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ABSTRACT

A general methodology for cost effectiveness analysis was developed and applied to the Colorado State University library loan desk. The cost effectiveness of the existing semi-automated circulation system was compared with that of a fully manual one, based on the existing manual subsystem. Faculty users' time and computer operating costs were measured. Labor costs were broken down for each circulation activity and were established by means of a time study analysis. The study also considered all, and measured some, changes in effectiveness in meeting the objectives of the circulation department. The results indicate that the existing system is more expensive than the manual one, that the semi-automated system is more effective in saving user's time, and that the record-keeping for the automated system is less accurate than that of the manual system. (Author/WH)

COST-EFFECTIVENESS ANALYSIS OF THE AUTOMATION OF A CIRCULATION SYSTEM

A Study submitted in partial fulfilment of the requirements for the degree of Master of Science in Information Studies at THE UNIVERSITY OF SHEFFIELD

by

ISOBEL MOSLEY

August 1974

ABSTRACT

A general methodology for cost-effectiveness analysis was developed and applied to the C.S.U. loan desk.

The cost-effectiveness of the existing semi-automated circulation system was compared with that of a fully manual one,based on the existing manual subsystem. Any cost to the whole University, which had changed as a result of automation was measured, including those of faculty users' time and computer operating costs. Overheads were excluded. Labour costs were broken down for each circulation activity, and were established by means of time study. The study also considered all, and measured some, changes in effectiveness in meeting the objectives of the Circulation Department. These objectives were: to circulate materials; to minimise user effort during borrowing; to give maximum demand satisfaction; and to maintain the collection intact.

The results were built into a unit cost model, which showed the existing system to be more expensive than the manual one (47.4¢ against 36.5¢ per unit circulated). The semi-automated system was more effective in saving users' time, but at a cost of $8.25 per hour of student or non-C.S.U. users' time. The records for the automated system were less accurate than those of the manual system.

Please correct:

p. ii lines 3 & 5: change Dr. Burns to Mr. Burns

p. 24 line 9: change input to output

p. 26 line 15: change "Landon (50)" to "Landau (53)"

p.104 line 8 (charging): change .206 to .026

p.121 line 14: change 766.38 to 796.38

line 18: change 9233.06 to 9263.06

line 19: " " " " and 5.65 to 5.67

ERRATA

p. 1 bottom line: for "an abbreviated" read "a truncated"

p. 55 line 24: should read "The unit costs of direct labour for hypothetical fully manual and fully automated systems and the existing semi-automated system are given in Table 1..."

p. 58 line 11: should read "22.95% of all charges..."

p. 69 line 24: should read "...reduced by a combination of rising salaries and an increased volume of circulation..."

p. 129 line 4: for "/1000 man. 1000 manual" read "/1000 auto. 1000 auto."

p. 139 line 11: insert " 53. LANDAU, H.B. The cost analysis of document surrogation: a literature review. American Documentation, 20 (4) 302-310, 1969."

ACKNOWLEDGEMENTS

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CHAPTER I

INTRODUCTION

The objectives of the study were:

1) to compare the cost-effectiveness of the operation of the loan desk at Colorado State University Library under the present automated system and the previous manual system; and

2) to establish a general methodology for cost-effectiveness studies of library automation.

Colorado State University (C.S.U.) Library serves a University population of over 16,000 students plus faculty and staff, as well as more than 2,000 non-C.S.U. users from the local community. The collection size is 904,000 volumes, and in 1973/4 circulation reached 288,000 items.

In September, 1972, the library introduced an automated circulation control system using punched book cards and borrower identification cards. Transactions are recorded through data collection terminals onto magnetic tapes. The tapes are processed six times a week by the University Computer Center to produce a Daily Activity Report, which is a printout of items on loan, at the bindery, or otherwise recorded as being absent from the shelves. Fines and overdue notices and statistics reports are produced at various intervals. The book cards (80 column punched cards) bear a L.C. classification number and an abbreviated title. To avoid

punching cards for the whole collection, the library is carrying out a gradual conversion. Cards are punched only for new books and for circulating items (excluding unbound periodicals) when they are returned. This approach to automation is based on the principle of obsolescence and the fact that a small part of the collection accounts for a large part of the use (1)*. In 1974, the 32% of the collection for which cards had been punched accounted for 69.5% of the circulation. It is anticipated that the manual system, based on an edge-notched card file, will continue as a back-up to the automated system during the foreseeable future.

The co-existence of the two systems gave an ideal opportunity for a cost-effectiveness comparison. It is hoped that the present study may offer some guidance to those considering automation, but able only to estimate possible costs of an automated circulation control system, before it is in operation.

In carrying out the study, the literature on library automation was first examined for other examples of cost studies and evaluations. These were few and not very helpful, except for highlighting the omissions. For example, a computer systems analyst will generally give equipment costs, and librarians sometimes give staff costs, but each will probably ignore the other's domain. For a thorough grounding in cost-effectiveness analysis and costing methods, economics and accounting literature was studied. Chapter III is based on this literature, and gives a general methodology for cost-

* Numbers in parentheses refer to references cited.

effectiveness studies, discussing their role in relation to cost-benefit analysis and cost accounting.

The methodology was used to establish what data were required for the cost-effectiveness study of the C.S.U. Library loan desk. Data collection was carried out during July, 1974, after a short period when the writer worked on the loan desk in order to become familiar with all the activities. The month of July is atypical, as the student population is only about one quarter of that during the other three sessions. It was necessary, therefore, to make some assumptions about the rest of the year, and these are given in the discussion of the methods used and of the cost model.

CHAPTER II

COST STUDIES OF LIBRARY AUTOMATION: A LITERATURE REVIEW

"In the beginning it was believed that automation would save money. For some libraries there have been savings in limited areas. For others it has been the most expensive exercise yet attempted.

It is now openly conceded that, on a long term basis, automation must prove economically feasible. This does not necessarily mean actual dollar savings. The question of feasibility should be resolved in terms of library objectives and services, and these in turn should be determined by librarians."

LaVahn Overmyer (2)

These remarks typify a changing attitude towards library automation, which has come as a result of ten years of mixed experiences in the field. Although the debate continues, improved service rather than cost savings now seems to be used more often to justify automation.

In 1969, Kilgour (3) stated that: "The computer constitutes for libraries an innovative technology that will enable librarians to increase productivity of staff and thus decelerate the exponential rise in costs." This is the underlying assumption that has spurred on automation, and the argument gains more weight as labour costs rise and computer costs fall. The promise is greatest for library housekeeping functions, which are repetitive, largely clerical, and require

little intellectual effort.

A 1971 survey (4) of British university libraries found that 60% had one or more computer applications, either operational or planned. The most popular application was in cataloguing (i.e. computer produced catalogues), with the promise of staff time savings in filing and reproduction of added entries, and the possibility of multiple copies of the catalogue. The second largest group of applications was in circulation control (14% of the libraries). A 1973 survey (5) of 180 U.K. libraries found 32 with operational computerized loans systems. In America, circulation has been the most popular subsystem for automation. Again, the computer is expected to save time by taking care of filing and record manipulations.

But have the promised labour savings materialised, and have they, in fact, reduced library costs? In an eloquent, but largely undocumented attack on library automation, Mason (6) claims that they have not. He depicts library automation as an inefficient, costly monster, giving worse service than its manual predecessor. He says that any labour savings are more than outweighed by the extra systems staff required, whose salaries rise at an even higher rate than those of clerical staff. The supposed benefits from the by-products of automation never materialise, because the by-products are never used. He makes the claims of improved service sound like a last ditch attempt, on the part of librarians, to save face when they find that the new systems cost more. Although Mason gives a very biassed view of automation, he does make some pertinent criticisms. Perhaps his most significant comment

is: " . . . I have yet to see or come close to a library automation project that has been chosen as the best of carefully appraised alternatives on a managerial basis." (7)

A review of the literature reporting automation projects to find the true situation reveals very few evaluations. Many reports give no indication of costs at all. Those which do often cite unreliable figures, and rarely give any basis for evaluation of automated systems, in comparison with manual ones.

Examining the literature on automated circulation systems shows that, frequently, only the most obvious costs are reported - those of the equipment. The cost of computer processing is often ignored, as it may not be borne by the library. (In many universities the jobs are run free of charge on the university's computer). A few papers, usually by systems analysts(8,9), do give computer running costs, but then ignore almost every other cost. In general, the choice of costs for inclusion is quite arbitrary.

A total of eleven reported cost comparisons between manual and automated circulation systems has been found - not many considering the number of automated circulation systems in existence. Of the eleven, five are American and six British, a ratio which probably reflects the policy of the British Office for Scientific and Technical Information*, (O.S.T.I.), in requiring evaluation of projects it supports, rather than the numbers of automated systems in the two countries.

The earliest is that of James Cox (10), head of the circulation department of the University of California at Los

*Now the British Library Research & Development Department.

Angeles. In 1963 he reported total system operating costs, including direct labour, machines, and materials, to be $31,000 per annum for an I.B.M. automated system, as against $26,000 for the previous manual system. However, the administration considered that the extra cost was justified by the improved service.

Neither this paper nor the later report (11) of the Southampton University Library automated circulation system make any breakdown of the staff time required for the manual and automated operations. The labour costs are estimated on the basis of gross number of staff required, either actual or predicted. The problem with this approach is that, although automation may not result in a reduction in staff numbers, staff time may be released for other jobs, for example stock taking or more reader services, but this is not apparent from the gross numbers of staff employed. Thus any gains due to automation are concealed. Southampton did, in fact, make the assumption that a reduction in staff numbers would be achieved. The report specifies the costs included and all the assumptions underlying the predictions. The most interesting aspect of the study is that, although the automated system was originally expected to be more expensive, a later amendment to the report shows that the 1970/1 operating costs were less than the estimated manual operating costs for that year (11.1p as against 11.4p per loan), because salaries rose more rapidly than expected.

Buckland (12) gives a unit cost of 12.72 cents per loan for Lancaster University's manual circulation system, and an estimate of up to 12 cents per loan for their proposed

hybrid automated system. However, he gives no indication of what these costs cover, which makes them useless for comparison.

Three more papers give fairly detailed cost comparisons between manual and automated circulation systems, including a breakdown of staff time under each, but largely ignoring development costs. The earliest of these is Kimber's cost comparison for Queen's University, Belfast (13). Although useful in serving as a model for future cost studies, this particular study contains so many omissions and methodological errors that the results are almost valueless. Overheads, materials costs, book preparation, reader registration, and parts of the overdues operation are all excluded from the costing, although they may change significantly with automation. For those labour costs which are included, gross time estimates for the manual system are compared with predicted unit times for the equivalent automated activities. The gross estimates almost certainly include time spent on activities such as personal conversation not included in the unit measures. Kimber's concluding statement: " . . . a 14.6% cost increase yielding a 45% saving in staff time . . . " is misleading, because the cost increase already includes the effect of the time savings. In fact, this study is a good example of the errors that can be made in costing - omission, double counting, and comparison of non-equivalent costs.

Poss and Brooks (14) follow Kimber's example, in giving a breakdown of staff time, which, in their case, is more detailed and comprehensive. They also include salary overheads (national insurance etc.), materials, and conversion costs, though not

systems development. Following the suggestion of Jeffreys (15) they also allow for user time savings, at least for academic staff users. The third paper (16) gives costs in support of a model for comparing the cost-effectiveness of circulation systems. Systems development costs are again excluded.

Systems development costs should not be underestimated. Most of the above cost studies include some allowance for purchase or rental of equipment and implementation costs (book preparation and reader registration), but none considers systems development costs. It has been suggested (17) that these are about as much as the purchase price of the equipment, and there is some support for this argument (18). The South West University Libraries Systems Co-operation Project (SWULSCP) submitted a proposal to O.S.T.I. for a sum of £105,615 over four years to finance the central systems development team, and central equipment for the automation of circulation, acquisitions, and cataloguing in the four co-operating libraries. The sum divides roughly equally between equipment and systems development staff. In America it has been estimated (19) that a systems programmer may cost as much as $35,000 per annum. Overheads could increase the basic salary from $15,000 to $24,000 per annum, and the computer time he requires may cost up to $1,500 per month. Jacobs (20) breaks down the staff requirements for development and implementation into the following stages: planning; design; programming; testing and debugging; file conversion; data preparation including file maintenance; and programme maintenance. There are also materials and equipment costs at each stage. Programme maintenance is a cost that is often

ignored on the assumption that systems development is a once and for all process. In practice it is more likely that modifications and improvements will continually be made. For example, a change in loans policy will require programme modifications. Systems development and maintenance are thus a significant part of the cost of automation and should not be ignored.

The SWULSCP feasibility study (21) is the only cost study of automated circulation found which includes development costs and amortises them over a period of years. This is the best example to date of a cost study in this field, and is based on a clearly stated methodology. All relevant costs were considered, including the cost of the user's time. The automated system was compared with an optimum manual system, as well as the existing manual systems. The automated system was found to be more expensive, but was recommended because of its greater effectiveness.

Two examples of the rejection of automated systems as a result of cost-effectiveness studies have been found in the literature. In one (22), as a result of an initial analysis of the existing manual system, an improved manual system was designed which was more cost-effective than the alternative automated system. In the other (23), a change from a batch-processing to an on-line circulation system was reversed, after experience with the on-line system. The original change was made in order to improve service, but due to a subsequent change in loans policy, the benefits of the on-line system were reduced. The up-to-dateness of the on-line files

(the supposed great advantage of on-line over batch systems) was found to be relatively unimportant to users, especially as books recorded as being returned had often not reached the shelves. The on-line system was vastly more expensive to develop and operate, and so was abandoned in favour of an improved batch automated system.

A number of cost comparisons between manual and automated circulation systems has been made as part of the American Library Association Library Technology Project (24,25). These are standardised, idealised circulation systems, not operational ones. Their purpose is to compare and evaluate alternative systems, and provide a basis for libraries to estimate their own operating costs under the different systems. All assumptions made in the calculations are clearly listed to enable such predictions. Because they are idealised systems the costs given almost certainly underestimate actual operating costs. Development costs for automated systems are not included.

Another attempt at finding standard costs has been made by Bourne (26), in reviewing cost data on manual and automated circulation systems published from 1960 to 1970. The data were normalised to 1968 dollar values, and converted to unit costs. However, the unit costs still varied from 0.6 to 74.6 cents per transaction, because different costs had been included. In general, the automated systems were more expensive, although in Bourne's own case studies the automated system was cheapest. Bourne proposes a standard method of data collection for circulation systems, suggesting which costs and activities should be included and excluded. He points out

that subsequent data analysis and modification for comparison are only possible if the original data are reported in sufficient detail. The methodology of costing circulation systems is developed further in Bourne's study than anywhere else in the literature.

For what they are worth, the figures given in the above studies indicate that automated systems do save on staff time, but that when computer time and equipment costs are added, the operating costs are usually higher than manual ones. Southampton is an exception. If systems development costs were added, the automated systems would be even more expensive over the amortisation period.

One might thus expect to see attempts to justify automated systems in terms of increased effectiveness. However, the literature shows little other than general claims of improved service and better control over stock and borrowing. The only attempts to quantify increased effectiveness have been in the few cases where user time savings have been included in the cost analysis. One frequent claim is that statistical information from automated systems will enable better management of the collection by providing the information on which to base loans, acquisition, and relegation policy decisions. As yet, no one has attempted to measure the quality of management, so the claim cannot be tested.

From the examination of the literature on evaluation of automated circulation control systems, four major requirements for cost-effectiveness comparisons have become clear:

1) Evaluations should include the costs of both old and new systems, preferably in the form of unit costs;

2) Cost studies should include all relevant costs, that is, development implementation, and operating costs. The development and implementation costs should be amortised over the life of the system, and added to the operating costs to give a true cost for the new system;

3) Labour costs should be calculated from full breakdowns of tasks for the old and new systems, to ensure comparability;

4) Changes in effectiveness (for better or worse) should be clearly documented, and as far as possible quantified.

CHAPTER III

GENERAL METHODOLOGY OF COST-EFFECTIVENESS ANALYSIS

Principles of cost-effectiveness and cost-benefit analysis

It is clear from Chapter II that cost alone is not a valid criterion for comparing manual and automated systems in libraries. The effectiveness of the alternatives should also be considered, but has often been ignored because of the difficulty of measuring effectiveness. In fact, some studies (16, 27) have suggested that costs should only be compared for alternatives at the same level of effectiveness.

However, library automation, or any other library project, can be evaluated by using cost-effectiveness analysis, which relates costs to effectiveness. It does not avoid the problem of measuring effectiveness; in fact, current research into measurement of library effectiveness could greatly enhance the utility of cost-effectiveness analysis. However, it does emphasise the importance of effectiveness when considering alternative projects.

Unfortunately, the purposes and methods of cost-effectiveness analysis and other costing techniques, particularly cost-benefit analysis and cost accounting, have been confused as the techniques have been introduced to librarians from other disciplines. The aim in this chapter is to clarify the role and methods of cost-effectiveness analysis in relation to those of other techniques. Cost-effectiveness analysis is the most practicable of the three techniques in libraries, as it involves neither the value judgements of cost-benefit analysis, nor the continuing committment to a cost accounting

system.

There is no standard definition of cost-effectiveness, but given that effectiveness is a measure of how near a system comes to meeting its objectives, Lancaster's (28) description seems to be the best: "Cost-effectiveness, then, deals with the relationship between level of performance (effectiveness) and the costs involved in achieving this level." It is a measure of how efficiently, in terms of costs, a system is satisfying its objectives.

The term cost-effectiveness analysis is frequently used synonymously with cost-benefit analysis, but as Mishan says:

> " . . . in cost-benefit analysis we are concerned with the economy as a whole; with the welfare of a defined society, and not any smaller part of it." (29)

Cost-effectiveness is measured in terms of the objectives of the particular system under study. The value of these objectives in contributing to social benefit is taken as given. This assumption makes the comparison simpler, but it begs the question of how much the system is worth. For example, a library may compare the cost per demand satisfied of alternative means (e.g. interlibrary loan, buying more books) of meeting all the demands placed upon it. But ultimately, someone at a higher level of authority must decide what value can be placed on satisfying these demands, and hence, if the ends justify the means.

The objectives of a system depend on where the system's boundaries are placed. If the library itself is considered to be the system, one of the objectives will be to satisfy the demand for books. If the library is considered a subsystem of

a parent body, the objectives become those of the parent body, for example, education and research. In this context the library is seen as one of a number of alternative sub-systems (and not necessarily the most effective) for helping the university reach its objectives. If the system boundaries are further widened, the objectives finally become those of society as a whole, at least for libraries in the public sector. In this context cost-benefit analysis is seen to be a special case of cost-effectiveness analysis.Even cost-benefit analysis is limited by system boundaries, which are normally placed at the national level, so that any benefits or costs to other nations are ignored.

Where the system boundaries are placed depends on the reasons for the cost-effectiveness analysis. Cost-effectiveness analysis is essentially a tool for decision making, so the most meaningful level is that at which the decision is made. As regards library automation, this may be in the library or at the level of the parent institution, or even higher.

Thus any cost-effectiveness analysis requires a clear understanding of the reasons for the study, as these determine the scope of the system and its objectives, which in turn determine the relevant costs and measures of effectiveness.

Reasons for cost-effectiveness analysis

The main use of cost-effectiveness analysis is as an aid in deciding between alternative means of reaching stated objectives. Once the choice has been made, the costs established during the analysis may be used in planning and budgeting for the selected project.

Cost-effectiveness analysis should again be used during the operating phase to ensure that the project is achieving the expected performance level, and that no changes have occurred in the system or its objectives which would invalidate the initial analysis.

Finally, the analysis gives unit costs (e.g. cost per demand satisifed, cost per book circulated), which have been used in attempts to set standards, against which, in principle, any comparable system could evaluate its performance. However, setting standards is only possible if standard methods and measures are used in the cost-effectiveness analysis, and in library automation this has not happened. The figures do have to be adjusted for time and place, for example, to allow for different wage levels and building costs.

Elements of cost-effectiveness analysis.

There are five basic elements in any cost-effectiveness study (28, 30):

1) The objectives of the system under study;
2) The alternative methods of reaching the objectives;
3) The costs and measures of effectiveness of the alternatives;
4) A model to relate costs to effectiveness;
5) A criterion to rank the alternatives in order of desirability.

These elements will be discussed in turn.

Objectives

The importance of establishing the objectives has already been discussed: it is from them that the measures of effect-

iveness are derived. It is not very common to find a clear statement of objectives in libraries or library subsystems, so part of the analysis is to elucidate the objectives.

Alternatives

Establishing the alternatives is part of the systems analysis process and will not be considered here. At the stage of cost-effectiveness analysis the alternatives will already be limited to a very few of the many possible methods.

Costs

There are numerous different ways of defining costs (31), and the word has completely different meanings to economists and accountants (32). For the purposes of cost-effectiveness analysis, costs can be defined as resources consumed, whether these resources be money, man hours, materials, equipment, or even building space. The resources are generally measured in terms of monetary units, the pounds or dollars simply being exchange units to compare amounts of different resources. It should be understood that resources consumed include more than resources input or budgeted, for costs may be incurred outside the immediate system, for example, by the user, or by a different administrative level (e.g. the university instead of the library).

In cost analysis a number of different kinds of costs must be distinguished. The first distinction is between relevant and non-relevant costs, and here again the reasons for the study and the definition of the boundaries of the system under consideration are all important. External costs are the first type of non-relevant cost. "'External costs

are those costs of a decision or a program that fall beyond the boundaries of the decision makers organization . . ." (31). The other type of non-relevant cost is invariant costs, that is, costs which are the same for all alternatives. If a cost remains the same regardless of the decision, it is irrelevant to the decision making process and the cost-effectiveness analysis.

When a new programme is being considered, the relevant costs include the non-recurrent costs of development and implementation, and the recurrent, or operating, costs. For a continuing programme, only the operating costs are relevant, because the initial costs have already been incurred. In each of these categories, there may be costs for labour, materials, machines, and services, which can be charged directly to the programme and which are likely to differ between the alternatives. Any cost which is consumed wholly by a programme should be charged directly to that programme, for example, the costs of special equipment should be charged directly, rather than as an overhead, whenever appropriate.

In addition, the three categories of development, implementation, and operating costs will each have indirect costs, or overheads, which may be relevant, depending on the particular choice under consideration. Indirect costs are " . . . costs that are not readily identified nor visibly traceable to specific goods, services, operations, etc., but are nevertheless charged to the product in standard accounting practice." (32). In cost comparisons, overheads are frequently excluded, often without explanation, but all indirect costs

should be carefully considered before including or excluding them from a cost-effectiveness comparison.

In cost accounting the indirect costs which are allocated to processes or products ("cost centres") are: the salary fringe benefits (pension, insurance and other contributions made by the employer); depreciation or rental, and maintenance costs of equipment (including computers); and the "space costs" which include depreciation or rental, and maintenance of the building and furnishings, insurance, heat, light, water, power, rates, telephone, janitor, and gardener. Some library applications also include book depreciation and maintenance (33, 34), and some studies (35, 36, 37) allocate administrative costs over the cost centres, although there is some disagreement as to whether these should be treated as a separate cost centre (33, 34).

However, cost accounting is based on different principles, and used for different purposes from those of cost-effectiveness analysis. A cost accounting system is a continuous procedure for relating input, in terms of costs and times etc., to output for various parts of an organisation (the cost centres). It was originally used in manufacturing industries to establish reasonable selling prices for a range of products, and has now been used for the same purpose by libraries and information units, particularly in industry (36). In order to operate a cost recovery system, the totals of the costs of all the operations, including both those directly charged and those allocated, must equal the actual costs of operation as accumulated by normal accounting methods (41), and so all overheads must be allocated between the cost centres.

However, in cost-effectiveness analysis, the only relevant costs are those which differ between the alternatives. Applying this criterion in the case of library automation, salary fringe benefits are relevant because the number of staff may change. Equipment costs will also change, but the costs of new equipment could be charged directly to the automated activity (if this is its only use), while general equipment costs (e.g. of typewriters) could be ignored if they remain unchanged. The other overhead costs are unlikely to change as a direct result of automation (except space costs in the case of a library acquiring its own computer), and are generally considered as fixed costs. There is no absolute dividing line between fixed and variable costs; it depends on the scope of the changes. A reduction in staff numbers by one or two as a result of automation will make no difference to space and administrative costs, whereas a reduction by 50% or an increase of 100% may well do so. However, even though this part of the overheads is fixed in total, the distribution between processing departments or cost centres may change as a result of automation, depending on the method of allocation. It is common accounting practice to lump all overheads together and allocate them in proportion to the direct labour costs of each cost centre. Hayes (41) gives a very good example of the results of automation of one department in such circumstances. The direct labour costs of this department decrease, so that it receives a smaller proportion of the total overhead, which means that all the other departments are charged more. The effect " . . . is to

provide positive encouragement to the replacement of labor by other kinds of direct costs and, especially, by mechanization. It also has the effect of penalizing the parts of an organization that do not attempt to use mechanization." It is even possible for the total costs of the automating department to fall, while the total costs of the whole library increase, as a result of automation.

Because these changes are artificial, resulting purely from arbitrary accounting practice, it is suggested here that any overheads which are not directly affected by the choice between alternative projects should be excluded from the cost-effectiveness analysis. An example of this practice is Magson's work (42) and the SWULSCP study (21).

Thus costs include all aspects of resource consumption, but the relevant costs to cost-effectiveness analysis include only those costs which are affected by the choice between alternatives.

Effectiveness

The criteria of effectiveness are determined by the objectives of the system, so there may be one or more criteria, depending on the number of objectives. Progress towards the objectives may be directly measurable, for example, by percentage of requests satisfied. However, effectiveness can often only be measured indirectly. For example, it is often suggested that user satisfaction, in the general sense, should be the main criterion of effectiveness (43), but this can only be measured subjectively. However, the use made of

the collection gives an indirect, objective measure of satisfaction.

One measure of effectiveness is usually the volume of activity - items processed or produced, or the units of service provided (e.g. reference questions answered). For service activities, response time and user effort may also be considered. Evans (44) gives a good review of effectiveness criteria for libraries, and further measures will be considered in Chapter IV.

While some of the criteria are convertible to a monetary scale (for example, user time), others will be incommensurable and even intangible. The intangibles cannot be included in models of cost-effectiveness.

The model

The model relates the costs to the effectiveness of each alternative. In fact, there may be more than one model for different alternatives and different effectiveness criteria. "The model used may take the form of mathematical equations, a computer program, or merely a complete verbal description of the situation." (28) In addition, it may be a "one off" model, valid only in a fixed set of circumstances, or it may be a general model with predictive value. In the latter case it is essential to distinguish between recurrent and non-recurrent costs and between fixed and variable costs. The non-recurrent costs are treated as capital investment, because their value is not consumed with n the normal accounting period of one year (48), and should be amortised over the expected life of the item (normally five to ten years for

automated systems development and implementation costs). If the variable costs (which vary with the level of output) are distinguished then the model can be used to predict costs at different production levels. If the model is to have predictive value the data must be collected over a typical period, including a full cycle of any cyclic activities.

It may not be possible to include all the effectiveness criteria in one model. The commonest approach is the unit cost model, relating cost to the volume of output or activity, and treating other effectiveness criteria separately. If the measure can be converted to monetary units it can be included in the model as a negative cost. In economic theory costs and benefits have the same dimensions, so " . . . it doesn't matter what side of the equation the costs and benefits are on, or what you call them, so long as all significant consequences of our decisions appear somewhere in our cost-benefit analyses and that they are neither forgotten nor double-counted." (31) The same principle can be used for effectiveness criteria.

Finally, if the model is to have predictive value (and if the analysis is for the purpose of decision making, the future costs and returns should be estimated), the question of whether or not to discount future costs to present values must be considered.

> "It has become customary to compare costs on a present value basis. That is we determine a planning period of, say, 20 years, and then we determine the amount of money required to be set aside today to meet the stream of costs to be incurred during the succeeding

20 years. Use of a non-zero interest rate causes the present value to be smaller than the expenditure required in the future by the amount of the compounded interest on the present value. The higher the interest rate the smaller the present value." (30)

It has also been suggested that future benefits be discounted at the same rate (45), as they are in economics. However, this treatment assumes that the decision maker has the choice of investing funds to cover future costs, and in most libraries this is not so. In fact, any unspent money normally has to be returned to the funding body at the end of the fiscal year. Therefore, the use of the discounted cash flow technique by libraries is of doubtful validity.

The criterion

In cost-benefit analysis the aim is to measure all costs and benefits on the same scale, and the criterion for ranking alternatives is simply net monetary benefit or benefit-to-cost ratio. In cost-effectiveness analysis the problem is more complex because of the incommensurables. The criterion must provide a method of weighing costs against estimated effectiveness. Cost-effectiveness ratio is the most likely criterion, but if there are a number of effectiveness criteria giving more than one ratio, some idea of the ranking of the objectives of the system will be necessary before the final choice can be made.

Comparability of cost data

"All too often in library literature we get bare cost

figures quoted, such as: 'on average an abstract costs £1.25'. But since we do not know (a) exactly what work is included in 'an abstract', (b) what is the salary cost of the abstractor, (c) what measure of productive hours has been used, and (d) whether overheads have been included, it is almost impossible to use such a figure to compare with others. If labour costs are to be quoted, we need the basic data (labour time) and the method of calculation to be stated as well."

B. C. Vickery (46)

Although the main reason for cost-effectiveness analysis is to help in making specific decisions, any cost study may have value to the library profession if the costs are stated clearly and precisely, avoiding the pitfalls which Vickery points out. Landau (53) has given a list of requirements for comparability, which are summarised below.

1) Labour costs should be reported by staff level; professional, clerical, etc.
2) The report should state if the salaries are basic or include overheads.
3) Figures should be reported as unit costs, with an indication of whether these unit costs are volume dependent.
4) The report should state if the costs are just operational, or if they include development too.
5) There should be a clear statement of precisely what tasks are involved in the process being costed.
6) Costs should be stated precisely, accurately, and unambiguously whether in terms of money or time.

CHAPTER IV

COST-EFFECTIVENESS OF C.S.U. LOAN DESK: METHODOLOGY

1. Objectives and scope of the study

The goal of this study of the C.S.U. loan desk was to compare the cost-effectiveness of the circulation system as it was operating in mid-1974, in a semi-automated state, with the predicted cost-effectiveness of the manual system at the same point in time. The study was thus an evaluation of the original decision to automate.

It was decided that the study should consider the changes in costs and effectiveness in the context of the whole University, rather than of the library, because book circulation is a service provided by the library to the University, for which the University pays. The original decision to automate took the users into account, and was made at the level of the University, as well as in the library. In fact, implementation required approval at many levels right up to the Colorado State government, but it seems likely that the decision-makers at the higher levels relied heavily on the judgement of the University and library personnel. In addition, the assignment of costs between the library and the University is somewhat arbitrary; for example, staff salaries come out of the library budget, but some of the salary fringe benefits are paid by the University. Similarly, the library is not charged for the services of the Computer Center, though it is for some maintenance services.

Indeed, some benefits from automation fell outside the University; another State University adopted the programs for its own circulation system. However, these benefits are

beyond the scope of the study as defined above.

Having defined the goals and scope of the study, the elements of the cost-effectiveness analysis were established in accordance with the principles outlined in Chapter 3.

2. Objectives of the circulation system

There were no written objectives for the circulation system prior to the study, apart from a general paragraph in the policy statement for the whole library (the first paragraph given below). After discussion with the Circulation Librarian, he provided the following statement of objectives:

> "The processes and services which result in bringing users and library materials into productive relationship are the circulation functions. While research and scholarship may be pursued within the building, convenience and economy are best served if the scholar can take the material where he chooses.
>
> The objectives of the circulation department are to make the material available to the patron when needed; to formulate and supervise a program which enables the scholars of the academic community to share the resources of the collection; to ensure that the collection is maintained intact, so that the users can obtain the material quickly, efficiently, and at reasonable costs to the University."

This statement was translated into the following four objectives:

(i) To circulate items from the collection.

(ii) To minimise the time and effort required of the user when borrowing materials.

(iii) To make material available when needed, or as soon as possible thereafter.

(iv) To maintain the collection intact.

3. Alternative methods of reaching the objectives

The cost-effectiveness of the existing, semi-automated circulation system was compared with that of a fully manual system, operating in the same way as the existing manual component. There had been some changes in the manual operations since automation, so that the study is not a comparison of the automated system with the original manual system.

In order to become familiar with the two systems, the writer first spent seven days working at the loan desk and questioning the employees while they worked. The basic circulation activities were analysed, and the results appear in the flow process charts in Appendix I, along with a general outline of the two systems.

4. Establishing the relevant costs

The relevant costs were selected according to the criteria identified in Chapter III; that is, they should be incurred within the system (the University), and should have changed as a direct result of automation of the loan desk. A cost is defined as any resource consumed, whether it be staff time, materials, equipment, services, or building space.

The relevant costs for the automated system, therefore,

included systems development and implementation costs, as well as operating costs. Continuing the manual system only involved the recurrent operating costs.

a) Variable operating costs

These vary directly with the volume of circulation, and were broken down for both systems into labour, materials, services (at the Computer Center), and the time of the faculty users. Computer services and faculty users' time were direct costs of the circulation systems to the University, though not to the library.

Labour costs for each of the basic circulation activities (those charted in Appendix I) were calculated, as most of these activities differ between the two systems.

Staff activities which were unchanged or only slightly modified as a result of automation were excluded from the labour costs. A list of these activities is included in Appendix II. Searching was affected by automation, in that, instead of filling out and filing a McBee card for the missing item, a new book card is punched and charged out on the automated system to a special borrower number for missing books. However, this part of the search procedure was considered to be insignificant in comparison with the amount of time spent verifying the call numbers and actually searching for the items in the stacks. Therefore, the search procedure was excluded from the study. Registration of non-C.S.U. borrowers was changed significantly by automation. Non-C.S.U. borrowers are now registered on forms which are optically scanned by the computer to provide input to the machine

readable registration file. Materials costs for non-C.S.U. borrower registration were included in the study, though the labour cost involved had to be excluded, because it was impossible to establish the cost of the equivalent manual operation.

General materials costs, for example, of pencils, were assumed to have remained unchanged. Materials costs were included only for those materials used in the basic circulation activities, for borrower identification cards (which require punching for the automated system), and for book cards and book pockets. Labour costs for punching and inserting the book cards were also measured. Although the borrower I.D. cards were supplied by the University Admissions and Records Department, and were used for identification outside the library, it was felt that their cost should be charged to circulation, because this was their main use, and because the machine-readable I.D.s in use in 1974 had been designed specifically for use in the automated circulation control system. The cost of creating the student and faculty identification files on magnetic tape was excluded, because the University creates these files for other uses, and because they already existed before the library automated.

b) Fixed operating costs

Each alternative also has a category of fixed labour costs for supervision, training, and general administration, which include the work of the loan desk supervisor, the administrative secretary, and the Circulation Librarian, and any other support staff costs not directly attributable to the circulation of items. The cost of systems maintenance

for the automated system comes in this category. General supervision and administration may have been affected by automation; for example, staff training may take more or less time, and one of the secretary's duties, billing students for books lost while on loan, is done automatically by the computer. But the time involved in producing the bill is small compared to the time spent searching the stacks and refunding the charge when the student finds the book, as eventually often happens. However, except for a few housekeeping activities for the automated system, (changing and delivering tapes, and collecting the printouts), the time for general supervision and administration could not be divided meaningfully between the automated and manual subsystems. Thus it was impossible to establish the time required for a fully manual system. Therefore, it was decided to set the on-going costs of general supervision, training, and administration of the department equal for both systems, but to include them in the cost model as a cost which might vary between the alternatives, and which could be set at different levels by anyone else using the model.

The fixed equipment costs were considered relevant only if they had changed as a result of automation. Thus equipment costs for the manual system were zero, but for the automated system include rental of the data collection devices, magnetic tape drives, and keypunch machine.

Except for salary fringe benefits, overhead costs were excluded from the study for the reasons given in Chapter III. The costs of building space and administration were unaffected by automation and were, therefore, irrelevant to the cost-

effectiveness study.

The costs specified above correspond fairly closely to those included in Bourne's standard data collection model (26). Any differences are because his model is for establishing standard unit costs, whereas the present study is measuring cost-effectiveness.

5. Criteria of effectiveness

Criteria for measuring effectiveness in terms of each of the objectives were considered, though in some cases actual measures could not be established because of the time limitations on the study.

i) To circulate items from the collection

Effectiveness in terms of this objective could be measured directly by the volume of circulation, but only in relation to a fixed set of circumstances (number of potential borrowers, loan period, etc.). It is unlikely that all the variables that do affect the level of circulation are known anyway, so isolating the effects of one variable, in this case automation, would be extremely difficult, if not impossible, and was not attempted in the present study. It was, therefore, assumed that the level of circulation would be the same regardless of the circulation system; that is, the manual and automated systems would be equally effective in meeting this objective. However, cost per item circulated was the main measure of cost-effectiveness used.

ii) To minimise the time and effort required of the user when borrowing materials

The obvious criterion here is user time required per item

borrowed, where the smaller the time the greater the effectiveness. However, user time is involved in at least five steps: travelling to and from the library; fetching the item from the shelf; filling out the McBee card; waiting for service; and being served. Of these, only the last three would be affected by automation. Therefore, instead of measuring total time a relative scale was used - minutes saved per item circulated by the automated system in comparison with the manual one. Since faculty users' time had already been included as a cost, their time savings were excluded from the effectiveness measure.

iii) To make material available when needed or as soon as possible thereafter

Effectiveness in meeting this objective has been measured in other situations by "satisfaction level" (47) (the proportio of all demands immediately satisfied) and by mean response time, which also takes into account the time taken for items which are not immediately available. However, during the time available for the study it was not possible to find values of either of these measures for the semi-automated circulation system then in existence, and, in any case, there were no figures available for the earlier manual system for comparison. Some of the possible effects of automation on availability will be discussed with the results.

iv) To maintain the collection intact

The number of books lost is an obvious measure of failure to meet this objective. However, a number of factors

contribute to maintaining the collection intact. The most important is the security system at the exit, for preventing theft, which is the same for both alternative circulation control systems. The accuracy of the records to control circulating materials also contributes to maintaining the collection intact, and this has been affected by automation. Therefore, the accuracy of the files in identifying the borrower of each item on loan was used as an indirect measure of effectiveness.

CHAPTER V

DATA COLLECTION

Data on the costs of labour, materials, computer time, and equipment had to be collected for both systems, as well as data for effectiveness measures on user time and costs, and the frequencies of certain events in the circulation processes. Of these, labour costs were by far the most difficult to establish, because there were no pre-existing data broken down in a form suitable for the cost-effectiveness study.

1. Labour costs

It was considered essential to break down staff time at the loan desk into unit times for each of the circulation activities, rather than use gross number of hours worked, for the following reasons.

i) This was the only way that time at the loan desk could be assigned to the manual and automated circulation subsystems.

ii) The loan desk staff carry out some duties not directly related to circulation work, e.g. locaation assistance, and the amount of time spent on such work is likely to vary at different times of the year. During July, when the study was carried out, loan desk staff were helping with shelving in the stacks and shelf reading. During the rest of the year they would not normally have time for such activities. As mentioned in Chapter II, this kind of peripheral activity,

which does not vary directly with the volume of circulation, would invalidate any comparison on the basis of gross staff time between the two systems. With automated systems more time is likely to be available and hence spent on peripheral activities.

iii) Subdividing circulation work into its constituent activities shows exactly what is involved, and gives more meaningful time and cost data. If given in sufficient detail, such data can be subsequently analysed, modified, and synthesised to predict, or compare with, data for other libraries (26).

iv) The process of analysing the activities is useful in its own right. It clarifies the reasons for the existing procedures, and highlights activities for which there are no apparent reasons. Thus it may lead to suggestions for improved methods.

In order to measure labour costs it is necessary to know, for each activity, the mean time taken, the frequency with which it occurs, the level or levels of staff performing it, and the staff salaries.

Time

There has been plenty of discussion elsewhere (21,46,48) on the choice of a method for measuring staff time spent on an activity (work measurement). For circulation work, which involves many short, repetitive activities and frequent changes between activities, there are only two practical options: time study with a stop watch, or activity sampling. In the present case, activity sampling was eliminated because there was no equipment (random alarm devices) available to enable self-recording, and it was felt that activity sampling

by one observer would take too long. Therefore, direct timing with a stop watch was used.

The first part of any time study is the analysis of the work into activities to be timed. This was done on the flow process charts reproduced in Appendix I. In choosing the units of activity to be timed, the following criteria were followed (49).

i) The beginning and end points should be easily identifiable, with no overlap between activities.

ii) Within the units there should be a continuity of steps, with no gaps.

iii) Only one person should be involved in the unit.

iv) There should be an easily identifiable end product or consequence.

v) There should be a commonality or relationship between the units timed. (For example, times for machines and people should not be compared).

The units were kept fairly short (most were under one minute), but if a sequence of events always occurred together, without any interruptions, then they were timed as a single unit. The units timed are indicated by brackets on the flow process charts. When any abnormal interruptions occurred during the timing of a unit, they were excluded from the time measure. However, normal, unavoidable delay within the units (for example, waiting for a patron to produce his I.D.) was included as a normal part of the activity.

The times were measured with a decimal stop watch and recorded on observation sheets. The continuous timing method

was used for activities such as filing, in which many units occurred in sequence. However, many activities, especially those involving patron service, only occurred singly.

Times were taken for a number of, if not all, the members of staff performing each activity. This differs from the normal practice in industry, where the times are all taken for one person, whose performance is rated as fast, slow, or normal, using a "personal rating factor" of above, below, or equal to 100%, respectively. This factor includes an allowance for the effect of the observer on the individual's performance. In this way a standard time is established, against which other individuals' performance can be evaluated. The industrial method has been used in library time study (50), but was considered inappropriate in the present study, which was attempting to find the real time taken, rather than a standard time. In industry the individual typically repeats an activity continuously, so it is feasible to judge his overall performance, although only subjectively. However, in circulation work a variety of people perform the task, discontinuously, and at different rates each time, thus making personal rating factors entirely impractical. Therefore, the average time of a large number of observations, of a variety of individuals, was considered to be a more reliable and realistic measure on which to base costs.

Staff were usually unaware of who was being timed at any particular moment, and performance was apparently unaffected by the presence of an observer. There was no resistance to the time study, because the staff knew that individual

performance was not being evaluated, and because they were already familiar with the observer.

It was originally hoped to obtain enough readings for each activity to give 95% confidence that the true mean time lay within ± 5% of the measured mean. After a number of readings had been taken for an activity, the following equation was used to determine the number of readings required to give this level of precision (51):

$$N' = \left(\frac{40\sqrt{N\Sigma X^2 - (\Sigma X)^2}}{\Sigma X} \right)^2 ,$$

in which:

N = actual number of observations;

X = value of each observation; and

N'= required number of observations.

However, with the variability innate in the work, (particularly when there is an interaction with the patron), and due to different staff, a large number of readings were required to reach this level of precision. It was attained for the most frequent activities, while for the rest, as many readings were taken as time and their occurrence permitted.

The results of the time study are reported in Appendix III, which gives mean times, 95% confidence limits, and the number of readings taken for each activity. Some of the manual activities occurred infrequently, and their confidence intervals are large. In the case of taking "holds" (reserves) on the manual system, only one occurrence was observed during the whole month. Part of the operation (taking the request and obtaining the McBee card from the circulation

file) was, therefore, assumed to have the same mean time as the equivalent operations in the renewal process. Similar assumptions were made for a few other activities, and are recorded in Appendix III.

Although the loan desk staff are not as busy in the summer, July circulation being only 75% of the normal level, it was assumed that the unit times recorded in July would be typical of the rest of the year. The units measured were short, and in many cases fairly mechanical activities, and it was considered that any rests would be more likely to occur between units, rather than within them. The unit time gives a realistic measure of one unit of an activity, but cannot be used to predict the number of units completed over a period of time spent on that activity. Doing so would almost certainly overestimate the rate of work, because unproductive time between the cycles of the activity reduces this rate.

Any work measurement based on direct timing must make some allowance for unproductive time. Some figures for unproductive time are given in the library literature, but they vary from 13% (21) to over 25% (24), and there seems to be no clear definition of what exactly it includes. Therefore, it was decided to measure unproductive time, defined in this study as: walking around between jobs; unavoidable delay, for example, waiting to ask the supervisor a question; idle time, such as talking or reading; and attending to personal needs (i.e. visiting the rest room). Coffee breaks and any delay time within timed cycles were excluded, being allowed

for elsewhere. The percentage of unproductive time was established by recording the numbers of productive and unproductive loan desk staff at ten minute intervals, covering one whole library opening period (7:30 a.m. to 10:00 p.m.), but spread over two days. The readings were taken on a Wednesday and a Thursday, because circulation is generally highest on Mondays and decreases through the week until it is lowest on Sunday. The percentage obtained was thought to be representative of July, but not necessarily of the rest of the year, because the staff were not as busy during July. An estimate of the average percentage of unproductive time was made, based on calculations and assumptions given in Appendix III. This was then converted to an unproductive time factor, which was used to convert observed mean times to real times including the unproductive allowance.

No library can hope to eliminate all unproductive time. Circulation work is especially prone to unavoidable delay and time lost when moving between jobs. Furthermore, it is usual to employ enough staff to cope with most peak demands for service, so there are bound to be periods of overstaffing between the peaks. Thus, one would expect unproductive time to be higher at the loan desk than in departments with a steady work load. All the Circulation Department can hope to do is to reduce the opportunities for idle chatter, by optimising the staffing pattern and the work schedule.

The work of a number of employees, for example, that of the supervisor, could not conveniently be broken down into activities. Therefore, gross times were used, based on the

estimates of the employees concerned. Unproductive time is already included in these gross estimates. The time for punching and verifying bookcards was based on existing records of the number of hours worked and the number of cards punched. In July a new keypunch operator was being trained, so direct timing would have given unrealistic results for keypunch time.

User time in filling out McBee cards was costed in the same way as staff time. Unit times were measured with a stop watch, and a mean time calculated. No allowance was made for unproductive time.

Frequency of circulation activities

The shortest representative time period which includes a full cycle of all the functions affecting circulation is a year. The frequencies of the circulation activities vary during the academic quarter and over the year; for example, Winter quarter (January to March) always has the highest level of circulation. In addition, the statistics from the automated system for July and for the year showed that, not only were the July statistics proportionately lower all round; the ratios of the various activities were different for the two periods. It was, therefore, decided to collect statistics for July, 1974 and for the year August, 1973 to July, 1974.

The frequencies of most activities on the automated system were taken directly from the statistical reports, though even this required a combination of quarterly, monthly, and daily reports to cover the desired periods. Statistics of

overdues and fines for periods not covered by quarterly reports were taken from counts on the notice lists printed at each computer billing run. Recalls are not counted on the automated system, but the staff member responsible kept a log of all items recalled, from which the July figures were obtained. The results are given in Appendix IV.

The only statistics kept routinely for the manual system were total circulation (charges plus renewals), and circulation broken down by borrower type. Therefore, counts were kept during July of renewals, first overdues, and recalls, and samples were made of holds. The other figures were derived as indicated in Appendix IV.

It was necessary to extrapolate from the July manual statistics to obtain estimates for the year. There were two possible ways of doing this. One was to assume that each activity remained in the same ratio to the manual charges as in July (i.e. frequency per 1000 manual charges was constant). However, the time within the quarter affects these ratios (for example, during the first two weeks of a quarter there will be relatively few renewals, overdues, and fines), and the statistics for the automated system showed that the July ratios were atypical of the whole year. The method used, therefore, was to assume that the proportion of each activity on the manual and automated systems would be the same in July as during the whole year. The actual percentages for manual charges were very close (31.8% in July, 30.5% for the year), which supported this assumption.

Frequencies for queries were obtained by keeping a count

of patron use of the Daily Activity Report (D.A.R.) during one whole library opening period, spread over a Wednesday and Thursday in July. Queries were defined as establishing whether or not an item, or items, were out on loan. (General queries were excluded from the study). On the manual system all queries had to be answered by the staff, whereas on the automated system the patron could find out for himself. This did not involve any more of the patron's time, because he would have had to wait while the question was answered, but it did reduce staff time. The total queries (based on extrapolation from the one day's figures) were assumed to be the same for either system. The count was divided into self-service and assisted queries, where "assisted" meant that the patron needed help in using the D.A.R., or requested that the item be looked up in the manual files as well. The figure for assisted queries was used to calculate staff time spent on queries for the existing semi-automated system.

All other statistics used and their derivation are indicated in Appendix IV.

Level of staff performing each activity

Loan desk staff were divided into four grades: administrative assistants, clerical assistants, secretary, and work-study students. For many of the overdue, fine, recall, and hold activities, only one person, or at most one grade, was involved. However, for counter service, filing, discharging, and shelving and sorting books on the return shelves, a variety of staff took part.

Some of the maual activities were "self-recording" in the sense that the staff member always initialled the McBee card or other record made. These included manual charging, discharging manual overdues, and sorting and counting the McBees from new charges. Counts were made of the numbers of each of these activities performed by each level of staff. The percentages at each level for manual charging were assumed to be the same for all counter work, that is, charging, renewing, queries, and accepting hold and recall requests. This was thought to be a reasonable assumption, as the staff do not know what the patron needs before serving him. The percentages for discharging manual overdues were assumed to hold for all manual discharging during the year.

For sorting books from the return bins to the discharge points and then onto the return shelves, and for automated discharging, a record was kept each day in July of which people had performed each activity. These records were used to establish the proportions of the activity done by each staff level. The percentages for manual filing were estimated in a similar way.

The results are given in Appendix VI.

Salaries

Salary figures were obtained from the library's accountant and fringe benefits from the University Personnel Office. Basic salary figures were used to establish a mean for each staff level, which, in the case of hourly paid staff, was weighted by the number of hours worked in July. Real mean

salaries were used, rather than the midpoints of the scales, because there was a fairly high turnover of staff at the loan desk (as in most libraries), so most salaries were at the lower end of the scale.

Mean salaries were then used to calculate a wage per minute on duty for each staff level, taking into account all paid leave and coffee breaks, and all fringe benefits, including free courses taken in the University. The full allowance of sick leave is included, as staff tend to take it all. The figures for funeral leave and courses taken are averages given by the Circulation Librarian. The calculations and results are given in Appendix V.

It should be noted that these figures were July, 1974 rates and could not be used to calculate actual labour costs for August, 1973 to July, 1974, or for any future period, because of continual pay increases.

2. Materials costs

A list of materials used directly in the circulation activities was made by going through the flow process charts. Unit costs for each of these materials were obtained from the Library Accounting Department. The unit costs were multiplied by frequency of use and totalled to give actual materials costs for the two systems. The calculations and costs are given in Appendix VIII.

3. Equipment costs

The Accountant supplied annual rental figures for the

keypunch machine, and for the C-Dek terminals, magnetic tape drives, and associated equipment. The figures include maintenance and are given in Chapter VI. Only half the annual cost of the keypunch machine is charged to circulation, because it was used half the time for other work.

4. Computer costs

The computer running costs for July were supplied by the Computer Center, based on its schedule of charges for University and government users. The cost given was divided by the automated charges for July to give a unit cost per item circulated. As the charge depends mainly upon core used, C.P.U. time, and input/output time, it would vary directly with the volume of circulation.

Charging by the Computer Center is all done through accounts. No real money changes hands and the library does not have to budget for computer costs.

CHAPTER VI

COST-EFFECTIVENESS MODELS AND RESULTS

1. Unit cost model

As explained in Chapter IV, it was assumed that a manual system, operating at the time of the study, would have the same level of circulation as the actual semi-automated system; that is, the two systems under comparison are equally effective in circulating materials. It was originally expected, before automation, that the automated system would stimulate circulation by reducing the user effort required. In fact, circulation dropped during the first year of automation, then increased by 8 to 9% in 1973/4 over 1972/3, though neither of these changes have any proven relationship with automation.

A cost-effectiveness model was constructed on the basis of the unit costs of circulation of the two systems. Unit cost models have been used widely in library research, but rarely with any explicit theoretical foundations. The present model has been constructed by carefully documenting and classifying all the relevant costs. For any cost that was excluded, a reason was given in Chapter IV. As a result, the model is considered to have some predictive value, and the overall unit cost can at least be broken down into its components.

The unit used is a conceptual one of one item passing through the system, such that every activity performed in the system is performed on that item proportionately (50). Thus the theoretical item is charged out once, renewed 0.06

times, receives 0.19 fines, 0.086 Overdue notices, and 0.06 queries (see Appendix IV for full figures). For convenience, frequencies and costs are given per 1,000 items in the cost tables. Thus, the number of charges is equal to the number of units, but the unit cost includes a lot more than the cost of charging.

The costs were classified according to the scheme:

- Non-recurrent: - fixed
  - People
  - Machines
  - Materials
- Operating
  - fixed
    - People
    - Machines
    - Materials
  - variable
    - People
    - Machines
    - Materials

The total annual costs are then given by the equation:

$$\Sigma Cost = D/Y + F + N \times U, \qquad (1)$$

in which D = non-recurrent or development cost;

Y = the period of amortisation in years (the expected life of the system);

F = total annual fixed cost;

U = total unit cost of the fixed components; and

N = number of items circulated per year.

This can be further broken down into:

$$\Sigma Cost = D/Y + (f_1 + f_2 \ldots + f_n) + N (u_1 + u_2 \ldots + u_n) \qquad (2)$$

in which each f and u is a component of the fixed and variable costs, respectively. Some of the components, for example,

labour costs, are further divisible into (time x rate).

Overall unit cost = (Σ Cost)/N.

The model will be built up giving each type of cost in turn, for both circulation systems.

Non-recurrent costs

These are the costs of systems development, programming, and testing for the automated circulation control system. The figures below were provided by the library's systems analyst. All salaries include fringe benefits, which were calculated as shown in Appendix V, (This applies to all salaries given in this chapter). These non-recurrent salaries are at 1972 rates. The computer cost includes materials.

i) Computer Center:	$
Systems analyst: 10 man months at $19,788 p.a.	16,490 p.a.
Programmer: 8 man months at $13,218 p.a.	8,812
Computer time in test	3,000
ii) Library	
Library systems analyst: 1 year at $16,503	16,503
Total	$44,805
Amortised over five years	$ 8,961 p.a.

The period of five years for amortisation was given by the library system analyst, because he considered that the availability of new hardware might substantially affect the system after that time.

Recurrent costs - fixed

i) Equipment

The annual cost of rental and maintenance of equipment

used by the automated system was:

	$
3 C-Dek input stations 1 Central controller 2 7-track 556 BPI magnetic tape recorders	6,384
Maintenance on the above	1,416
½ I.B.M. keypunch machine (rental and maintenance)	421
Total . . .	8,221 p.a.

(the keypunch was used only half the time for circulation work)

ii) Implementation

This is the annual cost of creating the book cards and borrower I.D.s. It is sometimes called conversion cost, but this implies that there is no cost for the manual system, whereas borrower I.D.s are in fact required for both systems. Only materials costs are included for borrower I.D.s, as explained in Chapter IV. The figures given are taken from Appendix VIII and Appendix VII.

Existing semi-automated system:

	$
Borrower I.D.s	6,523.23 p.a.
Book cards and pockets	346.10
Labour in keypunching	2,681.28
Total	9,550.61 p.a.

Manual system:

	$
Borrower I.D.s	4,278.76 p.a.

The annual cost of keypunching is included here as a recurring cost, rather than treating it as a non-recurrent, development cost, because keypunching is expected to continue at the same

rate in the near future. At the present rate it would take over twelve years to convert the whole of the collection, including new books, and this is making no allowance for replacement of worn out and lost cards. In addition, over the past nine months the proportion of circulation on the automated system has stayed fairly constant at around 70%, even though the books converted have increased from 27.5% to 31.8% of the collection. Thus, the balance between the manual and automated components of the existing system is expected to change very slowly over the next five years, unless some extra effort is put into keypunching.

iii) Systems maintenance

Systems maintenance has been a continuing commitment to the automated system, representing 12% of the library system analyst's time:

12% x $20,865 = $2,504 p.a.

iv) Supervision and administration

This represents time spent by the Circulation Librarian, supervisor, and administrative secretary, which, while not involved directly in the basic circulation activities, is essential to the continuing operation of the loan desk. It is assumed to be the same for both manual and automated systems. These figures are based on estimates given by the personnel involved. The Circulation Librarian also supervises the reserve desk, the stacks, and the monitors. For the automated system there is an additional fixed labour component, that of changing the magnetic tapes and delivering them them to the Computer Center, and collecting the D.A.R.

Manual

	$
Circulation Librarian: 50% of $14,788	7,394 p.a.
Supervisor: 95% of $10,385	9,866
Administrative secretary: 53% of $8,756	4,641
Total . . .	$21,901 p.a.

Semi-automated:

	$
Supervision, etc. (as above)	21,901 p.a.
Collect D.A.R.: 25 mins/day at $2.40 per hour (WS)	250
Change and deliver tapes: 30 mins/day at $3.76 per hr (CA)	470
Total . . .	$22,621 p.a.

The total fixed costs for the two systems are:

	Manual	Semi-automated
Systems development		8,961
Implementation	4,279	9,551
Equipment		8,221
Systems maintenance		2,504
Supervision etc.	21,901	22,621
	$26,180 p.a.	$51,858 p.a.
Total fixed component of unit cost (÷ 271,710)	$0.09635	$0.19086

The fact that these fixed costs are for a fully manual system and the existing, semi-automated system, not for a fully automated system, is stressed. The whole book stock would have to be converted for a fully automated system, and this would cost much more than the present cost of conversion.

Recurrent costs - variable

i) Direct labour

The costs of labour for the basic circulation activities were calculated as shown in Appendix VII. The times for each element (in the lefthand column) are the results from Appendix III. For any element which does not occur every time the activity does, an adjusted time is given in the second column. (For example, 55% of the recalls are by post card). This is then multiplied by the unproductive time factor (U.P.T.F.) to give the total time allotted to each occurrence of the elements. Multiplying by the wage per minute (already adjusted for time off and fringe benefits) gives the cost for each element. The total cost and time of each activity, singly and per 1,000 charges, is calculated. Tables 1 and 2 of Appendix VII give the costs and times of the manual and automated parts of the existing system. Table 3 gives direct labour costs and times for a purely manual and a purely automated system. These differ slightly because the present manual component is atypical in the frequencies of some of the activities. For example, there were fewer renewals and holds per 1000 manual charges than overall. This is to be expected as the manual component is mainly current periodicals (which cannot be renewed) and infrequently circulating books.

The unit costs of direct labour for each of the systems are given in Table 1 of this chapter.

ii) Error correcting

This represents time spent by an administrative assistant dealing with snags on the manual system, and going through the

TABLE 1. UNIT COSTS AND COMPONENTS FOR EXISTING, MANUAL, AND AUTOMATED SYSTEMS (DOLLARS)

	Variable costs					Total variable component of unit cost (U)	Total fixed component of unit cost	Total unit cost
	Direct labour	Error correcting	Faculty user	Materials	Computer			
Automated:								
Unit cost	0.10659	0.01077	-	0.00456	0.16870	0.29062		
Manual:								
Unit cost	0.17415	0.00738	0.07608	0.01101	-	0.26862	0.09635	0.36497
Semi-automated:								
Automated part	0.07639	0.00749	-	0.00322	0.11725			
Manual part	0.04995	0.00225	0.02320	0.00331	-			
Unit cost	0.12634	0.00974	0.02320	0.00653	0.11725	0.28306	0.19086	0.47392

error lists which the computer edit programmes print out. On the manual system errors usually result from McBees and books being wrongly matched during discharging. On the automated system some keying-in errors are edited, and such things as a discharge transaction being followed by a hold for the same item. It is difficult to relate the time spent in correcting these errors to particular circulating items. However, the time spent in error correcting does vary overall in direct proportion to the volume of circulation. It has, therefore, been included as a variable cost, measured as a gross percentage of the administrative assistant's time.

Existing system:

Automated component: 25% at $8,141 p.a.	2035.25 p.a.
Manual component: 7.5% at $8,141 p.a.	$610.57
Dividing by the number of charges p.a. (271,710): -	
Unit cost of automated component over all charges:	$0.00749
Unit cost of manual component over all charges:	$0.00225
Total unit cost per charge of error correcting:	$0.00974

Automated system:

Unit cost = $2,035.25/188,951 (automated charges per annum) = $0.01077

Manual system:

Unit cost = $610.57/82,759 (manual charges per annum) = $0.00738

iii) Faculty users' time

The time for faculty users was considered as a direct cost to the University (rather than as a measure of effectiveness) and was, therefore, included in the unit cost model. The mean time for filling out a McBee card was found to be 1.48 minutes. The mean faculty salary for the whole University, adjusted for time off and fringe benefits, was $0.224 per minute (Appendix V).

Manual system:

1.48 x $0.224 = $0.3315 per faculty manual charge.

22.95% of charges are to faculty, therefore:

overall unit cost = $0.3315 x 22.95%

= $0.07608 per manual charge.

Automated system:

No cost.

Existing semi-automated system:

Only 30.5% of all charges are manual.

Unit cost of faculty time = $0.07608 x 30.5%

= $0.02320.

iv) Materials costs

The materials costs for the existing manual and automated components, and for entirely manual and entirely automated systems, are calculated in Appendix VIII. The unit costs are given in Table 1.

v) Computer costs

The charges in Appendix IX were given for July, 1974 by the Computer Center. As the cost depends on core used, C.P.U. time, input/output time, and pages of printout, it is assumed to vary directly with the volume of circulation.

There were no figures available from the Computer Center on which to base any other assumptions. C.P.U. time may not vary directly in proportion to the number of records processed, but in the absence of any evidence it was assumed to do so. The unit cost per automated charge was calculated by dividing the total cost for July by the number of automated charges in July.

Automated system:

$$\text{Unit cost of computer time} = \frac{\$1,962.28}{11,632}$$

$$= \$0.1687 \text{ per automated charge.}$$

Existing system: only 69.5% of charges are automated:

$$\text{Unit cost per charge} = \$0.1687 \times 69.5\%$$

$$= \$0.11725$$

Results of applying the unit cost model

Table 1 summarises all the component costs and the overall unit costs for the existing semi-automated system, and a purely manual system. Variable costs are given for a fully automated system, but not fixed costs, because of the difficulty of establishing the cost of converting the book stock for such a system.

The unit costs per circulating item are 36.5 cents for the manual system, and 47.4 cents for the semi-automated system. The difference of almost 11 cents is attributable to the computer costs and the fixed costs of the existing system. Even the variable part of the unit cost is higher for the automated and semi-automated systems. Thus the

difference in total cost between a manual system and the existing one will increase with the level of circulation, as is shown in Figure 1. This figure was plotted using Equation (1) above.

It can be seen that the total cost does not level off as the volume of circulation increases, for either the manual or the semi-automated system. This is a direct result of the assumptions on which the model is based, in particular, the assumption that all variable costs vary directly with the volume of circulation. In the case of the computer costs this assumption may be questionable. If computer costs do not increase at the same rate as circulation (for example, Burgess (16) has suggested a 5% increase in computer costs with a 25% increase in circulation) then the costs for the semi-automated system would level off with increasing circulation. Even so, it would take a big increase in circulation to narrow the present gap in costs.

Increasing salaries will also reduce the cost differential between the existing system and a manual one. The model can be manipulated to show this; for example, a 10% increase in labour and materials costs would equalise the variable component of the unit cost of the two systems. However, since the fixed component includes a large element of labour and materials costs, and this is much higher for the semi-automated system, there is little reduction in the overall difference between the two. It would take a very large increase in salaries before the total costs equalised.

The costs of circulation to the library, as opposed to

the University, can be extracted from the model, which gives the following figures:

	Variable part	Fixed part	Total unit cost to library
Manual	$0.19254	+ $0.08060	= $0.27314
Semi-automated	$0.14261	+ $0.14602	= $0.28863

Automation is not quite so expensive for the library as it is for the University. The total unit cost for the existing system is still slightly higher, but the variable component is lower. Thus with an increasing volume of circulation the total costs will even out. This is shown by th lower two lines on Figure 1. However, it would take a 29% increase in circulation for the costs to equalise.

The model could also be adjusted to show the effect of changing the proportions of the manual and automated components of the existing system. There is no built-in factor to do this, because the proportions appear to be changing very slowly. This does limit the use of the model to the short term future.

This model does not take into account any increase in the variable components of the unit cost, or of the total fixed cost, for increasing levels of circulation. Some authors (16, 27) claim that with increasing circulation and file sizes, direct labour would increase disproportionately, because the work would become more difficult (particularly on a manual system). However, this is likely to be a long term effect. Fixed costs, as discussed in Chapter III, are never absolutely fixed, but change stepwise with large increases in activity. For example, it is anticipated that a new C-Dok

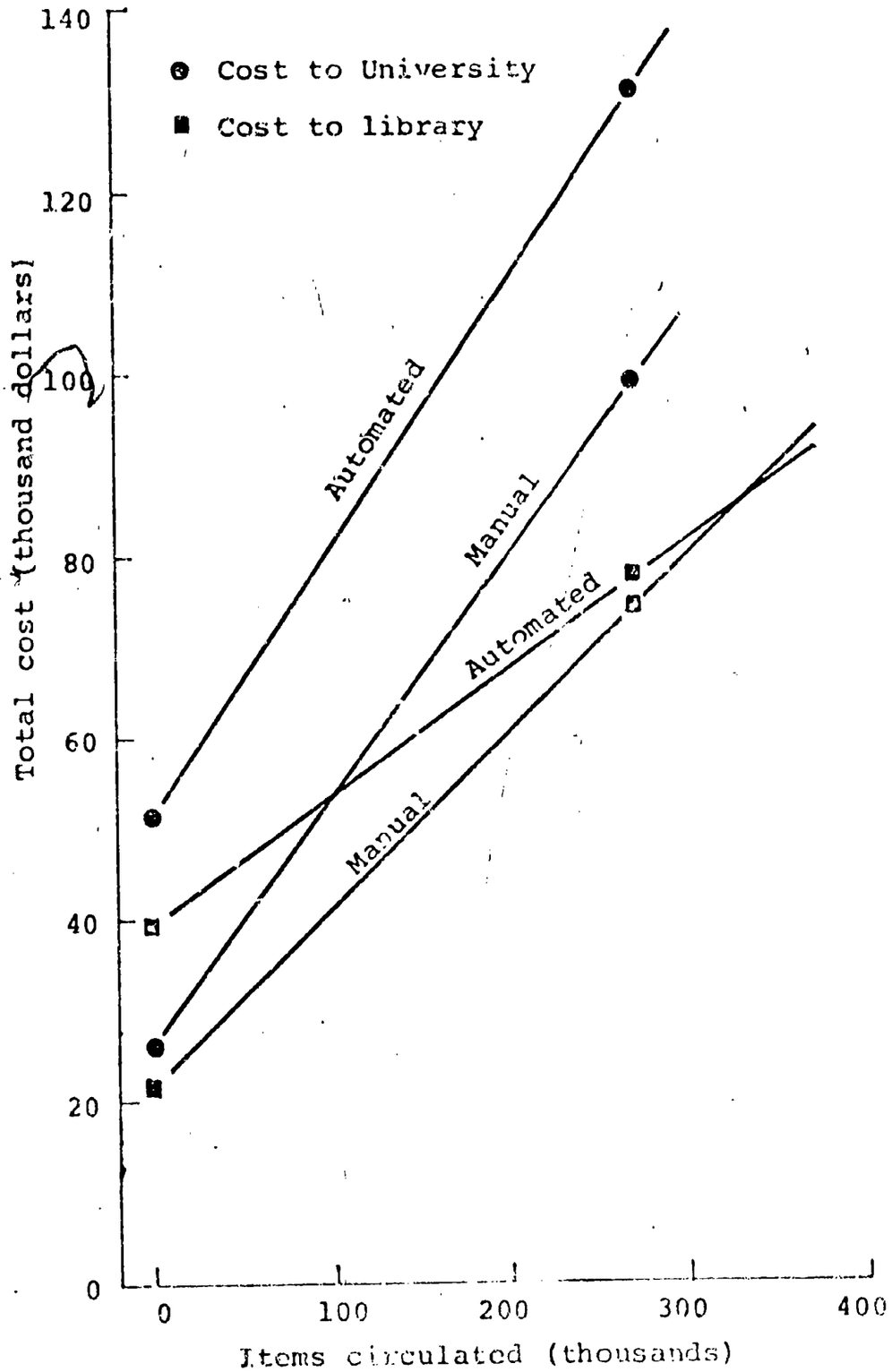

Figure 1. Relationship between total cost and circulation.

terminal will be installed within the next year. Such changes would require the fixed costs in the model to be adjusted.

Thus the model shows that the existing semi-automated circulation system is more expensive than the equivalent manual one, and is likely to remain so for the next few years. The model is useful for showing just where the costs lie. Computer costs are seen to be a large component of the unit cost for the existing system. Perhaps the best hope for the future of the system is that falling hardware costs will eventually lower the running costs to the University.

2. User time savings

The three elements of user time which could be affected by automation are: i) filling out the McBee card; ii) waiting for service; and iii) being served. In fact, i) has been completely eliminated for the automated component of the existing circulation system, representing a saving of 1.48 minutes per automated loan. The times taken by staff to charge out books are 0.461 and 0.431 minutes for the manual and automated systems respectively. The user spends an equal amount of time waiting, while being served. The difference between the two systems on this element of user time is so slight that it has been ignored. As element iii) above is unchanged, there is no reason to think that queuing time would have been affected by automation. As it was impossible to measure any difference in user waiting time, because there was no fully manual operation for comparison, waiting time was assumed to be the same for both alternatives.

Thus the overall time saving to the user of a fully automated system, as against a manual system, is 1.48 minutes per item circulating. The time savings of faculty users have already been included in the unit cost model, as a cost to the manual system. However, student and non-C.S.U. time cannot be charged directly to the University, so is treated here separately. Non-faculty account for 77.05% of the loans; therefore, the time saved per item circulating on the automated subsystem is:

$$1.48 \times 77.05\% = 1.14 \text{ minutes per item.}$$

Since only 69.5% of circulation is on the automated system, the unit saving of non-faculty users' time by the existing subsystem is:

$$1.14 \times 69.5\% = 0.792 \text{ minutes per item.}$$

As the increase in unit cost of the existing system over the manual system is 10.9 cents, the cost of this time saving is 13.76 cents per minute saved, or $8.25 per hour.

The semi-automated system is obviously more effective in meeting the objective of minimising the user's time required. However, in terms of cost-effectiveness, $8.25 per hour is a very high price to pay for students' and non-C.S.U. users' time.

It is possible that the savings in user time may lead to an increase in circulation. It has been reported (52) that in one library a minute of faculty time saved in getting to library materials induced faculty to spend two or three minutes acquiring and reading more literature. After a halving of access time for students, circulation doubled. Thus the demand for books may well be elastic, depending on the library's

effectiveness, as well as on the size of the user population.

3. Satisfaction level

It was impossible to measure the effectiveness of the alternative circulation systems in meeting the objective of immediate satisfaction of user needs. However, automation may affect availablility and satisfaction level in a number of ways, and these are considered.

Discharging books is quicker on the automated system than on the manual (0.25 against 0.38 minutes). When the library is busy, backlogs of books waiting to be discharged tend to build up at the loan desk. This should happen less frequently with the automated system than with a manual system, thus resulting in a quicker return of books to the shelves, and in increased availability. No backlogs were observed during the summer, and, in any case, it was impossible to compare the semi-automated system with a fully manual one, without data for the latter.

One of the justifications frequently used for automated circulation control systems is their ability to produce statistical reports showing the use of various parts of, or items in, the collection. The belief is that these reports give librarians a firm basis on which to decide what books to buy. The value of statistical reports has sometimes been measured by the cost of gathering the same data manually. However, this method assumes the value of the reports, and a large number of them may be useless in terms of meeting the library's objectives.

The only sensible way of evaluating statistical reports is in terms of the objective of satisfying user demands. If the reports are used as a basis for deciding how to spend funds, the end result should be an increase in user demand satisfaction level. If the reports are not used, they have no value.

At C.S.U., the "books in demand" reports are just beginning to be used by subject librarians as a basis for fund allocation. So far, only a few slight changes have been made, so it is not likely that there have been any changes in overall effectiveness.

Use statistics have also been employed to establish priorities for reclassifying items from the older part of the collection from Dewey to L.C. The most used items are reclassified first. This should make it easier for the user to find items of interest.

One possible decrease in effectiveness of the automated system is the longer time lag before records appear in the files. This is up to 39 hours for the automated system, though usually less than 24 hours. For the manual system it is usually about 4 hours. It is possible that this may lower the satisfaction level, by discouraging people from looking for items which the records show to be on loan, but which have, in fact, been returned. This probably happens infrequently. The converse problem, of not showing an item to be on loan when it was, gave rise to only 7 of 176 search requests during the month of July. (Since the search is always delayed until the following day, when the record would show on the D.A.R., no more staff time is involved).

4. Maintaining the collection intact

As mentioned in Chapter IV, book loss is largely due to theft, which is out of the control of the automated circulation system. An interesting use of the statistical reports on item use has, however, been made in relation to this problem. The library is about to install a book detector system, but cannot afford to process every item in the collection, so that it will be detected. Therefore, the statistical reports havebeen used to show the areas of heaviest use and of heaviest loss, and the processing will initially concentrate on those areas. Thus, the automated system may contribute to reducing book loss.

An area more directly related to the circulation system is the accuracy of the files for circulating items. It is through these files that the loan desk controls circulation. If any of the records are missing, or erroneous in such a way that the item on loan cannot be traced to a particular person, then the library can only rely on the honesty of the borrower to make him return the item. It is unlikely that such errors in the circulation files result in many book losses, but accuracy of the files is an indirect measure of effectiveness in this respect.

The problem of missing records occurs in the manual system when books and McBees are wrongly matched at discharging. The "snags"are books which later come in, but have no matching McBee card in the file. Once the "snag" book comes in the original error can usually be traced, but until it does return the staff are unaware of the error. An estimate, given by the

loan desk staff, of 4 snags per day was used to calculate the the percentage of books circulating for which there are no records. This comes to 1 - 2%; that is, the manual files are 98 - 99% accurate.

For the automated system the main problem is errors in keying-in I.D. numbers and borrower status. The resulting "bad I.D." cannot be matched against any particular borrower, and the item on loan is, therefore, out of the control of the system. In fact, many of the bad I.D.s can be traced to borrowers by checking against different registration files, for example, when a non-C.S.U. borrower has been keyed in as a student. In other cases, transposing digits yields the answer. However, this involves considerable time, and there are always some which are unresolved. The percentage of bad I.D.s was calculated by examining the printout of lists of notices (fines, overdues, and bills) from the June and July billing runs. The result showed that approximately 5% of the overdue items have bad I.D.s. Therefore, it can be assumed that only 95% of the items circulating have accurate records.

Mispunched borrower I.D. cards have caused similar problems in maintaining control over the circulating items. A large number of the student I.D. cards were punched with the wrong social security number one year, and are still causing problems in relating items on loan to their borrowers. However, this problem is not inherent in the automated system.

Thus the automated system is less effective than the manual one in this respect. The time taken in resoving these errors has already been involved in the cost model.

Some of the products of the automated circulation system cannot be related directly to objectives. Examples are the fines notices to student borrowers (which are not sent on the manual system) and the lists of items on loan to one borrower. Perhaps the fact that only about six of the latter lists have been produced for borrowers since the system started indicates that they have little value. Measuring effectiveness in terms of objectives is thus a good way to isolate the items and activities of real value.

One by-product of the automated circulation system is the attendance module for hourly employees. The employees "clock in" on the C-Dek terminals. At the end of each pay period the computer calculates hours worked and pay earned for each person. This has saved a considerable amount of time (2½ to 3 man-days per month) in the library accounting department. However, in July, 1974 a change in the University pay and accounting policy eliminated any benefits from the attendance module.

Summary of findings

i) The unit cost per item circulated is 36.5 cents for the manual system, and 47.4 cents for the existing semi-automated system. Thus the existing system is 10.9 cents per unit, or 30% more expensive than the manual system. This difference will be reduced by rising salaries and an increasing volume of circulation; however, it will be some years before the costs equalise.

ii) The saving in non-faculty users' time by the existing system over a manual one is 0.79 minutes per item circulated.

At an increased cost of 10.9 cents per item, this gives a cost-effectiveness ratio of $8.25 per hour saved.

iii) The accuracy of the files for the existing automated subsystem is lower than that of the existing manual system; 95% as against 98-99% accuracy.

CHAPTER VII

CONCLUSIONS AND RECOMMENDATIONS

The conclusion is unavoidable that the existing semi-automated circulation system at Colorado State University cannot at present be justified in terms of cost-effectiveness. However, in the future the long term effects of automation on the composition of the collection may result in an increase in effectiveness which justifies the cost. Improved measures of effectiveness would be needed to establish any change and to relate it to automation. The decision as to how much it is worth to increase effectiveness must be made by the head of the library, or by the University in allocating its funds. The cost-effectiveness study merely shows the effectiveness for a given cost.

The difference in cost between the existing system and a manual system will decrease only slowly as salaries and the circulation level rise. Thus, the automated system is expected to remain more expensive over the next few years, unless there is a fall in computer running costs. The cost difference to the library is not as great, as a large part of the cost of automation is borne by the University. In the end, the University pays the whole bill for the library's services, so it is only sensible to compare costs at the University level.

This study has highlighted some of the components of the automated system whose efficiency could be increased. For example, calculating fines is one activity in which the

computer should be more efficient. But with the present method of prorating manual against automated fines, there is, in fact, very little cost saving, because 40% of the fines have to be recalculated.

Similarly, although the computer is more accurate than man can be, errors in keying in I.D. numbers make the automated records less accurate than the manual ones. A check digit appended to the numbers would eliminate most of the problems. However, this would require different hardware to verify the numbers.

Holds are much less efficient on the automated system than on the manual. This is basically a limitation of the equipment. It would be ideal to have a trapping store to store the call numbers on hold. Then whenever an item with a hold on was discharged or renewed, it would be flagged by the trapping store, and some indication would be given to the operator of the terminal. This would also eliminate the present procedure of checking the D.A.R. for holds, every time an item is renewed.

It is hoped that this study will help dispell some of the fallacies about automated systems, for example, that they are necessarily cheaper, and that they are more accurate than manual systems. In fact, automated systems are much less tolerant of human error than manual systems, and require better quality control over the data input. Thus, while the bad I.D.s cannot be corrected by computer, they can often be manually traced to the correct borrower, by finding an I.D. which is very similar to the incorrect one. The computer,

however, can only make perfect matches.

The list of costs given should also help prevent omission of relevant costs in future cost studies. The cost of systems maintenance is one that is often ignored, or not expected. This was one of the reasons why the original pre-automation cost study at C.S.U. underestimated the cost of the automated system.

It is hoped that future cost studies will have a sounder theoretical basis than previous ones. The most important points are that costs should only be measured in relation to effectiveness, and effectiveness should be measured in relation to explicitly stated objectives. Only in this way can one see, for example, that having volumes of statistics for every aspect of circulation may not be particularly effective, especially if they remain on the shelf unopened.

The objectives of this study have not been fully realised, in that measures were not established for all the effectiveness criteria. This was due to the shortage of time, but the lack of adequate criteria and measures is likely to hinder future studies. Research into library effectiveness should concentrate on finding criteria which can be quantified, and then these can be used in cost-effectiveness studies.

Although not fulfilling all its objectives, this study has produced much information which could be useful to the C.S.U. library, and to other libraries. It is felt that the results of time study and cost-effectiveness analysis would be well worth the effort involved for any library, and their use is highly recommended.

APPENDIX I

DESCRIPTION OF CIRCULATION SYSTEMS AT COLORADO STATE UNIVERSITY

All the operations which were timed are flow process charted on the following pages. A general outline of the two circulation systems is given in order to put the individual operations into context.

General

The loan period is two weeks for books and older periodicals and two days for recent periodicals, including unbound current issues. One renewal is allowed on books. Faculty and staff members and research students with special borrowing privileges may borrow books for the quarter, and are not fined, although they do receive overdue notices. There is no limit to the number of items a person can borrow.

The loan transaction is made at the loan desk, the date due stamp being evidence to the monitor at the exit that the book has been charged out. Therefore, this date due stamp must always be cancelled when a book is returned. To return a book the patron simply places it in one of the book drops. As fines are not collected in the library, the patron does not have to be present when the book is discharged.

Manual system

The manual system is based on a circulation file of edge-notched McBee cards arranged by L.C. call number. For each item borrowed, the patron fills out a McBee card, which

is punched before filing so that, a few days after it becomes overdue, it will separate from the rest of the file on needling. The first overdue notice is simply a Xerox copy of the McBee card, stamped "overdue". Other notching positions are used for special types of loan, such as interlibrary loan or bindery, so that these can be separated from the file. For holds and some special loans the McBee cards are flagged by coloured tags to alert the staff when the book is discharged. There is no access by borrower name, but this is rarely needed anyway.

Fines are collected by the University Accounts Department, but the library calculates amounts. Non-C.S.U. patrons are notified of fines by typed invoice. Student fines are debited against the students' accounts, and the students are not notified until they receive the regular monthly statements from the Accounts Department. All students have an account with the University, into which course fees, library fines, etc. are paid. Students did receive typed bills before the automated system was introduced. Illegible handwriting by the patron is frequently a problem when processing of fines, overdues, and recalls, when the patron's name, social security number, and address or telephone number are taken from the McBee card.

The only statistics recorded are counts of loans to each type of borrower.

Automated system

Loan transactions are recorded by placing a punched 80 column book card and the borrower's plastic I.D. card

(punched with his nine digit social security number) into the C-Dek terminal. For borrowers without I.D.s, including non-C.S.U. borrowers, the social security number can be keyed into the terminal. Keys for loan period and borrower type are also pressed, and the transaction is recorded. For discharging, only the book card is required. The circulation file is stored on magnetic tape and can be accessed by transaction number (a ten digit number generated by the computer at the time the record is created), call number, borrower number, date due, and by hold or renew status. The file is updated daily and printed out in call number order as the Daily Activity Report (D.A.R.)

The computer generates fines and overdue notices twice weekly, and reminder notices to faculty and others with quarter charges before the end of each quarter. These notices bear the borrower name and address, which are obtained by matching the borrower type and social security number against the appropriate magnetic tape name and address file. Errors in keying in borrower type and number cause non-matches for 5 percent of the notices. Names and addresses for these unmatched social security numbers then have to be searched for manually.

The computer calculates fines, but about 40 percent are recalculated manually because of a change in policy since the programs were written (reduced fines if two or more items per person were overdue at the same time). Student fines are automatically debited against their accounts, though any corrections have to be manually recorded on load sheets

(data coding forms) and sent to the Accounts Department. Non-C.S.U. fines are notified by typed invoice.

Holds are keyed in on the terminal, causing the word "hold" to appear on the D.A.R. beside the relevant record, which should prevent renewal of the loan. Apart from this, holds are taken care of manually. The hold slip is placed on a hardboard block (hold "dummy") and interfiled with the books on the return shelves at the loan desk, where it should be matched with the book on its return. However, some books do slip through, so that a weekly check of hold slips against a computer printed list of holds (the stop list) is required. If the book on hold is one that can be recalled, (normal two week loans cannot be), the computer automatically changes the due date. The borrower is still informed manually by telephone or post card, rather than by a computer generated notice, as this can be done the same day as the hold is placed. For recalls on the automated system, the borrower's name and address have to be looked up by social security number in printouts of the registration files. Errors in keying in cause the same problems as with the fines notices.

The computer produces daily, monthly, quarterly, and annual statistical summaries of each type of transaction, in total, by each borrower category, and by time of day. Reports can also be produced, on demand, of the books out to a particular borrower or station (e.g. library, loan), and of "books in demand", that is, items which have circulated more than a given number of times in a set period. A library file of all transactions is kept on magnetic tape.

The C-Tek terminals are also used to produce the after

ance of all hourly paid employees in the library. These records go onto a separate file and are used to automatically calculate the hours worked and pay earned at the end of each pay period.

APPENDIX I (cont)

FLOW PROCESS CHARTS OF

ACTIVITIES TIMED

Symbols:

○ = Operation

⇨ = Transportation

□ = Inspection

D = Delay

▽ = Storage

Units timed are indicated by brackets.

Library C.S.U.

Sheet ____ of 80

Subject Charted: Charging - manual
Filing - manual

Date July 1971

Symbol	Step #	Process Description
○⇨□D▽	1	Go to charge counter.
○⇨□D▽	2	Pick up McBee card and book/magazine.
○⇨□D▽	3	Check McBee card against book spine/magazine.
○⇨□D▽		cover.
○⇨□D▽	4	Check McBee card against I.D. card.
○⇨□D▽	5	Open book/magazine to inside cover.
○⇨□D▽	5a	Glue in date due slip if missing.
○⇨□D▽	6	Select date due stamp.
○⇨□D▽	7	Stamp book and McBee card.
○⇨□D▽	8	Replace date due stamp in holder.
○⇨□D▽	9	Hand book to patron. Tell patron due date.
○⇨□D▽	10	Initial McBee card.
○⇨□D▽	11	Place McBee card in cardboard box.
○⇨□D▽	12	Leave desk.
○⇨□D▽		
○⇨□D▽		FILING - MANUAL
○⇨□D▽		
○⇨□D▽	1	Pick batch of cards from box.
○⇨□D▽	2	Move to presorter.
○⇨□D▽	3	Drop cards into appropriate slots.
○⇨□D▽	4	Open drawers of presorter.
○⇨□D▽	5	Remove cards from presorter, arranging contents
○⇨□D▽		at right angles to contents of previous slot.
○⇨□D▽		Close drawers.
○⇨□D▽	6	Carry stack of cards and filing box to table.
		(Filing box contains card punch).

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Subject Charted: Filing - manual
Discharging - manual

Date _____

Symbol	Step #	Process Description
○⇨□D▽	7	Arrange contents of each slot and whole "pull"
○⇨□D▽		into call number order.
○⇨□D▽	8	Count number of faculty, student, and "other"
○⇨□D▽		loans made. Write on slip of paper.
○⇨□D▽	9	Punch cards for proper due dates - book,
○⇨□D▽		periodical, quarter, I.L.L., bindery, or specia
○⇨□D▽	10	Place cards and punch in filing box.
○⇨□D▽	11	Go to supervisor's desk.
○⇨□D▽	12	Write counts and total on "circulation count"
○⇨□D▽		slip. Initial.
○⇨□D▽	13	Return to table.
○⇨□D▽	14	Pick up filing box.
○⇨□D▽	15	Take it to manual discharging table.
○⇨□D▽	16	Interfile cards into main circulation file.
○⇨□D▽		
○⇨□D▽		DISCHARGING - MANUAL
○⇨□D▽		
○⇨□D▽	1	Pick books from return bin.
○⇨□D▽	2	Sort for discharge stations 1 and 2 (manual)
○⇨□D▽		and 3 (automated).
○⇨□D▽	3	Carry in batches to discharge bins.
○⇨□D▽	4	Pick book/magazine from bin.
○⇨□D▽	5	Select matching McBee card and remove from
○⇨□D▽		file.
○⇨□D▽	6	Overstamp due date in book/magazine "CSU"

Library C.S.U. Sheet

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Subject Charted: Discharging - manual Date

Shelving - manual and automated

Symbol	Step #	Process Description
○⇨□D▽	7	Inspect McBee card for hold (orange tag)
○⇨□D▽	7a	Place book with McBee card inside on hold
○⇨□D▽		table.
○⇨□D▽	8	Inspect McBee card for overdue.
○⇨□D▽	8a	Write return date and initials on overdue
○⇨□D▽		McBee card.
○⇨□D▽	8b	Stamp "CSU" beside due date on overdue McBee
○⇨□D▽		card.
○⇨□D▽	8c	Place overdue McBee card on box for overdues.
○⇨□D▽	9	Stamp "CSU" over due date on McBee card
○⇨□D▽	10	Place McBee card in normal discharge box.
○⇨□D▽	11	Place book on book truck.
○⇨□D▽		
○⇨□D▽		SHELVING - MANUAL AND AUTOMATED - on to
○⇨□D▽		sorting shelves
○⇨□D▽		
○⇨□D▽	1	Move book truck to sorting shelves.
○⇨□D▽	2	Pick up handful of books.
○⇨□D▽	3	Inspect call number on first book.
○⇨□D▽	4	Move to correct shelf.
○⇨□D▽	5	Place book on shelf
○⇨□D▽		Repeat 3 to 5
○⇨□D▽	6	Return to book truck.
○⇨□D▽		Repeat 2 to 6 until all books are on shelves.
○⇨□D▽	7	Sort books on each shelf into order.

Library C.S.U. Sheet

Subject Charted: Shelving - manual/automated of 83

Renews - manual Date

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Symbol	Step #	Process Description
○⇨□D▽	8	Check books against hold dummies on each
○⇨□D▽		shelf.
○⇨□D▽	8a	Place book and dummy on hold desk. (N.B., Step
○⇨□D▽		8 and 8a are unnecessary in completely manual
○⇨□D▽		system).
○⇨□D▽		
○⇨□D▽		
		RENEWS - MANUAL
○⇨□D▽	1	Go to loans desk.
○⇨□D▽	2	Take item from patron.
○⇨□D▽	3	Go to manual circulation file.
○⇨□D▽	4	Select matching McBee card from file. Inspect
○⇨□D▽		for holds. (N.B. book on hold cannot be
○⇨□D▽		renewed).
○⇨□D▽	5	Return to loan desk with book and McBee card.
○⇨□D▽	6	Stamp new due date on book and McBee card.
○⇨□D▽	7	Check patron's I.D. card against McBee card.
○⇨□D▽	8	Pass book to patron.
○⇨□D▽	9	Inspect original due date on McBee card to see
○⇨□D▽		if overdue.
○⇨□D▽	9a	Inspect borrower status on McBee card to see
○⇨□D▽		if student.
○⇨□D▽	9b	Stick orange tag on student overdue McBee,
○⇨□D▽		and write "overdue when renewed" on back.
○⇨□D▽	10	Initial and date McBee card beside new due
○⇨□D▽		date.

Library C.S.U.

Subject Charted: Renews - manual
Hold/recalls - manual

Date

Symbol	Step #	Process Description
○⇨□D▽	11	Repair edge-notched hole in McBee.
○⇨□D▽	12	Place McBee card in cardboard box.
○⇨□D▽		
○⇨□D▽		HOLD/RECALLS - MANUAL
○⇨□D▽		
○⇨□D▽	1	Go to counter.
○⇨□D▽	2	Take call number of book or periodical name
○⇨□D▽		and volume etc. from patron.
○⇨□D▽	3	Go to manual circulation file.
○⇨□D▽	4	Search for corresponding McBee card in file.
○⇨□D▽	4a	If not there inform patron book not checked
○⇨□D▽		out.
○⇨□D▽	5	Take McBee card to counter. Ask patron to
○⇨□D▽		fill in.
○⇨□D▽	6	Wait while patron writes his name and phone
○⇨□D▽		number/adress on back of McBee card.
○⇨□D▽	7	Stick orange tag to McBee.
○⇨□D▽	8	Inspect McBee card to see if item can be
○⇨□D▽		recalled. (N.B.: Quarter charges, and period-
○⇨□D▽		icals on 2 week charges can be recalled).
○⇨□D▽	8a	For recall write call number and details on
○⇨□D▽		slip of paper.
○⇨□D▽	8b	Go to recall desk.
○⇨□D▽	8c	Place McBee card on recall spindle.
○⇨□D▽	8d	Go to manual circulation file.

Library C.S.U.

Subject Charted: Hold/recalls - manual
Recalls - manual

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Date

Symbol	Step #	Process Description
○⇨□D▽	8e	File paper slip in call number order.
○⇨□D▽	9	Replace McBee card in manual circulation file.
○⇨□D▽		
○⇨□D▽		RECALLS - MANUAL
○⇨□D▽		
○⇨□D▽	1	Take McBee card from spindle.
○⇨□D▽	2	Inspect McBee card for borrower's phone
○⇨□D▽		number to see if present and legible.
○⇨□D▽	2a	Inspect McBee card for borrower status.
○⇨□D▽	2b	Look up phone number in appropriate directory,
○⇨□D▽		by name.
○⇨□D▽	2c	If no phone number, write recall card, and
○⇨□D▽		address to borrower. Go to step 5. (N.B.:
○⇨□D▽		address is on McBee card, or if illegible can
○⇨□D▽		be found from directory).
○⇨□D▽	3	Phone borrower.
○⇨□D▽	3a	If no reply, repeat step 3 later or go to 3b.
○⇨□D▽	3b	If still no reply write recall card and
○⇨□D▽		address to borrower.
○⇨□D▽	4	Inform borrower of hold and new due date on
○⇨□D▽		item.
○⇨□D▽	5	Record date and new due date on McBee card.
○⇨□D▽	6	Repair edge notch and punch to fall on new
○⇨□D▽		due date. Orange tag if not already done.
○⇨□D▽	7	Record phone call or card in log book.

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Subject Charted: Recalls - manual

Date ____

Holds - notifying patron - manual and auto.

Symbol	Step #	Process Description
	8	Replace McBee card in circulation file.
		Discard paper slip.
	9	Place recall cards in mail box. (i.e. box at
		the loan desk for outgoing mail).
		HOLDS - NOTIFYING PATRON - MANUAL AND
		AUTOMATED
	1	Pick up book from desk. Examine hold card or
		slip for phone number.
	1a	Look up phone number in directory.
	2	Phone patron.
	3	Wait for answer.
	4	Inform patron book is on hold.
	4a	If no reply write card and address to patron.
	5	Record date and details on card or slip.
		Repeat steps 1 to 5.
	6	Carry batch of books to hold shelves.
	7	Sort into alphabetical order by patron's name.
	8	Place cards in mail box.
		OVERDUES - MANUAL (TWICE WEEKLY)
	1	Take equipment from drawers.
	2	Carry to manual discharge table.

Library C.S.U. Sheet ____ of 87

Subject Charted: Overdues - manual Date ____

Symbol	Step #	Process Description
○⇨□D▽	3	Go to calendar.
○⇨□D▽	4	Get dates and numbers to be needled and
○⇨□D▽		punched that day.
○⇨□D▽	5	Return to discharge table and sit down.
○⇨□D▽	6	Remove small stack of McBee cards (in call
○⇨□D▽		number sequence) and pass needle through
○⇨□D▽		appropriate hole. Shake so that overdues drop
○⇨□D▽		out.
○⇨□D▽	7	Sort the drops into 1st and 2nd overdues and
○⇨□D▽		place cards face down in call number sequence.
○⇨□D▽	8	Replace remaining stack of McBee cards in tray.
○⇨□D▽		Repeat steps 6 to 8 until all cards in 1st
○⇨□D▽		two trays have been needled.
○⇨□D▽	9	Move to other discharge table.
○⇨□D▽		Repeat steps 6 to 8 until all cards in 2nd
○⇨□D▽		two trays have been needled.
○⇨□D▽	10	Check through drops.
○⇨□D▽	11	Mend and refile any errors.
○⇨□D▽	12	Take 2nd overdues to the secretary and return.
○⇨□D▽	13	Go through stamping day's date on back of
○⇨□D▽		1st overdue McBee cards.
○⇨□D▽	14	Go through overdues punching to fall again in
○⇨□D▽		two weeks.
○⇨□D▽	15	Put away equipment - needle, tray, stamp, punch.
○⇨□D▽	16	Carry overdues down to Xerox room.

Sheet ____

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Subject Charted: Overdues - manual Date ____

Symbol	Step #	Process Description
○⇨□D▽	17	Fill out Xerox application.
○⇨□D▽	18	Return to loan desk. (N.B.: if there are few
○⇨□D▽		overdues, steps 18 and 20 are omitted).
○⇨□D▽	19	Xerox attendant copies overdues eight at a
○⇨□D▽		time, keeping in call number order.
○⇨□D▽	20	Pick up overdue McBee cards and Xerox copies
○⇨□D▽		from Xerox room.
○⇨□D▽	21	Return to loan desk.
○⇨□D▽	22	Stamp each copy on each sheet "OVERDUE" (8 per
○⇨□D▽		page).
○⇨□D▽	23	Check and clarify addresses on each sheet,
○⇨□D▽		looking up in directory if necessary.
○⇨□D▽	24	Cut up sheet.
○⇨□D▽	25	Sort copies by first letter of borrower's
○⇨□D▽		surname.
○⇨□D▽	26	Take envelopes and fines lists from counter
○⇨□D▽		to work table.
○⇨□D▽	27	Take each alphabetic group of copies and sort
○⇨□D▽		by borrower. (To bring together books checked
○⇨□D▽		out to one person).
○⇨□D▽	28	Put fines schedules in envelopes.
○⇨□D▽	29	Fold each borrower's overdue notices a d place
○⇨□D▽		in appropriate envelope. (Window envelope
○⇨□D▽		stamped campus or Fort Collins, or plain
○⇨□D▽		white envelope for out of Fort Collins - with
		fines schedule for students).

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Subject Charted: Overdues - manual

2nd overdues - manual

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Date

Symbol	Step #	Process Description
	30	Place envelope in Campus, Fort Collins, or
		out of town pile.
		Repeat steps 29 and 30 for each borrower's
		overdue notices.
	31	Fasten each pile of envelopes together with
		a rubber band.
	32	Take envelopes and place in mail box.
	33	Put away spare envelopes and equipment.
	34	Refile overdue McBee cards in circulation file.
		2ND OVERDUES - MANUAL
	1	Take 2nd overdues (from needling) and search
		stacks for them.
	2	Check against "no box" (for returned manual
		books for which there is no McBee card in
		the circulation file).
	3	Check against Daily Activity Report. (N.B.:
		step 3 does not occur in purely manual system).
	4	Record "searched", and date on McBee card.
		Separate faculty.
	5	Phone faculty members; give message. Go to 10.
	5a	If no answer, repeat, or go to step 6.
	6	Type in details from McBee card onto printed
		2nd overdue memos.

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Subject Charted: 2nd overdues - manual
Fines - manual

Date

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Symbol	Step #	Process Description
○⇨□D▽	7	Xerox memos. Place copy in box to be filed.
○⇨□D▽	8	Type envelopes from McBee cards. (Check
○⇨□D▽		address if necessary).
○⇨□D▽	9	Place memos in envelopes.
○⇨□D▽	10	Record "hold" on back of McBees. Fix edge
○⇨□D▽		notches. Orange tag.
○⇨□D▽	11	Repunch.
○⇨□D▽	12	Refile in circulation file.
○⇨□D▽	13	Take envelopes to mail box.
○⇨□D▽		
○⇨□D▽		FINES - MANUAL
○⇨□D▽		
○⇨□D▽	1	Take discharged overdue McBee cards from
○⇨□D▽		discharge terminal to secretary's table.
○⇨□D▽	2	Sort overdue McBee cards by borrower name
○⇨□D▽		into alphabetiser. Discard any faculty,
○⇨□D▽		staff, GTA and GRA cards.
○⇨□D▽		(Steps 1 and 2 are daily; the rest weekly).
○⇨□D▽	3	Go through putting into alphabetical order
○⇨□D▽		and stapling together all cards for the same
○⇨□D▽		person.
○⇨□D▽	4	Open computer notice printout to list of fines.
○⇨□D▽	5	Go through checking McBee cards against
○⇨□D▽		printout looking for matching transactions.
○⇨□D▽	5a	Deal with matches with automated fines.

Sheet _____

Sheet _____

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Subject Charted: Fines - manual

Date _____

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Symbol	Step #	Process Description
		Steps 4 and 5 are unnecessary for a com-
		pletely manual system.
	6	Examine due date on McBee card(s) to see if
		ready for fining. If recent, replace in
		alphabetiser. (In case more books on the
		same transaction come in).
	7	Calculate fine using fine calculator.
	8	Prorate or add any additional fines for the
		same person. Record total on top McBee card.
	9	Place McBee(s) in student or non-CSU pile.
		Repeat steps 6 to 9 for all overdue McBees.
		STUDENT FINES
	10	Record student Social Security Number and
		fine from McBee onto load sheet for computer
		billing.
	11	Place McBee card(s) in box for filing.
		Repeat steps 10 and 11 for all student fines.
	12	Total all fines on load sheets, and record
		load sheet number and date in log.
	13	Go to Xerox room.
	14	Xerox load sheets.
	15	Return to loan desk.
	16	Put Xerox copies in folder.

Library C.S.U.

Subject Charted: Fines - manual

Sheet ____ of ____

Date ____

Symbol	Step #	Process Description
○⇨□D▽	17	Mail load sheet originals to Student Account
○⇨□D▽		Department.
○⇨□D▽		
○⇨□D▽		NON-C.S.U. FINES
○⇨□D▽		
○⇨□D▽	18	Go to recalls desk.
○⇨□D▽	19	Take non-C.S.U. name and address file to
○⇨□D▽		secretary's desk.
○⇨□D▽	20	Check McBee cards by Social Security Number
○⇨□D▽		to ensure non-faculty. (Visiting faculty are
○⇨□D▽		not fined).
○⇨□D▽	20a	Correct adresses on McBees if illegible.
○⇨□D▽	21	Take invoices from drawer.
○⇨□D▽	22	Type details onto invoice from McBee card.
○⇨□D▽	23	Tear out carbon sheets from 4-part invoice,
○⇨□D▽		and discard.
○⇨□D▽	24	Place top copy in window envelope (sometimes
○⇨□D▽		with fines list).
○⇨□D▽	25	Fold pink copy and staple to McBee card(s).
○⇨□D▽		Place in box for filing.
○⇨□D▽	26	Place other two copies in a pile to be sent
○⇨□D▽		to accountants.
○⇨□D▽		Repeat steps 22 to 26 until all fines are
○⇨□D▽		dealt with.
○⇨□D▽	27	Sort envelopes into Fort Collins and out of
		town.

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Subject Charted: Fines - manual

Date

Symbol	Step #	Process Description
○⇨□D▽	28	Fasten each together with rubber band.
○⇨□D▽	29	Take to mail box.
○⇨□D▽		At infrequent intervals: -
○⇨□D▽	30	Take McBee cards from filing box and pre-sort
○⇨□D▽		into card sorter.
○⇨□D▽	31	Go to cupboards under counter and take out
○⇨□D▽		files of fines.
○⇨□D▽	32	Take to work table.
○⇨□D▽	33	Interfile McBee cards with other fines.
○⇨□D▽	34	Return file trays to cupboard.
○⇨□D▽		
○⇨□D▽		
○⇨□D▽		
○⇨□D▽		
○⇨□D▽		
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○⇨□D▽		
○⇨□D▽		
○⇨□D▽		

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Subject Charted: Charging - automated
Discharging - automated

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Date ____

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Symbol	Step #	Process Description
○⇨□D▽	1	To charge counter.
○⇨□D▽	2	Pick up book.
○⇨□D▽	3	Open book. Remove book card.
○⇨□D▽	4	Check book card against book.
○⇨□D▽	5	Insert book card in C-Dek.
○⇨□D▽	6	Pick up patron I.D. card.
○⇨□D▽	7	Insert I.D. in C-Dek.
○⇨□D▽	7a	Keypunch patron I.D. in C-Dek.
○⇨□D▽	8	Keypunch borrower type and loan period, etc.
○⇨□D▽		Press record bar.
○⇨□D▽	9	Check for green light on C-Dek.
○⇨□D▽	10	Return book card to book pocket.
○⇨□D▽	10a	Glue in date due slip if necessary.
○⇨□D▽	11	Select date due stamp.
○⇨□D▽	12	Stamp date in book.
○⇨□D▽		(N.B.: Steps 2 to 5 and 8 to 12 are repeated
○⇨□D▽		if patron has more than one book.)
○⇨□D▽	13	Remove I.D. from C-Dek.
○⇨□D▽	14	Pass book(s) and I.D. to patron.
○⇨□D▽		
○⇨□D▽		DISCHARGING - AUTOMATED
○⇨□D▽		
○⇨□D▽	1	Pick books from return bin.
○⇨□D▽	2	Sort for manual and automated discharge points.
○⇨□D▽	3	Carry a batch to discharge bin.

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Subject Charted: Discharging - automated

Renews - automated

Date ____

Symbol	Step #	Process Description
○⇨□D▽	4	Pick book from bin.
○⇨□D▽	5	Remove book card from book.
○⇨□D▽	6	Inspect book card and book spine to ensure
○⇨□D▽		book card is correct.
○⇨□D▽	7	Insert book card in C-Dek. Press record bar.
○⇨□D▽	8	Replace card in book pocket.
○⇨□D▽	9	Stamp "C.S.U." over due date.
○⇨□D▽	10	Place book on book truck.
○⇨□D▽		
○⇨□D▽		SHELVING - AS MANUAL
○⇨□D▽		
○⇨□D▽		RENEWS - AUTOMATED
○⇨□D▽		
○⇨□D▽	1	To charge counter.
○⇨□D▽	2	Pick up book.
○⇨□D▽	3	Take book to DAR.
○⇨□D▽	4	Find record of transaction.
○⇨□D▽	5	Check for any holds.
○⇨□D▽	5a	If there is a hold, inform patron he cannot
○⇨□D▽		renew item.
○⇨□D▽	6	Write "renew" and initials on DAR.
○⇨□D▽	7	Return to C-Dek.
○⇨□D▽	8	Insert book card. Press renew and loan period
○⇨□D▽		keys and record bar.
○⇨□D▽	9	Replace book card in book.

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Subject Charted: Renews - automated
Holds - automated

Date

Symbol	Step #	Process Description
○⇨□D▽	10	Stamp new due date.
○⇨□D▽	11	Hand book to patron.
○⇨□D▽		
○⇨□D▽		HOLDS -AUTOMATED
○⇨□D▽		
○⇨□D▽	1	To counter.
○⇨□D▽	2	Take call no. from patron.
○⇨□D▽	3	To DAR.
○⇨□D▽	4	Verify that item is on loan.
○⇨□D▽	5	Take hold slip to patron.
○⇨□D▽	6	Wait while patron fills out hold slip.
○⇨□D▽	7	Check details on slip and accept hold.
○⇨□D▽	8	To DAR.
○⇨□D▽	9	Write "hold" and initials beside record on DAR
○⇨□D▽	10	Inspect record to see if item can be recalled.
○⇨□D▽	11	Record transaction no. from DAR onto slip.
○⇨□D▽	11a	For recalls also record borrower no. and
○⇨□D▽		status and date item was checked out.
○⇨□D▽	12	Key in hold on C-Dek.
○⇨□D▽	13	Write "O.T.", date and initials on hold slip.
○⇨□D▽	13a	For recalls, write call no., "hold", date
○⇨□D▽		and initials on slip of paper.
○⇨□D▽	13b	take hold slip and place on recall spindle.
○⇨□D▽	14	Go to shelf where hold dummies are kept.
○⇨□D▽	15	Place hold slip or paper slip in dummy.

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Subject Charted: Holds - automated

Date

Holds - automated. Weekly check.

Symbol	Step #	Process Description
○⇨□D▽	16	Take hold dummy to sorting shelves.
○⇨□D▽	17	Place on appropriate shelf.
○⇨□D▽	18	Interfile with books.
○⇨□D▽		
○⇨□D▽		HOLDS -WEEKLY CHECK
○⇨□D▽		
○⇨□D▽	1	Take stop list (of holds and renewals) to
○⇨□D▽		sorting shelves.
○⇨□D▽	2	Remove hold dummy from shelf (in call no.
○⇨□D▽		order).
○⇨□D▽	3	Check against stop list to ensure hold is on
○⇨□D▽		record.
○⇨□D▽	3a	If not keep hold and go to 2.
○⇨□D▽	4	Check list to see if item is overdue.
○⇨□D▽	4a	If so, place hold slip on recall desk.
○⇨□D▽	4b	Put note with details in dummy.
○⇨□D▽	5	Return dummy to shelf.
○⇨□D▽		Repeat steps 2 to 5 for all holds.
○⇨□D▽	6	Return stop list to counter.
○⇨□D▽	7	Take holds from 3a and check on DAR.
○⇨□D▽	8	Search, rekey or discard as necessary.
○⇨□D▽		
○⇨□D▽		RECALLS - AUTOMATED
○⇨□D▽		
○⇨□D▽	1	Take hold slip from spindle.

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Subject Charted: Recalls - automated
Overdues - automated

Date _____

Symbol	Step #	Process Description
	2	Inspect slip to establish borrower status.
	3	Select appropriate SSN list.
	4	Look up borrower name.
	5	Select appropriate directory.
	6	Look up borrower phone no.
	6a	If no phone no., take name and address from
		directory and fill out recall card. Go to 9.
	7	Phone borrower.
	7a	If no reply repeat step 7 later.
	7b	If still no reply go to 6a.
	8	Inform borrower of hold and new due date.
	9	Record recall in log book.
	10	Place hold slip in corresponding dummy on
		sorting shelves. Discard paper slip.
	11	Place recall cards in mail box.
		OVERDUES - AUTOMATED
	1	Sort computer printed notices into 1st
		overdues, 2nd overdues and bills, student
		fines, and non-C.S.U. fines.
	2	Take 1st overdue notices to work table.
	3	Go to counter storage shelf.
	4	Take window envelopes and explanation sheets
		to work table.

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Subject Charted: Overdues - automated

2nd overdues - automated

Symbol	Step #	Process Description
○⇨□D▽	5	Fold notice and explanation sheet and place
○⇨□D▽		in envelope.
○⇨□D▽	6	Place envelope in pile for Campus, Fort
○⇨□D▽		Collins, or out of town.
○⇨□D▽		Repeat steps 5 and 6 for all notices.
○⇨□D▽	7	Fasten each pile of envelopes with rubber band.
○⇨□D▽	8	Take envelopes to mail box.
○⇨□D▽		
○⇨□D▽		2ND OVERDUES - AUTOMATED
○⇨□D▽		
○⇨□D▽	1	Sort computer notices (as above).
○⇨□D▽	2	Sort 2nd notices into call no. order.
○⇨□D▽	3	Take notices and search stacks for items.
○⇨□D▽	4	Record "searched" and date on computer
○⇨□D▽		printed notice list.
○⇨□D▽	5	Fold notice and place in window envelope.
○⇨□D▽	6	Sort notices into Campus, Fort Collins etc.
○⇨□D▽	7	Take envelopes to mail box.
○⇨□D▽		
○⇨□D▽		FINES - AUTOMATED
○⇨□D▽		
○⇨□D▽	1	Place card sorter with McBees for fining
○⇨□D▽		on table.
○⇨□D▽		STUDENT FINES
○⇨□D▽	2	Open computer notice list to student fines.

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Subject Charted: Fines - automated

Date

Symbol	Step #	Process Description
○⇨□D▽	3	Check McBees against printout for matching
○⇨□D▽		transactions for each person.
○⇨□D▽	4a	For recent non-matches, return to sorter.
○⇨□D▽	4b	For older non-matches, keep for manual fining.
○⇨□D▽	4c	For matches, record the no. of McBees on
○⇨□D▽		printout, and:
○⇨□D▽	c(i)	if refund is necessary, write "auto" and
○⇨□D▽		date on McBee and place in box for filing,
○⇨□D▽	c(ii)	for surcharges, calculate correct fine, write
○⇨□D▽		surcharge on McBee, and place in load sheet
○⇨□D▽		box.
○⇨□D▽	5	Prorate and correct remaining student fines
○⇨□D▽		on printout.
○⇨□D▽	6	Sort computer printed notices (as before).
○⇨□D▽	7	Correct student fine notices from printout.
○⇨□D▽		Stamp "information only".
○⇨□D▽	8a	For refunds, place notice in load sheet box.
○⇨□D▽		Go to 10.
○⇨□D▽	8b	For others, fold.
○⇨□D▽		Repeat steps 7 and 8 for all notices.
○⇨□D▽	9	Place notices in window envelopes.
○⇨□D▽	10	Record SSN and amount of refund on load
○⇨□D▽		sheet. Repeat for all refunds.
○⇨□D▽	11	Fold and envelope notices.
○⇨□D▽	12	Take McBees for surcharging (from 4c(ii))

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Subject Charted: Fines - automated

Date

Symbol	Step #	Process Description
	12	(cont.) and record SSNs and amount of
		surcharge on load sheet.
	13	Place McBees in box for filing.
	14	Record load sheet no. and date in log.
	15	Total all fines and surcharges on load sheet.
	16	Xerox load sheet. Put copy in folder.
	17	Mail load sheet originals to Student Accounts.
		NON-C.S.U. FINES
	2	Open computer printed notice list to non-
		C.S.U. fines.
	3	Check non-C.S.U. fines against McBees for
		matching transactions for each person.
	4a	For recent non-matches, return to sorter.
	4b	Keep older non-matches for manual fining.
	4c	For matches record the no. of McBees on
		printout, and:
	c(i)	if refund is necessary, write "auto" and
		date on McBee and place in box for filing,
	c(ii)	for surcharges, calculate the amount and
		record on McBee and printout.
	5	Prorate remaining non-C.S.U. fines.
	6	Sort computer printed notices (as above).
	7	Take invoices from drawer.
	8	Correct notice, clip to invoice and any McBees
		and write invoice no. on printout.

Symbol	Step #	Process Description
		Repeat step 8 for all non-C.S.U. fines.
	9	Check address file to ensure non-faculty.
	10	Type details on to invoice; tear out carbons.
		Repeat for all non-C.S.U. fines.
	11	Place top copy and notice in window envelope.
	12	Staple any McBees to folded pink copy. Place
		in box for filing.
	13	Place other 2 copies in pile to be sent to
		accountants.
		Repeat steps 11 to 13 for all fines.
	14	Sort envelopes into Fort Collins and out of
		town.
	15	Take to mail box.
		At infrequent intervals:-
	16	File pink slips.

APPENDIX II

DUTIES CARRIED OUT BY LOAN DESK STAFF WHICH ARE EXCLUDED FROM THE COSTING

1. Searching for missing items requested by patrons and creating records (manual or automated) so that such items will be automatically flagged if discharged.
2. Collecting, charging out, and despatching items requested by faculty at an outlying campus.
3. Answering general enquiries, lending pencils, answering telephone queries, etc.
4. Location assistance, i.e. helping patrons to locate books by means of the call number. (Usually just directing them to the right part of the library.)
5. Monitoring the exit during monitors' breaks.
6. Taking applications for special borrowing privileges, lockers, study carrels, and for registering non-C.S.U. borrowers.
7. Helping with the record, tape, and microfilm collection.
8. Shelving books in the stacks during slack periods.
   N.B. Shelving books in the stacks is not normally a duty of loan desk staff and was excluded from this study.
9. Operating the telephone switchboard in the evenings and at weekends.

APPENDIX III

RESULTS OF TIME STUDY

TABLE 1. MANUAL OPERATIONS

Operation timed		Mean time mins.	95% confidence interval	No. of readings	Time per item	Totals
CHARGE/DISCHARGE						
Charging	(steps 1-13)[1]	.461	.026	179	.461	.461
Presort	(filing, step 3)	.036	.004	25	.036	.242
Count, sort & punch	(filing, steps 4-15)	.206	.015	25	.206	
File	(filing, step 16)	.158	.012	191	.158	.158
Sort books from bins	(discharge, steps 1-3)	.141	.014	61	.141	.141
Discharge	(discharge, steps 4-11)	.385	.023	164	.385	.385
Place on sorting shelf	(shelving, steps 2-6)	.119	.011	54	.119	.273
Sort book on shelf	(shelving, steps 7-8)	.154	.023	37	.154	
RENEW	(renew, steps 1-12)	1.039	.138	20	1.039	1.039
Look up in file	(renew, steps 3-5)	.373	.058	32	.373	.373
HOLD						
Take request, get McBee	(hold, steps 1-5)	.413	.056	22	.413	.913
Record details; tag	(hold, steps 6-8)	(.5)[2]	-	-	.5	

APPENDIX III, TABLE 1 (cont.)

Operation timed		Mean time mins.	95% confidence interval	No. of readings	Time per item	Totals
Recall operations	(hold 8a-8d)	(.88)[2]			.88	.88
Refile hold McBee	(hold 9)	(.2)[2]			.2	.2
RECALL						
Inspect McBee, get phone no.	(recall 1-2b)	.549	.108	11	.549	.805
Dial no.	(recall 3)	.256	.075	24	.256	
Wait for answer	(recall 3)	.210	.077	14	.210	1.212
Give message	(recall 4)	1.002	.197	13	1.002	
Wait: no answer	(recall 3a)	.494	.124	11	.494	2.597
Write recall card	(recall 3b)	2.103	.289	6	2.103	
Record details, tag & fix	(recall 5)	.447	.114	8	.447	2.066
Repunch	(recall 6)	.543	.032	10	.543	
Log	(recall 7)	.703	.096	4	.703	
Refile McBee[3]	(recall 8)	.373	.058	32	.373	

Footnotes: 1. Refers to steps in flow process charts in Appendix I.
2. Estimate based on one reading. 3. Assumed to be the same as renew 3-5.

APPENDIX III, TABLE 1,(cont.)

Operation timed		Mean time mins.	95% confidence interval	No. of readings	Time per item	Totals
Notify patron	(notify 1-5)	1.273	.133	43	1.273	1.427
Take books to hold shelf	(notify 6-7)	.154	.017	7	.154	
OVERDUES						
Needle file/46 overdues	(overdues 5-9)	29.44	1.21	5	.640	.804
Check & mend	(overdues 10-12)	.083	.017	4	.083	
Stamp date	(overdues 13)	.029	.004	14	.029	
Punch/46 overdues	(overdues 14)	2.372	1.359	6	.052	
Go to xerox & return/46	(overdues 16-18 & 20-21)	1.87	.476	6	.041	.041
Xerox/8 at a time	(overdues 19)	.455	.050	10	.057	.057
Stamp/8	(overdues 22)	.164	.034	21	.020	.907
Check addresses/8	(Overdues 23)	1.836	.489	23	.229	
Cut up & sort	(overdues 24,25 & 27)	1.295	.129	18	.162	
Envelope schedules/person(/1.62)	(overdues 28)	.203	.036	9	.125	
Envelope & sort/1.62	(overdues 29-30)	.344	.047	78	.213	
Refile McBees[4]	(overdues 34)	.158	.012	191	.158	

Footnote: 4.Assumed to be the same as filing 16.

APPENDIX III, TABLE 1 (cont.)

Operation timed		Mean time mins.	95% confidence interval	No. of readings	Time per item	Totals
FINES						
Sort McBees	(fines 2)	.025	.002	16	.025	
Sort & staple	(fines 3)	.045	.007	19	.045	.150
Calculate fine/1.62	(fines 6-9)	.130	.019	68	.080	
Load sheet/1.62	(fines 10-11)	.478	.038	77	.296	.296
Check status/1.62	(fines 20)	.242	.036	45	.150	
Type invoice/1.62	(fines 22-23)	1.306	.049	51	.807	1.239
Sort & envelope/1.62	(fines 24-26)	.456	.033	43	.282	
Sort envelopes/1.62	(fines 27)	.020	.004	9	.012	.012
Presort McBees/1.62	(fines 30)	.025	.002	16	.015	.276
File with overdues/1.62	(fines 34)	.422	.047	68	.261	
2ND OVERDUES						
Search	(2nd overdues 1)	1.445	.448	14	1.445	1.653
Check "no box"	(2nd overdues 2)	.208	.059	5	.208	
Record "searched"	(2nd overdues 4)	.120	.019	4	.120	.120
Phone faculty/1.62[5]	(2nd overdues 5)	-	-	-	-	2.107

APPENDIX III, TABLE 1(cont.)

Operation timed		Mean time mins.	95% confidence interval	No. of readings	Time per item	Totals
Phone- no answer/1.62[6]	(2nd overdues 5a)	-	-	-	-	1.299
Type memo/1.62	(2nd overdues 6)	1.172	.171	7	.725	
Type envelope/1.62	(2nd overdues 8)	.412	.062	10	.255	1.078
Envelope memo/1.62	(2nd overdues 9)	.158	.010	10	.098	
Record, fix & tag	(2nd overdues 10)	.447	.114	8	.447	
Repunch	(2nd overdues 11)	.543	.032	10	.543	.99
Refile[7]	(2nd overdues12)	.158	.012	191	.158	.158
ANSWER QUERY[8]		.413	.056	22	.413	.413
PATRON FILLING IN MCBEE		1.48	.110	102	1.48	1.48

Footnotes: 5&6. Sum of equivalent steps in recall operation, i.e. recall 1-4 and 1-3a respectively.
7. Assumed to be the same as filing 16.
8. Assumed to be the same as renew 3-5.

APPENDIX III (cont.)

TABLE 2. AUTOMATED OPERATIONS

Operation timed		Mean time mins.	95% confidence interval	No. of readings	Time per item	Totals
CHARGE/DISCHARGE						
Charging	(charging 1-15)	.431	.020	180	.431	.431
Sort books from bins	(discharge 1-3)	.141	.014	61	.141	.141
Discharge	(discharge 4-10)	.257	.011	94	.257	.257
Place on sorting shelf	(shelving 2-6)	.119	.011	54	.119	.273
Sort on shelf	(shelving 7-8)	.154	.023	37	.154	
RENEW	(renew 1-12)	.914	.075	60	.914	.914
Look up in DAR	(renew 3-7)	.527	.053	58	.527	.527
HOLD						
Take hold, key in etc.	(hold 1-17)	3.028	.612	12	3.028	3.028
Sort on shelves[1]	(hold 18)	.154	.023	37	.154	.154
Check holds	(weekly check 2-5)	.234	.074	16	.234	.234
RECALL						
Inspect hold slip	(recall 1-2)	.421	.189	13	.421	1.647
Look up name & no.	(recall 3-6)	.970	.541	8	.970	
Dial no.	(recall 7)	.256	.075	24	.256	

APPENDIX III, TABLE 2 (cont.)

Operation timed		Mean time mins.	95% confidence interval	No. of readings	Time per item	Totals
Wait for answer	(recall 7)	.210	.077	14	.210	1.212
Give message	(recall 8)	1.002	.197	13	1.002	
Wait- no answer	(recall 7a)	.494	.124	11	.494	2.597
Write recall card	(recall 6a)	2.103	.289	6	2.103	
Record in log	(recall 9)	.703	.096	4	.703	.703
Notify patron						
Take books to hold shelf		AS MANUAL				1.427
OVERDUES						
Sort notices/person (/1.62)	(overdues 1)	.047	.003	40	.029	.029
Fold with sheet/1.62	(overdues 5)	.238	.018	33	.147	.276
Envelope & sort/1.62	(overdues 5-6)	.208	.016	35	.129	
2ND OVERDUES						
Sort notices/1.62	(2nd overdues 1)	.047	.003	40	.029	.094
Sort 2nd notices/1.62	(2nd overdues 2)	.105	.008	4	.065	
Search	(2nd overdues 3)	1.445	.448	14	1.445	1.445

Footnote: 1. Assumed to be the same as shelving 7-8.

APPENDIX III, TABLE 2 (cont.)

Operation timed		Mean time mins.	95% confidence interval	No. of readings	Time per item	Totals
Record searched/1.62	(2nd overdues 4)	.294	.036	18	.182	.350
Fold & envelope/1.62	(2nd overdues 5)	.253	.017	35	.156	
Sort envelopes/1.62	(2nd overdues 6)	.020	.004	9	.012	
FINES						
Match with McBees/page (/35.7)	(fines 3-4)	1.716	.262	21	.048	.242
Prorate/35.7	(fines 5)	.906	.167	17	.025	
Sort notices/1.62	(fines 6)	.047	.003	40	.029	
Correct notices/1.62	(fines 7&8)	.226	.010	124	.140	
Envelope/1.62	(fines 9)	.094	.004	94	.058	.058
Load sheet/1.62	(fines 10 & 12-13)	.478	.038	77	.295	.451
Fold & envelope/1.62	(fines 11)	.253	.017	35	.156	
Match with McBees/35.7	(non-CSU fines 3-5)	1.716	.262	21	.048	1.596
Sort notices/1.62	(non-CSU fines 6)	.047	.003	41	.029	
Correct, record etc./1.62	(non-CSU fines 8)	.412	.059	44	.279	
Check status/1.62	(non-CSU fines 9)	.242	.037	45	.149	

APPENDIX III, TABLE 2 (cont.)

Operation timed		Mean time mins.	95% confidence interval	No. of readings	Time per item	Totals
Type invoice/1.62	(non-CSU fines 10)	1.306	.049	51	.807	
Sort & envelope/1.62	(non-CSU fines 11-13)	.456	.033	43	.282	
Sort envelopes/1.62	(non-CSU fines 14)	.020	.004	9	.012	.012
ANSWER QUERY[2]		.652	.060	64	.652	.652
POCKETING/BOOK		.126	.021	13	.126	.126

Footnotes: 2. Assumed to be the same as the equivalent renew operations, 3-7.

APPENDIX III (cont)

UNPRODUCTIVE TIME

July

Results of work sampling (90 readings):

% of productive time = 72.5% ±5% (at 95% confidence)

i.e. unproductive time = 27.5% of total time

August 1973- July 1974

This figure was considered to be too high for the whole year. Therefore the total hours worked in both July and the full year were calaulated. Actual figures are given for July and for student employees for the year. The Civil Service hours for the year were calculated on the same basis as those in Appendix V. Records were kept during July of the time spent on activities peculiar to the summer, because of the low circulation work load then. The total time spent on these activities was subtracted from the hours worked in July, to give the hours spent on loan desk work. The figures exclude the supervisor's time.

	July	Aug.-July
Total loan desk hours:	1210	17,950

The total time spent on the basic circulation activities (those activities which were timed - see Appendix I), was calculated from the unit times and frequencies of the activities. Unproductive hours for July were calculated as 27.5% of the total. Time spent on other work in July was established by difference. (Appendix II lists the 'other' activities.)

	July	Year
Circulation	438.5 hrs = 36.3%	6,903.9 hrs = 38.46%
Other	438.7 " = 36.3%	
Unproductive	332.3 " = 27.5%	
Total loan desk hours	1,210 "	17,950 "
Circulation=	17,069	271,710

The assumption was made that the time spent on 'other' work would vary in direct proportion to the level of circulation. This seems reasonable, since most of the activities do vary directly with the use of the library, and time spent on activities unique, for loan desk staff, to the summer (shelving and shelf reading) has already been excluded.

Making this assumption, it was possible to estimate 'other' as 6,983 hours or 38.9% for the year. This leaves 22.6% for unproductive time for the year.

The unproductive time was spread over all other activities by multiplying the unit time for each by an unrpoductive time factor (UPTF), to give the total unit time, including the unproductive allowance.

$$UPTF = 1 + \frac{22.6}{77.4}$$

$$UPTF = 1.29$$

APPENDIX IV

CIRCULATION STATISTICS

TABLE 1. JULY 1974 STATISTICS

	Total	Overall frequency per 1000 charges	Automated	Frequency per 1000 automated charges	Manual	Frequency per 1000 manual charges	Percent on manual
Charges	17,069	1000	11,632	1000	5,437	1000	31.8
Renews	1,310	76.7	1,034	88.9	276	50.8	21.0
Holds	312	18.2	284	24.4	(28)[1]	5.1	9.0
Recalls	104	6.1	101	8.8	3	0.4	3.0
1st overdue	1,228	71.9	858	73.8	370	68.0	30.0
2nd overdue	324	19.0	227	19.5	(97)[2]	17.8	(30.0)[2]
Fines	1,510	88.5	1,045	89.8	(465)[3]	85.5	30.8
Queries	(1,040)[4]	60.9					
Assisted queries	(208)[4]	12.2					

Appendix IV, Table 1: Footnotes

1. Estimate based on two counts of hold slips and McBees with holds. A 10:1 ratio for auto:manual was found both both times.
2. Estimate based on the assumption that manual 2nd overdues will be the same percent of the total 2nd overdues as 1st manual overdues are of the total 1st overdues.
3. Estimate based on counting the number of students charged on load sheets for July, multiplying by the number of items per person, and then adding 11% for non-C.S.U. fines (11% is the proportion of non-C.S.U. auto fines in July).
4. Estimate based on counts during two days in July.

APPENDIX IV (cont)

TABLE 2. STATISTICS FOR YEAR AUGUST, 1973 TO JULY, 1974

	Total	Overall frequency per 1000 charges	Automated	Frequency per 1000 automated charges	Manual	Frequency per 1000 manual charges	Percent on manual
Charges	271,710	1000	188,951	1000	82,759	1000	30.5
Renews	16,634	61.2	13,137	69.5	(3,497)[1]	42.2	(21.0)[1]
Holds	4,508	16.6	4,102	21.7	(406)[1]	4.9	(9.0)[1]
Recalls	11,714	6.3	(1,663)[2]	(8.8)[2]	(51)[1]	0.6	(3.0)[1]
1st overdues	23,333	85.9	16,333	86.5	(7,000)[1]	84.6	(30.0)[1]
2nd overdues	2,756	10.1	1,929	10.2	(827)[1]	10.0	(30.0)[1]
Fines	50,630	186.3	35,036	185.4	(15,594)[1]	188.4[4]	(30.8)[1]
Queries	(16,547)[3]	(60.9)[3]					
Assisted queries	(3,309)[3]	(12.2)[3]					

Appendix IV, Table 2: Footnotes

1. Estimated on the assumption that the percentage in each category would be the same as in July.
2. Estimated on the assumption that the frequency per 1,000 charges would be the same as on the automated system in July.
3. Assumes the same frequency per 1,000 charges as in July.
4. 15% of these are dealt with on the automated system, hence the figure is given as 160.14 in the tables of cost calculations for the present manual component.

APPENDIX IV (cont)

Other statistics used in calculating times, labour costs, and material costs.

46 1st overdues (items) per needling	The average for July when the timings were taken.
1.62 items fined or overdue per person per billing run or per needling	Average from a sample of automated billing runs from throughout the year. Assumed to be the same ratio for 1st and 2nd overdue notices, and for manual fines and 1st and 2nd overdues. (The average from two needlings in July was 1.56 1st overdues per person, which was considered close enough to justify the assumption).
35.7 items fined per page of printout of billing run	The average for July when the timings were taken.
27.9% of manual loans to faculty	From manual circulation statistics for year.
22.95% of all loans to faculty	From combined manual and auto statistics for year.
11% of fines (items) to non-C.S.U. in July	From July billing runs. Assumed to be the same percentage on manual.
8% of fines (items) to non-C.S.U. for year	The average from the auto statistics for the year. Assumed to be the same percentage of persons fined. (There was no significant difference in the number of items fined per person between students and non-C.S.U.) Assumed to be the same on the manual system.
23% of 1st overdues to faculty	Average from auto statistics for year. Assumed to be the same for manual system.
34% of 2nd overdues to faculty	Ditto.
75% of faculty phone calls unsuccessful on 2nd overdues	Secretary's estimate. (50% reached on 1st phone call, 25% on 2nd, and 25% on 3rd).

APPENDIX IV (cont)

Other statistics used (cont)

55% of recalls and hold notifications by post-card	Based on sample counts from the log of recalls. Assumed to be the same for holds.
15% of manual fines dealt with on automated system	Estimate based on counting the number of matches recorded on the July billing run printouts.
40% of automated student fines adjusted and put on load sheet	Average of figures from sample billing runs from whole year.

APPENDIX V

SALARIES

Administrative assistants

Working days per year: 52 x 5	= 260.0 days per year
Holidays	11.0 - "
Vacation	15.0 - "
Sick leave	15.0 - "
Funeral leave	1.25- "
	217.75
	(i.e. 1742.0 hours per year)
Coffee breaks (half hour per day)	= 108.87- hours
Time on duty ----------	= 1633.13 hours per year

Mean salary	= $8383 per year
PERA (pension: - 9.5%)	796.38 + "
Insurance	22.18 + "
Free courses worth:	61.50 + "
(Av. half quarter per year at $123/qtr)	
Mean salary with fringe benefits	= $9263.06 per year

Mean hourly wage = $\frac{9263.06}{1633.13}$ = $5.67 per hour on duty

= $0.094 per minute on duty

Mean hourly wages per hour on duty,

Calculated in same way: -

Secretary	$5.36	= $0.089 per minute
Xerox operator	$4.27	= $0.071 "
Book preparation	$4.86	= $0.081 "
Keypunch supervisor	$4.48	= $0.075 "

APPENDIX V (cont)

SALARIES

Clerical assistants

Working days per year: 52 x 5	= 260.00 days per year
Holidays	11.00 - "
Vacation	12.60 - "
Sick leave	15.00 - "
Funeral leave	1.25 - "
	220.15 days per year
	(i.e. 1,761.2 hours per year)
Coffee breaks (half hour per day)	110.1 hours per year
Actual working time - - - - - - - - -	1,651.1 hours per year

Mean clerical assistant salary	= $5,598.00 per year
P.E.R.A. (retirement) at 9.5%	531.81 + "
Insurance	22.18 + "
Free courses worth:	61.50 + "
(Average ½ qtr/yr at $123/qtr)	
Mean salary and fringe benefits	= $6,213.49 per year

Mean hourly wage = $\frac{\$6213.49}{1651.1}$ = $3.76 per hour on duty

= $0.063 per minute

Work-study and hourly staff

Per hour worked	= 1.00 hours
Coffee breaks (¼ hour in four hours)	0.06 hours
Time on duty (hrs)	= 0.94 hours

APPENDIX V (cont)

Work-study and hourly staff (cont)

Mean hourly wage = $2.26 per hour

= $\frac{\$2.26}{0.94}$ per hour on duty

Mean hourly wage - - - - - - - - - - = $2.40 per hour on duty

= $0.04 per minute

Similarly, hourly keypunch operator = $2.60 per hour on duty

= $0.043 per minute

APPENDIX V (cont)

SALARIES

Faculty (whole University)

Working days per year: 52 x 5	= 260.00 days per year
Holidays	11.00 - "
Vacation	24.00 - "
Sick leave	15.00 - "
Funeral leave	1.25 - "
	208.75 days per year
	(i.e. 1670 hours per year)
Coffee breaks (half hour per day)	104.37 -
Actual working time ----------	= 1565.63 hours per year

Mean salary	= $18,957.00 per year
PERA (10.5%)	1,990.48 + "
Insurance	23.40 + "
Disability insurance	6.18 + "
Free courses worth:	61.50 + "
Mean salary with fringe benefits	= $21,038.56 per year

Mean hourly wage = $\frac{\$21,038.56}{1,565.63}$ = $13.44 per hour

= $0.224 per minute

Annual salaries including fringe benefits:

System analyst = $20,865

Circulation librarian = $14,788

APPENDIX VI

Staff performing, and weighted wages for duties performed by more than one grade of staff.

AA: - Administrative assistants at $0.094 per minute.

CA: - Clerical assistants at $0.063 per minute.

WS: - Work study students at $0.040 per minute.

Sec: - Secretary at $0.089 per minute.

Counter work (charging, renewing, taking holds, queries)	AA: 13.4%	
	CA: 42.6%	
	WS: 44.0%	
	Weighted wage per minute:	$0.057
Discharging - manual	AA: 34.0%	
	CA: 30.0%	
	WS: 40.0%	
	Weighted wage per minute:	$0.065
Discharging - automated	AA: 8.0%	
	CA: 52.0%	
	WS: 40.0%	
	Weighted wage per minute:	$0.056
Sorting books and shelving	CA: 35.0%	
	WS: 65.0%	
	Weighted wage per minute:	$0.048
Filing (estimate)	AA: 20.0%	
	CA: 70.0%	
	WS: 10.0%	
	Weighted wage per minute:	$0.067

APPENDIX VI (cont)

Staff performing, and weighted wages (cont)

Sort and count McBees	AA: 42.0%
	CA: 58.0%

Weighted wage per minute: $0.076

Searching for second	Sec: 50.0%
overdues (estimate)	CA: 50.0%

Weighted wage per minute: $0.076

APPENDIX VII

LABOUR TIME & COSTS

TABLE 1. MANUAL SUBSYSTEM

Operation	Time mins.	Adjusted[1] time mins.	xUPTF mins.	Staff[2] performing	Wage per min.$	Cost per unit$	Total time mins.	Total cost $	Frequency /1000 man. charges	Cost/ 1000 manual $ charges	Time/ Hrs.
arging	.461	.461	.595	ALL	.057	.034					
rt etc.	.242	.242	.312	CA & AA	.076	.024					
le	.158	.158	.204	ALL	.067	.014	2.142	.130	1000	130.0	35.7
rt returned books	.141	.141	.182	CA & WS	.048	.009					
scharge	.385	.385	.497	ALL	.065	.032					
elve	.273	.273	.352	CA & WS	.048	.017					
new	1.039	1.039	1.340	ALL	.057	.076	1.340	.076	42.2	3.22	0.942
ke hold	.913	.913	1.178	ALL	.057	.067					
file hold	.2	.2	.258	ALL	.057	.015	3.277	.198	4.9	0.97	0.268
tify patron	1.427	1.427	1.841	CA	.063	.116					
ke recall	.88	.88	1.135	ALL	.057	.065					
spect and dial	.805	.805	1.038	CA	.063	.065					
it and give message	1.212 x .45	.545	.703	CA	.063	.044	7.383	.458	0.6	0.27	0.074
it, write card	2.597 x .55	1.428	1.842	CA	.063	.116					
g, record, etc	2.066	2.066	2.665	CA	.063	.168					
erdues	1.752	1.752	2.260	CA	.063	.142	2.334	.147	84.6	12.45	3.291
rox overdues	.057	.057	.074	Xerox	.071	.005					

Footnotes: 1. Adjusted for any element which does not occur every time the activity does.

2. Symbols are as in Appendix VI.

APPENDIX VII, TABLE 1 (cont)

Operation	Time mins.	Adjusted time mins.	xUPTF mins.	Staff performing	Wage per min.$	Cost/ unit $	Total time mins.	Total cost $	Frequency /1000 man. charges	Cost/ 1000 manual $ charges	Time/ Hrs.
Search 2nd overdues	1.653	1.653	2.132	CA & Sec	.076	.162					
Record	.120	.120	.155	Sec	.089	.014					
Phone faculty	2.017 x .34	.686	.885	Sec	.089	.079					
Phone unsuccessfully	1.299 x .25	.325	.419	Sec	.089	.037	5.989	.502	10.0	5.02	0.998
Type memo	1.078 x .66	.711	.917	Sec	.089	.082					
Fix, tag, etc.	.990	.990	1.277	Sec	.089	.114					
Refile	.158	.158	.204	ALL	.067	.014					
Fines- calculate	.150	.150	.193	Sec	.089	.017					
Fines- students	.296 x .92	.272	.351	Sec	.089	.031					
Fines- non-CSU	1.239 x .08	.099	.128	Sec	.089	.011	1.043	.074	160.14	11.85	2.784
Sort envelopes	.012	.012	.015	Sec	.089	.001					
File fined McBees	.276	.276	.356	WS	.040	.014					
Queries	.413	.413	.533	ALL	.057	.030	.533	.030	--	--	--
								TOTALS		$163.78	44.057 hours

TABLE 2. AUTOMATED SUBSYSTEM

									Frequency /year		
Book pocketing	.125	.125	.163	Prep.	.081	.013					
Punching book cards	Gross times		.706	Keypunch	.043	.030	0.963	.050	54,720	2745.07	878.256
Verifying " "			.094	" supervisor	.075	.007					

APPENDIX VII (cont)

TABLE 2. AUTOMATED SUBSYSTEM (cont)

Operation	Time mins.	Adjusted time mins.	xUPTF mins.	Staff performing	Wage/ min. $	Cost/ unit $	Total time mins.	Total cost $	Frequency /1000 man. charges	Cost/ 1000 manual $ charges	Time/ Hrs.
Charging	.431	.431	.556	ALL	.057	.032					
Sort returned books	.141	.141	.182	CA & WS	.048	.009	1.422	.077	1000	77.0	23.7
Discharge	.257	.257	.332	ALL	.056	.019					
Shelve	.273	.273	.352	CA & WS	.048	.017					
Renew	.914	.914	1.179	ALL	.057	.067	1.179	.067	69.5	4.67	1.366
Take hold	3.028	3.028	3.906	ALL	.057	.223					
Sort on shelves	.154	.154	.199	CA & WS	.048	.010	6.248	.368	21.7	7.99	2.260
Check holds	.234	.234	.302	CA	.063	.019					
Notify patron	1.427	1.427	1.841	CA	.063	.116					
Recall- inspect and dial	1.647	1.647	2.125	CA	.063	.134					
Wait and give message	1.212 x .45	.545	.703	CA	.063	.044	5.577	.351	8.8	3.09	0.818
No answer, write card	2.597 x .55	1.428	1.842	CA	.063	.116					
Log	.703	.703	.907	CA	.063	.057					
Sort overdues	.029	.029	.037	Sec	.089	.003	0.393	.025	86.5	2.20	0.567
Envelope overdues	.276	.276	.356	CA	.063	.022					
Sort 2nd overdues	.094	.094	.121	Sec	.089	.011					
Search 2nd overdues	1.445	1.445	1.864	CA & Sec	.076	.142	2.436	.193	10.2	1 97	0.414
Envelope " "	.350	.350	.451	Sec	.089	.040					
Student fines	.242 x .92	.223	.288	Sec	.089	.026					
Envelope student fines	.058 x .55	.052	.067	Sec	.089	.006					
Load sheet etc.	.451 x .37	.167	.215	Sec	.089	.019	0.749	.067	185.4	12.42	2.314
Non-CSU fines	1.596 x .08	.127	.164	Sec	.089	.015					
All- sort envelopes	.012	.012	.015	Sec	.089	.001					
Queries	.652	.652	.841	ALL	.057	.048	0.841	.048	12.2	0.58	0.171
								TOTALS		$109.92	31.61 Hr

APPENDIX VII (cont)

TABLE 3. FULLY MANUAL AND FULLY AUTOMATED SYSTEMS

	Overall frequency /1000 charges	Manual time/ activity mins.	Auto. time/ activity mins.	Manual time/ 1000 charges hours	Auto. time/ 1000 charges hours	Manual cost/ activity $	Auto. cost/ activity $	Manual cost/ 1000 charges $	Auto. cost/ 1000 charges $
Charge/discharge	1000	2.142	1.422	35.7	23.7	.130	.077	130.0	77.0
Renew	61.2	1.340	1.179	1.367	1.203	.076	.067	4.65	4.10
Hold	16.6	3.277	6.246	0.907	1.729	.198	.368	3.29	6.11
Recall	6.3	7.383	5.577	0.775	0.586	.458	.351	2.89	2.21
1st overdue	85.9	2.334	0.393	3.342	0.563	.147	.025	12.63	2.15
2nd overdue	10.1	5.989	2.436	1.008	0.410	.502	.193	5.07	1.95
Fines	186.3	1.043	0.749	3.239	2.326	.074	.067	13.79	12.48
Assisted query Manual	60.9								
Assisted query Auto.	12.2	0.533	0.841	0.541	0.171	.030	.048	1.83	0.59
TOTALS				46.879	30.688 hours			$174.15	$106.59

APPENDIX VIII

MATERIALS COSTS

Item	Cost per unit	Present manual		Present auto.		Overall frequency /1000 charges	Cost /1000 charges	
		Frequency /1000 charges	Cost /1000 charges	Frequency /1000 charges	Cost /1000 charges		Fully manual	Fully auto.
CHARGE/DISCHARGE								
McBee card	.0053	1000.0	5.30	-	-	1000.0	5.30	-
Date due slip (15 uses)	.000145	1000.0	.145	1000.0	.145	1000.0	.145	.145
RENEW								
Keysort card savers	.000055	42.2	.002	-	-	61.2	.003	-
HOLD								
Orange tag	.0054	4.9	.027	-	-	16.6	.090	-
Hold slip (xeroxed)	.0067	-	-	21.7	.145	16.6	-	.111
Notification post cards (for 55% of holds)	.0075	2.7	.020	11.9	.089	9.1	.068	.068
RECALL								
Recall post cards (for 55%)	.0075	.3	.002	4.8	.036	3.5	.026	.026
OVERDUES								
Xerox (8/sheet)	.0125	84.6	1.057	-	-	85.9	1.074	-
Fines notice (xeroxed) (for 77% -not to faculty)	.0133	65.1	.868	-	-	66.1	.879	-
Small window envelope	.010	84.6	.846	-	-	85.9	.859	-
Explanation notice(for 77%)	.02	-	-	66.6	1.332	66.1	-	1.322
Large window envelope	.00695	-	-	86.5	.602	85.9	-	.597
2ND OVERDUES								
Orange tag	.0054	10.0	.054	-	-	10.1	.054	-
Card savers	.000055	10.0	.001	-	-	10.1	.001	-
Memo (2 copies, xeroxed, for 66% -not faculty)	.06	6.6	.396	-	-	6.7	.402	-
Large envelope (66%)	.00695	6.6	.046	-	-	6.7	.047	-
Large window envelope	.00695	-	-	10.2	.071	10.1	-	.070

APPENDIX VIII (cont.)

MATERIALS COSTS

Item	Cost per unit	Present manual Frequency /1000 charges	Present manual Cost /1000 charges	Present auto. Frequency /1000 charges	Present auto. Cost /1000 charges	Overall frequency /1000 charges	Cost /1000 charges Fully manual	Cost /1000 charges Fully auto.
FINES								
Load sheet (2 copies, 12/ sheet. Only stu.- 92% & only 40% 0f auto.)	.01	173.3	1.733			171.4	1.714	
	.01			68.3	.683	68.6		.686
Invoices (non-CSU, 8%)	.01628	15.1	.246	14.8	.241	14.9	.243	.243
Large window envelope (only 8% of manual)	.00695	15.1	.105	185.4	1.288	14.9	.104	
						186.3		1.295
TOTALS			10.85		4.63		11.01	4.56

		Frequency/year		
Book cards	.001125	54,720	-	61.56
Book pockets	.0052	54,720	-	284.54
BOOK PREPARATION MATERIALS				346.10
Student ID, old type	.55	7,600	4180	-
Student ID, present	.85	7,600	-	6460
Faculty ID, old	.35	100	35	-
Faculty ID, present	.35	100	-	35
Non-CSU card, old	.008	2,277	45.54	-
Registration form, old	.02	2,277	18.22	-
Non-CSU card, present	.003	2,277	-	6.83
Op-scan form, present	.0094	2,277	-	21.40
TOTAL COST OF REGISTRATION MATERIALS			4278.76	6523.23

APPENDIX IX

TOTAL TIMES & COST OF COMPUTER PROCESSING IN JULY 1974

	No. of runs	Total CP secs.	Total I/O secs.	Charge factor	Core	No. of pages
Daily run	22	4290	10054	1.3	110k	902
Billing run	8	2656	6472	1.3	110k	544
Monthly and quarterly statistics	2	4282	5628	1.4	130k	64
Other jobs	5	1655	1135	1.3	77-120k	107

CP time: basic rate = $290 per hr.; x 1.3 = $377 per hr.; x1.4 = $406 per hr.

I/O time: basic rate= $60 per hr.; x 1.3 = $78 per hr.; x 1.4 = $84 per hr.

Total costs:	CP	$1,383.62
	I/O	513.98
	Pages	64.68
Total cost , July	=	$1,962.28

Computer installation: CDC 6400

APPENDIX X

GLOSSARY

Billing run	Computer run which produces overdue notices, fines and bills for lost books.
Call number	Classification number.
Carrels	Study cubicles.
C-Dek	Type of input terminal.
Charge	Issue a book.
Continuous timing	The watch runs continuously through the timing, instead of being set back to zero at the start of each cycle.
CPU	Central processing unit.
Fixed cost	One that does not vary with the level of output.
GRA, GTA	Graduate research/teaching assistant.
Hold	Reserve.
Issue	Charge out.
L.C.	Library of Congress.
Load sheet	Computer coding sheet.
McBee	Small, edge-notched card on which manual circulation transactions are recorded.
Monitor	Check books leaving the library to ensure that they have been charged out.
Quarter	University term.
Reserve	Hold.
Session	University term.
Shelf reading	Checking shelves to see books are in order.
SSN	Social security number.
Stock taking	Checking collection for lost items.
Variable cost	One that varies directly with output.

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