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Quantitative Management in Libraries

Based on a position paper originally presented at the Institute on Quantitative Methods in Librarianship at Ohio State University Libraries in August, 1969, the author discusses some of the elements of management: motion, time and cost studies, operations research and other mathematical techniques, and data processing equipment.

Introduction

Modern management is a fusion of various pioneer approaches to the subject.[1] The operational school, popularized through the work of the French industrialist Henri Fayol (1841–1925), identified the activities or functions of managers and from these derived his principles of management. There is general agreement that the four major functions of all managers are planning, organizing, staffing, and control.

The traditional approach of the operational school has not been quantitative. Mathematics, or operations research, has been utilized extensively by business and government administrators in planning and control only since World War II. In the planning process numerical methods have proven particularly useful in evaluating alternative courses of action—that is, in providing a rational basis for decision making. The mathematics associated with operations research can be quite sophisticated, including calculus and linear programming, and with a heavy emphasis on mathematical models and optimal solutions.

The quantitative approach to control was developed by a second major management school. This approach, known as scientific management, achieved prominence through the work of the American engineer Frederick W. Taylor (1856–1915).[2] This school was concerned primarily with developing fair performance standards. Motion and time study techniques were developed and utilized. Although the approach from the beginning has been quantitative, the mathematics utilized tends to be much simpler than that of operations research. Often only addition, subtraction, multiplication, and division are needed. When equations are needed, basic algebra will usually suffice.

Although the library profession has not entirely ignored quantitative management, neither has it adopted it with any enthusiasm. Only one library school, Rutgers, has consistently emphasized this subject and made it an integral part of the curriculum. This was due primarily to the impact of Professor Ralph Shaw of Rutgers, long a leader in this area. The library literature devoted to quantitative management also is not extensive. In 1954 an issue of *Library Trends* (edited by Shaw) was devoted to "Scientific Management in Libraries."[3] But it was not until 1966 that the first book devoted entirely to applying quantitative management techniques to libraries appeared, written by former students of Shaw.[4] There is, however, gradually increasing library interest in the subject.

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Motion Study

The logical and necessary first step in the control process is to establish standards. Thus the development and utilization of performance standards is at the heart of scientific management. Since it makes no sense to perpetuate an inefficient procedure, and since a standard time has no meaning except in relation to standard methods, motion study is the prerequisite to time study. The chief technique for motion study is the chart, of which there are many varieties. Each chart has its strengths and weaknesses, and for any given management situation there will be one or more which is appropriate. The two major types are process and decision charts. The process group includes the flow process chart, form process chart, gang chart (for group efforts), and operations chart (for hand and foot motions at one work station).[5] They are appropriate for charting repetitive procedures, that do not involve too many yes-no alternatives. Decision charts, on the other hand, are appropriate for recording operations with many possible subprocedures—a common case in libraries.[6]

Activities charted may range over an entire building, or take place at a single desk. The basic procedure is to record the present method, to analyze it, and from this analysis to develop an improved method. The improved method may be timed in order to develop performance standards and/or used (in chart form) as a procedure manual for staff reference and the training of new employees. As may be seen from the examples listed in the references, as well as many others which have appeared in the literature, charting has been employed to describe and analyze a wide variety of library activities, both in technical and public services, and has even been used to analyze the reference process.

Motion study is the most useful of scientific management activities in libraries at the present time, and the savings it can produce are substantial. The fact that the mathematics involved is minimal is important because the mathematical ability of some librarians is also minimal. Charting is a possible undertaking where time study is not feasible—all persons experienced in making management studies know the resistance encountered when a time study is made. The typical employee finds a chart much less offensive than a watch.

Time Study

Time study is the most reliable method for determining performance standards. However, unless it is used with discrimination, it may result in more harm than good. Although industrial employees do not like the idea of being timed, they are at least used to the idea, as industry has timed operations for fifty years. In libraries, however, the idea is new, and employee resistance can be expected to be substantially greater. Professional librarians sometimes particularly resent the idea of their work being quantified. There is no question that it is easier to develop time standards for clerical than professional tasks. Nonetheless, professional library work does involve the expenditure of time, and the possibility of time study should not be ruled out. Even when time standards are impractical it may be possible to develop verifiable qualitative objectives and standards.

Another major obstacle in developing time standards in libraries is the necessity for rating the worker. The timer must decide whether the employee being observed is working faster or slower than "normal" so that he can adjust the observed time accordingly with a quantitative rating factor. Clearly, considerable judgment and experience are necessary here. Even professional study analysts find rating a difficult task. Thus it is advisable that libraries apply time analysis with considerable caution, and

certainly not until thoroughgoing motion study analysis has been carried out.

Another technique that can be used to collect time data, which avoids the use of a stop watch, is work sampling. Random observations are made to determine the proportions of productive and idle time, and the average rating factor for a job. These data, along with the number of units produced and the worker allowances for personal needs, fatigue and delay, provide the data needed to compute standard times.[7]

Cost

Cost standards are usually not as useful as time standards. Since cost is a function of time, the times must in any case be known before the costs can be computed. 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 is adhered to. Costs, in contrast, will vary according to the labor and other rates for a given region or city, as well as with time.

Gross salary figures are useful in estimation, but for analytical purposes it is necessary to relate cost to production. Many librarians would be aghast (if they knew them) at their actual labor costs per productive hour as compared to the hourly wage. With the decreasing length of the work week, and the increase in employer-paid benefits, this differential can only increase. If in addition to worker allowances, vacation, paid holidays, and sick leave, we add space costs, equipment depreciation and maintenance, supplies, supervisory costs, and time spent on conferences with supervisors or in staff meetings, the actual cost per productive hour may be close to twice the hourly wage.

In estimating costs, it is sometimes sensible to ignore overhead and/or depreciation and/or supply costs. However, they should not be omitted out of ignorance, for to do so is to delude oneself that the cost of an operation is less than it really is. Sometimes these costs are of real utility. For example, the idea of depreciation is most helpful in buttressing arguments for an expensive piece of equipment in those cases where a library system considers equipment purchases as current expenditures.

Comparison of Times and Costs Between Libraries

Once time data and/or costs based on them are collected by a library it is natural for it to want to compare them with data for similar operations in other libraries. This is not easy to do. Even when such data have been published, there are many variations in the methodology used for collecting, organizing and disseminating them. In addition, the tasks timed are seldom defined in sufficient detail, if at all, for library journals are limited in space, and the desired details are usually difficult to come by—if they were recorded in the first place. Full-text technical reports containing quantitative library data are increasingly available, but, without standardized collection and reporting procedures, such data are of limited utility for comparative purposes.

Ideally, 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 the catalog to learn how much time it would take it to perform a given task, just as a mathematician consults a table of trigonometric functions, rather than work out the value of the sine, cosine or tangent of a particular angle each time he needs it. A small start has been made at determining standard time units for certain repetitive library operations such as posting book pockets, both manually and by machine, using an electric eraser, finding the "Secret" page, and the like, but a profession-wide effort is required for significant progress embracing broad areas of library activity.

Operations Research

Operations research was first used extensively during the Second World War. Although it has since been used widely in industry, it has to date received little attention from librarians. A substantial portion of the literature applying operations research to libraries has been written by nonlibrarians: industrial engineers and other scientists. These scientists are too often either unable or unwilling to write in a style appropriate for librarians. Some librarians, on the other hand, are ignorant even of basic mathematics which they might reasonably be expected to know. The result is a communications gap of substantial proportions.

Operations research problems are generally classified as belonging to the following types: allocation, sequencing, inventory, replacement, queueing theory, and competitive strategies.[9] In allocation the problem is to distribute a limited resource, such as space or labor or dollars, in the most effective way. For example, mathematical models have been developed for optimal shelving of books by size;[10] for allocating personnel in a technical services operation so as to eliminate backlogs and achieve a minimal overall per-volume processing time;[11] and for creating standards for evaluating budget proposals of a university library.[12] In sequencing we are concerned with the order of operations. There are, for example, procedures for determining the minimal time or cost for searching a group of bibliographic tools and for visiting service points in the routing of centrally processed material.[13]

Inventory theory is concerned with balancing the economies and costs associated with different levels of goods on hand. It has been applied by a publisher in determining how many copies of a back list title to reprint.[14] Queueing theory, which analyzes the interrelations between customer arrival, waiting, and servicing, has been used in libraries to help predict the effect of providing duplicate services, usage restrictions, and reserves.[15] Little has been done by libraries to date in the areas of replacement and competitive strategies.[16]

Other Mathematical Techniques

Mathematical techniques not leading to optimal solutions may still be useful for predictive purposes. Library collections and catalogs are growing larger. If, for example, library records show a particular collection or catalog to be growing at a more or less constant rate, it is possible to utilize compound interest tables and equations to predict its size at some future time, or the point in time when a particular size will be achieved.[17] As books grow older, they are, on the average, used less. When this decrease in use occurs at a fairly constant rate, the same basic formulas and others derived from them help us to make rational judgments as to an appropriate age at which to retire books into depository storage for less active materials.[18]

Traditional statistical procedures have also proven helpful in quantitative library management. The single most useful technique is sampling—especially random sampling. Over and over again it happens that a librarian needs to take a sample, and does not have any clear notion of how to do it. This is a serious problem, for most detailed discussions of sampling require considerable mathematical sophistication.[19]

Data Processing Equipment

Machines are not a satisfactory substitute for either mathematical ideas or techniques, or the creative imagination required to see their application to libraries. The advent of data processing equipment, however, has stimulated interest in scientific management in libraries. The expense of automating an operation, and of making major changes

once the procedure is operational, encourage careful planning. One of the serious faults with some of the current efforts to automate has been the failure to examine and evaluate adequately present practices. As a result the automated system, based on an inefficient manual system, is cumbersome and overly expensive.

The computing power of the digital computer, which in some cases allows problem solving approaches that were not practical with hand calculation, has been used extensively in operations research. Sometimes, in lieu of an available analytical technique, a problem can only be solved by evaluating a very large number of possibilities, and then selecting the desired one (say minimal cost) from the group. The cost and tedium of doing this by hand is prohibitive. Difficult equations may sometimes be solved by iteration—that is, by successive approximations. Where the number of approximations is large, the computer may still be able to achieve a solution. It is possible to use the computer to select a random sample. This technique can be useful in connection with simulated, or Monte Carlo, sampling: when it is too expensive or even impossible to take an actual sample, a sample described by some appropriate probability distribution is substituted. There has to date been little use of these new quantitative possibilities in libraries.

Conclusion

The fact is that quantitative management is not used extensively in libraries at the present time. It is not difficult to find reasons for this, the basic one being that the majority of librarians are humanities-trained and oriented. They are products of an educational system that allows students to acquire graduate degrees in English literature, for example, without having any clear idea even of elementary mathematical techniques and applications. It is unrealistic to expect the library profession to modify the American system of education. It is, however, quite possible for library schools to pay at least passing attention to quantitative ability in assessing admissions standards, to make clear to students at the outset that some work with numbers is necessary and to be expected, and to insert a reasonable amount of quantitative management into the curriculum, preferably within the broader general framework of administration. The need is not to make industrial engineers or mathematicians out of library school students, but rather to inculcate the idea that the utilization of numbers (the language of size) to solve library problems is not incompatible with loving books and people. The real value of quantitative management comes not so much from special management studies as from its absorption into the everyday-thinking and activities of the average librarian.

A second problem is that most libraries are still quite small units of operation. Most of the quantitative management done has been in connection with larger library systems. Librarians are busy people, and things do not get done unless there is somebody to do them. Larger libraries often have a special person, or even several, who devote their full time to work improvement, standards, and other research. A few university libraries have even made use of their local Department of Industrial Engineering.[20] Small libraries seldom have such specialized talent at hand. Nor do they usually have access to highly specialized equipment, such as high speed computers.

The trend toward larger units of library service is gradually alleviating the problem of minuscule library systems. Attention to quantitative matters in recruiting and training librarians is another matter. This will require a conscious, coordinated effort on the part of library leaders and educators. Books

appropriate as texts are now available,[21] and many library schools have at least one faculty member with some numerical interest and facility. Bibliography is the foundation stone of librarianship; but a few more stones are required to complete the building.

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