

SCOPE: A COST ANALYSIS OF AN AUTOMATED SERIALS RECORD SYSTEM

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A computerized serials record and control system developed in 1968/69 for the Technical Information Department of Pfizer Inc. is described and subjected to a cost analysis. This cost analysis is conducted in the context of an investment decision, using the concept of net present value, a method not previously used in library literature. The cost analysis reveals a positive net present value and a system life break-even requirement of seven years at a 10% cost of capital. This demonstrates that such an automated system can be economically justifiable in a library of relatively modest size (approx. 1,100 serial and periodical titles). It may be that the break-even point in terms of collection size required for successful automation of serial records is smaller than has been assumed to date.

INTRODUCTION

The field of librarianship has in general not been characterized by an abundance of cost analysis articles. This is by no means a novel observation (1,2,3). Library automation has been no exception, despite its more quantitative aura. In particular there has been an almost complete lack of any analysis of the cost of an automated system as an investment decision.

The bulk of material that has been written regarding costs and cost analysis has concentrated upon costs per unit of productivity of a functioning system, or upon comparison of such costs among various systems (4,5,6). Though still perhaps underrepresented, there is a growing core of such articles. Indeed, Jacob's article on standardized costs (7) indicates that a certain level of maturity has been reached.

The analysis of library automation in terms of its justifiability as an investment decision is not an appropriate area for benign neglect. Librarians, whether they be special, academic, or public, typically must justify their budgets to some higher authority, and the decision to automate must almost invariably be an investment decision, requiring an expenditure of funds above the normal operating budget. If librarians hope to be successful in justifying their pleas for an investment in automation, an "investment in the library's future", they should be prepared to justify their requests in terms of what they represent—investment decisions.

The cost analysis described below is an example of such an analysis. It is an after-the-fact analysis, but the principle remains the same.

METHODS AND MATERIALS

The SCOPE (Systematic Control Of *PER*iodicals) system was implemented in 1968 by the Technical Information Department of Pfizer, Inc., at the Medical Research Laboratories in Groton, Connecticut. The system is not radically different from others described in the literature (8,9,10). It is reasonably sophisticated in its handling of such features as claiming, binding, and budgeting. The basic design element of the system is the computer generation each month of a deck of IBM cards corresponding to anticipated receipts for that month. As an item is received, the corresponding card is pulled from the anticipated deck and is used to inform the system of the receipt of the item. This "tub file" feature, first used by the University of California at San Diego (11) is the major design difference between SCOPE and the University of Minnesota Bio-Medical Library system described by Grosch (12) and Strom (13), with which SCOPE seems most comparable in terms of system sophistication and capability.

SYSTEM DESCRIPTION

The system was originally written in Fortran IV for an IBM 1800 computer with two tape drives. A total of twelve programs were written. Two of these programs are quite large (the weekly update and the monthly generation program) comprising about 600 statements each; the remainder average 200 statements. Since that time the programs have been revised to operate on an IBM 360/30 computer using two 2400 tape drives and two 2311 disk drives. Several more programs have also been written. Fortran IV was chosen as a program language to render the system relatively immune to hardware changes and has fully justified itself. A listing of programs follows.

<i>Program Number</i>	<i>Function</i>	<i>Core Requirements Bytes</i>
EPC01	Weekly Update	17060
EPC02	Monthly Card Deck Generation	15992
EPC03	Vendor Listing	5648
EPC04	Periodical Title Evaluation & Budget Listing	6916
EPC05	Holdings Listing	6992
EPC06	SCOPE File Print	6852
EPC07	PSN File Swap—to reassign PSN & realphabetize	7638
EPC08	Daily Receipt Listing	1768
EPC09	Binding Listing	2480
EPC10	Short Title vs. Full Title Thesaurus	3876
EPC11	Skeleton Binding Punch	3024
EPC12	Copy Tape File	2008
EPC13	General Skeleton Punch	2920
EPC14	Cross Index Punch	3300
EPC15	Receipt Edit	1444
EPC16	Purchase Order Analysis	2796
EPC17	Discipline Analysis	3024

File Design

SCOPE maintains a magnetic tape file in which each periodical is recorded in sequence by its Periodical Sequence Number (PSN). Appearing once in the file for every PSN are records giving title, cross-reference, holdings, and journal control information, including, for instance, "separate index." Records for one or more copies then follow this basic information. Each copy within a PSN consists of records for all current expected receipts (XRs), binding units (BUs) not yet complete, as well as a trailer (TL) summary. A File Print program is provided which enables the library staff to inspect every item of data in the file.

"Anticipated" Deck

SCOPE generates monthly a deck of approximately 2,500 80-column Hollerith cards to be used for posting periodicals as received. A card is made for each receipt expected within the succeeding five weeks. For all regular known publication schedules, these cards are complete as to volume, issue (including separate index) and publication date. For irregular or unknown publication schedules, one or more incomplete cards are provided in the deck.

Upon receipt of an issue, the proper card is pulled from the "anticipated" deck, the actual date of receipt is punched and the card used to prepare the Daily Receipts listing. The card is also used to update the tape file on a weekly cycle. Unexpected issues require that a card be prepared manually by the library staff. Issues which are omitted by the publisher require that the card be returned to the system as a "throwback." If an issue is

unexpectedly divided into two or more parts, separate cards are manually prepared and the original card deleted.

Claims

In order to issue claims on a current basis, the tape file is updated weekly with receipts. Every receipt will find a copy of itself on the SCOPE tape (generated when the "anticipated" deck was produced) and a received code (R) and the current date will be posted to the record. Consequently, any item not marked received becomes a claim as soon as the "claim delay" period is exceeded. A card to be used for claiming will be punched on the weekly cycle first exceeding "lag" and "claim delay," and once again every four weeks thereafter until resolved either by receipt or transfer to the Missing Issue File. The "lag" is the period in weeks lapsing between formal date of publication and earliest anticipated date of receipt. The "claim delay" period is calculated as the weeks elapsing between earliest anticipated date of receipt and latest normal date of receipt. "Lag" and "claim delay" may be modified for each publication based on experience.

Binding

Binding units are created within the SCOPE file during the monthly generation run. A unit is punched when all the issues comprising it are received or claimed (that is, when none of them is yet to be anticipated). If the unit is complete (no claims) it will be dropped from the tape file at the time it is punched and will not be punched again.

Binding units are formed whenever a volume changes or whenever the "issues per bind" factor is satisfied. Receipts having been accumulated in the file from week to week are dropped at the time of the monthly generation after being counted for binding.

From the Binding Unit cards a listing is prepared that is used by the library staff to make up bundles of periodicals for the binders. The binding unit card accompanies the shipment and is used by the binder. It includes information on issues included, indexes, color of binding, etc.

File Maintenance

In addition to receipts and "throwbacks" the weekly update procedure allows add, change, and delete transactions to affect the SCOPE file on a record-for-record basis. Such transactions are needed to handle new periodicals, additional copies, closed series, discontinued copies, name changes, publication schedule changes, revised costs, vendor changes, and the like. The update operation is ordered by PSN, copy number, record type, and (for XRs) volume and issue, in that order. An entire publication schedule may be added to the file in such cases as when the schedule is known but highly irregular (Frequency Code 99).

After the receipt cards are processed by the update each week, they are filed in the "manual receipt file" together with copies of claims sent to

vendors. As binding units are created, copies of binding cards are filed in the same file, and receipt cards representing binding cards are discarded, as are earlier binding cards. This manual file corresponding to 1,000 journals requires about 5,000 cards and occupies three card file drawers. It is filed by PSN and is therefore in order alphabetically by journal title. Discards and additions to the manual file are about equal and hence it does not increase substantially in size. It permits rapid manual examination of the current status of each periodical.

Holdings List

A program is provided that lists the complete SCOPE file showing full title and abbreviated holdings statement for each PSN. In addition, any cross reference/history data and any desired holdings detail will be printed. Since the file maintenance process insures an accurately updated file, this listing may be run at any time to provide an accurate reflection of library holdings.

Periodical Title Evaluation (Scrutiny)

A program is provided that lists all copies in the SCOPE file requiring annual review prior to renewal. This procedure is controlled by the "value code" assigned individually to each copy within a PSN. In addition to full title and abbreviated holdings statement, the listing shows by whom abstracted, the discipline codes associated with the periodical, and the annual cost. Given this information, library users are requested to vote for retention of items for the next year. Those not receiving sufficient votes are not renewed. Separate programs not part of the SCOPE system are used to prepare vote cards and tabulate results.

Budget List

The program that prepares the Periodical Title Evaluation List can be used to prepare lists by "Department Charged," a convenient budgetary tool used each Fall to plan purchases for the following year. The lists may, of course, be run at any time.

Vendor Order List

A program is provided to prepare from the SCOPE file a listing of all non-terminated copies associated with each requested vendor. A three-character vendor abbreviation is used to control this process and is coded into each copy control record. In addition to the short title, the list gives vendor reference (his identifier for the periodical), Pfizer purchase order number and date, and the estimated annual cost. Each different condition (form of publication, such as periodical, microfilm) is listed with the number of copies ordered.

Although prices are not firm at the time of ordering, this listing nevertheless provides the detail needed for purchasing documents. As price

change information is made available and updated into the file, the listing may be rerun for checking out final billings from the vendor.

Similar lists can be produced by purchase order number, a convenient tool for resolving those financial complexities which inevitably occur.

Discipline List

This program is used to prepare lists by discipline/subject, as microbiology, immunology, etc., a useful tool for maintaining collection balance, and for assuaging patrons' fears that their disciplines may not be adequately represented.

System Capacity

Present counts indicate approximately 9,000 tape records in the system, representing approximately 1,100 journals. About 200 issues are posted weekly. There are no restrictions on future expansion of the system as presently implemented.

METHOD

The method of cost analysis used was the "net present value method." Perhaps the clearest most readily available description of this concept is to be found in chapters 19 and 20 of Shillinglaw's *Cost Accounting, Analysis and Control* (14). Briefly the idea is that of comparing a given investment decision with what might reasonably be expected from an alternative use of that same money for another investment. An investment is typically defined as "an expenditure of cash or its equivalent in one time period or periods in order to obtain a net inflow of cash or its equivalent in some other time period or periods." (14, p. 564). The librarian typically thinks of investing in automation now in order to make possible a lessened expenditure in the future—at least a lessened expenditure in comparison to what would be necessary to accomplish the same level of operations in a non-automated fashion. Conceptually these are the same; investment now in order to reap some future benefit. Future savings can be treated as a future cash inflow.

The concept of net present value is rather simple; it consists of converting all present and expected future cash flows (or their equivalents) to a present value and examining that value in comparison to alternative uses for the resources invested. The process of conversion is that of relating time and money. Time does of course influence the worth of money. A dollar a year from now is worth less than a dollar today, for the dollar today can be invested and a year from now it will be worth more than a dollar, or at least the mathematical expectation of its worth is more than a dollar. The question is at what rate future cash flows should be discounted. Business firms typically use their "Cost of Capital" (the cost which the business must pay to obtain capital) as the discount rate. A business decision should yield a positive net present value when the appropriate future cash flows are discounted at the cost of capital. If not, the invest-

ment is a losing proposition, and the business would have been better off by not obtaining the capital, or by investing it elsewhere. The calculation of an appropriate cost of capital is a complicated exercise involving such things as debt capital, equity capital, etc. The figure of 10% is often cited as a good rule of thumb; happily it is appropriate in the case at hand and is the one used here.

To the obvious question "is there any relevance in this net-present-value/cost-of-capital idea to an academic or a public library which does not obtain its funds in the same way, or have any explicit cost of capital?" the response is "yes." If a decision to automate, when analyzed in this fashion in comparison with alternative methods, should result in a negative net present value, then that decision is demonstrably poor. For if the money invested in automation were instead invested in the market, it could supply the alternative system's future greater operating costs with money left over to utilize elsewhere. This latter course might not be an option in fact, but the mere presence of its theoretical preferability would cast doubt on the desirability of any decision to automate. Conversely a positive net present value would argue for the desirability of automation, regardless of the source of the funds.

The cost analysis that follows is expressed in terms of set up cost outlays (investment) and projected savings (cash inflow). The investment expenses are of course reasonably well documented. The operational savings are based on 18 months' successful experience with the system.

Set-up Costs (including 1968 and 1969 parallel running costs)	
Systems analysis and programming: (fees paid to consultant)	\$10,450
Keypunching:	2,000
Conversion reprogramming: (IBM 1800 → IBM 360/30)	500
Computer time:	4,000
Personnel, opportunity costs:	10,000
(Asst. Librarian \$4,000	
Tech. Info. Mgr. \$6,000)	
 Total Set-up Costs:	<hr/> \$26,950
 Yearly Running Costs	
System maintenance: (retainer to Detmer Systems)	\$ 500
Computer time (full costing):	5,000
Allowance for machine conversion: (based on an expectation of conversion at 3 yr. intervals at a cost of \$750 each time)	250
 Total	<hr/> \$ 5,750

Operational Savings 1970 → , per year (in comparison with continued running of the previous manual system)	
Posting: (based on a saving of 8 hours per week of clerical work)	\$ 1,400
Claiming: (based on a saving of 10% of an assistant librarian's time)	1,050
Binding: (based on elimination of approximately 450 hours of overtime, clerk and assistant librarian, and 150 hours regular time per year)	2,700
Replacement costs: (represents decreased replacement costs due to rapid binding and consequent lower loss rate)	400
Production of holdings list: (based on a savings of 50 hours per year of assistant librarian's time)	250
Ordering/Bookkeeping: (based on a savings of 250 hours per year of assistant librarian's time)	1,250
Total	<hr/> \$7,050
Savings Resulting from Control of the Collection not Previously Practicable (see discussion below)	
Space saving per year:	\$ 750
Subscription saving per year:	2,000
Incremental overhead saving per year:	1,500
Total	<hr/> \$ 4,250
Total Yearly Savings	\$11,300
Yearly Running Costs	\$ 5,750
Difference (Realized Savings)	<hr/> \$ 5,500

RESULTS

The net present value at the end of 1970 based on 10% cost of capital and 15 year life expectancy follows. The present value of one unit one year ago is 1.1052, at 10% cost of capital (assuming for simplicity that the 1968-70 set-up prices were paid in a lump one year prior to the end of 1970); 7.7688 is the present value of an annuity of one unit per year for 15 years at 10% cost of capital.

<i>Net Present Value Factor</i>	<i>Net Present Value</i>
1968-1970 set-up costs:	
(\$26,950) × (1.1052) =	(-\$29,785)
Yearly savings, commencing 1970:	
(\$ 5,500) × (7.7688) =	(+ \$43,117)
Net Present Value =	\$13,332

These findings indicate that the crude payback period \cong 4.9 years (commencing January 1971). The system life required to break even at 10% cost of capital \cong 7 years.

Another way of looking at the matter is to calculate the discounted rate of return. That is, at what rate of discount is the sum of the positive present values equal to the sum of the negative present values. In this case, the discounted rate of return \cong 17%. In other words, since the discounted rate of return (17%) is significantly above that available for alternative uses of the resources (say 10%), this is a reasonable candidate for investment.

DISCUSSION

The net present value method has two inputs in addition to the raw data. The first one, already discussed, is the cost of capital. Most large businesses can supply such a figure, or at least inform the librarian or information manager what approximation is used by that company (though surprisingly many otherwise sophisticated businesses do not use this method). In an academic environment, advice can usually be obtained from someone in the economics department or in the business school. In any case, 10% is a good rule of thumb. The second input is the expected life span. This is not as crucial as one might suppose, for the farther distant the cash flow, the less its net present value. The net present value factor in this case for 15 years' life expectancy was 7.7688; for ten years it would have been 6.3213, for 20 years 8.6466—not a great difference.

As is invariably the case, many of the effects of SCOPE were difficult to quantify. The most difficult were those in the sections "savings resulting from control of the collection not previously practicable." Since the collection can now be easily analyzed and scrutinized with only a minimum expenditure of research staff time, the rate of growth of the collection has been considerably tamed, while maintaining customer satisfaction. Prior to SCOPE, new subscriptions had been added at the rate of about 90 a year. When SCOPE was implemented, this fell to 10, and has now risen to approximately 30. During its first year of operation, SCOPE apparently resulted in 80 fewer periodical subscriptions, the second year, 60 fewer. Continuing this progression, 80, 60, 40, 20, 0, one would arrive at the conclusion that a long-range reduction in collection size of 200 subscriptions was achievable. To be conservative, the calculation has been based

on an estimate of a reduction of 100 subscriptions/year. Even this estimate represents a saving of over \$4,000 per year. The resulting space savings were based on a cost of \$10 per square feet per year (standard occupancy charges adjusted for stack use) and a ten-year cycle in stack space enlargement. This scrutiny might have been done manually at a justifiable cost, but it had not been done, and more importantly probably would not have been done.

The operational savings may be open to some criticism because, as is probably obvious to an experienced serials record librarian, the previous manual system was not strikingly efficient. It can well be argued that the most efficient possible manual system rather than the previous system should have been the alternative against which SCOPE was evaluated. From the point of view of the organization, however, the relevant comparison is to actuality, not to what is theoretically possible, but in generalizing the results this specificity must be borne in mind.

Somewhat mitigating this circumstance, however, is the fact that the running costs of SCOPE are probably overestimated. The computer cost is based on full costing, inappropriately high for the following reasons: 1) it includes programming overhead, but since SCOPE was programmed externally, the SCOPE project is being doubly charged for its programming; 2) the same double charging applies to program maintenance; 3) the costing makes no distinction between high priority jobs, and relatively low priority jobs such as SCOPE, and presumably low priority is less expensive.

Since the distortions in the two paragraphs above are difficult to estimate and since they are to a degree counterbalancing, they are simply noted rather than quantified.

The yearly operational savings (\$7,050) still intuitively appear surprisingly high. One's initial reaction is that even with overhead included, this is not a great deal less than the yearly cost of one library assistant. In point of fact, one library assistant has been transferred from the Library to the rapidly expanding Computer Based Information Section (computer based SDI and retrospective searching), with no apparent deterioration of library services. The Library is in fact handling a greater work load than previously, with one less person. This cannot be entirely attributed to SCOPE, as some other rationalization of library operations has been introduced, but it does indicate that the calculated savings are not a grossly distorted reflection of reality.

CONCLUSION

As pointed out in the introduction, almost any significant attempt at library automation will require an investment decision. Librarians should be prepared to make analyses of their proposals in terms of their justifiability as investment decisions, both for reasons of politics and for their own satisfaction and confidence. The net present value method is a powerful, convenient, and useful tool for such analyses. It is hoped that this

article will serve as a reasonable case study for the application of this technique to the problems of library automation.

An automated serial records system for a relatively modest (1,100 serial and periodical titles) special library has run successfully and achieved its objectives for more than a year and a half. One of the major objectives was to produce a system that allowed clerical help to be substituted for a librarian's scarce and costly time, thus allowing more effective utilization of the professional librarian's skills. This objective has been met. Furthermore, a complete turnover of the personnel interfacing with the system has been accomplished easily and painlessly. No small part of the credit goes to the originators who designed and documented the system for such turnover. It is an old chestnut, but well worth repeating—"design the systems not for yourself, but for the person who will be chosen to replace you."

The cost analysis of the operations of the system indicate that its design, implementation, and operation are economically justified, and that capital investment will be paid off in approximately seven years. (The crude payback period was less than five years.) The major implication of this economic justification lies in the relatively modest size of the Library's operation. It may well be that the break-even point in terms of collection size required for successful and cost-effective automation of serial records is smaller than has heretofore been assumed.

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