The main problem considered in this project is whether it will be possible for civilization to cope with the increasing quantities of archival information that must be stored in libraries, and if so, whether traditional methods of identification and access will prove adequate to the task. It is concluded that unless the storage, transmission, and retrieval of information in library archives is automated, there is no hope of keeping pace with the exponential growth of libraries. Part I explores the problem of determining the relationship of library growth to the growth of those components of civilization that support and use libraries. Part IT analyzes cost factors in maintaining and updating card catalogs. It was found that simple situations do not require automation, but that complex ones, which appear unavoidable for most large libraries, demand automation on economic as well as on access grounds. (Author/JP)
The research reported herein was performed pursuant to a contract with the Office of Education, U. S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.
ACKNOWLEDGEMENT

The authors wish to express their appreciation to Henriette Avram (Library of Congress, Washington, D.C.) and Mr. Neil Barron (Sacramento State College, Sacramento, California) for their important contributions of cost figures and other technical data used in this report. We also wish to thank the various State Libraries throughout the United States who gave freely of their time to respond in detail to our need for cost information.

We wish to thank the publishers who have kindly given their permission for the reproduction of figures which first appeared in the indicated publications: Figure 3—reproduced from Energy in the Future by P. Putnam, by permission of Van Nostrand-Reinhold Company, a division of Litton Educational Publishing, Inc., Litton Industries, Princeton, New Jersey, 1953; Figures 6 and 7—reproduced from The Biology of Population Growth by Raymond Pearl, by permission of Alfred A. Knopf, Inc., New York, 1925; and Figure 12—reproduced from Science Since Babylon by Derek J. de Solla Price, by permission of Yale University Press, New Haven, Connecticut, 1961. The above figures are found in Chapter 1.
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INTRODUCTION
AND
SUMMARY
THE COST OF MAINTAINING AND UPDATING
LIBRARY CARD CATALOGS

INTRODUCTION AND SUMMARY

This is the final report prepared under Contract Number OEC-9-8-00292-0107 for the U. S. Office of Education, Bureau of Research. Its principal concerns are broader than the title indicates, for although a great amount of detailed information concerning comparative estimates of the cost of maintaining and updating library card catalogs will indeed be found in Chapter 2, the authors view their contribution as directed toward wider concerns. The main problem considered in this work is whether it will be possible for civilization to cope with the increasing quantities of archival information that must be stored in libraries, and if so, whether traditional methods of identification and access will prove adequate to this task.

The answer is clear, and was already presented in our earlier book, Computerized Library Catalogs: Their Growth, Cost, and Utility (by J. L. Dolby, V. J. Forsyth, H. L. Resnikoff) July 1969, M.I.T. Press. The original report, without revisions, was prepared for the Office of Education in July 1968 (OE Proposal 7-1182 and OE Contract OEC-1-7-071182-5013) under the title of An Evaluation of the Utility and Cost of Computerized Library Catalogs: unless the storage, transmission, and retrieval of information in library archives is automated, there is no hope of keeping pace with the exponential growth of libraries. In the first chapter of the present work this thesis is elaborated upon, and the critical problem of determining the relationship of library growth to the growth of those components of civilization that support and use libraries is explored.

Although we believe that all major libraries will ultimately be highly automated, the problem of when and how a particular library ought to convert from traditional processing techniques to automated techniques is one that deserves serious attention. The catalog operation is certainly an early and obvious candidate for conversion. In Reference 1 we studied the cost and problems associated with automated library catalogs.
To place the information presented there in the proper background, Chapter 2 of this report provides a comparable study of the cost of traditional non-automated catalog techniques. The question of the utility of the traditional techniques has by and large been ignored as lying outside the compass of this study.

The major conclusions of this study can be summarized as follows:

1. Exponential growth of library holdings will persist for the foreseeable future. To maintain current growth rates, automation of the production of portions of the intellectual content, as well as the production of the physical books and equivalent forms of stored information, will increase.

2. There is a connection between the growth of library archives and the growth of various estimators of the degree, level, or state of civilization. The role of the preservation and transmission of information in the development of civilization ought to be investigated to provide a working tool for those responsible for the allocation of national resources. Our studies indicate that this can be done in an objective way, and that clarification of the details of this relationship will possibly lead to techniques for controlling the rate of development of civilization in a rational manner. We use the term "civilization" in a limited way, principally referring to the technological component of society.

3. Growth curves of importance to library management consist in general of piecewise exponential segments connected by transitional fluctuations. Determination of the nature of the current and short-term future portions of the curves is necessary for realistic and practical planning purposes.
Turning now to questions concerned with the maintenance and updating of card catalogs, our conclusions are of a piece with the above: in general, we find that simple situations do not require automation, but that complex ones, which appear unavoidable for most large libraries, demand automation on economic as well as on access grounds.

4. Libraries using the short form of a catalog and having no immediate need for multiple copies of the catalog may find it desirable to wait a while before converting to an automated system.

5. Libraries using the full form of catalog, or those requiring multiple copies of the catalog will almost certainly find that there is a substantial economic advantage to computer- ization at the present time.
CHAPTER 1

ANALYSIS OF LIBRARY GROWTH

H. L. Resnikoff and J. L. Dolby
ANALYSIS OF LIBRARY GROWTH

INTRODUCTION

The single most striking statistical fact about library holdings is their rapid rate of growth. Whereas population growth in the United States proceeds at rates less than 1.5 percent, all major university libraries add at least 3 percent annually to their holdings (which consequently double every 23 years), and the Universities of Connecticut, Maryland, and Toronto are adding to their holdings at a 10 percent annual rate (doubling in less than 8 years) (Ref. 3). Such rapid growth to an ever-increasing extent determines the reaction to the collection of both library users and library management. It creates and sustains an ever-present and ever-increasing pressure against the human, financial, and physical resources of the library, and limits opportunities for increasing access to the information buried in the growing archive.

In a previous study (Ref. 3) the nature and most obvious implications of library growth were examined. There it was concluded that for long periods, in some cases nearly 500 years, the current exponential pattern of holdings growth has sustained itself, subject only to local fluctuations representing the effect of major historical phenomena, but always returning to the steady certainty of exponential growth. This important observation referred to the number of holdings arranged by date of imprint; it did not refer to growth in holdings arranged by date of accession. Although these two types of growth are related, they behave in significantly different ways. Even libraries that are much younger than the invention of printing show the exponential behavior of their collections as a function of imprint date, but they also usually show a much more complex behavior of holdings as a function of accession date. For example, the holdings of the Library of Congress as a function of accession year are displayed in Figure 1 on semi-logarithmic graph paper—see also Table 1 on the following page. It is evident from Figure 1 that there are several distinct periods of growth, each of which is approximately exponential, but with varying growth rates. In effect, the Library's growth rate was greatest when it was small and inadequate; as it developed, a smaller rate of growth appeared. This pattern is easy to interpret, and occurs in many situations.
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NOTE - The decline in Bound Newspaper Volumes 1961-1966 is undoubtedly due to the weeding out of old newspapers and replacing by microfilm.
unrelated to library problems. Of more significance is that this growth is essentially piecewise exponential, that is, it consists of consecutive growth periods, each of which is exponential (see Section 3).

In Figure 2 the growth of the Widener Library subcollection represented in Volume 7 (bibliography) of the Widener Shelf List (Ref. 15) is shown as a function of date of imprint. This distribution, which covers a period of more than 400 years, is exponential for almost 300 with but minor deviations. It should be contrasted with Figure 1.

The significant conclusion which is suggested by these two figures, and confirmed by further studies, is that there are two kinds of library growth. Some care must be taken to distinguish them from each other. What we have called the imprint growth rate is related to the total amount and nature of all published materials; the other kind of growth is particular to the life cycle of each library; it can reasonably be called accession growth. It is obvious that accession growth must be influenced by the more fundamental growth of imprints, but, except possibly in special situations that do not currently exist, the converse is not true. Accession growth does not influence imprint growth.

The management problems of a specific library will be composed of a complex combination of sub-problems stemming from both types of growth (as well as from other variables). It is necessary to be able to separate these two kinds of sub-problems to be able to analyze their relative importance and to be able to provide reliable projections of future requirements.

It should not be thought that the observed long-term exponential growth of imprints will continue indefinitely. Physical resources, as well as author resources, cannot maintain the pace of exponential growth. It follows that the current phase of imprint growth must ultimately terminate, yielding to a type of growth, or perhaps decline, that will have an upper bound. It is important to know whether this time is come, or whether it still is far in the future, for in the first case we may breathe a sigh of relief, assured that our resources will come into compass with library requirements and perhaps even permit the luxury of elaborating access to library collections in a studied and leisurely manner not subjected to the current continual strain to catch up with the flood of accessions. In the second case, which the authors believe is the more likely of the two, exponential growth
at least current (and historic) rates will continue for a long period, and a relaxation of current accession pressures cannot be hoped for. In this case, every effort must be bent to command resources in the most efficient and rapid manner possible to cope with the information glut. It is in this case that the computer inevitably enters, for the growth with time of the number of computer operations per second, and the number of operations per dollar, are both exponential also, and therefore provide the possibility of containing and assimilating the growing flow of information.

Because the current phase of exponential growth must ultimately change to some type of growth occurring at a lower rate, and ultimately to a growth or decline which has an absolute upper bound, it is of some interest to study the likely forms that future growth curves will take, as well as the way in which one growth stage will pass into the next. The remaining sections of this chapter are devoted to determining the forms of natural growth curves that appear pertinent to the problem of library growth so that three main problems can be investigated. These are:

1. Is the current phase of exponential growth likely to persist for long?

2. What is the utility of approximating library and related growth curves by piecewise exponential functions in place of more complex curves?

3. What is the nature and interpretation of fluctuations about the exponential trend?

The answer to the first problem has the greatest immediate significance, for it determines whether future decades have in store for us exponential struggle, or the peaceful and perhaps dull coexistence with a steady state of information production and decay.

FOUR FUNDAMENTAL COMMUNICATION INVENTIONS

The purpose of the library is to store and provide access to the information accumulated by man throughout history. Thus it is reasonable to expect a relationship between library growth and growth or change in other components of civilization. This fundamental relationship does not seem to have been sufficiently emphasized in the literature, but it is important for a balanced understanding of the current growth situation. Therefore, it seems appropriate to make a brief historical digression.
Four fundamental inventions can be recognized in the history of civilization. Each of them produced changes of unprecedented magnitude and extent; all of them have a common aspect. The first was the invention of complex writing systems, capable of expressing abstract concepts as well as names and actions, in the Near East not much earlier than 3000 B.C. (cp. Ref. 4). It was immediately followed by the rise of the oldest of the high civilizations known today — the Egyptian and Mesopotamian — and was, perhaps, the cause of their rise. These elaborate and inefficient writing systems made possible the accumulation of archival information stores containing records of complex processes and observations relating to mathematics, astronomy, law, political administration, and commercial accounts. There is no indication of the existence of complex political organizations or scientific effort in societies not having a writing system.

Nearly 2000 years later the alphabetic system of writing was introduced by the Greeks (Ref. 4)¹, and their remarkable civilization rose to its great heights shortly after. The significance of an alphabetic writing system cannot be overestimated: it is markedly more efficient for communication, requires less time to learn, and is therefore accessible to greater numbers of people. It provides a startling comparative advantage in communication for the maintenance of commercial and administrative records, for the recording of mathematical and scientific information, and even for those communications necessary for the extended prosecution of military efforts ranging over great distances. The mental effort and time required to read a given amount of information recorded in one of the ancient Egyptian writing forms or in cuneiform Akkadian is enormous compared with an alphabetic language representation; scientific information presents special difficulties.

The third invention that we consider fundamental is that of movable type, and its application to printing, probably by Gutenberg and Johann Fust, in the mid-fifteenth century; the earliest known book printed in Europe is dated 1456. Although movable type was known in China and Korea before its independent invention in Europe, its influence in China was negligible, no doubt because of the non-alphabetic nature of the Chinese language, while its development in Korea antedated the European invention by about 50 years, and was probably connected with the Korean adoption of a phonetic alphabet about that time.

¹Gelb (Ref. 4) writes: "If the alphabet is defined as a system of signs expressing single sounds of speech, then the first alphabet which can justifiably be so called is the Greek alphabet."
Each of these three inventions provided a remarkable advantage over previous methods for storing, transmitting, and retrieving information, with a corresponding decrease in the unit costs involved. The principle consequence of increased efficiency and effectiveness was the opportunity to build on past knowledge and experience; this greatly accelerated the growth and progress of civilization in each of the periods of invention.

The modern general-purpose digital computing machine epitomizes the common properties of these three earlier inventions; no one other instrument or technique in the history of civilization has created such a change in the ability to store, transmit, and retrieve information as has the computer. It is difficult not to view it as the fourth fundamental invention in the field of communication of information, and to speculate that its effect will be no less than the effects of each of its predecessor inventions. From this standpoint, a new "information explosion" must be anticipated, that is, a new period of exponential growth having a growth rate (i.e., an exponent) greater than that characteristic of the post-printing press growth period. One consequence of this new explosion will be an increased rate of library accession of information and quite likely a new role for libraries as archives of information in machine-readable form. If this argument is accepted, the answer to the first of the questions posed in Section 1 is clear: the current exponential growth rate is not likely to persist; it will be replaced by an information growth rate greater than the current rate.

If the role of the computer in civilization is in fact similar to the roles previously played by the invention of writing systems, alphabet, and printing, then there will probably be changes in the essential fabric of civilization as we know it that cannot now be foreseen. The role of the library is central to this point of view; for libraries represent the archive wherein the knowledge and experience accumulated by previous generations is maintained and organized (albeit superficially); they are the information repositories on which all future developments are founded. If it is true that the growth of civilization, and indeed its growth rate, depends on the capabilities for storage, transmission, and retrieval of information, then it inevitably follows that the role of libraries as storage banks for information in printed as well as machine-readable form—and of computers to transmit and retrieve, as well as to analyze, modify, and re-store that information—must become more central and important as time passes. Governmental support for library systems, and library support for
and experiments with, computers is, if our argument is essentially correct, imperative for the continued growth of civilization. Examples of the interaction between efficient information-processing and the growth of civilization that may help to place the previous remarks in perspective are discussed below.

World Population Growth

The "population explosion" is a consequence of decreased death rates since there is relatively little that can be done to increase the per capita annual birth rate. As Figure 3 shows, the rate of growth of world population—that is, the decrease in the death rate—increased markedly after 1500, and has been increasing ever since in an historically unprecedented manner. This must be attributed primarily to the rapid communication of medical knowledge, sanitation techniques, advances in agriculture, and so forth, made possible by the invention of printing a few decades earlier. A similar population explosion probably occurred in the Greek world between 1000 B.C. and 500 B.C., and even earlier in historical Egypt and Mesopotamia, although accurate population estimates are lacking. The vast construction programs of the Egyptians, and Akkadians, and the similar later ones of the Chinese, provide evidence of a massive long-term employment of labor and consequently of a relative surplus of population. It is of no importance to this argument what proportion of these populations might have been "immigrants" of one type or another.

Mathematical Research

Mathematical research depends in a direct way on the availability of an archive and the efficient transmission of information. Even in ancient times there was relatively rapid communication of new important results. For instance, Archimedes was well-informed about the astronomical theories of Aristarchus although the latter was only 25 years older than Archimedes and they were separated by most of the "known" world of the times (circa 200 B.C.), Archimedes residing in Sicily, and Aristarchus on the island of Samos near modern Turkey. Because of the critical role that communication plays in mathematical progress, one would expect that mathematics would experience a renaissance following an invention which decisively improves communication. In fact, there is no real mathematics known prior to the Egyptian and Mesopotamian civilizations, although
RATE OF GROWTH OF WORLD POPULATION

Fig. 3  Estimated trend in the rate of growth of World population, A.D. 700 to 1950. The point for 1951 was estimated by the U.N., 1952.

serious mathematics of high caliber is attested in the earliest phases of these civilizations. Much more information is available about what has happened since Greek times, and it supports our view. Indeed, if the number of memorable mathematicians is graphed as a function of the birthdate of the mathematician, then the curve displayed in Figure 4 results. Here a mathematician is "memorable" if he is named in the index to a standard history of mathematics; the book by Struik (Ref. 13) has been used for the illustration. Other choices would not change the shape of the curve. Estimates of world population are shown in Figure 4 for comparison purposes. Observe that the number of memorable mathematicians rose rapidly after 700 B.C.—that is, not long after the invention of the alphabet by the Greeks—and grew exponentially from 300 B.C. until about 1450 A.D. after which time the growth rate increased dramatically. If the exponential portion of the memorable mathematician curve is extended back in time, it suggests that the "first" memorable mathematician lived about 3700 B.C., not long before the first writing systems are attested, and probably simultaneous with their development.

European Universities

The growth curve illustrating the currently extant European universities as a function of their date of founding (Figure 5) is interesting. The data came from the Random House Dictionary, and is given in Table 2. Figure 5 shows four distinct phases of growth, three of which are clearly exponential, with a fourth that is approximately so. The earliest period, from 1100 to 1210, corresponds to such small numbers of universities that statistical arguments cannot be reliable, and we thus ignore it. The second period, from about 1210 to 1500, indicates a uniformly exponential growth doubling approximately every 110 years. After 1500, there is a 300-year period of roughly exponential growth, which may mark a transitional phase from the previous period to the next one, beginning in 1800 and continuing to the present, which shows exponential growth proceeding at the same rate as the 1210 to 1500 growth.2 Thus, shortly after the invention of printing, a major change in the growth rate of

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2The data given in Table 2 appears to agree with that used by De Solla Price for his figure on page 115 of Reference 2, but his description of the growth there given seems to be in error.
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(INCLUDES SOVIET UNION)
BY DATE OF FOUNDERING

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the number of universities occurred. One interpretation of this phenomenon is that printing made the textbook cheaper and more available and thus permitted an increased student-to-teacher ratio, decreasing the necessity for founding new institutions. After 300 years, the natural growth in the student population increased this ratio beyond levels that could be efficiently maintained even with the availability of inexpensive texts, thus encouraging the foundation of more universities, at the previously observed rate. This explanation is offered solely as a possibility; research would have to be done to see if it is consistent with the growth of student populations. An indication that this explanation may not be far-fetched is the contemporary effort to introduce television and teaching machines to permit greater student-to-teacher ratios; both of these devices are improved means for transmitting information, which of course the printed text is too.

STABLE GROWTH

The growth with time of a population (of people, or books, or any other quantity) is said to be exponential if its rate of change is proportional to the population; the constant of proportionality is the growth exponent. In the standard notations of the differential calculus, this is expressed by writing

1) \[ \frac{dP(t)}{dt} = aP(t) , \]

where \( P(t) \) denotes the population at time \( t \), and \( a \) is the growth exponent. The solution to this differential equation is

2) \[ P(t) = P(t_0)e^{at-t_0} , \]

where \( t_0 \) is any conveniently chosen time. If a population does grow according to this equation, then its logarithm varies linearly with the time, that is,

\[ \log P(t) = \log P(t_0) + at-t_0 ; \]

here \( \log \) denotes the natural logarithm function. This means that exponential growth is represented by straight lines on semi-logarithmic graph paper, such as is used for Figures 1 and 2, for instance.

Since two constants determine a straight line, it follows that two constants completely determine the equation of exponential growth. Complex social or natural processes
will usually require more than two constants for their accurate representation, so that exponential growth laws should not be able to represent such processes for long periods except in special circumstances.

If the growth exponent is positive, then \( P(t) \) will increase indefinitely as time passes. For populations on the earth, this cannot happen, so it must be the case that a population which follows an exponential growth process must ultimately change. This change cannot be described without introducing new assumptions; it is by no means clear what these assumptions should be for human or book populations, although a number of proposals have been made.

If \( P(t) \) does grow exponentially, then it doubles every \( \left( \frac{\log 2}{a_o} \right) \) units of time; if time is measured in years (as will be assumed from here on), then \( P(t) \) doubles every \( (0.69315/a) \) years. The annual rate of increase is given by \( (e^{a_o} - 1) \); if \( a_o \) is small, this is approximately equal to \( (a_o + a_o^2/2) \). For instance, of \( a_o=0.1 \), then the annual growth rate will be \( 0.1052... \), just more than 10 percent. For growth rates, or growth exponents, less than 0.1, the growth exponent is essentially the same as the annual growth rate.

Recognition that most growth processes could not be described by a two-parameter curve such as the exponential led many investigators to attempt generalizations having a greater number of parameters that could be adjusted so as to fit the data. This is a difficult problem. There are mathematical theorems which state that any sufficiently smooth curve—and all of the growth curves that we are considering satisfy this condition—can be represented as closely as desired if enough parameters are used. The practical problem is to provide a representation that uses as many parameters as are necessary, but no more, so that there is some hope that the representation actually corresponds to the actual underlying physical or probabilistic processes in a natural manner. The earliest well-reasoned generalization of the exponential to fit growth data was made by Verhulst (Ref. 14) in the mid-nineteenth century; his discovery of the logistic curve was independently repeated by Pearl and Reed (Ref. 11) in 1920. Verhulst's idea was to replace the differential equation (1) by the "simplest" generalization. Upon dividing both sides of eq(1) by \( P(t) \), one finds

\[
\frac{dP/dt}{P} = a_o;
\]

Verhulst assumed that the right hand side should be replaced by a more general function, say \( f(t,P(t)) \), which might
depend on the time \( t \) as well as on the population \( P(t) \).

If the population growth rate depends only on the population, and not on the time (this is realistic; for instance, had the United States been discovered 300 years earlier, its population growth is likely to have proceeded in the same manner as actually occurred), then \( f \) depends only on \( P(t) \).

Verhulst's next assumption was that this dependence could be expressed by means of a power series, that is, in the form

\[
f(P(t)) = a_0 + a_1 P(t) + a_2 P(t)^2 + \cdots
\]

\( (a_0 > 0) \);

further, he made the approximation that all of the terms on the right except the first two in eq(3) could be neglected, and arrived at the differential equation

\[
\frac{1}{P} \frac{dP}{dt} = a_0 + a_1 P(t)
\]

if \( a_1 = 0 \), this coincides with the original differential equation, eq(1) above. The solution is the logistic curve,

\[
P(t) = \frac{-a_0/a_1}{1 + e^{-a_0 t + c}},
\]

where \( c \) is a constant that must be determined from the value of \( P(t_0) \) at some time \( t_0 \). This equation therefore involves three parameters \( a_0, a_1, \) and \( c \) instead of the two appearing in the exponential. For \( P(t) \) to be positive it is necessary that \( a_1 \) be negative; then the term \( a_1 P(t) \) in the differential eq(4) corresponds to an influence retarding the growth of \( P \) with time, and in fact, as \( t \) becomes indefinitely large, \( P(t) \) does not, but rather approaches the value \(-a_0/a_1\) as an absolute maximum. The positive number \( a_0 \) represents, as before, the growth exponent. Pearl (Ref. 10) provides a useful example of a logistic curve, making use of Carlson's (Ref. 17) data on the growth of yeast cells; we have reproduced this curve in Figure 6. It illustrates both the shape of the logistic and the fact that logistic curves do sometimes provide accurate representations of growth processes. Unfortunately, the complex processes of library imprint growth, human population growth, or other growth phenomena related to society do not in general behave logistically. For instance, neither the holdings growth of the Library of Congress (Figure 1) nor the growth in the number of universities (Figure 5) are well-represented by logistic curves. Numerous attempts have been made to fit the data of civilization to logistic curves and to successions of logistics (cp. Ref. 2, 6, 7, 9, 10, 11, 16, 17).
THE LOGISTIC CURVE

Fig. 6  The growth of a population of yeast cells. Data from Carlson (see Ref. 17) represented as small circles.

Logistic curve equation

\[ P(t) = \frac{66.5}{1 + e^{-0.5355t + 4.1896}} \]

If it is found that some data can be nicely fit by a sequence of \( N \) logistics, this means that at least \( 4N - 1 \) parameters are involved (as well as some additional ones to describe where consecutive logistics are to be fit together, but this can be ignored since this problem is common to all piecewise fitting processes), since each logistic requires three parameters, giving \( 3N \), and all but one (and sometimes that last one also!) must be shifted up or down, which requires an additional constant. For instance, if data can be fit by two logistics, as shown in Figure 7 taken from Pearl (Ref. 10), then eight parameters are required. Only 11 data points were available to Pearl, so it is no surprise that an eight parameter function could be found that would provide a good fit; it is not clear that other functions might not provide an equally good fit with the use of fewer parameters. Indeed, Pearl's data is shown on a semi-logarithmic scale in Figure 8, from which it is readily seen that the leftmost four points are well fit by the two parameter exponential, the next three could be fairly well fit, and the remaining four are again well fit by an exponential. Therefore three exponentials, requiring a total of six parameters appear to do about as well as two logistics requiring eight parameters. One difference is that there is no evident place to transfer from one logistic to the other; Pearl arbitrarily does this at 1855. The exponential fits of Figure 8 immediately suggest that something happened between the adjacent data points for 1840 and 1855, and the fact that the lines representing the earliest and latest exponentials in the graph are nearly parallel suggests that whatever occurred to change the population growth rate between 1840 and 1855 had returned to normal by 1870. The revolutions and turmoil of 1848 and the following years could have affected the birth rate, and it might have taken a generation—about 20 years—to recover the rate loss, thus accounting for all of the features of this graph in an informative way that the logistic interpretation does not permit. Indeed, it is precisely the fluctuation from exponential growth that is of interest in this case; the logistic curves smooth that fluctuation so as to make it invisible.

The following paragraphs will argue that piecewise exponential approximation to growth curves provides the most convenient and informative tool for understanding the underlying processes. We will argue that the nature of civilization is such that when influences which tend to retard growth are encountered, the exponent of the exponential growth curve is changed to relieve that retarding pressure; in general, the form of the function is not changed. This is the same as saying that the growth exponent of the exponential is a
THE POPULATION GROWTH OF GERMANY

Fig. 7 The population growth of Germany, showing two cycles of growth which have overlapped during the period of census history.

For the period up to 1855, \( P(t) = 10.109 + \frac{34.036}{1 + 2.495e^{-0.0394t}} \)

From 1855 on, \( P(t) = 33.587 + \frac{82.944}{1 + 297.546e^{-0.0472t}} \)

function of time, and, with a sufficiently complex variation of this exponent with time, any growth curve can be traced out. But it appears from a study of various important classes of growth curves that the variation of the exponent with time is of a particularly simple nature. It is constant most of the time, but, in reaction to external retarding influences, it makes a transition from its original constant value to another constant value which is compatible with the external circumstances.

Consider, for instance, the population growth of the United States, shown in Figure 9, for the period 1610 to date. Until 1690, growth was extremely rapid and exponential; from 1700 until 1880 growth was again exponential with a remarkable degree of accuracy and consistency. After 1880 a more complex pattern occurs (to be discussed in Section 4). The departure from exponential growth which shows up for the first time in the 1880 census corresponds to what historians call "Turner's thesis," concerned with the closing of the Western Frontier. It is evident that the 270-year period from 1610 until 1880 can be accurately described by two exponentials, thus four parameters.

Population statistics are unusually complete for the United States; most other nations have only recently begun to accumulate accurate population estimates based on census data. Nevertheless, it will be useful to look at the population growth of one other nation. Figure 10 displays the growth of Japanese population since 1872. It can be accurately represented by two exponentials, from 1872 until 1900, and from 1900 to date. There is a sharp population decline, shown by the 1945 census, due to manpower losses in World War II, but this was completely made up by the 1950 census. The long-term trend rate of Japanese population growth has returned approximately to that level that it has held since 1900. In the popular press as well as in demographic literature there has been concern for the rapid growth of the Japanese population since the war, and some relief that it appears to be coming back under control at last. This is misleading; in fact, having retrieved the population lost in the war, the growth rate is now returning to its traditional value. This shows a danger inherent in looking at short sections of time series. The local fluctuations may obscure the general picture and lead to gross mis-estimates of what is happening. Further examples of this type of problem will come up in what follows.

Returning to Figure 2, the Widener Shelf List Volume 7 imprint date distribution, observe its essential exponentiality; Figure 11 displays the same information for the
JAPANESE POPULATION

IMPRINT DATE DISTRIBUTION BY DECADE
FROM THE
STANFORD UNDERGRADUATE CATALOG
1966.

YEAR

1885 1895 1905 1915 1925 1935 1945 1955

Fig. 32
Stanford Undergraduate Library. This collection is restricted to recent imprints because of its small size and limited purpose. Nevertheless the usual exponential trend is clearly evident. It appears to make no difference whether a sub-collection of a large library or an entire small library is examined. In Reference 3 it was shown that similar growth occurred in a random sample from a university library of some 300,000 items, exclusive of periodicals.

Figure 12, taken from Reference 2, shows that the number of scientific periodicals and also the number of scientific abstract journals have been growing exponentially, the former for approximately 300 years.

Turning to quite a different type of growth statistic, in recent years the Basic Oxygen Process has been increasingly used for the production of steel in the United States. Growth in the output of BOP raw steel is shown in Figure 13. It consists of two parallel lines on the semi-logarithmic graph paper, separated by about a year. Thus, apart from this fluctuation (which will be discussed in Section 4), this statistic also follows the exponential growth law.

LOCAL FLUCTUATIONS IN GROWTH

All of the graphs that have been discussed show consistent exponential trends for most of their duration, but there are deviations of several types.

1. There are minor fluctuations which appear to have an average value of zero with respect to the underlying exponential trend. These probably correspond to random influences that are of no long range importance, and which cannot be subjected to a deterministic analysis. There is not much that has to be said about them other than that they always exist in natural time series and that there is little that can be done to analyze them. Figure 14 illustrates the residuals of the Widener Shelf List data used for Figure 2 with respect to exponential trend lines. Trends were obtained using least squares methods on the

3 The datum of 1967 does not lie on the fitting line. Since the most recent statistic in an economic time series is usually revised, this number has been ignored in fitting the exponential.
NUMBER OF SCIENTIFIC PERIODICALS

FIG. 12

logarithms of the data for two distinct samples: the period 1830-1876, and the period 1876-1965. The residuals are the deviations of the logarithms of the data from the logarithms of the fitted exponentials. From 1870 to 1914 it appears that the residuals are essentially random; this represents Type-I fluctuation. The three largest residuals occur in 1965, 1945, and 1918. The first is due to the incompleteness of the collection in the most recent years; plotting by imprint date invariably introduces a bias in the most recent figures because items published in any given year are acquired over a span of years following. Technically, this bias extends over the entire collection; however, it is most noticeable in the most recent 5 to 10 years. It would be of interest to determine the distribution of imprint dates for a given year's acquisitions to determine the effect of the bias more precisely. The other two large residuals occur in the final years of the world wars, and are both negative, as might be anticipated. These fluctuations are clearly not Type-I. The large residuals that occur in early portions of the sample (e.g., that in 1840) are of questionable significance because of the small sample sizes for those early years.

2. There are departures from exponential growth which last for a short period relative to the duration of the exponential part, followed by a longer period of stable exponential growth proceeding at a different growth rate. This type of departure from exponential regularity appears to correspond to a change in the underlying environment which requires a readjustment of the growth rate. The readjustment is effected by passing in some (possibly irregular) manner from the initial constant growth rate to the new constant rate by means of a transition period of relatively short duration. Two examples of this type of process are shown in Figure 9 (U. S. Population), one in Figure 10 (Japanese Population), and two in Figure 1 (LC holdings).

3. The third type of fluctuation is perhaps the most interesting. It is represented by a period of regular exponential growth which is followed by a transition period of relatively short duration. The transition period precedes another period of
stable exponential growth (as in Type 2 above) which proceeds at the same rate of growth as the exponential preceding the transition. Thus, on semi-logarithmic graph paper, the initial and final exponentials will appear as parallel lines; the transition corresponds to a curve connecting the two exponentials which can be irregular. The two exponentials may actually be parts of one; this is shown in Figure 10, where the transition is constituted by the rapid decrease in Japanese population from 1940 to 1945 followed by an even more rapid increase from 1945 to 1950, bringing the population back up to the exponential trend line as if World War II had not occurred. In other cases, the two parallel lines representing exponential growth do not coincide; usually, the terminal line lies below the initial one, which means that although the population growth rate has returned to its initial state, there has been an unrecovered absolute loss in population. This is well illustrated by Figure 13 (Basic Oxygen Process Raw Steel Output in the U. S.) which shows an unrecovered loss which can be interpreted as having set the industry back by slightly more than one year.4

4 The Kennedy confrontation with the steel industry concerning its pricing policies occurred after the sharp transitional drop in BOP steel output growth rate in 1960-61. The proposed price increases may have been a reaction to this transition. Had it been known at the time that the transition was of Type-III but not of Type-II, and that it would last for only 1 year in its depressive phase, the industry might not have reacted with its proposed non-transitional price increase. This example illustrates the importance of studying the causes of transitions and learning how to distinguish the various types as they occur.

This problem also illustrates the importance of further statistical study of the procedures to be used in interpreting growth data. It is possible to "fit" the BOP steel output data with a single straight line that effectively "hides" the transition period of 1960-61. The procedures for testing the improvement introduced by the notion of a break in the growth function are fairly obvious. Isolation of the period involved, given that a break occurred, is also straightforward. However, the problem of finding break points when there is no a priori information as to how many are present does not appear to have been studied at any length.
There are other types of departure from exponential growth, but they are not so easily characterized nor do they seem to play an important role in the types of populations that are under consideration in this chapter.

Fluctuations of Type-III and their connection with unrecov-
erable losses are worth some further discussion. An im-
portant example is furnished by population and economic
time series for the United States encompassing the period
of the Great Depression, which is a Type-III fluctuation.

Figure 15 shows the population of the United States during
the 1880–1960 period, as given by the decennial census.
In connection with Figure 9, it was pointed out that a
Type-II transition occurred about 1880, corresponding to
the closure of the frontiers; the effect of this transi-
tion is visible in the first three data points of Figure 15;
the next three lie on a line, which is not remarkable since
two points determine a line. The remaining three points
lie on another line which is nearly parallel to the first.
Therefore, the data from 1910 to 1960 can be interpreted
as indicating a constant growth rate with a Type-III
fluctuation occurring between 1930 and 1940, the decade of
the depression. Pursuing the implications of this inter-
pretation, shift the 1940–1960 line to the left so that it
coincides with the 1910–1930 line, and measure the number
of years of shift required to obtain this coincidence; it
is approximately 6 years (we will use 5.89 years).
Figure 16 shows the same data used for Figure 15 with a
5.89-year shift to the past for post-1930 data. The six
points corresponding to the population figures from 1910
through 1960 now lie on a line with very good precision.
It is possible to interpret this Type-III fluctuation as
implying that the effective duration of the Great
Depression was about 5.89 years. In other words, the
non-recoverable population loss due to the depression was
equivalent to 5.89 years of exponential population increase
at the previously and subsequently prevailing rate. It
should be observed that World War II had as little effect
on U. S. population as it had on Japanese population
(cp. Figure 10).

As a check on the notion that there was really a non-
covered loss of population during the Great Depression,
we can investigate the behavior of the Gross National
Product (GNP) on the assumption that there is a close
relation between the two time series. This can be done
either by assuming the 5.89-year gap and testing the
departure from linearity using this gap, or by deriving
the gap (if any) from the GNP data directly.
Fig. 15
U.S. POPULATION - 1880-1960
WITH A 5.89-YEAR CORRECTION

Fig. 16
Figure 17 shows the GNP (in current dollars) for the period 1894 to 1965. The values up to 1921 are 5-year averages; the subsequent values are by individual years. The data prior to the first World War and the data subsequent to the second World War are quite consistent with the general hypothesis of exponential growth. The intervening period (1914-1945) exhibits rather wild fluctuations—as might be expected. From this superficial examination alone it is quite clear that GNP does not possess the stable growth pattern shown by population growth.

Figure 18 shows the same data with the 5.89-year interval in the 1930's removed. Even with the larger variation of the GNP data, it is clear that this data is not inconsistent with the "depression gap" hypothesis. In fact, a good portion of the data for the 1920's is included within the rough limits of variation sketched in Figure 18. One could conjecture that the real roots of the Great Depression are to be found in the "excessive" growth of the GNP in World War I, or, more precisely, in the difficulty in guiding the GNP back to its basic growth rate without losing momentum.

Derivation of the depression gap value from GNP alone leads to some problems. If one uses the 5-year averages for the two periods of evident linearity before World War I and after World War II, one obtains a depression gap of 2.05 years. This can be explained in part by the variation introduced by the Korean War: if the 5-year period including the Korean War is eliminated, the estimate of the gap becomes 3.29 years. Better agreement might be obtained were it possible to obtain GNP figures for individual years prior to World War I or if the study were based on real rather than on current data.

However, our main interest in this data is in showing the need for careful analysis of long-term growth as well as growth in the short term. Without sufficient long-term statistics, a Type-III fluctuation may be misinterpreted as one of Type II, and an underestimate of the trend growth rate may be made. Indeed, this has often happened in the past 30 years; libraries and other institutions have rapidly outgrown facilities constructed under the misapprehension of future lower trend growth rates due to an analysis of insufficient portions of their growth records.

Figure 19 exhibits the history of United States Invention Patents issued from 1790 through 1966 (cp. Table 3). This complex graph (see third page following) contains
U.S. GNP IN CURRENT DOLLARS
WITH A 5.89 YEAR
CORRECTION FOR THE
DEPRESSION

Source - Stat. History of the U.S.-Colonial Times to Present & Pocket Data Book USA-1967
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fluctuations of all three types. There is an important Type-III fluctuation during the Great Depression which increases in its effect during World War II, and two others, from about 1812 to 1822, and 1830 to 1845. There is a basic change in the trend growth rate, a Type-II deviation, at about 1870 which appears to correspond to the Type-II transition observed in the U. S. population curve (Figure 9) about 1880. And there are the inevitable Type-I, random fluctuations throughout the graph.

SPECTRAL ANALYSIS OF GROWTH TIME SERIES

In recent years numerous efforts have been made to apply Fourier transform techniques to the analysis of time series. Reference 5 presents a treatment of applications to economic time series, which are closely related to the various types of growth curves that should be of concern to library planners. Most of the spectral analysis techniques—as these applications of Fourier analysis have come to be known—are designed for trendless data, and therefore are not directly applicable to growth curves, although some studies have been made which discuss the problem of removing trends from the data so as to create a trendless series. From what has been said above it is evident that most of the growth curves that pertain to library problems will consist of a number of distinct exponential portions as well as certain transition regions. If these distinct regions can be delimited, then the trends can be extracted and the residuals (such as those illustrated in Figure 14) can be spectrally analyzed to detect any periodic components that may be present. For growth curves that are piecewise exponential (apart from transition intervals of short duration), an analysis of the logarithms of the data after removal of the (then linear) trends should prove to be the most promising means for obtaining spectral analyses that can be interpreted in terms of meaningful causes and effects.

This is perhaps an appropriate place to remark that sequences of overlapped short-term Fourier transforms are likely to have more predictive value than the transform of a long-term series, which is insensitive to local transitions.
CONCLUSIONS

In Section 1 three problems were stated. The answers that have been given above are all tentative because they have been based upon a study of limited proportions. It does appear to us that future research of a more complete and detailed nature will bear out the following conclusions:

1. Exponential growth of library holdings will persist for the foreseeable future. To maintain current growth rates, automation of the production of portions of the intellectual content, as well as the production of books and equivalent forms of stored information, will increase.

2. Growth curves of importance to library management consist in general of piecewise exponential segments connected by transitional fluctuations. Determination of the nature of the current and short-term future portions of the curves is necessary for realistic and practical planning purposes. Piecewise exponential approximations are the simplest techniques for exhibiting the structure of these growth curves.

3. As far as growth rates are important for planning purposes, fluctuations of Type III must be detected and ignored in the evaluation of future requirements of a library.

4. Much more detailed studies of the time series associated with library operations must be made. Analytical methods that will permit the objective determination of the points of transition from periods of one type of growth to another must be developed as well as the interrelation of statistical information pertaining to different types of growth statistics.

5. As discussed in Sections 2 and 3, it seems clear that there is a connection between the growth of the library archives and the growth of various estimators of the state of civilization. It ought to be determined which is cause and which is effect. More precisely, the role of the preservation and transmission of information in the development of civilization certainly ought to be investigated not only as a subject of abstract intellectual interest but also to provide a working tool for those responsible for allocation of
national resources. Furthermore, as the details of this relationship become clarified, library management will be in a better position to improve the means of accessing the information archive.
REFERENCES


CHAPTER 2

AN ANALYSIS OF COST FACTORS IN MAINTAINING AND UPDATING CARD CATALOGS

J. L. Dolby, V. J. Forsyth
and H. L. Resnikoff
AN ANALYSIS OF COST FACTORS 
IN MAINTAINING AND UPDATING CARD CATALOGS 

INTRODUCTION 

One of the more interesting side benefits of the present interest in library automation is the amount of attention now being given to the study of the traditional methods of librarianship. This phenomenon is hardly unique to librarianship; in almost every field of human endeavor where attempts have been made to introduce the use of computers, workers in the field have suddenly discovered that they did not understand some of their long standing methods quite as fully as they had believed. The source of this seeming anomaly is easy to find: to program a computer, it is necessary to specify the work to be done in much greater detail than is necessary to explain the same problem to a human being, that curious human phenomenon known variously as "common sense", "maturity", or "experience" making up the difference. Thus it has not been uncommon over the past decade to hear many survivors of the "automation experience" admit that one of the main benefits achieved through the use of the machine was the acquisition of better procedures through a more detailed understanding of the process involved.

The improved knowledge of "processes about to be automated" extends to the cost of the process as well, and with added force. If one is to substitute one procedure for another in a cost-conscious atmosphere, it behooves one to proffer sound financial reasons for doing so. Not only are computers expensive devices, but they also represent the expenditure of a different kind of money: capital or lease funds in place of labor expense. Thus, although one can still hear the occasional cry that it is difficult to obtain reasonable cost data on various parts of the library operations, it is becoming increasingly difficult to pick up an issue of almost any library journal that does not include at least one piece of cost information.

Our concern in this paper is with the cost of maintaining and updating card catalogs. As we have observed elsewhere (Ref. 1) the cost of computing is going down
at a rather spectacular rate while the cost of labor is increasing. If this trend continues, almost every library shall be forced to automate certain aspects of the catalog operation, at some point in time. In that same report we also provided some information about the cost of computerized library catalogs. By adding a summary of the cost factors in the use of card catalogs, we hope to place in slightly better perspective the more difficult problem of deciding (in the context of a particular library) when the crossover point between manual and automated methods is to be reached.

Our plan of attack remains essentially the same as in our previous report: rather than attempt time and motion studies of our own, we have selected from among the growing number of papers on the subject those which, in our opinion, provide comparable sets of cost information which are pertinent to the various cost elements of the card catalog operation. It is appropriate, therefore, to begin this study with a brief description of the difficulties in comparing cost statistics in this way.

PROBLEMS OF COMPARATIVE COST STUDIES

Although comparative cost studies have much to recommend them, they are also fraught with certain difficulties (see, for example, Reference 2). In the first place, few librarians would group the elementary cost operations in precisely the same way. Thus one library may consider a particular element of cost as part of the acquisitions operation, a second as a part of the cataloging operation, while a third may ignore it altogether or include it in the burden or overhead cost. Nor is this mere capriciousness on the part of the members of the library community. Library operations not only differ from one another, but they also change with time.

Consider for example, the problem of obtaining a set of catalog cards for a particular monograph. Any or all of the following alternatives might be in use at a given library:

1. the cards may be supplied with the book as a service provided by the bookseller at some extra cost
2. the cards might be ordered from the Library of Congress

3. the cards might be provided by a centralized cataloging operation serving several libraries (as in a county or state library system)

4. the cards may be prepared by catalogers working in the library

5. the cards may be generated by computer program from standard listings (e.g., from MARC tapes).

Comparing any two of these procedures within a given library does not present any overwhelming problems, though minor questions of definition do occur (for example, how much of the cost of ordering should be allocated to the acquisitions department and how much to the cataloging department when both the book and the catalog cards are obtained simultaneously from the same source?). However, when one wishes to compare costs from two different libraries, each with a different "mix", it is essential to know what proportion of each source was used by each library. Fortunately for the purposes of this study most libraries are presently using a mix of method 2 (LC) and method 4 (own catalogers) and at least some provide sufficient information to enable us to determine the appropriate mix for each. However, the problem is indicative of one of the essential difficulties in comparative cost analyses, and a difficulty that, although eased, would not be eliminated by having all libraries band together and adopt a standard costing procedure.

A second difficulty arises from temporal and geographic differences in the cost of manpower. On the surface, this problem can be eliminated—or substantially reduced—by having all studies based on manhours spent rather than on dollars required per item, and a number of writers have suggested such a change in reporting procedure. However, the problem is not quite this simple. In the first place, determining the number of manhours spent, say, on cataloging adds cost to the study that tends to reduce the number of libraries willing to report; those that do report may or may not be a representative sample of the total.
However, there is a more basic problem. In almost all libraries the real restraint is financial: there are just so many funds available for cataloging and these must be used to at least keep the backlog of uncatalogued material down to the amount of space available to store this material. Suppose, for instance, that the amount of material to be catalogued increases by 10 percent from one year to the next and that the catalogers are fortunate enough to obtain 10 percent salary increases over the same period. It is not impossible to consider that in some libraries the catalogers may be forced to "earn" this raise by absorbing at least a part of the increased load without extra help. The question of balancing salary increases by productivity increases is, of course, a familiar one in industry and it may well exist in the library. As evidence that such an effect is present, we shall note later in this report that three studies made in three rather different libraries over a period of 6 years showed costs of from $0.228 to $0.235 per card for preparation, production, and filing.

The total range ($0.007) represents only 3 percent of the average cost per card ($0.230). Such close agreement would be startling if it were found in three simultaneous studies of three nearly identical library operations. Yet we hesitate to set this agreement aside as pure coincidence. It seems more reasonable to assume librarians are forced to operate under strong financial constraints and that they adjust their performance to those constraints through hiring of less well-trained personnel, increased time pressures on all personnel, etc. If this is the case, "standardized" reporting through time figures might be quite misleading unless cost figures were reported as well.

1 The notion that certain things should have a fixed cost regardless of changes in their surrounding costs is not novel. Since its inception in the 1920's, the major appliance industry has found that it could never sell major appliances in maximum quantities if they were priced over $500. Just why the American public should figure that major appliances should never cost more than $500 is not quite clear, particularly when the average family income has increased considerably over the same period. Yet the sales pattern of color television sets has provided recent evidence that the $500 barrier is still in effect.
Finally, there is the question of allocation of burden or overhead. Potentially, burden could present a severe problem—and occasionally it may. However, in most of the reports cited here, burden is either ignored or separately stated and we find no reason to suspect that the results given in the summaries are noticeably biased by unseen burden differences. Nevertheless, it would be of interest to determine proper overhead figures for library operations as the switch to automation (which we are convinced is inevitable) will entail the use of more machines and fewer people, which in turn may drastically alter the overhead structure.

THE USE OF COST INFORMATION

Having noted some of the difficulties that tend to cloud cost comparisons, it is perhaps useful to investigate how cost information is likely to be used. The nature of the problem can be illustrated by two rather different situations.

1. Library A, a large public library of some years standing, is considering the possibility of changing from its present manual procedures to some form of automation, and wishes to determine a reasonable strategy for implementing such a change over the next 5 years.

2. Library B, a comparable public library, has been keyboarding the catalog records of its current acquisitions for the last 3 years and has now decided to convert its retrospective catalog and wishes to choose the most economic procedure for this step.

The differences in the problems facing two such library situations are basically the classic differences between strategy and tactics. Library A must lay out a long-term plan, taking into account the growth in its collection over the 5-year period, likely changes in equipment and personnel available to it, increases in labor costs, decreases in equipment usage costs, etc. Library B, on the other hand, is in the position of making a specific set of decisions as to whether the work should be done in-house or subcontracted; whether they should use punched cards, punched paper tape, or optical character-recognition devices; and so forth.
In terms of cost, Library B has to prepare a specific budget request for its funding agency and it is reasonable to assume that that funding agency will require assurance that the task is to be accomplished at the minimum cost consistent with the designated quality level. Thus, cost differences of as little as 5 percent may be quite important to Library B. General cost summaries can be of use only in helping with the enumeration of the possible alternatives. Even the accounting procedures in effect in the local system will have a bearing on the final decision.

Thus, the primary utility of a general cost summary such as we are attempting here to the library about to commit itself in a tactical situation is the information it can provide about the problem statement: which cost factors have other libraries been able to identify in similar situations; which of the various alternatives may be safely eliminated from consideration on the grounds that their present costs are considerably higher than other existing methods; and so forth. The likelihood that any general study, or, for that matter, any particular study, will be sufficiently like the library now undertaking the problem to enable that library to take over cost structures unchanged seems remote.

A library, like Library A, faced with establishing a long-range plan, has much more flexibility available to it. Its interest in specific costs will be established by some gross notion as to what quantity of funds are likely to be available over the period under plan. Some procedures may be seriously considered because they are relatively new and untried and hence of potential interest to national funding agencies who would not consider funding further experiments with procedures that have been thoroughly tested. Access to good cost information of such well-tested procedures will help in establishing the likely costs for important aspects of the overall plan. Of even greater interest is the possibility that certain costs are likely to undergo substantial change over the planning period. For instance, in Reference 1 it was noted that OCR may be a very attractive long-run option for catalog conversion problems precisely because it is so new and hence has not had time to allow a sufficient number of service centers to spring up to provide truly competitive service capabilities. Computer typesetting with the new generation of hardware is in much the same category.
In both situations it is clear that what is most needed is the enumeration of cost elements on the one hand and operating cost experience on the other. Precise estimates of any one cost element are of relatively little importance, either because they are so likely to change over the long run or because they are likely to be not appropriate to a specific application even in the short run.

Comparative cost information thus would seem to provide a good basis for either application. The comparison forces an enumeration of cost elements precisely because one must evaluate the cost structure of each source to be sure that a reasonable comparison is possible. The reporting of the actual experience of several libraries provides a range of experience, not only over several libraries but also over time so that the extremes reported give an indication of the variability that must be allowed for. In what follows, therefore, we shall concentrate on the problems of cost element definition and on the reporting of as many sources as we have managed to find to be comparable in the broad sense. Because precise estimates are not only difficult to obtain, but also unlikely to be relevant to most users, we shall make no attempt to provide formal estimates either of the average cost figures or of their underlying variability.

THE COST OF CATALOGING

The preparation of catalog information for a given monograph is perhaps the most sophisticated operation in the entire catalog operation. As such it is probably the last to be considered a candidate for automation, although it is not unreasonable, even now, to consider the use of computers as aids to the cataloger. Thus in many operations the cost of cataloging will continue to be an invariant regardless of whether automation is introduced into other aspects of the catalog operation or not. Nevertheless, it is useful to study the cost of catalogs both to establish the relative cost of cataloging and the subsequent processing steps and to establish the line of demarcation between the catalog step and the subsequent steps.

Any enumeration of the detailed steps involved in a complex process must be tentative. This is nowhere more
true than in the cataloging operation. Fortunately the number of descriptions in detail is growing. For the cataloging operation, we have used three sources of information:

**Lockheed (Ref. 3):** A detailed analysis made as part of an overall time and motion study of the operations in the Lockheed Research Library.

**New York (Ref. 5):** A detailed study of the cataloging and processing activities of the New York Public Library as a preliminary to possible automation of some of these operations.

**Columbia (Ref. 6):** A detailed study of the acquisitions, cataloging, and other processing operations of the Columbia University Science Libraries.

(Because many of the studies cited here will be cited in a number of sections of this report, we shall refer to them by the underlined title of each entry. A summary of these studies is given in Table 1.)

In addition to the eight items in Table 1, the Lockheed Library study included five other items that we have chosen to include in subsequent operations.

It is generally true that professionals do not like to have their jobs subjected to the minutia of time and motion study. There is always the ugly feeling that the creative (and most important) aspects of the job cannot be subjected to simple measurement. Nevertheless, cataloging is a continuing effort in most libraries and it is possible to establish some average production rates in terms of number of books cataloged per month or the number of minutes needed per book. The problem, as with most statistical studies, is not with the establishment of objective measurements but rather in the manner in which they are interpreted. Use of comparative statistics does not eliminate the possibility of misinterpretation but it does tend to minimize it.

The comparative studies selected for the cataloging operation, in addition to those already cited, are:
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<tr>
<td>3a. (with LC information)</td>
<td>Insert and type copy slip and temporary catalog card, check LC subject headings and other references. Descriptive and subject catalog book. Pencil call number on title page</td>
<td></td>
</tr>
<tr>
<td>3b. (without LC information)</td>
<td>Insert and type descriptive part only on copy slip and temporary catalog card. Write subject data only on catalog card. Pencil call number on title page</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Tear and separate copy slips and temporary cards. Proof and correct as necessary</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. Take report to reports cataloging</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6. Travel to library, check national union catalog or other reference book</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7. Count and tally titles cataloged</td>
<td></td>
</tr>
</tbody>
</table>
Colorado (Ref. 2): A study based on average cataloging times for 11 librarians from 6 cooperating libraries.

Southern California (Ref. 4): A study of ordering, cataloging, and preparations in several Southern California libraries.

The catalog cost information for these five studies is summarized in Table 2.

<table>
<thead>
<tr>
<th>Library Source</th>
<th>Date</th>
<th>Average Time, min.</th>
<th>Cataloging Cost</th>
<th>Implied Avg. Salary (per hour)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lockheed</td>
<td>1967</td>
<td>10.0</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Colorado</td>
<td>1969</td>
<td>28.6</td>
<td>$ 2.07</td>
<td>$ 4.34</td>
</tr>
<tr>
<td>New York</td>
<td>1968</td>
<td>39.8</td>
<td>6.30</td>
<td>5.25</td>
</tr>
<tr>
<td>Southern California</td>
<td>1961</td>
<td>44.8</td>
<td>2.23</td>
<td>2.98</td>
</tr>
<tr>
<td>Columbia</td>
<td>1967</td>
<td>84.0</td>
<td>5.85</td>
<td>4.17</td>
</tr>
</tbody>
</table>

In the Lockheed and Colorado studies, basic times of each operation were studied and then "standard" time factors were added to allow for nonproductive time. The standard factors increased the Lockheed times by 13 percent and the Colorado times by 48 percent. (The times in the table include these allowances.) The figures for New York were derived from their reported statements that they processed 65,000 books using 49 catalogers at a total cost of $409,500 (not including fringe benefits). The Columbia figures have been reduced by 20 percent to eliminate fringe benefits. The implied average salary for each source was obtained by dividing the total cataloging cost by the average time and multiplying by 60 to convert to cost per hour.

The simplest conclusion to reach from a study of Table 2 is that cataloging costs vary widely from one library to another. Average times differ by more than 8 to 1 and
CARD PROCESSING COSTS

If cataloging is the least likely part of the library operation to be automated in the near future, the procedures that immediately follow cataloging are precisely the opposite in character. Card preparation, production, and filing all involve time-consuming routine operations that can be done automatically, thus relieving the library community of a significant proportion of manhours that could be applied to problems of greater intellectual content. However, the cost factors must nonetheless be considered.

As with cataloging, the description of the basic cost elements will vary from one library to another. For a detailed breakdown in this case we again make use of the Columbia and New York studies previously cited and add data from an unpublished study kindly made available to us by Neil Barron of Sacramento State College Library (see Table 3). Barron's cost elements are given in finer detail than in the other studies used here. To achieve maximum compatibility with the other studies, we have grouped both the New York data and the Sacramento data into three categories: preparation, production, and filing.

In addition to the Sacramento and New York data, we have included data from four other studies:

- **Stanford** (Ref. 7): A study of existing cost factors made prior to the preparation of the undergraduate catalog by machine methods.

- **Ontario** (Ref. 8): A study of manual costs made in conjunction with early machine methods.

- **Air Force** (Ref. 9): A comparative study of manual methods and a special-purpose machine procedure.

- **Yale** (Ref. 10): Results of experiments made using computers to produce cards for subsequent manual filing.

The results of these six studies are summarized in Table 4. The costs are here taken on a "per-card" basis rather than on a title basis, as differing library requirements show averages ranging from 3.0 cards per title at Stanford to 9.8 cards per title at New York.
### TABLE 3

**PROCESSING COST ELEMENTS**

<table>
<thead>
<tr>
<th>Columbia University</th>
<th>New York Public</th>
<th>Sacramento State</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Card production</td>
<td>1. Receive and distribute planning sheets</td>
<td>1. Type master cards from handwritten slips</td>
</tr>
<tr>
<td>2. Card Set completion</td>
<td>2. Type headings for added entries and subject entries</td>
<td>2. Produce subject cross reference cards</td>
</tr>
<tr>
<td>5. Typing of book pockets</td>
<td>5. Paint edges of cards when required</td>
<td>5. Complete card sets</td>
</tr>
<tr>
<td></td>
<td>7. Type masters for offset printing</td>
<td>7. Alphabetize</td>
</tr>
<tr>
<td></td>
<td>8. Prepare copy for Itek masters</td>
<td>8. File and revise</td>
</tr>
<tr>
<td></td>
<td>9. Check format of entry on masters</td>
<td>9. Card shifting</td>
</tr>
<tr>
<td></td>
<td>10. Check letter for letter on planning sheet</td>
<td>10. Update existing cards</td>
</tr>
<tr>
<td></td>
<td>12. Prepare Itek masters and print cards on offset</td>
<td>12. Withdrawals</td>
</tr>
<tr>
<td></td>
<td>13. File</td>
<td>13. Weed order slips</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14. Assembly of statistics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15. File temporary slips</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16. File permanent slips</td>
</tr>
<tr>
<td></td>
<td></td>
<td>17. Shelf list shifting</td>
</tr>
<tr>
<td></td>
<td></td>
<td>18. Blank catalog card stock</td>
</tr>
<tr>
<td>------</td>
<td>----------</td>
<td>-----------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Card prep.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Card prod.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Card filing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The most significant fact that is evident from Table 4 is the extraordinary agreement among three of the studies: the total processing costs range from 22.3¢ per card to 23.5¢ per card for these three sources even though the reports were prepared over a 6-year period, including significant changes in the cost of labor and materials. Furthermore, these costs are reasonably constant for the individual categories in these four sources: card preparation varies from 9.3¢ per card to 11.4¢ per card; card production varies from 7.9¢ per card to 9¢ per card; and card filing varies from 4¢ per card to 4.3¢ per card. In one sense this close agreement should not be surprising: if it is indeed true that cataloging involves relatively high intellectual content that is difficult to automate, and card processing involves straightforward operations that are relatively easy to automate, it is reasonable to argue that the latter should show much less variability from one operation to the next.

The fact that the New York operation has significantly higher costs can be partially explained by the following observations. The New York costs are based on the supposition that all cards are locally produced. The other libraries indicate that a significant proportion of their work is based on the acquisition of LC cards. The breakdown for the Air Force study is shown in Table 4 and the breakdown for Sacramento is approximately the same. Secondly, New York is clearly the largest of the operations under consideration here and it is not unreasonable to expect that the size of the file will have an effect on the cost of filing. In fact, if we assume that the New York cost of preparation and production is the same as that for the Air Force locally produced cards (27.6¢) and assign the rest of the New York cost to filing, the latter figure becomes 10.3¢ per card or a little more than twice the average for the other four sources (4.4¢ per card). If this is the case, it would be of interest to know whether the problem is one of sheer size of the catalog or rather one of increased density that naturally occurs in larger files (e.g., is it more costly to file Smith, Adrian J. in a file with 100 Smith's or 1000 Smith's).

Finally, in the two cases of partial automation (the Air Force and Yale studies) the cost of card preparation and production is significantly lower (7.5¢ and 8.8¢) than that indicated for LC cards (16.6¢) or the average for
the four closely agreeing sources (21.6%). This observation alone should point the library community strongly towards automation of the card processing function. Nor is this observation new; both of the authors of the two preliminary studies at Air Force and Yale made the point more than adequately. Furthermore, as we shall see shortly, the cost of filing is also reduced in an automated system.

Several factors may be contributing to the slowness of the library community to introduce changes to achieve such cost savings. First, there is inevitably a substantial initial cost involved in any automation project. Second, although the potential cost saving is a substantial proportion of the processing cost, it is still small when compared to the cost of cataloging: a librarian under pressure to reduce costs could gain more by cutting back on the time allowed for cataloging without the initial investment necessary for automation. Third, there is a persistent difficulty in finding trained personnel in the automation field. Finally, librarians are certainly aware of the rapid changeover in equipment in the computing field with the concomittant costs of adapting programs to new equipment.

CASE AND SPACE

In the preceding discussion, we have provided some notion as to the cost of obtaining the required cataloging information, encoding it on catalog cards, and entering those cards in a catalog file. These costs can be compared with other possible approaches to the problem, including those that involve some degree of automation. There are, of course, a number of associated costs that must be taken into account to obtain a full picture of the cost of card cataloging. Such costs would include, at a minimum, the cost of the:

1. space occupied by the catalog
2. catalog filing cases
3. user of using the catalog
4. library of maintaining the catalog in usable form.
The allocation of capital expenditure costs to a form comparable to the costs per title and the costs per card used in the earlier sections of this report raises certain difficulties. Accounting procedures vary from one institution to another. Further there is the real but difficult to measure problem of comparing funds of various types in a particular situation. Nonetheless, it is useful to know whether under any reasonable accounting system the cost of space and cabinets is of sufficient magnitude to make it worthwhile to consider these costs in the overall evaluation. Let us assume, therefore, that a filing case capable of storing 72,000 cards fully packed costs $800 and occupies approximately 30 square feet of space, including room for aisles and access area. Let us further assume that land and construction costs are approximately $30 per square foot. Then the total cost of the cabinet and the space it occupies would be approximately $1,700. Finally, let us assume that on the average a catalog is approximately 60 percent full. Then the initial cost of space and case is of the order of 4¢ per card. Four cents a card is not negligible, but it is only about 15 to 20 percent of the cost of producing the cards and an even smaller fraction of the total cost when cataloging is included. Hence, it seems reasonable to put this in the category of a secondary cost item that will favor book catalogs, microfilm catalogs, and other high-density forms; but it is unlikely to be the determining factor unless other cost factors are very closely balanced.

USER COSTS

Among all the various cost factors involved in cataloging, the most difficult to assess objectively is the cost to the user. The problem is that no one really knows what a user does in a library, nor what impact a given change will have on the utility to the user. Whether they like it or not, library users do use the card catalog, and it is thus a usable device for providing access to library materials. Equally, many libraries in times past and again more recently have used book catalogs; hence they are also viable devices. But which is better?

Perhaps an enumeration of the advantages of each, relative to the other would shed some light on the problem.
1. **Updating.** A card catalog is updated by the simple expedient of entering the recently obtained cards in the file. A book catalog is updated by periodically printed revisions. Hence any search for a particular item will in general require fewer specific searches in the card catalog than in the book catalog, if the proper information is available to the searcher.

2. **Accessibility.** Card catalogs are large and costly and there are few savings to be had over the original cost in producing a second copy. Reproducing books after the first copy is relatively inexpensive. Thus libraries with many branches or a decentralized set of users will provide better service with book catalogs.

3. **Flexibility.** Whether cards or books are used, the existence of a machine-readable catalog provides much greater flexibility as time goes on. Revisions of cataloging practice become much simpler if the revisions can be programmed on a computer.

4. **File Extension.** The added cost of maintaining more than a few files is heavy with cards and light with books.

In sum, machine-readable catalogs appear weak only when immediate updating is the primary criterion for comparison.

**COMPARATIVE COSTS OF CATALOG CONVERSION**

Table 5 is an extension of Table 6 of Reference 1. Two new columns have been added to incorporate information from the Library of Congress (Ref. 11) and the New York Public Library (Ref. 5). The previous horizontal entries of "punched cards" and "coding sheets" have been merged into the single entry "supplies". Two new horizontal entries have been added: "sort and merge" under computer costs and "supervision".

With seven sources of data representing three public libraries and four university libraries and with data gathered for the most part independently over a 4-year
### Table 5

**Comparative Conversion Costs Per Title**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LC</td>
<td>LACP</td>
<td>ONLUP</td>
<td>NYP</td>
<td>UC/B</td>
<td>CHY</td>
<td>SUL</td>
</tr>
<tr>
<td>446 char.</td>
<td>$0.169</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>450 char.</td>
<td></td>
<td>$0.480</td>
<td></td>
<td>$0.307</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$0.207</td>
<td></td>
<td></td>
<td>$0.188</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>000 char.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$0.188</td>
<td></td>
<td></td>
</tr>
<tr>
<td>300 char.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$0.117</td>
<td></td>
</tr>
<tr>
<td>317 char.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$0.103</td>
</tr>
<tr>
<td>Supplies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$0.133</td>
</tr>
<tr>
<td>Conversion &amp; List</td>
<td>0.020</td>
<td></td>
<td></td>
<td>0.024</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edit List</td>
<td>0.359</td>
<td></td>
<td></td>
<td>0.141</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sort &amp; Merge</td>
<td>0.080</td>
<td></td>
<td></td>
<td>0.165</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supplies</td>
<td>0.080</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supervision</td>
<td>0.183</td>
<td></td>
<td>0.580</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

1/ Includes provision for keypunch rental, and supplies
2/ Full keypunch rental absorbed by pilot project
3/ Includes use of automatic error-detection routines
4/ Includes cost of magnetic tapes and other supplies
period, it is worth making a number of separate comparisons within the data to test it for consistency.

1. Perhaps the most outstanding comparison is between the encoding costs for the Library of Congress and the Los Angeles Public Library. For records of essentially the same average length (446 characters versus 450 characters) the coding costs agree to the penny! Yet the methods of production are significantly different. The Library of Congress invested heavily in the coding and editing operation and used paper tape typewriters with their relatively high rental. As a result their costs in this area are significantly higher than LACP. On the other hand these procedural changes resulted in significantly lower keying costs so that the overall cost for encoding was the same.

2. The encoding costs of UC/B (University of California at Berkeley), CHY (the Columbia, Harvard, Yale study), and SUL (the Stanford Undergraduate Library) are all very close (within 3 cents per title) even though there is a fair range of record size (from 180 for SUL to 317 for UC/B) and these three studies probably provide a more reasonable picture of the underlying variation in cost than the unusually close figures for LC and LACP.

As a check on these five studies, we can plot the average cost versus the average record length (in characters per record) (Figure 1). The rightmost point is the average for LC and LACP, the center point is for the three studies—UC/B, CHY, and SUL. The line is simply drawn through the origin (zero dollars, zero cost) and the LC/LACP point. The other points added are as follows:

1. The New York Public point of $.45 for a 300-character record. This point is not "real" because it is not based on actual NYP experience but rather on a study of information from other studies. Its proximity to the line suggests that NYP's analysis of existing information comes to similar conclusions to ours.
2. The Ontario New Universities Library Project (ONULP) point does not include the full rental charge indicated in their study because they wrote off the entire cost of keyboard rental on the project even though the machines were not nearly fully used. We have arbitrarily chosen $.08 per record for machine rental in plotting this point.

3. The point for the Harvard University Library (HUL) is based on information received from them in a private communication.

Although there is a significant amount of variation from one study to the next it seems reasonable to conclude that the cost of encoding is in the order of $.15 per title per hundred characters.

The cost of computation is not as well-documented. There are basically three computational operations common to those studies that reported computer costs at all:

1. The cost of conversion and listing. This cost included the cost of converting the original machine-readable form (be it cards or paper tape) to magnetic tape form. In most cases a by-product of this operation was a listing (all-caps only) of the material on the tape.

2. The cost of an edit run including a listing in upper and lower case. The latter was eschewed in a number of cases because of the added costs. However, many libraries would require a proper edit run and many librarians would prefer to edit from an upper/lower case printout than an all caps printout.

3. The cost of sorting and merging the tapes. Many of the early studies did not explicitly report on this cost because they were primarily concerned with the cost of converting the retrospective list. However, in an on-going operation this would be a continuing cost of some magnitude.

The available information points to a uniform cost of approximately $.02 per record for conversion and list, and approximately $.08 per record for editing. The two studies where both these costs are given indicate that a
ratio of 4 to 1 is appropriate. The only study giving a ratio between the sort and merge operation and the edit operation is the NYP study and this is based on before-the-fact-information only. Their figure is approximately 8 to 7. For convenience, we will assume that this ratio is unity, thus giving us an overall ratio of 4-4-1. The most complete history of total computer cost is given by LC: a total of $.36 per record for 446 character records. Using our rough breakdown for their total we obtain a breakdown of $.04 for conversion and list, $.16 for editing, and $.16 for sort and merge. Extending the Stanford cost of $.12 for conversion and list and editing we obtain a total cost for SUL of $.22 for their 180 character records. This figure is considerably more than 180/446 parts of the LC cost.

One other pertinent piece of information is available from the SUL data. In the production of their annual catalog, Stanford estimates a cost of $.121 per title for what is roughly comparable to the cost of sort and merge. This cost is then roughly 1.2 times the SUL cost for conversion and list and editing, thus verifying the notion that the cost of "sort and merge" is in the same general order of magnitude as the cost of editing.

The ratios of SUL costs to LC are .367/.690 for encoding (=.532) and .225/.359 (=.625) for computer time. This suggests that the means of computing average record length may be different for the two institutions. If we take the LC figures as the standard and assume that both computing and encoding costs are strictly a function of record length, then the SUL record length should be between (.532x446=) 238 and (.625x446=) 279. This discrepancy may be a result of one source (presumably LC) counting all delimiter and other non-printing characters while the other does not. NYP indicates that the ratio of printed characters to total characters is in the order of 3:4. If the SUL figure of 180 is expanded by one third we obtain the figure of 240 which agrees well with the lower limit (based on encoding costs) given above.

The cost of sort and merge is a function of the size of the data base, not the amount of material being put into it. The Library of Congress points this out in their study (Ref. 11) and report on an average month (where their data base grows for a period and then is reduced to zero.) Stanford Undergraduate Library figures are based on their second year of operation where they
added 16,000 titles to form a total base of 41,000 titles. The actual cost of this step in the operation will therefore depend strongly on the operating strategy employed. Clearly, the number of times one has to sort and merge the entire database should be minimized, particularly when one takes into account the fact that sorting costs go up faster than linearly. Thus if the master file is arranged in $n$ orders (author, subject, title, class number, etc.), it will generally be less expensive to sort the updating material into those $n$ orders and make $n$ merge runs with the sorted master files than to make a single merge with a single ordering of the master file and then sort the master file $n$ times to obtain the required updated orderings of the master file.

THE COMPARATIVE COST OF MANUAL AND COMPUTER PROCESSING

Our objective was to try to shed some light on the various factors that enter into the cost calculations to determine the relative costs of manual and computer processing of catalog information and to report on the present indicated cost values for those factors. At the expense of possible oversimplification, let us now compare the actual costs for these two alternatives for a "typical" library, i.e., a library whose cost structure approximates the average costs of those presented in the preceding tables.

From Table 5 we obtain average figures for two cases: catalogs with approximately 425 characters per entry and catalogs with approximately 250 characters per entry; let us call these "full entries" and "short entries," respectively.

From Table 4, we can compute similar figures for "full catalogs" and "short catalogs" by clustering the three larger cases (those having 9.8, 9.0, and 7.0 cards per title) and the three smaller cases (those having 3.0 and 4.6 cards per title). For the full catalogs we find that the average cost of processing is 26.7¢ per card and 8.6 cards per title, or a total cost of $2.29 per title. For the short catalogs we find that the average cost of processing is 20.3¢ per card and 3.8 cards per title, or $0.78 per title. Combining these two sets of figures we obtain the results in Table 6.
TABLE 6
COMPARATIVE COSTS OF MANUAL
AND COMPUTERIZED PROCESSING

<table>
<thead>
<tr>
<th></th>
<th>Short Entries</th>
<th>Full Entries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual</td>
<td>$0.78</td>
<td>$2.29</td>
</tr>
<tr>
<td>Computer</td>
<td>$0.84</td>
<td>$1.31</td>
</tr>
</tbody>
</table>

From Table 6 we see that our hypothesized "typical" library would be slightly better off with manual methods if it chose the short form entries and noticeably better off with the machine if it chose the full form of the entry.

In making this quick comparison, we have not considered several factors that should obviously be taken into account even in this simple example. First, we have not included either the initial cost of programming or the initial cost of converting the retrospective records. Either or both of these costs could be substantial, but they are one-time costs and as libraries are basically long term institutions, such costs should be written off over a relatively long period—even though they must be financed out of a given year's budget.

Second, we have not included the cost of printing the catalog (assuming a book catalog is in fact to be used in the computerized system). Thus the comparison in Table 6 is between a card catalog and a catalog in machine-readable form. Such a comparison is complicated by the fact that a card, once filed, stays in the catalog indefinitely, subject only to long-term wear and tear and a certain rate of attrition due to unauthorized removal, misfiling, and so forth, while the machine-readable catalog must be updated periodically and supplemented by interim publications. And, of course, the comparison is also complicated by the corresponding low cost of producing a number of copies of the book catalog where this is useful for a given system.
However, to put the printing cost in some degree of perspective, let us make a quick calculation based on the production of a single book catalog using a standard upper-lower case print chain. At present commercially available prices this would cost between 35¢ and 50¢ per 10,000 characters or approximately 9¢ per entry for the full form entries and 5¢ per entry for the short form entries (assuming four complete listings for author, title, subject, and class number listings). This added cost would make the comparison between manual and computerized methods even less favorable for the short form but still substantially better for the long form entries ($1.40 to $2.29).

CONCLUSION

The conclusion of this study is that the card processing operations in typical libraries can be automated economically in many situations today. Libraries using the short form of a catalog and having no immediate need for multiple copies of the catalog may find it desirable to wait a year or two, depending upon their local situation, the availability of trained personnel and, of course, the availability of capital to finance the initial cost of programming and retrospective conversion.

However, libraries using the full form in their catalogs or those needing multiple copies of their catalogs will almost certainly find that there is a substantial economic advantage to computerization at the present time. Even when allowance is made for substantial departures from the "typical" costs found in this study, it is difficult to visualize any library using full form information not finding significant economic gains in computerization.

When one adds to this the greater flexibility available in machine-readable records, the greater services that can be offered to the user, and the fact that machines costs are decreasing while labor costs are increasing, one is led to the conclusion that more and more libraries will move towards automation of their catalog.

Tables 7 to 11 are reference tables for calculating costs.
**TABLE 7**

**COST/CARD — LIBRARY OF CONGRESS CATALOG CARDS (July 1968)**

<table>
<thead>
<tr>
<th>LC Cards Ordered by/for</th>
<th>1-2 cds only</th>
<th>1st cd of 3 or more order</th>
<th>Add'l copies same ed ordered same tm.</th>
<th>All titles specific subject</th>
<th>Subsc for all cds</th>
<th>Extra chgs/title all orders lacking recd info</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) LC #</td>
<td>$ .22</td>
<td>$.10</td>
<td>$.06</td>
<td>$ ---</td>
<td>$ ---</td>
<td>---</td>
</tr>
<tr>
<td>2) Author &amp; Title</td>
<td>$.27</td>
<td>$.15</td>
<td>$.06</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>3) Series</td>
<td>---</td>
<td>$.10</td>
<td>$.06</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>4) Subject</td>
<td>---</td>
<td>$.10</td>
<td>$.06</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>5) Chinese/Japanese/Korean</td>
<td>.22 - .27</td>
<td>.10 - .15</td>
<td>.06</td>
<td>---</td>
<td>.04</td>
<td>.04</td>
</tr>
<tr>
<td>6) Motion Pictures &amp; Filmstrips</td>
<td>.22 - .27</td>
<td>.10 - .15</td>
<td>.06</td>
<td>.10</td>
<td>.04</td>
<td>.04</td>
</tr>
<tr>
<td>7) Phonorecords</td>
<td>.22 - .27</td>
<td>.10 - .15</td>
<td>.06</td>
<td>.10</td>
<td>.04</td>
<td>.04</td>
</tr>
<tr>
<td>8) Revised &amp; Cross Ref.</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>.04</td>
</tr>
<tr>
<td>9) Anonymous</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>.04</td>
</tr>
</tbody>
</table>

**Source** - LC cds, July 1968-GPO
# TABLE 8
**CATALOG CARD COSTS**

<table>
<thead>
<tr>
<th>CARDS</th>
<th>COST/CARD</th>
<th>COST/HOUR</th>
<th>TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>LC Cards</td>
<td>$0.22-$0.27 (min order 1-2 cds)</td>
<td>$0.04 extra chg all orders lacking req. info.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$0.10-$0.15 (1st cd - 3 or more order)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$0.04-$0.06 (add'l copies same cd-same order)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blank Cards</td>
<td>&lt; 3-&lt; 4 for $0.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Original Card Preparation</td>
<td>$0.20-$2.34</td>
<td>$2.40 - 4.70</td>
<td>5-30 min/cd</td>
</tr>
<tr>
<td>Card Checking Before Filing</td>
<td>$0.21</td>
<td>$4.20</td>
<td>3 min/cd</td>
</tr>
<tr>
<td>Correcting Detected Errors</td>
<td>$0.12</td>
<td>$2.40</td>
<td>3 min/cd</td>
</tr>
<tr>
<td>File</td>
<td>$0.024</td>
<td>$2.40</td>
<td>100 cds/hr</td>
</tr>
<tr>
<td></td>
<td>0.03</td>
<td>3.00</td>
<td>100 cds/hr</td>
</tr>
<tr>
<td></td>
<td>0.047</td>
<td>4.71</td>
<td>100 cds/hr</td>
</tr>
<tr>
<td>Store</td>
<td>$0.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reproduce</td>
<td>$0.0023-$0.00208 (AB Dick Offset Press = $0.125/bk(54-60 cds)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$0.045 (Xerox - 1K-100K cds)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### TABLE 9
CARD CATALOG MAINTENANCE COSTS

<table>
<thead>
<tr>
<th>Requirement Space</th>
<th>Estimated Cost/Sq Ft</th>
<th>Cost/Mo</th>
<th>Cost/Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Card Catalog Cabinet - 6 sq ft</td>
<td>$ .42</td>
<td>$ 2.52</td>
<td>$ 30.24</td>
</tr>
<tr>
<td>Room for Users -16 sq ft</td>
<td></td>
<td>6.72</td>
<td>80.64</td>
</tr>
<tr>
<td>Aisles - 3 sq ft</td>
<td></td>
<td>1.26</td>
<td>15.12</td>
</tr>
<tr>
<td>Catalog Table - 5 sq ft</td>
<td></td>
<td>2.10</td>
<td>25.20</td>
</tr>
<tr>
<td>30 sq ft</td>
<td>$ 12.60</td>
<td>$ 151.20</td>
<td></td>
</tr>
</tbody>
</table>

Source - E. Graziano/Univ. Calif. at Santa Barbara and R&D Consultants Co.
TABLE 10
(ESTIMATED) ANNUAL COST OF 1000 SQ FT OF STORAGE SPACE

1) Minnesota State Dept. of Education (1968) - $520

Source - Private communication

2) R&D Estimate

<table>
<thead>
<tr>
<th>Year</th>
<th>Construction Cost</th>
<th>Annual Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1968</td>
<td>$30,000</td>
<td>$300/yr</td>
</tr>
<tr>
<td></td>
<td>$30 sq ft x 1000 sq ft</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$1 yr/sq ft x 100 yrs (life of bldg)</td>
<td>$1300/yr</td>
</tr>
<tr>
<td>1974</td>
<td>$50,000</td>
<td>$500/yr</td>
</tr>
<tr>
<td></td>
<td>$50 sq ft x 1000 sq ft</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$1 yr/sq ft x 100 yrs (life of bldg)</td>
<td>$1500/yr</td>
</tr>
</tbody>
</table>

Source - E. Graziano/Univ. Calif. at Santa Barbara
TABLE 11
CARD CATALOG COST/YEAR

Given the following variables, 1 card catalog case with a maximum card capacity of 72,000 cards (purchase price-$789) - the cost/card to store would be $.01. Therefore we also find the following to be true:

<table>
<thead>
<tr>
<th></th>
<th>Estimated Cost/sq ft</th>
<th>Construction Cost $30/sq ft $30/sq ft + 100 yrs life bldg Cost/Yr</th>
<th>Maintenance Est. @ $1/sq ft Cost/Yr</th>
<th>Cost/Yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cabinet (6 sq ft)</td>
<td>$30.24</td>
<td>$1.80</td>
<td>$6.00</td>
<td>$38.04</td>
</tr>
<tr>
<td>Room for Users (16 sq ft)</td>
<td>80.64</td>
<td>4.80</td>
<td>16.00</td>
<td>101.44</td>
</tr>
<tr>
<td>Aisles (3 sq ft)</td>
<td>15.12</td>
<td>.90</td>
<td>3.00</td>
<td>19.02</td>
</tr>
<tr>
<td>Catalog Table (5 sq ft)</td>
<td>25.20</td>
<td>1.50</td>
<td>5.00</td>
<td>31.70</td>
</tr>
<tr>
<td>+ 72,000 cards @ $.01 (to store)</td>
<td></td>
<td></td>
<td></td>
<td>720.00</td>
</tr>
<tr>
<td>TOTAL COST/YR</td>
<td></td>
<td></td>
<td></td>
<td>$910.20</td>
</tr>
</tbody>
</table>
REFERENCES


APPENDIX A

BIBLIOGRAPHY OF LIBRARY COST/AUTOMATION
Arranged Alphabetically by Author

ADAMS, SCOTT
BIBLIOGRAPHICAL ORGANIZATION IN THE BIOMEDICAL SCIENCES
WILSON LIBRARY BULLETIN 40 APR 1966 PP 714-718

ATHERTON, PAULINE
IS COMPATIBILITY OF AUTHORITY FILES PRACTICABLE
NEWMAN, SIMON N.-ED. INFO SYSTEMS COMPATIBILITY - WASH. SPARTAN BK
1965. AM UNIV, WASH DC - TECHNOLOGY OF MANAGEMENT SERIES, V.1 P.69-81

ATKINSON, FRANK
COLD COMPOSITION ON FILM AND PAPER
AUSTRALIAN LITHOGRAPHER - FEB 68 REPRINTS AVAILABLE THIS COUNTRY THRU
CIS NEWSLETTER SPRING 1968

AVRAM, H.D.
GUILES, K.D.
MEADE, G.T.
FIELDS OF INFO. ON LIBRARY CONGRESS CATALOG CARDS ANALYSIS OF A
RANDOM SAMPLE, 1950-1964
U.CHICAGO-1967 SEE LIBR QUARTERLY 37 NUMBER 2 APR 67

AVRAM, H.D.
MARKUSON, B.E.
LIBRARY AUTOMATION AND PROJECT MARC AN EX. IN THE DIST OF MACHINE-
READABLE CATALOGING DATA
THE BRASENOSE CONF ON AUTOMATION OF LIBRARIES, OXFORD, ENG., 30 JUN-
3 JUL 1966. PROCEEDINGS - MANSELL, LONDON, 1967-P97-127

AVRAM, H.D.
FREITAG, R.S.
GUILES, K.D.
A PROPOSED FORMAT FOR A STANDARDIZED MACHINE READABLE CATALOG RECORD
LIBR CONGR, JUNE 1965

BANKS, PAUL N.
SOME PROBLEMS IN BOOK CONSERVATION
LRTS 12 SUMMER 1968 330-338

BARNETT, M.P.
COMPUTER TYPESETTING, EXPERIMENTS & PROSPECTS
MIT PRESS - CAMBRIDGE, MASS. 1965 - 245PP

BATT, N.C.
DATA ANALYSIS OF SCIENCE MONOGRAPH ORDER/CATALOGING FORMS
SPECIAL LIBRARIES 57 OCT 1966 PP 583-586

BAUER, C.K.
LIBRARY PLANNING FOR AUTOMATION REVIEW OF KENT, ALLEN-ED
SPECIAL LIBRARIES 57 JUL - AUG 1966 PP 413-414

BECKER, JOSEPH
THE STUDY OF BIBLIOPHONE & THE SPIRAL BOOK CHUTE
D.C. LIBRARY 37 SPRING 1966 PP 15-19

BECKMAN, MARGARET
A DOCUMENTATION CENTER AT THE UNIV. OF GJELPH LIBRARY

A - 1
ONT. LIBR. REV. DEC 1966 PP 226-229

BERUL, LAWRENCE H.
SURVEY OF IS&R EQUIPMENT
DATAMATION MAR 68 - P. 27-32

BISHOP, DR. CHARLES
AN INTEGRATED APPROACH TO THE DOCUMENTATION PROBLEM
AMER DOC 4 1953 54-65

BLACK, DONALD V.
FARLEY, EARL A.
LIBRARY AUTOMATION
ANNUAL REVIEW OF INFO. SCIENCE & TECHNOLOGY - CARLOS CUADRA-ED
INTERSCIENCE, N.Y. 1966 - VOL. 1 PP 273-303

BLOCK, H.
GNP SERIES FOR SELECTED AREAS, 1950-70 TABLE 1
PREPARED AT THE US DEPT OF STATE FOR THE SOCIETY FOR INTERNATIONAL
DEVELOPMENT & ASSN. FOR COMPARATIVE ECONOMICS, DATA THRU 1965, REVISED
FOR THE SOVIET UNION THRU JAN 1967

BOBROW, D.G.
RAPHAEL, BERTRAM
A COMPARISON OF LIST-PROCESSING COMPUTER LANGUAGES
COMM. ACM 7 4 APR 64 231-240

BOURNE, C.P.
FORD, D.F.
COST ANALYSIS & SIMULATION PROCEDURES FOR THE EVALUATION OF LARGE
INFORMATION SYSTEMS
AMER DOC 15 NUMBER 2 APR 64 142-149

BREGZIS, RITVARS
THE ONTARIO NEW UNIVERSITIES LIBRARY PROJECT--AN AUTOMATED
BIBLIOGRAPHIC DATA CONTROL SYSTEM
COLL & RES LIBR. 26 NOV 65 493-508

BREGZIS, RITVARS
THE ONULP BIBLIOGRAPHIC CONTROL SYSTEM
PROC. 1965 CLINIC ON LIBR APPL. OF DATA PROCESSING-UNIV ILLINOIS

BROWN, MARGARET C.
A BOOK CATALOG AT WORK
LIB RES & TECH SERV. 8 FALL 1964 PP 349-358

BROWN, MARGARET C.
IS THE CARD CATALOG OBSOLETE
PENN. LIBR ASSN BULL-18 FEB 1963 PP 1-13

BRYAN, HARRISON
AMERICAN AUTOMATION IN ACTION
LIBR. JOURNAL 92 - 15 JAN 67 PP 189-196

CAIN, A.M.
JOLLIFFE, J.W.
ALPHABETS IN A MULTI-LINGUAL LIBRARY
THE BRASENOSE CONF. ON AUTOMATION OF LIBRARIES, OXFORD, ENG. 30 JUN-
3 JUL 1966. PROCEEDINGS - MANSELL, LONDON 1967 - PP 84-96

A - 2
CAMPBELL, H.C.
A PROPOSAL FOR A BIBLIOGRAPHIC BANK FOR THE PROVINCE OF ONTARIO
LIBRARY RESOUR. TECH. SERV. 10 FALL 1966 PP 512-519

CARRINGTON, DAVID K.
BIBLIOGRAPHY OF LIBRARY COOPERATION
SPEC. LIBRARIES 57 JUL-AUG 1966 PP 395-399

CARTWRIGHT, KELLEY L.
SHOFFNER, RALPH M.
CATALOGS IN BOOK FORM A RES. STUDY OF THEIR IMPLICATION FOR THE CALIF
STATE LIBRARY & THE CALIF. UNION CATALOG, WITH A DESIGN FOR THEIR
IMPLEMENTATION
INST. OF LIBR. RES - BERKELEY, CALIF 1967 - 1 VOL VARIOUS PP

CHAPIN, RICHARD E.
PRETZER, DALE H.
COMPARATIVE COSTS OF CONVERTING SHELF LIST RECORDS TO MACHINE READABLE
FORM
JOURNAL OF LIBRARY AUTOMATION 1 MAR 68 66-74

CHAVE, LEONARD
ADVANCES IN COMPUTER TYPESETTING PRODUCTION REPORT
PRINTING TECHNOLOGY - JUL 67 PP 94-101

CLAPP, VERNER W.
THREE AGES OF REFERENCE WORK
SPEC. LIBR. 57 JUL-AUG 1966 PP 379-384

COX, JAMES R.
THE COSTS OF DATA PROCESSING IN UNIV. LIBRARIES. IN CIRCULATION
ACTIVITIES
COLL RES LIBR 24 NOV 63 492-5

COX, N.M.S.
DEWS, J.D.
DOLBY, J.L.
THE COMPUTER & THE LIBRARY
ARCHON PRESS, HAMDEN, CONN. 1967

COX, N.M.S.
GROSE, M.
ORGANIZATION & HANDLING OF BIBLIOGRAPHIC RECORDS BY COMPUTER
1967, ORIEL PRESS

COX, N.M.S.
DOLBY, J.L.
STRUCTURED LINGUISTIC DATA & THE AUTOMATIC DETECTION OF ERRORS
ADVANCES IN COMPUTER TYPESETTING/INST OF PRINTING, LONDON, 1966

CRONIN, JOHN W.
THE LIBRARY OF CONGRESS NATIONAL PROGRAM FOR ACQUISITIONS & CATALOGING
LIBRI 16 2 1966 PP113-117

CULBERTSON, D.S.
THE COSTS OF DATA PROCESSING IN UNIVERSITY LIBRARIES, IN BOOK
ACQUISITION AND CATALOGING
COLL RES LIBR 24 NOV 63 487-89

CURRAN, ANN T.
THE MECHANIZATION OF THE SERIAL RECORDS FOR THE MOVING & MERGING OF THE BOSTON MEDICAL & HARVARD MEDICAL SERIALS
LIBR. RESOUR. TECH. SERV. 10 SUMMER 1966 PP362-372

DANIELSON, ROSAMOND
SERIALS HOLDINGS INFORMATION SERVICE IN RESEARCH LIBRARIES
LIBR. RESOUR. TECH. SERV. 10 SUMMER 1966 PP 261-283

DAVIDSON, DONALD C.
MY IDEAL YORKSHIRE ACADEMIC LIBRARY A COMPOSITE VIEW BY A VISITING AMERICAN USER
LIBRARY ASSN RECORD 70 JAN 68 P.6-10

DE GENNARO, RICHARD
A COMPUTER PRODUCED SHELF LIST
COLL RES LIBR. 26 JUL 65 311-315/353 SEE LIB CONGR NUMBER Z671,C6, V. 26

DE GENNARO, RICHARD
THE DEVELOPMENT & ADMINISTRATION OF AUTOMATED SYSTEMS IN ACADEMIC LIBRARIES
JOURNAL OF LIBRARY AUTOMATION 1 MAR 68 75-91

DE GENNARO, RICHARD
A STRATEGY FOR THE CONVERSION OF RESEARCH LIBRARY CATALOG TO MACHINE READABLE FORM
COLL RES LIBR. V.28 NUMBER 4 253-257

DE SULLA PRICE, D.J.
RESEARCH ON RESEARCH JOURNEYS IN SCIENCE, U. OF NM PRESS/ALBUQUERQUE, NM 1967 2-21

DE SULLA PRICE, D.J.
SCIENCE SINCE BABYLON 1962, YALE UNIVERSITY PRESS/NEW HAVEN, CONN

DENNIS, BERNARD K.
FINANCING A TECHNICAL INFORMATION CENTER INFORMATION RETRIEVAL MANAGEMENT DETROIT 1962 - CHAP 9 61-75

D IMPERIO, M.E.
TEMAC A MACHINE LANGUAGE FOR PROCESSING TEXT. PROGRAMMING MANUAL, PT1 DOD

D IMPERIO, M.E.
TEMAC TEXT MACRO COMPILER A MACHINE LANGUAGE FOR PROCESSING TEXT 1965, DOD

DIX, WILLIAM S.
CENTRALIZED CATALOGING & UNIVERSITY LIBRARIES TITLE 2/PT C OF THE HIGHER EDUCATION ACT OF 1965 LIBRARY TRENDS - JUL 67 P 97-111

DOLBY, J.L.
PRIORITY & PROCEDURES FOR NOISY MATCHES IN CATALOG SEARCHING DEC 67, R&D CONSULTANTS CO.

DOLBY, J.L.
RESNIKOFF, H.L.
ON THE STRUCTURE OF WRITTEN ENGLISH WORDS A - 4
DOUGLAS, J.
SURVEY OF STUDENT LIBRARY USE
SAN JOSE STATE COLLEGE LIBRARY MEMO 5 MAR 68

DOYLE, L.B.
EXPANDING THE EDITING FUNCTION IN LANGUAGE DATA PROCESSING
CACM 8 NUMBER 4 APR 65 238-43

DREW, D.L.
SUMMIT, R.K.
TANAKA, R.I.
WHITELEY, R.B.
AN ON-LINE TECHNICAL LIBRARY REFERENCE RETRIEVAL SYSTEM
AMER DOC 17 NUMBER 1 JAN 66 3-7

EYMAN, ELEANOR G.
FRIDLIN, CHARLES C.
OLSON, S. BRUSE
BAKER, SAMUEL M., JR.
PIERATT, ASA B.
PERIODICALS AUTOMATION AT MIAMI-DADE JR. COLLEGE
LIBR. RESOUR. TECH. SERV. 10 SUMMER 1965 PP 341-361

FARBER, D.J.
GRISWOLD, R.E.
POLONSKY, I.P.
SNOBOL, A STRING MANIPULATION LANGUAGE
J. ACM 11 1 JAN 64 21-30

FASANA, PAUL J.
AUTOMATING CATALOGING FUNCTIONS IN CONVENTIONAL LIBRARIES
LIBR RES & TECH SERV. V.7 FALL 1963 350-365

FASANA, PAUL J.
DETERMINING THE COST OF LIBRARY AUTOMATION
ALA BULLETIN JUN 67 - P. 656-651
FOREST, BOB
BALGOL AT STANFORD
DATAMATION DEC 61 24-26

FRANKE, RICHARD D.
COMPUTERIZED LIBRARY CATALOG CROSS-INDEXING FOR THE NAVY
DATAMATION FEB 68

FREEMAN, MONROE E.
DETERMINING COSTS OF INFORMATION SYSTEMS
JOURNAL OF CHEMICAL DOCUMENTATION MAY 1967 - P. 101-106

GELLER, WILLIAM
DUPLICATE CATALOGS IN REGIONAL & PUBLIC LIBRARY SYSTEMS
LIBR QUAR 34 JAN 64 57-67

GRAZIANO, EUGENE
MACHINE-MEN AND LIBRARIANS, AN ESSAY
COLL RES LIBR 28 NUMBER 6 PP 403-406

GRIFFIN, HILLIS L.
ESTIMATING DATA PROCESSING COSTS IN LIBRARIES
GRISWOLD, R.E.
PREL. DESCRIPTION OF THE SNOBOL 4 PROGRAMMING LANGUAGE
6 JUL 67, BELL TEL LABS

GROSE, M.W.
LINE, M.B.
ON THE CONSTRUCTION AND CARE OF WHITE ELEPHANTS
ALA BULLETIN JUN 68 741-747

HALPERN, M.I.
A MANUAL OF THE XPOP PROGRAMMING SYSTEM THIRD ED
MAR 67, LOCKHEED/PALO ALTO

HALPERN, M.I.
XPOP A META-LANGUAGE WITHOUT METAPHYSICS
PROCEEDINGS FJCC 1964 57-68

HAMBLEN, JOHN W.
COMPUTERS IN HIGHER EDUCATION
S. REGIONAL EDUCATION BOARD/GA. AUG 67

HAMER, ELIZABETH E.
69TH MEETING OF THE ASSN OF RES. LIBRARIES
COLL RES LIBR NEWS - NUMBER 3 MAR 67 PP 64-70

HAMMER, D.P.
PROBLEMS IN THE CONVERSION OF BIBLIO DATA - A KEYPUNCHING EXPERIMENT
AMER DOC 19 JAN 68 12-17

HARRISON, JOHN
LASLETT, PETER
THE BRASENOSE CONF ON AUTOMATION OF LIBRARIES. PROCEEDINGS OF THE
ANGLO-AMERICAN CONF. ON THE MECHANIZATION OF LIBRARY SERVICES HELD AT
OXFORD UNDER THE CHAIRMANSHIP OF SIR FRANK FRANCIS & SPONSORED BY THE
OLD DOMINION FOUNDATION OF N.Y. -30 JUN-3 JUL 66
MANSELL, LONDON 1967 - 175PP

HASTING, ELEANOR R.
SOLUTIONS IN ESTABLISHING A NEW CATALOG AT THE US DEPT OF HEALTH,
EDUCATION & WELFARE LIBRARY
LIBR RES TECH SERV 10 FALL 1966 495-498

HAYES, R.M.
SHOFFNER, R.
WEBER, D.
THE ECONOMICS OF BOOK CATALOG PRODUCTION
LIBRARY RESOURCES & TECHNICAL SERVICES 10 90 - WINTER 1966

HAYES, ROBERT M.
INFORMATION RETRIEVAL AN INTRODUCTION
DATAMATION MAR 68 - P. 22-26

HAYES, ROBERT
LIBRARY SYSTEMS ANALYSIS

HARVEY, JOHN-ED - DATA PROCESSING IN PUBLIC & UNIV. LIBRARIES.
COMBINED PROCEEDINGS OF THE DREXEL CONF. ON DATA PROCESSING IN UNIV.
LIBRARIES 24-26 JUN 65 & THE DREXEL CONF ON DATA PROCESSING IN PUBLIC
LIBRARIES 22-23 OCT 65, PHILA. PA. SPARTAN BKS, WASH DC 1966 P. 5-20
HEINRITZ, FRED
BOOK VS CARD CATALOG COSTS
LRTS 7 SUMMER 1963 229-236

HEINRITZ, FRED
PREDICTING THE NEED FOR CATALOG EXPANSION
LRTS 11 SPRING 67 247-8

HENDERSOM, JAMES W.
ROSENTHAL, JOSEPH A.
LIBRARY CATALOGS THEIR PRESERVATION AND MAINTENANCE BY PHOTOGRAPHIC
AND AUTOMATED TECHNIQUES
NY PUBLIC LIBRARY-MIT PRESS, 1968

HINES, THEODORE C.
HARRIS, JESSICA L.
COMPUTER FILING OF INDEX, BIBLIOGRAPHIC & CATALOG ENTRIES
BR-DART FOUNDATION, NEWARK, N.J. 1966 - 126P

HOLLEY, EDWARD G.
HENDRICKS, DONALD D.
RESOURCES OF TEXAS LIBRARIES
TEXAS STATE LIBRARY/AUSTIN, TEXAS 1968

HOLZBAUR, F.W.
FARRIS, E.H.
LIBRARY INFORMATION PROCESSING USING AN ON-LINE, REAL-TIME COMPUTER
SYSTEM
IBM/POUGHKEEPSIE, NY - 7 DEC 66 47P

HOUSER, LLOYD J.
EFFECTIVENESS OF PUBLIC LIBRARY SERVICES DEVELOPMENT OF INDICES OF
OF EFFECTIVENESS AND THR RELATIONSHIP TO FINANCIAL SUPPORT
DEPT HEALTH, EDUCATION/WELFARE DEC 67 PROJ 6-8095 CONTRACT
OE-6-10-343

HSU, R.W.
CHARACTERISTICS OF FOUR LIST-PROCESSING LANGUAGES
1963, NATIONAL BUSTD RPT 8163/WASH DC

IKER, HOWARD P.
HARWAY, N.I.
A COMPUTER APPROACH TOWARDS THE ANALYSIS OF CONTENT
BEHAVIORAL SCIENCE 10 NUMBER 2 APR 65 173-81

IKER, HOWARD P.
HARWAY, NORMAN I.
A COMPUTER SYSTEMS APPROACH TOWARDS THE RECOGNITION & ANALYSIS OF
CONTENT
NATIONAL CONF ON CONTENT ANALYSIS 16-18 NOV 67, U. OF PENN/PHILA

JOHNSON, RICHARD D.
A BOOK CATALOG AT STANFORD
JOURNAL OF LIBRARY AUTOMATION 1 MAR 68 13-50

KAHN, H.
WIENER, A.J.
THE YEAR 2000
1967, THE MACMILLAN CO., NY
KAREL, L.
AUSTIN, C.S.
CUMMINGS, M.M.
COMPUTERIZED BIBLIOGRAPHIC SERVICES FOR BIOMEDICINE
SCIENCE 148 1965 766-72

KERSHAW, G.
DAVIS, J.E.
MECHANIZATION IN DEFENSE LIBRARIES
DATAMATION JAN 1968 48-53

KERSHAW, G.A.
CROWDER, D.
DAVIS, J.E.
LOGES, E.G.
MERENDINI, E.
STUDY OF MECHANIZATION IN DOD LIBRARIES & INFO. CENTERS
BOOZ, ALLEN APPLIED RESEARCH, INC. BETHESDA, MD. - SEP 1966 - 354 P.

KILGOUR, F. G.
COMPREHENSIVE MODERN LIBRARY SYSTEMS
THE BRASENOSE CONF. ON AUTOMATION OF LIBRARIES, OXFORD, ENG., 30 JUN-3 JUL 66 PROCEEDINGS...MANSELL, LONDON 1967 & 64-56

KILGOUR, FREDERICK
COSTS OF LIBRARY CATALOG CARDS PRODUCED BY COMPUTER
JOURNAL LIBR AUTOMATION JUN 68 121-127

KILGOUR, F. G.
LIBRARY CATALOGUE PRODUCTION ON SMALL COMPUTERS
AMER. DOC., 17 JULY 1966 PP 124-131

KILGOUR, F. G.
MECHANIZATION OF CATALOGUING PROCEDURES
BULL MED LIBR ASSN 2 1965 152-162

KILGOUR, F. G.
SYMBOL-MANIPULATIVE PROGRAMMING FOR BIBLIOGRAPHIC DATA PROCESSING ON SMALL COMPUTERS
COLL RES LIBR 27 NUMBER 2 1966 95-98

KING, GILBERT W.
AUTOMATION & THE LIBRARY OF CONGRESS
A RPT SUBMITTED BY GILBERT KING & OTHERS. LIBRARY OF CONGRESS, WASH DC 1963 - 88PP

KNIGHT, KENNETH E.
CHANGES IN COMPUTER PERFORMANCE
DATAMATION SEP 66 40-54

KNIGHT, KENNETH E.
EVOLVING COMPUTER PERFORMANCE 1963-1967
DATAMATION JAN 68 31-35

KOSTER, KURT
THE USE OF COMPUTERS IN COMPILING NATIONAL BIBLIOGRAPHIES,
ILLUSTRATED BY THE EXAMPLE OF THE DEUTSCHE BIBLIOGRAPHIE
LIBRI 16 4 1966 PP 269-281
KOUNTZ, JOHN C.
COST COMPARISON OF COMPUTER VS MANUAL CATALOG MAINTENANCE
JOURNAL LIBRARY AUTOMATION 1 SEP 68 159-177

KOZUMPLIK, W.A.
LANGE, R.T.
COMPUTER-PRODUCED MICROFILM LIBRARY CATALOG
OCT 66 - LMSC RPT 50-10-66-6

KOZUMPLIK, WILLIAM A.
TIME & MOTION STUDY OF LIBRARY OPERATIONS
SPEC LIBR - OCT 67

KRAFT, DONALD H.
A TOTAL SYSTEMS APPROACH TO LIBRARY AUTOMATION W/DATA PROCESSING EQUIPMENT
IRM - MAR 66

KUENTZEL, L.E.
CURRENT STATUS OF THE CODEN PROJECT
SPEC LIBR. 57 JUL-AUG 1966 404-406

LANE, DAVID O.
AUTOMATIC CATALOG CARD PRODUCTION
LIBR RES TECH SERV 10 SUMMER 1966 383-386

LANE, GORHAM
ASSESSING THE UNDERGRADUATES USE OF THE UNIVERSITY LIBRARY
COL & RES LIB 27 JUL 66 277-282

LEE, MALCOM K.
THE DEMISE OF THE KEYPUNCH
DATAMATION MAR 68 - P.51-55

LIPETZ, BEN-AMI
INFORMATION STORAGE & RETRIEVAL
SCIENTIFIC AMER. 215 SEP 66 224-232 &

LIPETZ, BEN-AMI
LABOR COSTS, CONVERSION COSTS, AND COMPATIBILITY IN DOCUMENT CONTROL SYSTEMS
AMER DOC 14 APR 63 117-122

LUBETZKY, SEYMOUR
THE LIBRARY CATALOG FOCUS ON FORM
REVIEW OF LIBRARY CATALOGS CHANGING DIMENSIONS. THE 28TH ANNUAL CONF. OF GRADUATE LIBRARY SCHOOL, 5-7 AUG 63 LIB RES & TECH SERV. 8 SUMMER 1964 PP 317-322

MCCARTHY, JOHN
LISP 1.5 PROGRAMMERS MANUAL
1962, MIT PRESS/CAMBRIDGE

MCCARTHY, J.
RECURSIVE FUNCTIONS OF SYMBOLIC EXPRESSIONS & THEIR COMPUTATION BY MACHINE
COMM. ACM 3 1960 184-195

MCCUNE, LOIS C.
SALMON, STEPHEN R.
MCGRATH, WILLIAM E.
A SIMPLE, MECHANIZED, NON-COMPUTERIZED SYSTEM FOR SERIALS CONTROL IN SMALL ACADEMIC LIBRARIES A PRIMER
LIBR RESOUR TECH SERV. 10 SUMMER 1966 373-382

KOLZI, HELEN

MATHEWS, M.V.
CHOOSING A SCIENTIFIC COMPUTER FOR SERVICE
SCIENCE 161 5 JUL 68 23-27

MOREHOUSE, H.G.

SHOFFNER, R.M.
AN EXPERIMENT IN LIBRARY APPLICATION XEROX LDX FACSIMILE TRANSMISSION EQUIPMENT. PHASE 1 PLANNING AND ANALYSIS
A STUDY PREPARED FOR COUNCIL ON LIBRARY RESOURCES, INC., INST OF LIBRARY RESEARCH, BERKELEY, CALIF. 1966, 261

MORGENSTERN, O.
THE ACCURACY OF ECONOMIC OBSERVATIONS
1963, PRINCETON - 2ND ED

MULHOLLAND, JOHN
CATALOGING SLEIGHT OF HAND
LIBR JOURNAL APR 68 1415-1417

GCONNOR, JOEL S.
AEC, DIVISION OF TECHNICAL INFO. TAPE DISTRIBUTION SYSTEM
29 SEP 67

OCONNOR, JOHN
SOME REMARKS ON MECHANIZED INDEXING & SOME SMALL-SCALE EMPIRICAL RESULTS
MACHINE INDEXING 1961 266-279

OVERHAGE, CARL F.J.
PLANS FOR PROJECT INTREX
SCIENCE 152 20 MAY 66 1032-1037

OVERMYER, LA VAHN
AN ANALYSIS OF OUTPUT COSTS AND PROCEDURES FOR AN OPERATIONAL SEARCHING SERVICE
AMER DOC APR 63 123-142

PALMER, FOSTER M.
CONVERSION OF EXISTING RECORDS IN LARGE LIBRARIES, W/SPECIAL REF. TO THE WIDENER LIBRARY SHELFIST
THE BRASENOSE CONF. ON AUTOMATION OF LIBRARIES, OXFORD, ENG. 30 JUN-3 JUL 66. PROCEEDINGS....MANSELL, LONDON 1967 - P. 67-77

PERRAULT, JEAN M.
THE COMPUTERIZED BOOK CATALOG AT FLORIDA ATLANTIC UNIVERSITY
COLL RES LIBR. 25 MAY 64 185-197

PERRAULT, J.
COMPUTERIZED CATALOGING THE COMPUTERIZED CATALOG AT FLORIDA ATLANTIC UNIVERSITY
LIBR RES TECH SERV 5 WINTER 65 38-34
SHIPMAN, JOSEPH C.
BIBLIOGRAPHIC ORGANIZATION IN THE PHYSICAL SCIENCES
WILSON LIBR BULL 40 APR 1966 PP 706-713

SHOFFNER, RALPH M.
INSTITUTE OF LIBRARY RESEARCH CURRENT RESEARCH & DIRECTION
PRESENTED AT THE AMERICAN SOCIETY FOR ENGINEERING EDUCATION ANNUAL
MEETING, JUNE 1966. PULLMAN, WASH. 1966 301.

SIMMONS, P.A.
AN ANALYSIS OF BIBLIOGRAPHIC DATA CONVERSION COSTS
LATS 12 SUMMER 1968 296-310

SIMON, JULIAN L.
HOW MANY BOOKS SHOULD BE STORED WHERE AN ECONOMIC ANALYSIS
COL RES LIBR MAR 67 92-103

SIMONTON, WESLEY
THE COMPUTERIZED BOOK CATALOG POSSIBLE, FEASIBLE, DESIRABLE
LIBR RES & TECH SERV. 8 FALL 1964 PP 399-407

SMITH, F.R.
JONES, S.O.
CARDS VS BOOK-FORM PRINTOUT IN A MECHANIZED LIBRARY SYSTEM
SPECIAL LIBRARIES NOV 67 639-643

SMITH, F.R.
JONES, S.O.
FIVE YEARS IN FOCUS - THE DOUGLAS AIRCRAFT COMPANY MECHANIZED INFO.
SYSTEM
BLACK, DONALD V.-ED - PROCEEDINGS OF THE 1966 ADI ANNUAL MEETING.
ADRIANNE PRESS, WOODLAND HILLS, CALIF 1966, P. 185-191

SPRENKLE, PETER
KILGOUR, FREDERICK
A QUANTITATIVE STUDY OF CHARACTERS ON BIOMEDICAL CATALOGUE CARDS - A
PRELIMINARY INVESTIGATION
AMER DOC JUL 63 202-206

SRYGLEY, TED F.
SERIALS RECORD INSTRUCTIONS FOR A COMPUTERIZED SERIAL SYSTEM
LIBR RES & TECH SERV. 8 SUMMER 1964 PP 248-256

STANWOOD, R.H.
THE COST OF A COMPUTERIZED INFORMATION RETRIEVAL SYSTEM
I.F.I.P. CONFERENCE 1967 -14-17 JUN 67

STARK, M.R.
MPL1 MULTIPLE PURPOSE LANGUAGE MANUAL VERSION 1
SEP 65, LOCKHEED-PALO ALTO

STEVENS, ROLLAND E.
THE STUDY OF THE RESEARCH USE OF LIBRARIES
LIBRARY QUARTERLY, V.26 JAN 56 PP 41-51

STRACHEY, C.
A GENERAL PURPOSE MACROGENERATOR
COMPUTER J. OCT 65

A - 12
TUMPKINS, MARY L.
TUKEY, JOHN W.
PERMUTED CIRCULARLY-SHIFTED INDEXES TO ABBREVIATIONS A MECHANICALLY PREPARED AID TO SERIAL IDENTIFICATION

TROTTER, H.F.
INTRODUCTION TO SNOBOL - PT 1
1966, PRINCETON UNIV COMPUTER CENTER/PRINCETON, N.J.

VAN COLLISTER, MR.
SAN JOSE REPORT OF LIBRARY SYSTEMS STUDY GROUP, 21 JUN 68
SAN JOSE STATE COLLEGE MEMO 21 JUNE 1968

VERHOEFF, J.
THE DELFT CIRCULATION SYSTEM
LIBRI 16 1 1966 PP 1-9

VOIGT, MELVIN J.
THE COSTS OF DATA PROCESSING IN UNIV. LIBRARIES IN SERIALS HANDLING
COLL RES LIBR 24 NOV 63 489-91

WEBER, DAVID C.
BOOK CATALOGS PROSPECTS IN THE DECADE AHEAD 1942-1961
COLL RES LIBR. 23 JUL 1962 302-310

WEBER, DAVID C.
BOOK CATALOG TRENDS IN 1966
LIBRARY TRENDS-JUL 1967 149-164

WEBER, DAVID C.
THE CHANGING CHARACTER OF THE CATALOG IN AMERICA
LIBR QUARTERLY 34 JAN 1964 20-33

WEINSTEIN, EDWARD A.
GEORGE, VIRGINIA
COMPUTER-PRODUCED BOOK CATALOGS ENTRY FORM AND CONTENT
BOEING SCIENTIFIC RES LABS/SEATTLE LIBR RES TECH SERV. VOL. 2-NUMBER 2 SPRING 67 185-189

WEINSTEIN, EDWARD A.
GEORGE, VIRGINIA
NOTES TOWARD A CODE FOR COMPUTER-PRODUCED PRINTED BOOK CATALOGS
LIBR RES & TECH SERV. 9 SUMMER 65 PP 319-324

WELLS, A.J.
THE BRITISH NATIONAL BIBLIOGRAPHY
THE BRASENOSE CONF. ON AUTOMATION OF LIBRARIES, OXFORD, ENG. 30 JUN-3 JUL 66 PROCEEDINGS....MANSELL, LONDON 1967 PP 24-31

WISHNER, RAYMOND P.
THE ROLE OF PAPER TAPE & OPTICAL SCANNING COMPUTER INPUT IN TEXTUAL DATA PROCESSING
1965 CONGRESS INTERNATIONAL FED. FR DOCUMENTATION IFID - ABSTRACT OCT 65, WASH. D.C. - P. 51-52 AD 625-498

WOOSTER, HAROLD
POST-MORTEMS CAN BE FUN - THE COST ANALYSIS OF INFORMATION SYSTEMS

A - 13
YNGVE, V.H.
COMM. ACM 6 3 MAR 63 83-4

ZUCKERMAN, RONALD
COMPUTERIZED BOOK CATALOGS & THEIR EFFECTS ON INTEGRATED LIBRARY DATA
PROCESSING RESEARCH & PROGRESS AT THE LOS ANGELES COUNTY PUBLIC LIBR
LOS ANGELES COUNTY PUBLIC LIBRARY

ZUCKERMAN, RONALD A.
OPTICAL SCANNING FOR DATA COLLECTION, CONVERSION & REDUCTION
AUG 67 - LA COUNTY PUBLIC LIBR & COUNCIL ON LIBR RESOURCES
ARRANGED ALPHABETICALLY BY TITLE

THE ACCURACY OF ECONOMIC OBSERVATIONS
MORGENSTERN, O.
1963, PRINCETON - 2ND ED

ADVANCES IN COMPUTER TYPESETTING
*NA
PROCEEDINGS 1966 INTERNATIONAL COMPUTER TYPESETTING CONF. - 1967. INST PRINTING/44 BEDFORD ROW/LONDON

ADVANCES IN COMPUTER TYPESETTING PRODUCTION REPORT
CHAVE, LEONARD
PRINTING TECHNOLOGY - JUL 67 PP 94-101

AEC, DIVISION OF TECHNICAL INFO. TAPE DISTRIBUTION SYSTEM
OCONNOR, JOEL S.
29 SEP 67

ALPHABETS IN A MULTI-LINGUAL LIBRARY
CAIN, A.M.
JOLLIFFE, J.W.
THE BRASENOSE CONF. ON AUTOMATION OF LIBRARIES, OXFORD, ENG. 30 JUN-3 JUL 1966. PROCEEDINGS - MANSELL, LONDON 1967 - PP 84-96

AMERICAN AUTOMATION IN ACTION
BRYAN, HARRISON
LIBR. JOURNAL 92 - 15 JAN 67 PP 189-196

AN ANALYSIS OF BIBLIOGRAPHIC DATA CONVERSION COSTS
SIMMONS, P.A.
LRTS 12 SUMMER 1968 296-310

AN ANALYSIS OF OUTPUT COSTS AND PROCEDURES FOR AN OPERATIONAL SEARCHING SERVICE
OVERMYER, LA VAHN
AMER DOC APR 63 123-142

ANNUAL RPT + DIRECTORY OF LIBRARIES IN OKLAHOMA
*NA
1967, OKLAHOMA DEPT OF LIBRARIES

ANNUAL REPORT OF THE PUBLIC LIBRARIES OF ALASKA
*NA
1966-67, STATE OF ALASKA/DEPT ED

ASSESSING THE UNDERGRADUATES USE OF THE UNIVERSITY LIBRARY
LANE, GORHAM
COL + RES LIB 27 JUL 66 277-282

AUTOMATED FUNCTIONS IN LIBRARIES + INFORMATION CENTERS
*NA
DOCUMENTATION GROUP - SPECIAL LIBR ASS NY CHAPTER

AUTOMATIC CATALOG CARD PRODUCTION
LANE, DAVID O.
LIBR RES TECH SERV 10 SUMMER 1966 383-386
A BOOK CATALOG AT STANFORD
JOHNSON, RICHARD D.
JOURNAL OF LIBRARY AUTOMATION 1 MAR 68 13-50

BOOK CATALOGS AS SUPPLEMENTS TO CARD CATALOGS
RICHMOND, PHYLLIS A.
LIBR RES + TECH SERV 8 FALL 1964 PP 359-365

BOOK CATALOG TRENDS IN 1966
WEBER, DAVID C.
LIBRARY TRENDS-JUL 1967 149-164

A BOOK CATALOG AT WORK
BROWN, MARGARET C.
LIB RES + TECH SERV. 8 FALL 1964 PP 349-358

BOOK VS CARD CATALOG COSTS
HEINRITZ, FRED
LRTS 7 SUMMER 1963 229-236

THE BRASENOSE CONF ON AUTOMATION OF LIBRARIES. PROCEEDINGS OF THE ANGLO-AMERICAN CONF. ON THE MECHANIZATION OF LIBRARY SERVICES HELD AT OXFORD UNDER THE CHAIRMANSHIP OF SIR FRANK FRANCIS + SPONSORED BY THE OLD DOMINION FOUNDATION OF N.Y. -30 JUN-3 JUL 66
HARRISON, JOHN
LASLETT, PETER
MANSELL, LONDON 1967 - 175PP

THE BRITISH NATIONAL BIBLIOGRAPHY
WELLS, A.J.
THE BRASENOSE CONF. ON AUTOMATION OF LIBRARIES, OXFORD, ENG. 30 JUN-3 JUL 66 PROCEEDINGS....MANSELL, LONDON 1967 PP 24-31

CANADA YEARBOOK
*NA
1962

CAPTURING DATA WITH AN OPTICAL SCANNER
*NA
1962 - NEW ORLEANS ASCS COM OFFICE

IS THE CARD CATALOG OBSOLETE
BROWN, MARGARET C.
PENN. LIBR ASSN BULL-18 FEB 1963 PP 1-13

A CARD-TRAY LIBRARY PLANNED BY BRITTANICA FOR SMALLER COLLEGES
*NA
WALL ST JOURNAL 12 DEC 68

CARDS VS BOOK-FORM PRINTOUT IN A MECHANIZED LIBRARY SYSTEM
SMITH, F.R.
JONES, S.O.
SPECIAL LIBRARIES NOV 67 639-643
CATALOGS IN BOOK FORM A RES. 1 OF THEIR CATION FOR THE CALIF STATE LIBRARY TH CALIF. UNION CATALOG, WITH DESIGN FOR THEIR IMPLEMENTATION CARTERIGHT, KELLEY L. SHOFFNER, RALPH M. INST. OF LIBR. RES - BERKELEY, CALIF 1967 - 1 VOL VARIOUS PP

CATALOGING SLEIGHT OF HAND WULFOLAND, JOHN LIBR JOURNAL APR 68 1415-1417

CENTRALIZED CATALOGING + UNIVERSITY LIBRARIES TITLE 2/PT C OF THE HIGHER EDUCATION ACT OF 1965 DIX, WILLIAM S. LIBRARY TRENDS - JUL 67 P 97-111

CENTRALIZED PROCESSING FOR THE PUBLIC LIBRARIES OF NEW YORK STATE NY STATE LIBRARY - THE BOOKMARK 25 APR 1966 243-46

CHANGES IN COMPUTER PERFORMANCE MATH, KENNETH E. COMPUTATION SEP 66 40-54

THE CHANGING CHARACTER OF THE CATALOG IN AMERICA WEBER, DAVID C. LIBR QUARTERLY 34 JAN 1964 20-33

CHARACTERISTICS OF FOUR LIST-PROCESSING LANGUAGES HSU, R.W. 1963, NATIONAL BUSTD RPT 8163/WASH DC

CHOOSING A SCIENTIFIC COMPUTER FOR SERVICE MATHEWS, M.V. SCIENCE 161 5 JUL 68 23-27

CODEN FOR INFO SEE FOLLOWING

CODEN FOR PERIODICAL TITLES PLUS SUPP 1

CODEN PERIODICAL TITLES PLUS SUPP 1

COMIT PROGRAMMERS REFERENCE MANUAL

COLD COMPOSITION ON FILM AND PAPER TINKINSON, FRANK AUSTRALIAN LITHOGRAPHER - FEB 68 REPRINTS AVAILABLE THIS COUNTRY THRU CIS NEWSLETTER SPRING 1968

COMIT YNGVE, V.H. COMM. ACM 6 3 MAR 63 83-4

COMM PROGRAMMERS REFERENCE MANUAL

1961, MIT PRESS/CAMBRIDGE, MASS
IS COMPATIBILITY OF AUTHORITY FILES PRACTICABLE
ATHERTON, PAULINE
NEWMAN, SIMON N.-ED. INFO SYSTEMS COMPATIBILITY - WASH. SPARTAN BKS 1965. AM UNIV, WASH DC - TECHNOLOGY OF MANAGEMENT SERIES, V.1 P.69-81

A COMPARISON OF LIST-PROCESSING COMPUTER LANGUAGES
BOBROW, D.G.
RAPHAEL, BERTRAM
COMM. ACM 7 4 APR 64 231-240

COMPARATIVE COSTS OF CONVERTING SHELF LIST RECORDS TO MACHINE READABLE FORM
CHAPIN, RICHARD E.
PRETZER, DALE H.
JOURNAL OF LIBRARY AUTOMATION 1 MAR 68 66-74

COMPREHENSIVE MODERN LIBRARY SYSTEMS
KILGOUR, F.G.
THE BRASENOSE CONF. ON AUTOMATION OF LIBRARIES, OXFORD, ENG., 30 JUN-3 JUL 66 PROCEEDINGS...MANSELL, LONDON 1967 ++ 46-56

A COMPUTER APPROACH TOWARDS THE ANALYSIS OF CONTENT
IKER, H.P.
HARWAY, N.I.
BEHAVIORAL SCIENCE 10 NUMBER 2 APR 65 173-81

COMPUTERS + AUTOMATION, MAY 1968 VOL 17, NUMBER 5
*NA
*NS

COMPUTER BUDGET, HOW TO SPEND THE
*NA
BUSINESS WEEK 1 JUN 68 -P. 100-104

COMPUTERS CHALLENGE CARDS IN LIBRARY CATALOGING STUDY
*NA
PUBLISHERS WEEKLY 189 28 FEB 66 71

COMPUTER DESK-TOP DATA GUIDE 1967
*NA
PROGRAMMING LANGUAGES ROSTER COSTS + SPEEDS - COMPUTERS

COMPUTER DIRECTORY + BUYERS GUIDE, 1968
*NA
COMPUTERS + AUTOMATION, JUN 68

COMPUTER FILING OF INDEX, BIBLIOGRAPHIC + CATALOG ENTRIES
HINES, THEODORE C.
HARRIS, JESSICA L.
BRD-DART FOUNDATION, NEWARK, N.J. 1966 - 126P

COMPUTER GETS FASTER RUNNING MATE
*NA
BUSINESS WEEK 8 JUN 68 84-85

COMPUTERS IN HIGHER EDUCATION
HAMBLEN, JOHN W.
S. REGIONAL EDUCATION BOARD/GA. AUG 67
THE COMPUTER + THE LIBRARY

COX, N.M.S.
DEWS, J.D.
DOLBY, J.L.
ARCHON PRESS, HAMDEN, CONN. 1967

COMPUTER-PRODUCED BOOK CATALOGS  ENTRY FORM AND CONTENT
WEINSTEIN, EDWARD A.
GEORGE, VIRGINIA
BOEING SCIENTIFIC RES LABS/SEATTLE  LIBR RES TECH SERV. VOL. 2-NUMBER 2  SPRING 67 185-189

COMPUTER-PRODUCED MICROFILM LIBRARY CATALOG
KOZUMLIK, W.A.
LANGE, R.T.
OCT 66 - LMSC RPT 50-10-66-6

A COMPUTER PRODUCED SHELF LIST
DE GERNAND, RICHARD
COLL RES LIBR. 2: JUL 65 311-315/353  SEE LIB CONGR NUMBER Z671.C6, V. 26

A COMPUTER SYSTEMS APPROACH TOWARDS THE RECOGNITION + ANALYSIS OF CONTENT
IKER, HOWARD P.
HARWAY, NORMAN I.
NATIONAL CONF ON CONTENT ANALYSIS 16-18 NOV 67, U. OF PENN/PHILA

COMPUTER TYPESETTING CONFERENCE PROCEEDINGS -JUL 64- LONDON UNIV
*NA
INST PRINTING LTD/44 BEDFORD ROW/LONDON

COMPUTER TYPESETTING, EXPERIMENTS + PROSPECTS
BARNET, M.P.
MIT PRESS - CAMBRIDGE, MASS. 1965 - 245PP

COMPUTING IN THE UNIVERSITY
*NA
DATAMATION MAY 62 27-30

COMPUTERIZED BIBLIOGRAPHIC SERVICES FOR BIOMEDICINE
KAREL, L.
AUSTIN, C.S.
CUMMINGS, M.M.
SCIENCE 148 1965 766-72

THE COMPUTERIZED BOOK CATALOG AT FLORIDA ATLANTIC UNIVERSITY
PERRAULT, JEAN M.
COLL RES LIBR. 25 MAY 64 185-197

COMPUTERIZED BOOK CATALOG + BOOK RECORD PRODUCTION - SUMMARY PROG RPT
*NA
LA COUNTY PUBLIC LIBRARY - SEP 65

THE COMPUTERIZED BOOK CATALOG POSSIBLE, FEASIBLE, DESIRABLE
SIMONTON, WESLEY
LIBR RES + TECH SERV. 8 FALL 1964 PP 399-407

b - 6
COMPUTERIZED BOOK CATALOGS + THEIR EFFECTS ON INTEGRATED LIBRARY DATA
PROCESSING RESEARCH + PROGRESS AT THE LOS ANGELES COUNTY PUBLIC LIBR
ZUCKERMAN, RONALD
LOS ANGELES COUNTY PUBLIC LIBRARY

COMPUTERIZED CATALOGING THE COMPUTERIZED CATALOG AT FLORIDA ATLANTIC
UNIVERSITY
PERRAULT, J.
LIBR RES TECH SERV 9 WINTER 65 20-34

COMPUTERIZED CATALOGUE CARD PRODUCTION
*NA
YALE UNIV. LIBRARY

COMPUTERIZED LIBRARY CATALOG CROSS-INDEXING FOR THE NAVY
FRANKE, RICHARD D.
DATAMATION FEB 68

COMPUTERWORLD
*NA
20 MAR 68 + 27 MAR 68
TRADE NEWSPAPER PROGRAMMERS SALARIES THROUGHOUT NATION

ON THE CONSTRUCTION AND CARE OF WHITE ELEPHANTS
GROSE, M.W.
LINE, M.B.
ALA BULLETIN JUN 68 741-747

CONVERSION OF EXISTING RECORDS IN LARGE LIBRARIES. W/SPECIAL REF. TO
THE WIDENER LIBRARY SHELF LIST
PALMER, FOSTER M.
THE BRASENOSE CONF. ON AUTOMATION OF LIBRARIES, OXFORD, ENG. 30 JUN-3
JUL 66. PROCEEDINGS....MANSs0LL, LONDON 1967 - P. 67-77

COST ANALYSIS OF CROSSFILER-PRODUCED CARD SETS
*NA
AD 640-100 - STUDY OF MECHANIZATION IN DOD LIBRARIES AND INFO CTRS SEP
66 BOOZ, ALLEN APPL RES, INC. P 9-27

COST ANALYSIS + SIMULATION PROCEDURES FOR THE EVALUATION OF LARGE
INFORMATION SYSTEMS
BOURNE, C.P.
FORD, D.F.
AMER DOC 15 NUMBER 2 APR 64 142-149

COST COMPARISON OF COMPUTER VS MANUAL CATALOG MAINTENANCE
KOUNTZ, JOHN C.
JOURNAL LIBRARY AUTOMATION 1 SEP 68 159-177

THE COST OF A COMPUTERIZED INFORMATION RETRIEVAL SYSTEM
STANWOOD, R.H.
I.F.I.P. CONFERENCE 1967 -14-17 JUN 67

THE COSTS OF DATA PROCESSING IN UNIVERSITY LIBRARIES, IN BOOK
ACQUISITION AND CATALOGING
CULBERTSON, D.S.
COLL RES LIBR 24 NOV 63 487-89

B - 7
THE COSTS OF DATA PROCESSING IN UNIV. LIBRARIES IN CIRCULATION ACTIVITIES
COX, JAMES R.
COLL RES LIBR 24 NOV 63 492-5

THE COSTS OF DATA PROCESSING IN UNIV. LIBRARIES IN SERIALS HANDLING
VOIGT, MELVIN J.
COLL RES LIBR 24 NOV 63 489-91

COSTS OF LIBRARY CATALOG CARDS PRODUCED BY COMPUTER
KILGOUR, FREDERICK
JOURNAL LIBR AUTOMATION JUN 68 121-127

COSTS OF PUBLIC LIBRARY SERVICE, 1963
NA
ALA 1964

CRITERIA FOR THE OPERATION OF LIBRARIES + INFO. RETRIEVAL SYSTEMS
REES, ALAN M.
SPEC LIBR 57 NOV 66 641-642

CURRENT STATUS OF THE CODEN PROJECT
KUENTZEL, L.E.
SPEC LIBR. 57 JUL-AUG 1966 404-406

DATA ANALYSIS OF SCIENCE MONOGRAPH ORDER/CATALOGING FORMS
BATTS, N.C.
SPECIAL LIBRARIES 57 OCT 1966 PP 583-586

THE DELFT CIRCULATION SYSTEM
VERHOEFF, J.
LIBR 16 1 1966 PP 1-9

DETERMINING COSTS OF INFORMATION SYSTEMS
FREEMAN, MONROE E.
JOURNAL OF CHEMICAL DOCUMENTATION MAY 1967 - P. 101-106

DETERMINING THE COST OF LIBRARY AUTOMATION
FASANA, PAUL J.
ALA BULLETIN JUN 67 - P. 656-661

THE DEVELOPMENT + ADMINISTRATION OF AUTOMATED SYSTEMS IN ACADEMIC LIBRARIES
DE GENNARO, RICHARD
JOURNAL OF LIBRARY AUTOMATION 1 MAR 68 75-91

THE DEMISE OF THE KEYPUNCH
LEE, MALCOM K.
DATAMATION MAR 68 - P. 51-55

DIGITAL COMPUTERS - COST + USE
NA
COMPUTER DESK-TOP DATA GUIDE MAY 67 40-48

DIGITAL COMPUTERS - INPUT + OUTPUT
NA
COMPUTER DESK-TOP DATA GUIDE MAY 67 30-40

B - 8
DIRECTORY OF MISSOURI LIBRARIES
*NA
1965-66, MISSOURI STATE LIBRARY

DIRECTORY OF OREGON LIBRARIES
*NA
1967, OREGON STATE LIBRARY

A DOCUMENTATION CENTER AT THE UNIV. OF GUELPH LIBRARY
BECKMAN, MARGARET
ONT. LIBR. REV. DEC 1966 PP 226-229

DUPLICATE CATALOGS IN REGIONAL + PUBLIC LIBRARY SYSTEMS
GELLER, WILLIAM
LIBR QUAR 34 JAN 64 57-67

THE ECONOMICS OF BOOK CATALOG PRODUCTION
HAYES, R.M.
SHOFFNER, R.
WEBER, D.
LIBRARY RESOURCES + TECHNICAL SERVICES 10 90 - WINTER 1966

THE ECONOMICS OF OPTICAL CHARACTER EQUIPMENT
*NA
NOV 62, STD EDP RPTS -23.020.120

EDP SALARY STUDY - 1968
*NA
BUSINESS AUTOMATION JUN 68 40-49

EFFECTIVENESS OF PUBLIC LIBRARY SERVICES DEVELOPMENT OF INDICES OF
OF EFFECTIVENESS AND THE RELATIONSHIP TO FINANCIAL SUPPORT
HOUSER, LLOYD J.
DEPT HEALTH, EDUCATION/WELFARE DEC 67 PROJ 6-8095 CONTRACT
OE-6-10-343

DER EINFLUSS DER ELEKTRONISCHEN DATENVERARBEITUNG AUF DIE
KATALOGISIERUNGSPRAXIS
PFLUG, GUNTER
WAGNER, EWALD-ED - AKTUELLE PROBLEME DER BIBLIOTHEKSVERWALTUNG
FESTGABE HERMANN FUCHS ZUM 70 GEBURSTAG AM 13. MARZ 1966 VON
FREUNDEN UND SCHULERN DARGEBRACHT. HARRASSWITZ WIESBADEN, 1966, P.
111-124

ESTIMATING DATA PROCESSING COSTS IN LIBRARIES
GRIFFIN, HILLIS L.
COLL RES LIBR 25 SEP 64 400-3+431

 EVOLVING COMPUTER PERFORMANCE 1963-1967
 KNIGHT, KENNETH E.
 DATAMATIC JAN 68 31-35

EXPANDING THE EDITING FUNCTION IN LANGUAGE DATA PROCESSING
DOYLE, L.B.
CACM 8 NUMBER 4 APR 65 238-43

B - 9
AN EXPERIMENT IN LIBRARY APPLICATION XEROX LDX FACSIMILE TRANSMISSION EQUIPMENT. PHASE 1 PLANNING AND ANALYSIS
MOREHOUSE, H.G.
SHOFFNER, R.M.
A STUDY PREPARED FOR COUNCIL ON LIBRARY RESOURCES, INC., INST OF LIBRARY RESEARCH, BERKELEY, CALIF. 1966. 26 P

AN EXPERIMENT IN TYPING FOR THE FARRINGTON OPTICAL SCANNER
*NA
NEW ORLEANS ASCS COMMODITY OFFICE

FEASIBILITY OF A COOPERATIVE PROCESSING CENTER FOR ANNE ARUNDEL, BALTIMORE, MONTGOMERY + PRINCE GEORGES COUNTIES IN MARYLAND
PFEFFERLE, RICHARD
HINES, THEODORE
NY, NY - 1967

FIELDS OF INFO. ON LIBRARY CONGRESS CATALOG CARDS ANALYSIS OF A RANDOM SAMPLE, 1950-1964
AVRAM, H.D.
GUILES, K.D.
MEADE, G.T.
U. CHICAGO-1967 SEE LIBR QUARTERLY 37 NUMBER 2 APR 67

FIVE YEARS IN FOCUS - THE DOUGLAS AIRCRAFT COMPANY MECHANIZED INFO. SYSTEM
SMITH, F.R.
JONES, S.C.

FILING RULES FOR THE DICTIONARY CATALOGS OF THE LIBRARY OF CONGRESS
*NA
US LIBR OF CONGR, WASH DC, 1956 - 187P FOR SALE BY THE SUPERINTENDENT OF DOCS. GOVERNMENT PRINTING OFFICE, WASH DC 20402 -$2.25 SEE LIB CONGR NUMBER Z695.95.053 1956

A FILING SYSTEM FOR THE MACHINE AGE
POPECKI, JOSEPH T.
LIB RESOUR TECH SERV. 9 SUMMER 1965 333-337

FINANCING A TECHNICAL INFORMATION CENTER
DENNIS, BERNARD K.
INFORMATION RETRIEVAL MANAGEMENT DETROIT 1962 - CHAP 9 61-75

FLORIDA LIBRARY DIRECTORY
*NA
1966-67, FLORIDA STATE LIBRARY

A FOUR-MARYLAND SYSTEMS PLAN A COOPERATIVE CENTER
*NA
ABMPG - PUBLIC LIBRARY SYSTEMS OF ARUNDEL, BALTIMORE, MONTGOMERY + PRINCE GEORGIAS COUNTIES, MARYLAND

A GENERAL PURPOSE MACROGENERATOR
STRACHEY, C.
COMPUTER J. OCT 65

B - 10
TABLE 1

Gross National Product - Growth Rates + Trend Data, by Region and Country


Higher Education Act of 1965

Title 2/PT C - See Centralized Cataloging + Univ Libraries by William S. Dix - Princeton Univ

The Higher Education Act of 1965 - A Symposium

Historical Statistics of the US - Colonial Times to 1957

Historical Statistics of the US - Continuation to 1962, and Revision

How Many Books Should Be Stored Where - An Economic Analysis

Simon, Julian L.

My Ideal Yorkshire Academic Library - A Composite View by a Visiting American User

Davidson, Donald C.

Library Assn Record 70 Jan 68 p.6-10

Index of Prices of Selected Hardcover Books, by Category, 1957-59 Thru 1966

Information Bulletin

Lib of Congr 25 14 Jul 66 395

Information Storage + Retrieval

Lipetz, Ben-Ami

Scientific Amer. 215 Sep 66 224-232

An Introduction to Comit Programming

1961, MIT Press/Cambridge, Mass

Information Retrieval - An Introduction

Hayes, Robert M.

Datamation Mar 68 - P. 22-26
ISAD--OFF TO A FLYING START
SALMON, STEPHEN R.
ALA BULL - 60 SEP 66 753-754

INSTITUTE OF LIBRARY RESEARCH CURRENT RESEARCH + DIRECTION
SHOFFNER, RALPH M.
PRESENTED AT THE AMERICAN SOCIETY FOR ENGINEERING EDUCATION ANNUAL
MEETING, JUNE 1966. PULLMAN, WASH. 1966 301.

AN INTEGRATED APPROACH TO THE DOCUMENTATION PROBLEM
BISHOP, DR. CHARLES
AMER COC 4 1953 54-65

INTRODUCTION TO SNOBOL - PT 1
TROTTER, H.F.
1966, PRINCETON UNIV COMPUTER CENTER/PRINCETON, N.J.

INVITATION TO SUBMIT PROPOSALS TO - PROVIDE DATA PROCESSING, PRINTING
+ RELATED SERVICES FOR LIBRARY CATALOG FUNCTIONS OF THE COUNTY OF LOS
ANGELES
*NA
SEP 1967

IOWA LIBRARY QUARTERLY
*NA
20 JAN 66 + 20 JAN 68 , 20 OCT 67 IOWA STATE TRAVELING LIBRARY

KANSAS PUBLIC LIBRARY STATISTICS
*NA
1966, KANSAS STATE LIBRARY

LABOR COSTS, CONVERSION COSTS, AND COMPATIBILITY IN DOCUMENT CONTROL
SYSTEMS
LIPETZ, BEN-AMI
AMER DOC 14 APR 63 117-122

LARC PRT 13 - PHOTOTYPESET OUTPUT VS COMPUTER PRINT-OUT OUTPUT IN BOOK
CATALOG PRODUCTION
*NA
LIBRARY AUTOMATION RESEARCH AND CONSULTING SERVICES NEWPORT BEACH CA

LARC RPT 14 - MECHANIZED PROCEDURES OF ROCAPPI, INC/SPRINGFIELD, PA
*NA
LIBRARY AUTOMATION RESEARCH AND CONSULTING SERVICES NEWPORT BEACH CA

LARC RPT 20 - 3 - CROSS-REF OFTEN POST PROBLEMS IN RECORDING
BIBLIOGRAPHIC DATA
*NA
LIBRARY AUTOMATION RESEARCH AND CONSULTING SERVICES NEWPORT BEACH CA

LIBRARY AUTOMATION
BLACK, DONALD V.
FARLEY, EARL A.
ANNUAL REVIEW OF INFO. SCIENCE + TECHNOLOGY - CARLOS CUADRA-ED
INTERSCIENCE, N.Y. 1966 - VOL. 1 PP 273-303

B - 12
LIBRARY AUTOMATION, OR ELSE
*NA
S. CALIF TECH PROC GROUP, 1967

LIBRARY AUTOMATION AND PROJECT MARC AN EX. IN THE DIST OF MACHINE-
READABLE CATALOGING DATA
AVRAMICH, M.D.
MARKUSON, B.E.
THE BRASENOSE CONF ON AUTOMATION OF LIBRARIES, OXFORD, ENG., 30 JUN-
3 JUL 1966. PROCEEDINGS - MANSELL, LONDON, 1967-P97-127

THE LIBRARY CATALOG FOCUS ON FORM
LUBETZKY, SEYMOUR
REVIEW OF LIBRARY CATALOGS CHANGING DIMENSIONS THE 28TH ANNUAL CONF.
OF GRADUATE LIBRARY SCHOOL, 5-7 AUG 63 LIB RES + TECH SERV. 8
SUMMER 1964 PP 317-322

LIBRARY CATALOGUE PRODUCTION ON SMALL COMPUTERS
KILGOUR, F.G.
AMER. DUC., 17 JULY 1966 PP 124-131

LIBRARY CATALOGS THEIR PRESERVATION AND MAINTENANCE BY PHOTOGRAPHIC
AND AUTOMATED TECHNIQUES
HENDERSON, JAMES W.
ROSENTHAL, JOSEPH A.
NY PUBLIC LIBRARY-MIT PRESS, 1968

THE LIBRARY OF CONGRESS AUTOMATION TECHNIQUES EXCHANGE LOCATE HAS
BEEN ESTABLISHED IN THE INFORMATION SYSTEMS OFFICE...
*NA
LIBR CONGR INFORM BULL 25 17 NOV 66 720

LIBRARY OF CONGRESS COST MODELS
*NA
*NS

THE LIBRARY OF CONGRESS NATIONAL PROGRAM FOR ACQUISITIONS + CATALOGING
CRONIN, JOHN W.
LIBRI 16 2 1966 PP113-117

LIBRARY INFORMATION PROCESSING USING AN ON-LINE, REAL-TIME COMPUTER
SYSTEM
HOLZBAUR, F.W.
FARRIS, E.H.
IBM/POUGHKEEPSIE, NY - 7 DEC 66 47P

LIBRARY OF CONGRESS WILL OFFER MAG TAPE CATALOGS
*NA
DATAMATION AUG 68 106

LIBRARY NEWS BULLETIN
*NA
34 APR-JUN 67, WASH. ST LIBRARY

LIBRARY PLANNING FOR AUTOMATION REVIEW OF KENT, ALLEN-ED
BAUER, C.K.
SPECIAL LIBRARIES 57 JUL - AUG 1966 PP 413-414

B - 13
LIBRARY STATISTICS OF COLLEGES AND UNIVERSITIES, 1965-66
*NA
ALA 1967

LIBRARY STUDY RECKONS CATALOG CONVERSION CHEAP
*NA
PUBLISHERS WEEKLY 189 28 FEB 66 71

LIBRARY SYSTEMS ANALYSIS
HAYES, ROBERT
HARVEY, JOHN-ED - DATA PROCESSING IN PUBLIC + UNIV. LIBRARIES.
COMBINED PROCEEDINGS OF THE DREXEL CONF. ON DATA PROCESSING IN UNIV.
LIBRARIES 24-26 JUN 65 + THE DREXEL CONF ON DATA PROCESSING IN PUBLIC
LIBRARIES 22-23 OCT 65, PHILA. PA. SPARTAN BKS. WASH DC 1966 P. 5-20

LIBRARY SYSTEMS STUDY
*NA
LOS ANGELES COUNTY PUBLIC LIBRARY

LIBRARIES IN MARYLAND
*NA
1963-65 RPT, MD ST DEPT/ED

LISP 1.5 PROGRAMMERS MANUAL
MCCARTHY, JOHN
1962, MIT PRESS/CAMBRIDGE

MACHINE-MEN AND LIBRARIANS, AN ESSAY
GRAZIANO, EUGENE
COLL RES LIBR 28 NUMBER 6 PP 403-406

A MANUAL OF THE XPOP PROGRAMMING SYSTEM THIRD ED
HALPERN, M.I.
MAR 67, LOCKHEED/PALO ALTO

MARC PROJECT PARTICIPATION
*NA
WASH. STATE LIBRARY - OLYMPIA 1966 -18 PP PLUS APPENDICES. NOTE -
THIS PUBL IS AVAILABLE ONLY ON INTERLIBRARY LOAN FRM WASH. STATE
LIBRARY

MASSACHUSETTS - 1 1966 ANNUAL RPT STATISTICS, 2 1967 SALARY
STATISTICS, 3 BD OF LIBR COMMISSIONERS 77TH ANNUAL RPT JUN 66
*NA
MASS. BUR LIBR EXTENSION/BOSTON, MASS

MECHANIZATION OF CATALOGUING PROCEDURES
KILGOUR, F.G.
BULL MED LIBR ASSN 2 1965 152-162

MECHANIZATION IN DEFENSE LIBRARIES
KERSHAW, G.
DAVIS, J.E.
DATAMATION JAN 1968 48-53
NOTES TOWARD A CODE FOR COMPUTER-PRODUCED PRINTED BOOK CATALOGS
WEINSTEIN, EDWARD A.
GEORGE, VIRGINIA
LIBR RES + TECH SERV. 9 SUMMER 65 PP 319-324

OHIO DIRECTORY OF LIBRARIES
*NA
1967, OHIO STATE LIBRARY

AN ON-LINE TECHNICAL LIBRARY REFERENCE RETRIEVAL SYSTEM
DREW, D.L.
SUMMIT, R.K.
TANAKA, R.I.
WHITELEY, R.B.
AMER CDC 17 NUMBER 1 JAN 66 3-7

THE ONTARIO NEW UNIVERSITIES LIBRARY PROJECT--AN AUTOMATED
BIBLIOGRAPHIC DATA CONTROL SYSTEM
BREGZIS, RIVTARS
COLL + RES LIBR. 26 NOV 65 495-508

THE ONULP BIBLIOGRAPHIC CONTROL SYSTEM
BREGZIS, RIVTARS
PROC. 1965 CLINIC ON LIBR APPL. OF DATA PROCESSING-UNIV ILLINOIS

OPTICAL CHARACTER RECOGNITION RESEARCH + DEMONSTRATION PROJECT
*NA
1968, L.A. COUNTY PUBLIC LIBRARY

OPTICAL SCANNING FOR DATA COLLECTION, CONVERSION + REDUCTION
ZUCKERMAN, RONALD A.
AUG 67 - LA COUNTY PUBLIC LIBR + COUNCIL ON LIBR RESOURCES

OPTICAL RECOGNITION IN GT BRITAIN - THE SOLARTRON READER
*NA
DATAMATION APR 61 86

ORGANIZATION + HANDLING OF BIBLIOGRAPHIC RECORDS BY COMPUTER
COX, N.M.S.
GROSE, M.
1967, ORIEL PRESS

PERIODICALS AUTOMATION AT MIAMI-DADE JR. COLLEGE
EYMAN, ELEANOR G.
FRIDLIN, CHARLES C.
OLSON, S. BRUSE
BAKER, SAMUEL M., JR.
PIERATT, ASA B.
LIBR. RESOUR. TECH. SERV. 10 SUMMER 1966 PP 341-361

PERMUTED CIRCULARLY-SHIFTED INDEXES TO ABBREVIATIONS A
MECHANICALLY PREPARED AID TO SERIAL IDENTIFICATION
TOMPKINS, MARY L.
TUKEY, JOHN W.
BLACK, DONALD V.-ED - PROCEEDINGS OF THE 1966 ADI ANNUAL MEETING
ADRIANNE PRESS, WOODLAND HILLS, CALIF 1966, P. 347-355
PLANS FOR PROJECT INTREX
OVERHAGE, CARL F.J.
SCIENCE 152 20 MAY 66 1032-1037

POST-MORTEMS CAN BE FUN - THE COST ANALYSIS OF INFORMATION SYSTEMS
WOOSTER, HAROLD
LIBR JOURNAL 90 JUL 65 2968-2973

PREDICTING THE NEED FOR CATALOG EXPANSION
HEINRITZ, FRED
LRTS 11 SPRING 67 247-8

PREL. DESCRIPTION OF THE SNOBOL 4 PROGRAMMING LANGUAGE
GRISWOLD, R.E.
6 JUL 67, BELL TEL LABS

A PRELIMINARY RPT ON THE MARC MACHINE-READABLE CATALOGING PILOT PROJECT
*NA
US LIBRARY OF CONGRESS-INFO SYS OFFICE WASH DC, 1966 - 101 PP

PRIORITY + PROCEDURES FOR NOISY MATCHES IN CATALOG SEARCHING
DOLBY, J.L.
DEC 67, R+D CONSULTANTS CO.

SOME PROBLEMS IN BOOK CONSERVATION
BANKS, PAUL N.
LRTS 12 SUMMER 1968 330-338

PROBLEMS IN THE CONVERSION OF BIBLIO DATA - A KEYPUNCHING EXPERIMENT
HAMMER, D.P.
AMER DOC 19 JAN 68 12-17

PROCEEDINGS OF THE SECOND CONF ON MACHINE-READABLE CATALOG COPY
*NA
22 NOV 65, LIB CONGR-WASH DC 1965 35P

PROCEEDINGS OF THE THIRD CONF ON MACHINE-READABLE CATALOG COPY
*NA
A DISC. OF MARC PILOT PROJECT 25 FEB 66, LIB CONGR-WASH DC 1966 30P

PROGRAM NEWS OF COMPUTERS IN BRITISH UNIVERSITY LIBRARIES
*NA
VOL 1-NOS 1-8, MAR 66-JAN 68, SCHOOL OF LIBRARY STUDIES/THE QUEENS UNIV. OF BELFAST

PROGRAMMERS GUIDE - PL/1
*NA
1966, IBM SYS REF LIBRARY

PROJECT INTREX - SEMIANNUAL ACTIVITY RPT 20 SEP 65 - 15 MAR 66
*NA
MIT/CAMBRIDGE 1966 - 11PP

PROJECT MARC
*NA
LIBR CONGRESS JUNE 1967
A PROPOSAL FOR AUTOMATING A MANUSCRIPT REPOSITORY
PLATNICK, PHYLLIS
BLACK, DONALD V-ED - PROCEEDINGS OF THE 1966 ADI ANNUAL MEETING
ADRIANNE PRESS, WCCDLAND HILLS/CALIF 1966 - PP 437-442

A PROPOSAL FOR A BIBLIOGRAPHIC BANK FOR THE PROVINCE OF ONTARIO
CAMPBELL, H.C.
LIBRARY RESOUR. TECH. SERV. 10 FALL 1966 PP 512-519

A PROPOSED FORMAT FOR A STANDARDIZED MACHINE READABLE CATALOG RECORD
AVRAM, H.D.
FREITAG, R.S.
GUILES, K.D.
LIBR CONGR. JUNE 1965

PUBLIC LIBRARIES IN ARKANSAS
*NA
1965-67, ARKANSAS LIBR COMM

PUBLIC LIBRARIES IN LOUISIANA
*NA
1967, LA. STATE LIBRARY

A QUANTITATIVE STUDY OF CHARACTERS ON BIOMEDICAL CATALOGUE CARDS - A
PRELIMINARY INVESTIGATION
SPRENKLE, PETER
KILGOUR, FREDERICK
AMER DOC JUL 63 202-206

A SELECTED READING LIST ON LIBRARY SCIENCE W/SPECIAL REFERENCE TO
RESEARCH LIBRARY AUTOMATION
*NA
LIBRARY CONGRESS

RECURSIVE FUNCTIONS OF SYMBOLIC EXPRESSIONS + THEIR COMPUTATION BY
MACHINE
MCCARTHY, J.
COMM. ACM 3 1960 184-195

SOME REMARKS ON MECHANIZED INDEXING + SOME SMALL-SCALE EMPIRICAL
RESULTS
OCONNOR, JOHN
MACHINE INDEXING 1961 266-279

RESEARCH ON RESEARCH
DE SULLA PRICE, D.J.
JOURNEYS IN SCIENCE, U. OF NM PRESS/ALBUQUERQUE. NM 1967 2-21

HENDRICKS, DONALD D.
HOLLEY, EDWARD G.
RESOURCES OF TEXAS LIBRARIES
TEXAS STATE LIBRARY/AUSTIN, TEXAS 1968

SAN JOSE' REPORT OF LIBRARY SYSTEMS STUDY GROUP, 21 JUN 68
VAN COLLISTER, MR.
SAN JOSE STATE COLLEGE MEMO 21 JUNE 1968

B - 18
THE ROLE OF PAPER TAPE + OPTICAL SCANNING COMPUTER INPUT IN TEXTUAL DATA PROCESSING
WISHNER, RAYMOND P.
1965 CONGRESS INTERNATIONAL FED. FR DOCUMENTATION IFID - ABSTRACT
OCT 65, WASH. D.C. - P. 51-52 AD 625-498

SCIENCE SINCE BABYLON
DE SOLL A PRICE, D.J.
1962, YALE UNIVERSITY PRESS/NEW HAVEN, CONN

SERIALS HOLDINGS INFORMATION SERVICE IN RESEARCH LIBRARIES
DANIELSON, ROSAMOND
LIBR. RESOUR. TECH. SERV. 10 SUMMER 1966 PP 261-283

SERIALS RECORD INSTRUCTIONS FOR A COMPUTERIZED SERIAL SYSTEM
SRYGLEY, TED F.
LIBR RES + TECH SERV. 8 SUMMER 1964 PP 248-256

SERIALS- RETENTION, MECHANIZATION OF RECORDS, BIBLIOGRAPHIC CONTROL
*NA
LIBR RESOUR TECH SERV 10 SUMMER 1966 261-382

A SIMPLE, MECHANIZED, NON-COMPUTERIZED SYSTEM FOR SERIALS CONTROL IN SMALL ACADEMIC LIBRARIES A PRIMER
MCGRATH, WILLIAM E.
KOLBE, HELEN
LIBR RESOUR TECH SERV. 10 SUMMER 1966 373-382

69TH MEETING OF THE ASSN OF RES. LIBRARIES
HAMER, ELIZABETH E.
COLL RES LIBR NEWS - NUMBER 3 MAR 67 PP 64-70

SNOBOL, A STRING MANIPULATION LANGUAGE
FARBER, D.J.
GRISWCLD, R.E.
POLONSKY, I.P.
J. ACM 11 1 JAN 64 21-30

SOLUTIONS IN ESTABLISHING A NEW CATALOG AT THE US DEPT OF HEALTH, EDUCATION + WELFARE LIBRARY
HASTING, ELEANOR R.
LIBR RES TECH SERV 10 FALL 1966 495-498

SOUTH CAROLINA STATE LIBRARY BD 23RD ANNUAL RPT
*NA
1965-66/SC ST LIBR BD

SOUTH DAKOTA 1 1967 LIBRARY BULLETIN, 2 ST LIBR COMM - 27TH BIENNIAL RPT 1966, 3 FINANCE BD COMPENSATION PLAN
*NA
S. DAKOTA ST LIBR COMMISSION

STATE LIBRARY STATISTICAL SYMMARIES
*NA
1966-68 ARIZONA, CONN., GEORGIA, HAWAII, IDAHO, ILLINOIS, KENTUCKY, MAINE, MINNESOTA, NEVADA, NEW JERSEY, NEW MEXICO, NEW YORK, PENN, TENN, W. VA., WYOMING

B - 19
STATISTICS OF INDIANA LIBRARIES
*NA
1966, INDIANA STATE LIBRARY

STATISTICS OF MONTANA PUBLIC LIBRARIES
*NA
1966-67, MONTANA STATE LIBRARY

STATISTICS OF NORTH CAROLINA PUBLIC LIBRARIES
*NA
1966-67, NORTH CAROLINA STATE LIBRARY

STATISTICS OF PUBLIC LIBRARIES IN ALABAMA
*NA
1966-67, ALABAMA PUBLIC LIBR SERVICE

STATISTICS OF VIRGINIA PUBLIC LIBRARIES
*NA
1966-67, VA. ST LIBRARY/RICHMOND

STATISTICAL ABSTRACT OF LATIN AMERICAN
*NA
1966, UCLA

STATISTICAL ABSTRACT OF THE US
*NA
1967, US DEPT/COMMERCE - P. 327

A STRATEGY FOR THE CONVERSION OF RESEARCH LIBRARY CATALOG TO MACHINE
READABLE FORM
DE GENNARO, RICHARD
COLL RES LIBR. V.28 NUMBER 4  253-257

ON THE STRUCTURE OF WRITTEN ENGLISH WORDS
DOLBY, J.L.
RESNIKOFF, H.L.
LANGUAGE 40 1964 167-196

STRUCTURED LINGUISTIC DATA + THE AUTOMATIC DETECTION OF ERRORS
COX, N.M.S.
DOLBY, J.L.
ADVANCES IN COMPUTER TYPESETTING/INST OF PRINTING, LONDON, 1966

STUDY OF ALTERNATIVES TO CONVENTIONAL CARD CATALOG
*NA
NY PUBLIC LIBRARY - 1966

THE STUDY OF BIBLIOPHONE + THE SPIRAL BOOK CHUTE
BECKER, JOSEPH
D.C. LIBRARY 37  SPRING 1966  PP 15-19

A STUDY OF COMPUTER PROCESSES AND THEIR APPLICATION TO DEVELOP
PROCESSING CENTER SYSTEMS FOR SERIAL CONTROL + BOOK CATALOG PRODUCTION
IN THE CALIF. STATE LIBRARY
*NA
INST. OF LIBR RESEARCH - U. CALIF

B - 20
STUDY OF MECHANIZATION IN DOD LIBRARIES + INFO. CENTERS
KERSHAW, G.A.
CROWDER, D.
DAVIS, J.E.
LOGES, E.G.
MERENDINI, E.
BOOZ, ALLEN APPLIED RESEARCH, INC. BETHESDA, MD. - SEP 1966 - 354 P.

THE STUDY OF THE RESEARCH USE OF LIBRARIES
STEVENS, ROLLAND E.
LIBRARY QUARTERLY, V.26 JAN 56 PP 41-51

SURVEY + ANALYSIS OF BIBLIOGRAPHIC APPARATUS
*NA
SCR-320 LIBR CONGR AUTO. PROGRAM 12 FEB 67, UNITED A/C CORP. SYS. CTR

SURVEY OF IS+R EQUIPMENT
BERUL, LAWRENCE H.
DATAMATION MAR 68 - P.27-32

SURVEY OF STUDENT LIBRARY USE
DOUGLAS, J.
SAN JOSE STATE COLLEGE LIBRARY MEMO 5 MAR 68

SYMBOL-MANIPULATIVE PROGRAMMING FOR BIBLIOGRAPHIC DATA PROCESSING ON SMALL COMPUTERS
KILGOUR, F.G.
COLL RES LIBR 27 NUMBER 2 1966 95-98

TELEPHONE BOOK PRINTING SYSTEM PHOTO-COMPOSITION AT TIMES MIRROR PRES, LA
*NA
DATAMATION OCT 68 148-149

TEMAC TEXT MACRO COMPILER A MACHINE LANGUAGE FOR PROCESSING TEXT
D IMPERIO, M.E.
1965, DOD

TEMAC A MACHINE LANGUAGE FOR PROCESSING TEXT. PROGRAMMING MANUAL. PT1
D IMPERIO, M.E.
DOD

TEXAS PUBLIC LIBRARY STATISTICS
*NA
1966, TEXAS ST LIBRARY

THREE AGES OF REFERENCE WORK
CLAPP, VERNER W.
SPEC. LIBR. 57 JUL-AUG 1966 PP 379-384

TIME + MOTION STUDY OF LIBRARY OPERATIONS
KOZUMPLIK, WILLIAM A.
SPEC LIBR - OCT 67

A TOTAL SYSTEMS APPROACH TO LIBRARY AUTOMATION W/DATA PROCESSING EQUIPMENT
KRAFT, DONALD H.
IBM - MAR 66

B - 21
TWO LIBRARY ADVISORY GROUPS ARE CREATED BY THE PRESIDENT
*NA
LIBR CONGR INFORM BULL - VOL 25 8 SEP 66 PP562-564

U.S. INCOME + OUTPUT
*NA
1958, US DEPT/COMMERCE - P.156-7

THE USE OF COMPUTERS IN COMPILING NATIONAL BIBLIOGRAPHIES,
ILLUSTRATED BY THE EXAMPLE OF THE DEUTSCHE BIBLIOGRAPHIE
KOSTER, KURT
LIBRI 16 4 1966 PP 269-281

THE USE OF DATA PROCESSING EQUIPMENT BY LIBRARIES + INFO. CTRS
CREATIVE RESEARCH SERVICES, INC.
SURVEY PREPARED FOR DOCUMENTATION DIV., SPECIAL LIBRARIES ASSN. +
LIBRARY TECHNOLOGY PROJECT, AM.LIBR.ASSN AMERICAN LIBRARY ASSN. N.Y.
1966 - 160PP

UTAH PUBLIC LIBRARY SERVICE
*NA
1967, STATE LIBR COMM OF UTAH
VERMONT LIBRARIES - FREE PUBLIC LIBRARY SERVICE 36TH BIENNAL RPT
*NA
1966, VT FREE PUBLIC LIBR SERV BD

WIDENER LIBRARY SHELF LIST NUMBER 7, BIBLIOGRAPHY + BIBLIOGRAPHY
PERIODICAL
*NA
1966, HARVARD UNIVERSITY LIBRARY

WHITHER KEYPUNCH
PRICE, DENNIS G.
DATAMATION 13 JUN 67 32-34

XPOP A META-LANGUAGE WITHOUT METAPHYSICS
HALPERN, M.I.
PROCEEDINGS FJCC 1964 57-68

THE YEAR 2000
KAHN, H.
WIENER, A.J.
1967, THE MACMILLAN CO., NY