



# Analysis and Evaluation of Current Library Procedures

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CHARTING a new course implies a knowledge of one's present position. Thus, analysis of present procedures is the logical prelude to design of a new system. Analysis consists essentially of detailed description by means of special techniques such as charting and sampling. Evaluation is a special aspect of analysis and dependent upon it. It implies comparison and tells us where we stand with regard to a formal standard, in relation to others, or in relation to ourselves at some other point in time. It thus stands between pure analysis and systems design.

The broad terminology of analysis is not precise. Although the word analysis appears as part of the term systems analysis, the former is only one phase of the latter, which implies a total systems approach. Analysis, as used in this article, is roughly parallel to the descriptive aspect of work-study. It implies more analytical depth than the term work simplification, and more variety of approach than operations research. The latter, depending heavily on mathematics, is covered elsewhere in this issue.

This article follows the traditional breakdown of work-study: the study of method, and then the determination of times and costs. This is followed by a look at some of the recent developments in evaluation of library services. Finally, there is a discussion of the role of sampling in the analysis of library procedures. It is assumed that the analyst begins with a clear idea of the administrative and physical organization of the library, as represented by organization charts, policy manuals and personnel job descriptions.

The purpose of method study (method analysis, motion study) is to set forth in detail the steps of a procedure and the sequential and other

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relationships between them. There are two basic categories for study. First, one may analyze the person or machine creating the product. This category is most often used when a highly detailed description of operations is wanted. Second, one may study the product being created, such as forms, files, catalog cards or book labels. Many of the standard techniques of methods analysis are applicable to either approach.

The chief technique employed by the methods analyst is the flow chart, which indicates graphically the sequence of operations upon data. There are two general types. The flow process family of charts is appropriate to record essentially repetitive tasks, which allow for few alternatives. However, where procedures contain many possible alternatives (subprocedures), a decision flow chart is often more appropriate.

Flow charts also differ in their level of detail. Analysis normally begins with a gross breakdown, giving an overview of the library, department, section or function. Succeeding charts increase the number of steps. If the detail is still not sufficient, then each step of the chart is treated as a new task to be analyzed. This process continues until the amount of detail achieved is sufficient for the purpose for which it is to be used.

Flow process charts, as mentioned above, give a picture of the steps in a relatively repetitive process. The steps are numbered serially, and classified according to whether they are operations, transportations, inspections, delays or storages. Distances, and often times, are recorded. These charts are especially effective at showing up excessive movement of people or material. To this end they are sometimes accompanied by a flow diagram. This is simply a scale diagram of the work area being studied, with the actual movement from work station to work station indicated as lines.<sup>1</sup>

Sometimes it is desirable to concentrate attention on a repetitive procedure being done at a particular work location, such as a desk or a charging machine station. This sort of study is usually called operations analysis, and is carried out by means of an operations chart. Such charts use essentially the same symbols and classification of steps as a flow process chart, although they chart each involved body member separately. Thus in two-handed activity the movements of each hand will be shown and correlated. If need be, even foot and eye movements may be recorded.<sup>2</sup>

The basic flow process chart is designed to follow only a single per-

son or product. Sometimes, however, it is necessary to describe work performed by a person whose work is coordinated with one or more other persons or machines. For this purpose so-called multiple activity charts have been developed. The gang process chart, a variety of flow process chart, allows the analyst to describe activities requiring several persons—for example, a large scale shifting of books to a new location.<sup>3</sup> The man-machine chart relates the actions of employees and the machines they use. The activity of each person or machine is charted in a separate column and correlated by means of a common time scale.<sup>4</sup>

The decision flow chart is appropriate to record procedures involving several alternative possibilities for action. Such charts consist of a series of standard enclosed symbols representing steps. These symbols contain appropriate descriptive words and are connected to one another by arrows showing the sequence of activity. The key symbol is a question box, which contains a question which can be answered yes or no, and has a yes and a no arrow leading from it. Although such analysis is very useful for manually performed operations, its binary nature makes it of particular interest when considering the possibility of automating procedures.<sup>5</sup>

The decision table, another way of recording alternative courses of action, has yet to receive from librarians the interest it deserves. It consists of a conditional section listing the various possible alternatives, with appropriate cross references to an action section listing the required courses of action for each alternative. Unlike the decision flow chart, which also shows operations, storage, etc., the decision table is concerned only with alternatives. Thus it does not indicate the temporal sequence of a procedure (although a series of tables can indicate a sequence of alternatives). However, for a complex decision with many alternatives the rectangular table format can be more convenient than the long series of question boxes into which such a situation would have to be resolved on a decision flow chart.<sup>6</sup>

Because forms hold in compact form the end results of a large amount of library effort, study of them is of particular interest in library systems analysis. Such analysis will hopefully lead a library eventually to a complete forms control program. A first step is an inventory of all the library's forms and files, which are then analyzed in a variety of ways.

Processing of single copies of a form may be described by a flow process chart. The relationship to each other of multiple copies of a form is, however, better seen by using a variation known as a form process

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chart. Different processing locations are indicated by separate columns. Each copy of the form is assigned a number and its course shown by means of lines and process chart symbols annotated by brief phrases.<sup>7</sup>

Since forms processing involves the use of files, it is sometimes useful to center attention on the latter. The (1) files themselves, (2) the work units responsible for maintaining them, and (3) the various standard file management functions (file created, file searched, etc.) may be related to each other in three different two-dimensional matrix patterns (1-2, 1-3, 2-3). Such analysis calls to attention gaps and overlaps with regard to responsibility and authority.<sup>8</sup>

It is important to know the extent to which elements of data (author, title, etc.) are common from one form to another. This may be shown by means of a two-dimensional data structure matrix, with forms in use listed along one axis and the various data elements along the other. Each element is checked under each form to which it applies. A line of checks (or row, if axes are reversed) indicates commonness of data from form to form. The point for initial entry of an item of data may be circled.<sup>9</sup>

Libraries often find that they must design many of their own forms. Another aspect of analysis is, therefore, to examine such forms to determine their suitability for the task for which they are being used. This analysis includes such things as space allocation, data sequence (to facilitate data transfer or use) and preprinting of instructions and other information.<sup>10</sup>

Work measurement (time study) is concerned with determining how long it takes to accomplish a task. Such measurement is necessary to establish fair performance standards and to calculate systems costs. Since it is necessary to have an accurate idea of what to measure, such study usually presupposes a certain amount of method analysis.

There are three major varieties of work measurement: continuous time study, work sampling and diary studies. In continuous time study an analyst with a stopwatch directly observes and records the time required for a given employee to accomplish each step of a particular task done in a particular manner. The situation is complicated by the fact that the employee is usually working either faster or slower than "normal," so that the analyst has to adjust the observed time to "normal time" by a rating factor. Clearly this requires considerable skill and experience. The normal time is then adjusted for worker allowances to make a fair performance standard. This one-to-one observation is useful in the measurement of low level repetitive tasks. However, it is not

well suited to less uniform activity, is very time consuming (and hence expensive), and can easily irritate employees, who resent being timed like rats in a maze.<sup>11</sup>

This resentment can sometimes be alleviated by substituting work sampling (activity sampling) for direct observation. Where circumstances allow several different workers to be observed by a single analyst, the cost is also lower than direct stopwatch study. Work sampling consists essentially of making random observations of workers and recording what is being done at the moment of observation. If care is taken to follow proper statistical procedures, idle times, the amount of time spent on various activities and performance standards can be calculated within reasonable tolerances.<sup>12</sup> One interesting recent work sampling development has been the use of a pocket-sized battery-operated mechanism which emits an audible signal at random intervals. The librarian carries the device on his person and records what he is doing at the moment of the sound.<sup>13</sup>

At the professional, managerial level diary study (work study) is often the best way to determine the times spent on different activities. A rather detailed list of activities performed by the personnel in question is developed. Then, following an agreed-on procedure, the staff member himself records the time he spends on the various listed activities. If output is measured at the same time, it is possible to compute unit times for it. This do-it-yourself analysis has great potential for professional library work, and should be employed more widely than it has been to date.<sup>14</sup>

The three general methods described above enable the analyst to measure only the performance of a given worker in a given library. Ideally, however, data collected by one library could be compiled into a catalog of standard motions or tasks, with times assigned to each operation. Another library could then consult this catalog to determine how much time it would take to perform a given task. A small start has been made at determining standard time units for certain repetitive library operations such as pasting book pockets.<sup>15</sup> However, a profession-wide effort is required for significant progress embracing broad areas of library activity.

Once times are known it is possible to determine costs. Cost analysis in connection with work-study should be distinguished from cost accounting. The latter is a management tool allowing continuous monitoring of the costs of an existing organization. Its primary value to the library administrator is to help give him day-to-day control over his

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library operation.<sup>16</sup> In contrast, work-study cost analysis requires a greater level of detail, and has as its objective the evaluation of various ways of executing operations, to help decide the design or redesign of a given system.

Costs are normally classified as to whether they are direct (labor, supplies) or indirect (depreciation, overhead).<sup>17</sup> The greatest single expense is usually labor. Many librarians would be aghast (if they knew them) at their standard costs per unit of work produced. This standard cost takes into account (in addition to salary) daily nonproductive time (such as coffee breaks), vacation, holidays, sick leave, personal leave, and employer contributions to company pension, social security, and health, hospitalization and other group insurance. Such benefits, even excluding daily nonproductive time, can easily consume fifteen percent of a library's salary budget.<sup>18</sup>

To consider equipment purchases as current expenditures—a common practice in libraries—distorts the cost picture, for it implies that the usefulness of the equipment will end with the current fiscal period. Normally a piece of library equipment has a useful life of several years. However, it usually depreciates in value over its useful life. There are various depreciation models from which the systems analyst may choose, varying in complexity and in accuracy for a given situation.<sup>19</sup> The book collection, a heavy investment in most libraries, would logically seem to be amortizable, and should normally be considered as such in systems analysis, even when the library's financial regulations do not allow this in the official budget.<sup>20</sup>

Overhead costs are those which cannot be assigned directly to particular operations. Examples include administrative salaries, building maintenance and repair, utilities, rent, and insurance on building and collection. Overhead costs are commonly allocated in proportion to direct labor costs. This procedure clearly encourages management to work toward library automation wherever feasible.

The library profession has made a small start toward the use of industrial cost techniques such as break-even analysis. This latter technique determines the magnitude of production required to make a particular method of production economical. Below a certain volume, one method is most economical; above this volume, another. A recent article has applied break-even analysis to determine when to photocopy Library of Congress proof slips, rather than to order sets of Library of Congress cards.<sup>21</sup>

For a variety of reasons it is very difficult to find useful cost data in

the library literature.<sup>22</sup> Valid cost comparisons from library to library are even more difficult than valid time comparisons. Whereas a time standard based on a standard method should be valid in any area so long as the work is the same and the method adhered to, costs will vary according to the labor and other rates for a given region or city, as well as with time.

The principal method for gathering quantitative data for library evaluation has been simple counting. Dissatisfaction with the analytic shallowness of this procedure has led to recent attempts to develop better methods. Between July 1966 and June 1968, supported by federal contract money, the Institute for Advancement of Medical Communication attempted to "develop methods for collecting objective data suitable for planning and guiding local, regional and national programs to improve biomedical libraries and the biomedical information complex."<sup>23</sup>

This team was able to develop an inventory of library services to individual users, a document delivery test (to determine the speed at which desired documents can be provided), tests for verifying citations and answering simple fact questions (to test a library's capability for basic reference service), and a mechanical sampling device (mentioned earlier in connection with work sampling) to encourage the collection by staff of reliable data on some major services (use of the card catalog, self-service photocopying, etc.) that until now have gone largely unmeasured except in one-time studies. The document delivery and basic reference tests are based on random samples of citations, underscoring the increasing importance of sampling for libraries. Although it is true, as the institute team states, that many of the techniques resulting from this work are also applicable to other types of libraries, the specific tests thus far developed are of use primarily for academic medical libraries.<sup>24</sup>

In July 1966, John I. Thompson & Company accepted a contract with Picatinny Arsenal, U.S. Department of the Army, to perform a study aimed at developing "criteria for evaluating the effectiveness of library operations and services" under the Army Technical Library Improvement Studies (ATLIS) program. One approach suggested is a review of existing library statistics on the basis of correlation analysis to "provide certain insights into current practices that could form the basis of effectiveness criteria."<sup>25</sup> A second idea is the use of a "paired-comparison" analysis to determine which of the many well-known management techniques (methods study, cost-effectiveness analysis, etc.) is the most appropriate for study of given library services and operations. A third

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approach requires the librarian to prepare, based on his library's mission statement, its goals and objectives, and the theoretical services and operations required to meet these goals. Then, by means of "utility analysis," he compares this theoretical situation with the real-life situation in his library. Although it contains some interesting ideas, this study (see Additional References) is not easy reading, and requires a fair amount of mathematical sophistication. It seems unlikely that it will have any widespread impact on the library profession in the foreseeable future.

Random sampling, already mentioned in connection with work sampling and the evaluation tests developed by the Institute for Advancement of Medical Communication, is a very powerful technique for the analysis and evaluation of library procedures. There is no doubt that the vast quantities of data to be analyzed in libraries will perforce increase its future use. All library education should include some knowledge of sampling, not to make librarians expert samplers, but to spread an appreciation of the potential of sampling among the profession as a whole.

Sampling is a compromise short-cut. We accept some tolerance in our answer in return for having to consider only a small proportion of the available data. The less tolerance we accept and the more insistent we are that the true answer is within the tolerance, the larger the required sample.<sup>26</sup>

It is possible to take random samples of either variables or attributes.<sup>27</sup> In the former we take into account the magnitude of some variable character for each of the objects or individuals observed. In the latter we merely note the presence or absence of some attribute in a series of objects or individuals and count the proportion or percentage which do or do not possess it. An example of sampling a variable would be determining the average number of days between the borrowing and return of library books. Work sampling is an example of attribute sampling.

Selection of the items to be included in the sample may be made by means of tables of random digits or permutations.<sup>28</sup> However, for a sizable sample it is much more efficient to do this by means of a computer. The numbers so generated are called pseudo-random, as they are computed in a completely deterministic way.<sup>29</sup> However, statistical tests have shown them to simulate true random numbers closely enough for practical purposes.

Sampling applications cover the gamut of library work: files, collection, staff and users. Files include the card catalog,<sup>30</sup> shelflist,<sup>31</sup> and cir-

ulation file.<sup>32</sup> Library collections are usually sampled by numbering locations, rather than books. If a unique number is assigned to each possible book location, then each book will have a unique number associated with it.<sup>33</sup> Staff may be analyzed by means of work sampling, which has already been discussed under time study. Similar random-time techniques may be used to sample library users.<sup>34</sup>

In conclusion, there is no shortage of appropriate techniques for the analysis of library operations. Many of those described here require no particular mathematical background, and are essentially extensions of common sense. Strengths and weaknesses of various techniques have been called to attention, and wider use by librarians of certain ones has been encouraged. This issue of *Library Trends* properly emphasizes analysis as the prelude to systems design. However, the librarian undertaking such analysis will also discover that, like virtue, it is to some extent its own reward.

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