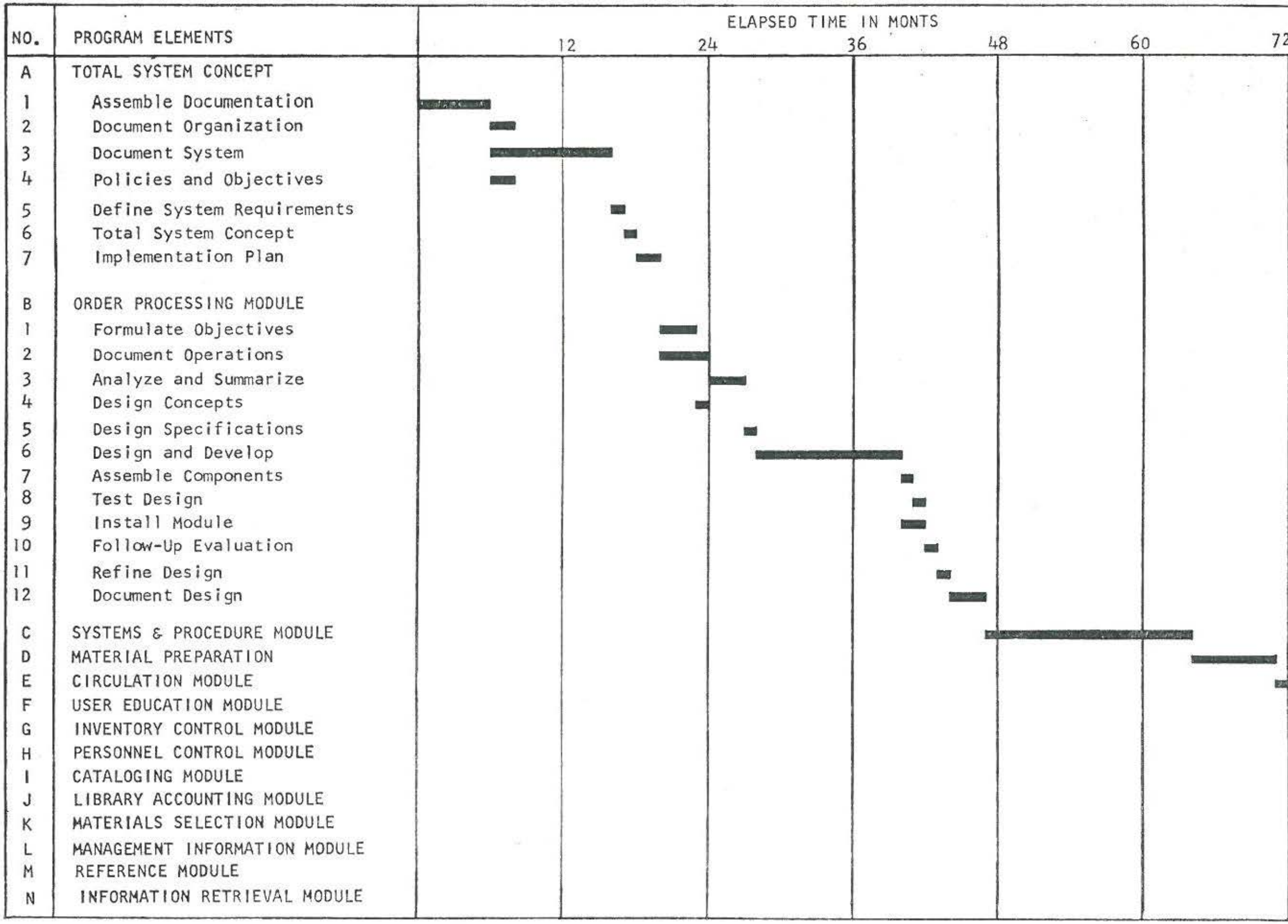


Fig. 11. Systems Development Program Schedule.

facilities will be required during that period. During the first months of a typical program there will be heavy demands made on various categories of manpower. Furthermore, later in the program there will be periods when practically no demand is made for the same categories of manpower. It usually would be desirable to minimize the peaks by shifting some of the activities to later times when fewer demands were being made. It is almost always possible to accomplish some shifting of schedules in a typical program.

After an evaluation of the manpower loading implications of various scheduling alternatives a program schedule like that shown for the example in Figure 11 might be adopted.

Based on the cost/time estimates presented in Figures 9 and 10 and the program schedules presented in Figure 11, resources requirements by year can be developed for the life of the program. The manpower loading chart (Figure 12) shows manpower requirements for each of the four categories of skills specified. The cost phasing chart presented as Figure 13 shows funding requirements by category for each year of the program. It would be possible, of course, to further break down the costs into individual accounts as discussed in the section describing the work breakdown structure. A much tighter time phasing of all categories of costs is required for program control, but that subject is beyond the scope of the present article.

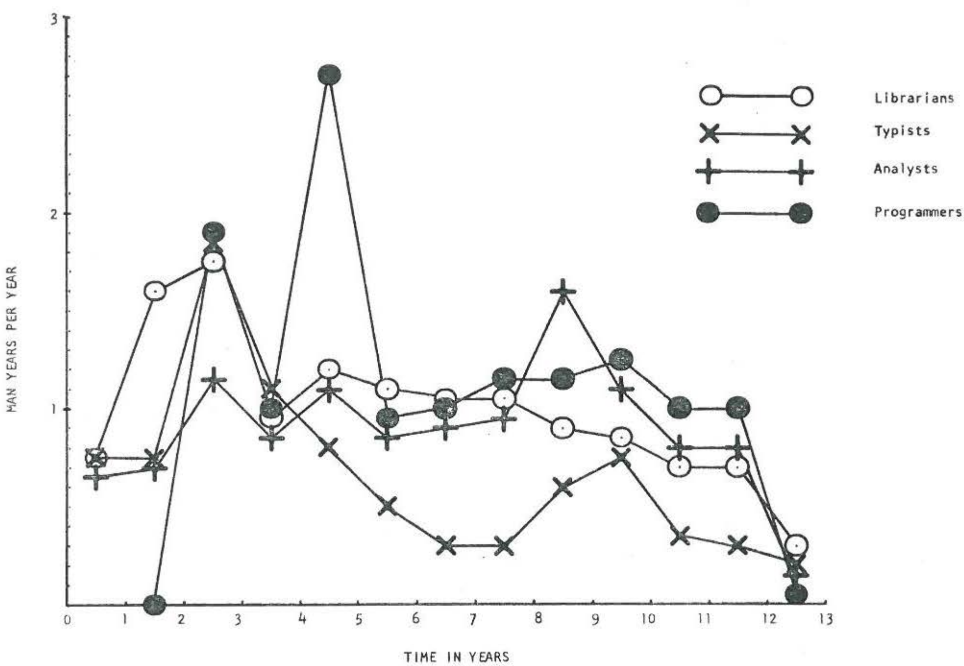


Fig. 12. Manpower Loading Chart.

YEAR	MAN HOURS BY CATEGORY*					COSTS BY CATEGORY**					
	1	2	3	4	5	GA	Ac.Sal.	N-Ac.Sal.	S & E	E & F	Total
1	1,300	1,300	1,100	0	0	0	8,000	12,000	-	-	20,000
2	2,800	1,300	1,200	0	300	1,000	16,000	12,000	2,000	1,000	32,000
3	3,400	3,600	2,400	3,500	1,000	3,000	20,000	37,000	10,000	0	70,000
4	1,800	1,700	1,800	2,200	1,500	4,000	10,000	17,000	46,000	25,000	102,000
5	2,300	1,500	2,200	5,200	500	1,000	13,000	15,000	80,000	55,000	164,000
6	2,000	900	1,600	1,800	0	0	12,000	9,000	14,000	1,000	36,000
7	2,000	500	2,000	2,000	0	0	12,000	5,000	51,000	35,000	103,000
8	2,300	500	2,000	2,300	0	0	13,000	5,000	11,000	7,000	36,000
9	1,700	1,200	3,000	2,200	0	0	10,000	12,000	46,000	8,000	76,000
10	1,800	1,500	2,200	2,500	0	0	10,000	15,000	0	10,000	35,000
11	1,400	700	1,500	2,000	0	0	8,000	7,000	57,000	0	72,000
12	1,400	500	1,500	2,000	0	0	8,000	5,000	0	50,000	63,000
13	400	300	300	0	0	0	2,000	3,000	0	0	5,000
TOTAL	24,600	15,500	22,800	25,700	3,300	9,000	142,000	154,000	317,000	192,000	814,000

*(1) Librarian (Academic Salaries) (@$5.80/hr.), (2) Clerk-Typist (Non-Academic Salaries) (@$2.70/hr.) (3) Systems Analyst (Non-Academic Salaries) (@$7.50/hr.), (4) Programmer (Supplies & Equipment) (@$5.35/hr.), (5) General Assistance (@$2.75/hr.), NOTE: 1,800 working hours per year used.

** Costs rounded to nearest $1,000

Fig. 13. Systems Development Program Cost Phasing.

THE "COMPLETED" PLAN

When the planned program is finally compatible with the externally imposed constraints and when there is a reasonable degree of concurrence among all the involved organizations, it is generally desirable to formalize the documentation. The temptation to consider the document unchangeable will be eliminated if it is pointed out that individual dates in the schedule reflect current "best estimate" targets, and that planning and rescheduling will be a continuing effort throughout the program.

The wide availability of program plans permits all involved individuals to assess the impact of their efforts on the overall program. Furthermore the PERT planning diagram provides them with a convenient means for recording their performance against the program goals. Finally, the cost and benefits data contained in the plans are major inputs to any Planning-Programming-Budgeting System (PPBS) and this more rational approach to partitioning limited resources among the many competing activities of large institutions, like universities, is going to become an increasingly significant part of library operations in the future (22, 23, 24).

No plan is ever final. It must be periodically reevaluated and warranted modifications reflecting newly identified requirements or changes in the operating environment, etc., must be made. It is an axiom of total systems design that the implementation of earlier parts of a system may so significantly modify the actual operating environment as to dictate major changes in the design specifications for other parts of the system to be implemented later. Thus, a total system is much more likely to evolve, than to unfold according to some predetermined design. We must continue to expect systems work to "evolutionize" rather than revolutionize library operations.

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REFERENCES

1. Hayes, R. M.: "Concept of an On-Line, Total Library System," *Library Technology Reports,* (May 1965), 13.
2. De Gennaro, Richard: "The Development and Administration of Automated Systems in Academic Libraries," *Journal of Library Automation,* 1 (March 1968), 75-91.

3. George, C. S., Jr.: *The History of Management Thought* (Englewood Cliffs, N. J.: Prentice-Hall, 1968).
4. Roberts, Edward B.: "Industrial Dynamics and the Design of Management Control Systems," In *Management Controls,* edited by Charles P. Bonini (New York: McGraw-Hill, 1964), pp. 102-126.
5. "Feedback," *The Systemation Letter,* 166 (1966).
6. Wheeler, J. L.; Goldhor, H.: *Practical Administration of Public Libraries* (New York: Harper and Row, 1962).
7. Deardon, John: "How to Organize Information Systems," *Harvard Business Review,* 43 (March 1965), 67-73.
8. "How a System is Built," *The Systemation Letter,* 186 (1966).
9. "Analysis Check List," *The Systemation Letter,* 12 (1958).
10. Holtz, J. N.: *An Analysis of Major Scheduling Techniques in the Defense Systems Environment* (Santa Monica, California: The Rand Corporation, 1966).
11. Minnich, C. J.; Nelson, O. S.: *Systems Management for Greater Profit and Growth* (Englewood Cliffs, N. J.: Prentice-Hall, 1966), pp. 16-34.
12. National Aeronautics and Space Administration: *NASA PERT in Facilities Project Management* (Washington, D.C.: U. S. Government Printing Office, March 1965), pp. 9-11.
13. Kadet, Jordan; Frank, Bruce H.: "PERT for the Engineer," *IEEE Spectrum,* 1 (November 1964), 131-137.
14. Management Systems Corporation: *DOD and NASA Guide PERT COST System Design* (Cambridge, Massachusets: June 1962), 145
15. National Aeronautics and Space Administration: *NASA-PERT "C" Computer Systems Manual* (Washington, D.C.: Government Printing Office, September 1964).
16. PERT Coordinating Group: *PERT Guide for Management Use* (Washington, D. C.: U. S. Government Printing Office, June 1963).
17. *PERT . . . a Dynamic Project Planning & Control Method. IBM General Information Manual* (White Plains, New York: IBM Data Processing Division), 28 pp.
18. Navy Department, Special Projects Office: *An Introduction to the PERT/COST System for Integrated Project Management* (Washington, D. C.: U. S. Government Printing Office, 1962).
19. "Brainstorming: Cure or Curse?" *Business Week,* 1426 (December 1956).
20. Osborn, Alex: "Brainstorming, New Ways to Find New Ideas," *Time,* 99 (February 1957), 90.
21. Systems and Procedures Association: *Business Systems* (Cleveland; 1966).
22. "Planning-Programming-Budgeting, Selected comment prepared by the Committee on Government Operations, United States Senate, July 26, 1967 (Subcommittee on National Security and International Operations).

23. Hartley, Harry J.: *Educational Planning-Programming-Budgeting: A Systems Approach* (Englewood Cliffs, New Jersey: Prentice-Hall, 1968).
24. Fazar, Willard: "The Importance of PPB to Libraries," Presented to the Institute on PPBS for Libraries, Department of Library Science, Wayne State University, Detroit, Michigan, September 23, 1968.