

COST COMPARISON OF COMPUTER VERSUS MANUAL CATALOG MAINTENANCE

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Is a computer assisted catalog system less expensive than its manual counterpart? A method for comparing the two was developed and applied to historical data from the Orange County Public Library. Comparative costs obtained were \$.89 per entry for computer assisted catalog maintenance versus \$1.71 for manual maintenance.

INTRODUCTION

Since November 1965, the County of Orange Public Library has performed all acquisitions by means of a computer assisted system. As a by-product of this continuing operation, records for over 30,000 titles are now available in machine readable form on magnetic tape. The next logical step to realize the Library's goal of mechanizing a major portion of its many nonprofessional functions is the production of a comprehensive multi-access list of its holdings suitable for both Library and patron use; in short, a Book Catalog. The 30,000 captive entries, however, comprise only a quarter of the Library's total holdings of 120,000 titles. Before the envisioned Book Catalog can be produced, approximately 90,000 titles remain to be captured, and subsequent file handling and data printout operations must be developed.

An undertaking of this magnitude naturally prompted a review of the literature. Initially, Hayes and Shoffner's work for the Stanford University Undergraduate Library (1) would appear adequate. On closer exam-

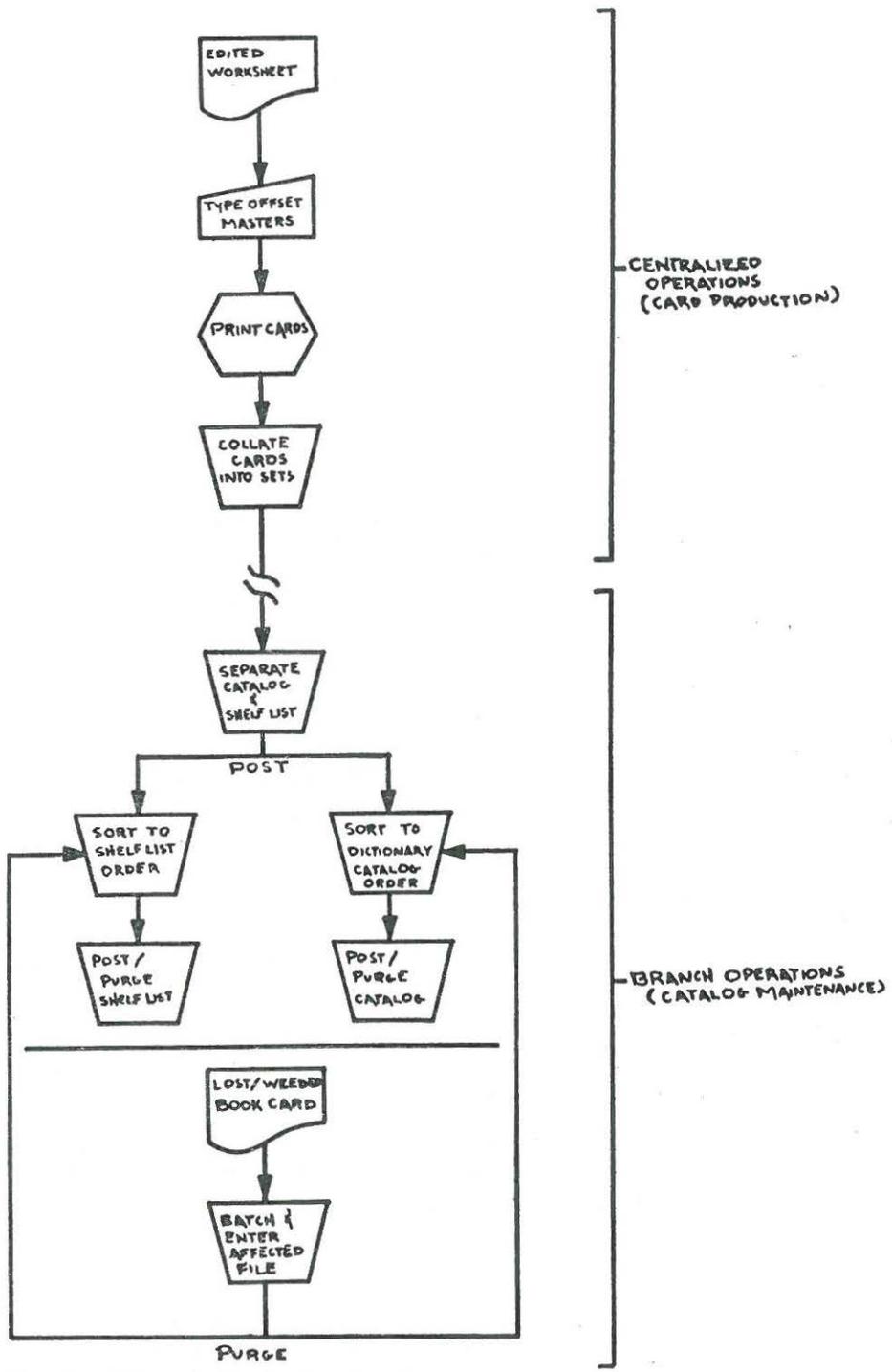


Fig. 1. Manual Card Catalog System.

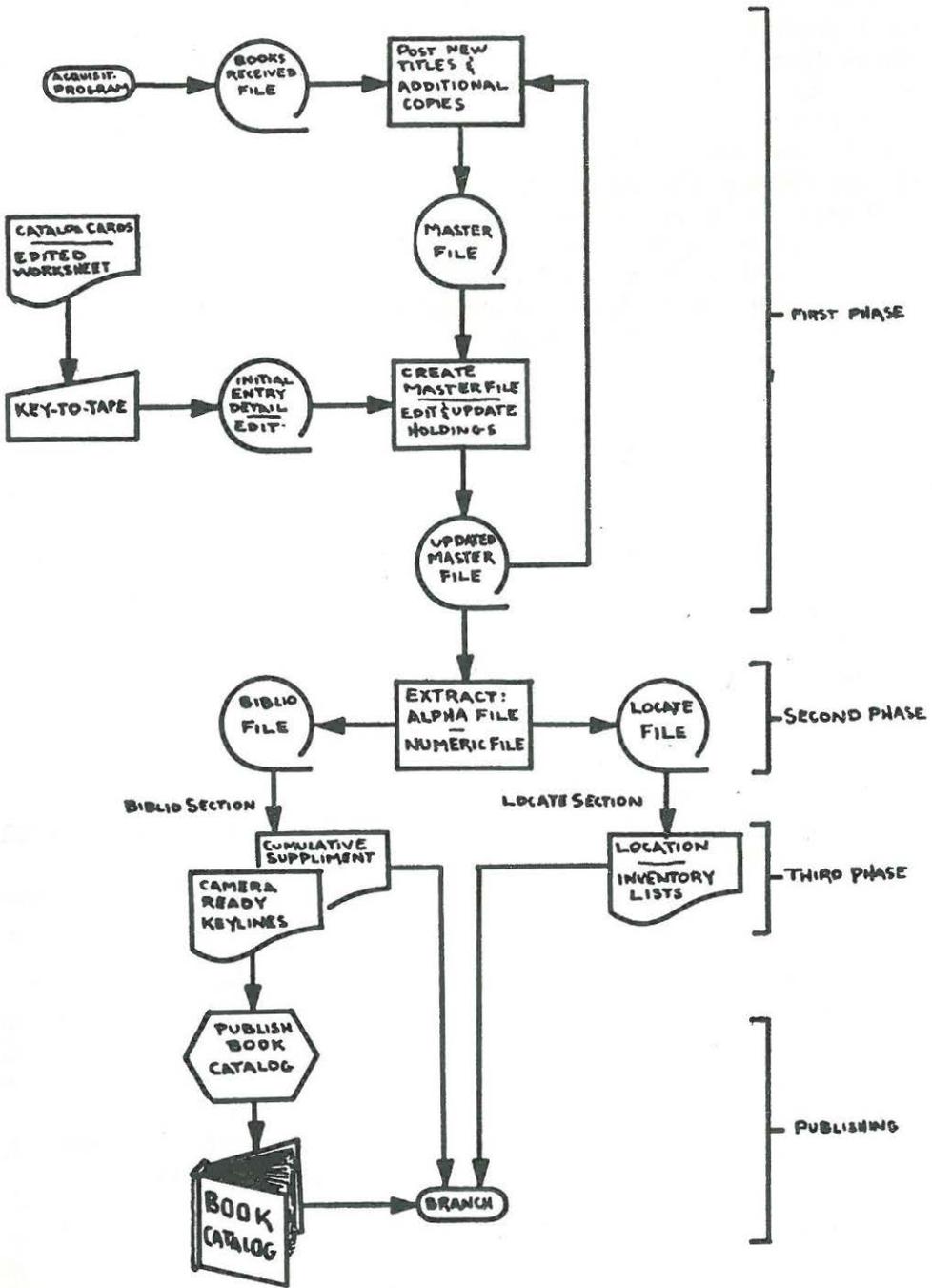


Fig. 2. Proposed Computer Assisted Book Catalog System.

ination, however, their approach did not optimize the cycle for supplement production or catalog reprint; nor was particular attention given this problem in the Institute of Library Research Report to the California State Library (2). The Cartwright and Shoffner Study for the California State Library (3) paid close attention to cycle length, but the system therein described differed extensively from the system proposed for Orange County. Further, though the costing of data capture has been well documented and continues to appear in the literature (4,5,6), there is little concerning the cost of maintaining data once on file. In brief, neither a method nor basic information was available which could be applied generally, although several specific approaches and results had been presented (1,7,8,9,10,11), and an approach to the analysis of manual operations established (12).

When it became apparent that more than article reading would be required, cost analysis of the existing manual operation and the proposed computer assisted Book Catalog program was performed. In addition, a method was designed to discern what cost benefit, if any, was implied in a computer maintained file before a massive keying effort and systems development should be undertaken. It is important to note that the analysis gives no consideration to increased level of service, esthetics, practicality, or the subsidiary products of a computerized system. Nor is the capital investment represented by existing card catalogs considered, as those units are assumed to have been paid for in the course of their creation.

MANUAL CARD CATALOG SYSTEM

The manual system to be replaced consists of individual card catalogs and shelf lists in each of the Library's service units, comprising 25 branches and a separate Bookmobile base.

This system, depicted in Figure 1, consists of: 1) centralized card production, and; 2) branch catalog maintenance. In the centralized operations, offset masters are created from worksheets prepared by the cataloging section and used for two-up card production. These cards are collated into sets, the sets merged with their corresponding books, and the completed packages sent to the ordering branches. When book and card packages are received by the branch, shelf list and catalog cards are sorted and merged with their respective files. Withdrawal of a book (discarded or lost) from a branch collection triggers a reversal of this process, and all cards for the withdrawn item are purged from the files.

PROPOSED COMPUTER ASSISTED BOOK CATALOG SYSTEM

The computer assisted system (Figure 2) consists of three phases of computer operation and catalog printing. In the first phase the computer receives as input magnetic tapes produced by the Library's ongoing book acquisition system and/or the output of a device providing a direct key-

board to tape capability, processes the input data into updated records, and merges the updated records with the Master File of Library holdings.

The first phase will build the initial Master File through capture of the Library's remaining 90,000 titles via the keyboard-to-tape device indicated above, and will also form the main avenue for communicating revision (update) data to the Master File.

In the second phase the computer extracts two print tapes from the Master File: the first is the Biblio File, consisting of all the bibliographic data and the record number for each Master File entry in alphabetical sequence (author-title mix); the second, or Locate File, contains location codes and copy counts for each record number in numeric sequence.

In the third and final phase, the Biblio and Locate Files are processed. From the Biblio File are produced keylines (camera-ready copy) for the Book Catalog and periodic cumulative supplements of new entries. Out of the Locate File are generated three numeric listings: 1) a Locate List containing all entries, 2) periodic cumulative Locate Supplements, 3) Branch Inventories.

In production of the Book Catalog, the computer produced keylines are used to create offset masters for printing. The end product of the printing process is 400 bound copies of the Book Catalog.

FACTORS IN COST COMPARISON

Following is an examination of the principal factors which must be equal or identical to permit comparative analysis of the two systems.

Unit of Comparison (ENTRY)

To facilitate the cost analysis between manual and computer assisted file maintenance systems, a unit of comparison was established which would be compatible to both. This unit is called the ENTRY, and in the analysis which follows is the basis for all cost comparisons.

For the manual system, ENTRY means creation, distribution, filing and, ultimately, purging of the complete set of cards (Figure 3) pertaining to a specific book; while for the computer assisted counterpart, an entry is a record (Figure 4) in machine readable form which has been captured, sorted, listed and updated.

Frequency of Transactions

Either system, in addition to creating and posting new records to a file, must periodically update both entire records and the elements of those records. The number of these updates can be determined for a given period of time, and for our purposes we call this figure the frequency of transactions. With regard to the systems under analysis, the frequency of transactions is identical, and includes two elements: titles added and withdrawn; and volumes added and withdrawn (including re-assignments) as shown in Table 1.

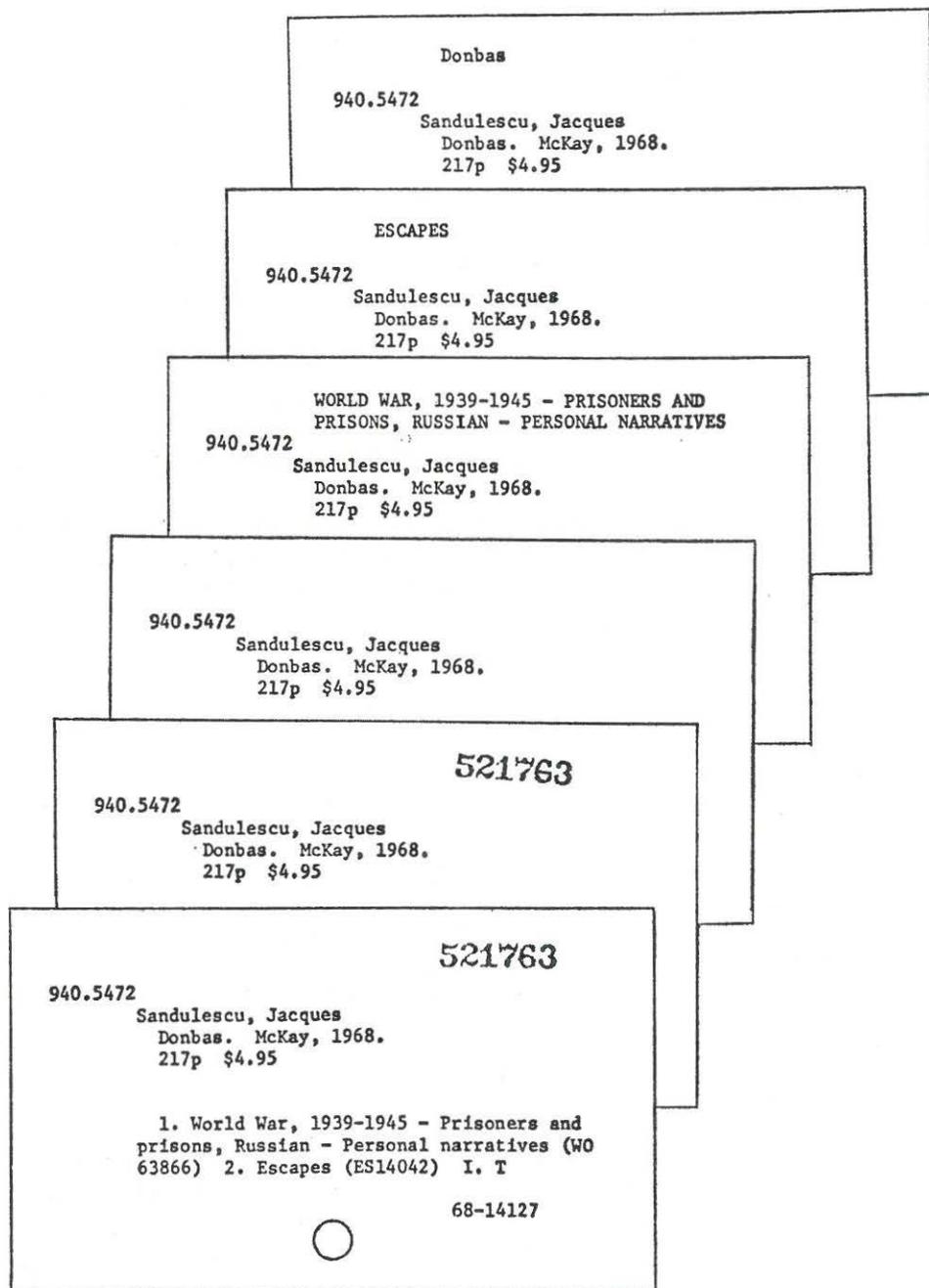


Fig. 3. Set of Catalog Cards.

Table 1. Frequency of Transactions for Manual and Computer Systems Per Year.

	<i>Added</i>	<i>Withdrawn</i>
<i>Titles</i>	15,000 (9,000 new)	4,000
<i>Volumes</i>	105,000	24,000

Table 2. Manual System Direct Costs

<i>Personnel:</i>	
File and typist-clerk	\$ 2.17 hr.
Offset operator	2.90 hr.
<i>Equipment:</i>	
Offset press depreciation (5-year)	900.00 year
<i>Materials:</i>	
Card stock	2.69 per 1,000
Offset masters	4.60 per 1,000
Press supplies	147.00 mo.

Table 3. Computer System Direct Costs

<i>Personnel:</i>	
Typist-Clerk	\$ 2.17 hr.
<i>Equipment:</i>	
Keyed Data Recorder— Mohawk 1181 (other possibilities include: IBM 50; or IBM MT/ST and 2495 Tape Cartridge Reader)	300.00 mo.
Computer — RCA Spectra 70/45F, 131 K Byte Core, 3 selector channels, four 70/442 tape drives (8 tapes), three 70/564 disc units. Software used is in RCA Cobol V version 15	82.00 hr.
<i>Materials:</i>	
Fanfold paperstock, } Magnetic tape }	Included in equipment cost.

Input

Both manually produced and computer generated catalogs use an identical input: the source document being the Sub Purchase Order (Figure 5), which is completed and edited by a cataloger. This document provides the text to be typed onto offset masters for card production (manual system); or the corrected data to be keyed into machine readable form (computer assisted system).

Output

Similarly, the output from each process must fulfill the primary objective of catalog creation: multi-access listing of the materials held by the Library (Figures 3 and 6). The On Order List in Figure 6 contains many elements which will appear later in the proposed book catalog.

COMPUTATION OF COSTS

Once identity of input, output, and frequency of transactions have been established, the activities internal to each process must be isolated and documented in terms of cost. Materials consumed and equipment used in each process to fulfill its objectives must also be accounted for. The direct costs for the two systems are shown in Tables 2 and 3, respectively. In addition to these direct costs, a burden rate could be applied to these figures to reflect the indirect charges involved in both systems. However, essentially the same burden rate is applicable to both, primarily because of the amortization of computer system development costs, the dollar amount of which approximates the supervisory and administrative costs of the manual system. Therefore burden rates are not included.

Following is a development of the costs incurred by each system, in an attempt to answer the question: Is a computer maintained book catalog less expensive than a manually maintained card catalog?

Manual Card Catalog System

The cost figures presented in Table 4 reflect the total card production load for the entire system and the average card catalog shelf list maintenance load for a single branch. They have been derived from time studies performed on both the manual card files and the Library's card production operation. As indicated in Table 4, the \$1.71 cost per entry is composed of \$0.99 for card production and \$0.72 for file maintenance at a single branch.

Computer Produced Book Catalog Cost

A computer assisted catalog system requires the construction of two forms of the same file: a machine readable record for file maintenance and a book catalog for staff and library users. To produce an accurate total cost picture, the specific costs in both the construction and maintenance of these "parallel" files must be identified and summarized.

Table 4. Manual Catalog Card Production and Maintenance Costs

<i>Operation</i>	<i>Supplies</i>	<i>Entry Cost</i>
<i>Card Production</i>		
Type Offset Masters		\$ 00.30
Print Cards		00.02
	Offset Masters	00.32
	Card Stock	00.22
	A.B. Dick 360 (5-year) amortization	00.06
Assemble sets with books		00.07
	Subtotal:	\$ 00.99
 <i>Maintenance (Single Branch)</i>		
Sort shelf list from catalog cards		00.11
<i>Shelf List</i>		
Sort		00.08
File/Purge		00.02
<i>Catalog</i>		
Sort		00.47
File/Purge		00.04
	Subtotal:	00.72
	TOTAL:	\$ 1.71

Table 5. Initial Costs for Machine Readable (Master File) Entries

<i>Operation</i>	<i>Unit Cost</i>	<i>Total</i>
Input of 90,000 titles		
Key-to-tape	\$00.37	
Correct errors	00.007	
	Subtotal:	\$00.377 \$33,930
Transfer of 30,000 entries		
Correct errors	\$00.007	
Merge with Master File	00.0048	
	Subtotal:	\$00.012 360
	TOTAL for 120,000 entries	\$34,290

Machine Readable File Construction

The first step toward implementing a computer assisted system is the construction of a machine readable file on magnetic tape of some 120,000 entries (90,000 entries of approximately 309 characters each to be captured, and the 30,000 entries captured previously). Costing the capture of the 90,000 entries has been closely estimated at \$0.37 per entry. But, to complete the initial file cost picture requires pricing the transfer of the 30,000 acquisitions entries and the correction of errors occurring in both the capture of the 90,000 entries and/or the transferred acquisitions entries. Further, it is known that the error correction figure will not include the price of deriving the update data (cataloging), nor the price of keying the original entries (acquisitions). Therefore, the error correction cost is the price of keyboarding update data, posting it to the erroneous entries and, in the case of acquisitions entries, merging those entries with the Master File.

The cost of error correction is tied to the number of errors to be corrected per entry. The figure used here was developed by surveying the acquisitions records (Figure 5), which have been used for pre-cataloging in the manual system, where an average of five characters per entry were found to be in error (edition, pagination, price, misspellings, etc.). For the computer assisted system an additional 9 characters will be required to contact a specific field in any record (record, card code, and action digit). Thus, approximately 14 keystrokes will be required to correct an error in an entry. At approximately 8,500 net keystrokes per hour, slightly more than 650 minimum changes per hour are possible. Therefore, if all 30,000 entries require correction, approximately 50 keyboard hours will be required (or a rounded \$195.00 for operator and machine), plus some 20 minutes of computer time (\$30.00), which can be reduced to an average cost of \$0.007 per entry.

To merge the updated acquisitions entries with the Master File will cost an additional \$0.0048 (historical cost derived from a similar operation in the acquisitions system) for a total of approximately \$0.012 per entry. This is shown in Table 5 in concert with the development of the initial Master File entry cost predicated on 120,000 entries, all of which have required a minimum error correction. The initial average cost per entry (Master File) is \$0.286.

Book Catalog Construction

The cost for a computer produced book catalog involves the computer production of camera-ready copy (keylines) and offset catalog production.

The first step in the transition from the Master File to the production of keylines is the rearranging of the individual elements (author, title, collation, LC order number) of each record into the sequence they will occupy in the printed entry, and translating the coded elements in each entry to their "real world" equivalents. The \$0.009 cost for "Reformat..."

SUB PURCHASE ORDER
COUNTY of ORANGE
 SANTA ANA, CALIFORNIA

ROUTE SHEET
 Sub P. O. No.
L 51282
 CONTRACT or ORDER
 NO: A 85200
 STORAGE: **634**
 PRIORITY:

Date: **04-25-68**

Vendor: **CARL J. LIEBEL, INC.**
1236 SOUTH HATCHER AVENUE.
LA PUENTE, CALIFORNIA

1. **WORLD WAR, 1935-1945-PRISONERS AND PRISONS**
RUSSIAN-PERSONAL NARRATIVES (Wo 63866)

2. **ESCAPES (ES14042)**

STRIPS:

COPIES **6** PRICE **4.95**

New Title Recat. End Papers Name Authority

New Ed. New Set Bind

Have Labels Reinforce

Class # **940.5472**
 LC # **Y**

~~33269-7~~
SANDULESCU, JACQUES
DONBAS
MC KAY 1968 (68-14127)

F850-66-2 **217 P**

Binding:		TRADE	<input checked="" type="checkbox"/>	PAPER	LIBRARY					PRE-BOUND		
Class:		9	8	<input checked="" type="checkbox"/>	7	6	5	4	3	2	1	ANF
01	02	1	03	11	12	13	14	15	18			
20	21		22	23	24	1	25	1	26	1	27	1
32	35		36	41	42		43		45		51	
53	54		55	56	61		63		71		72	

Fig. 5. Sub Purchase Order.

ADULT TITLES ON ORDER	BRANCH 11 LAGUNA BEACH	04-30-67	PAGE	3
019335	ARCO SCORING HIGH ON READING TESTS	03-67	1	\$6.50
019413	ARCO VOCABULARY, SPELLING, GRAMMAR	03-67	1	\$4.00
022015	ARMSTRONG, CHARLOTTE THE GIFT SHOP	05-67	1	\$4.95
022483	ASHLEY MONTAGU, M. F. AMERICAN WAY OF LIFE	05-67	1	\$5.95
017896	ASHLEY-MONTAGU ON BEING HUMAN	-	1	\$4.50
021535	ASIMOV, ISAAC WELLSPRINGS OF LIFE	05-67	1	\$3.75
022599	ATTWOOD, WILLIAM THE REDS & THE BLACKS	05-67	1	\$5.95
020713	AUCHINCLOSS, LOUIS TALES OF MANHATTAN	04-67	1	\$4.95
019960	AUER, ALFONS OPEN TO THE WORLD	03-67	1	\$5.95
022460	AUSTEN, JANE PRIDE & PREJUDICE	05-67	1	\$5.95
018680	AUSTEN, JANE EMMA	-	1	\$3.95
021536	BAKER, GEOFFREY MOTFLS	05-67	1	\$15.00
021666	BALOGH, THAS ECONOMICS OF POVERTY	05-67	1	\$7.95
018176	BANNISTER, MARGARET BURN THE LITTLE LAMP	-	1	\$4.95
022093	BARING-GOULD, WILLIAM THE LURE OF THE LIMERICK	05-67	1	\$5.00
018392	BARLOW, JAMES ONE MAN IN THE WORLD	-	1	\$5.95
021188	BARNETT, A. DOAK CHINA AFTER MAO	04-67	1	\$6.00

Fig. 6. On Order Listing.

is taken from historical costs for the operation of a report generator doing this in the acquisitions system. Similarly, the reformatted entries in "printable" form must also be sequenced alphabetically (single author-title mix) before they can be printed, and again the \$0.00034 cost is taken from historical data. Finally, the sorted, reformatted entries are printed (upper case) at a cost of \$0.027 each (2 lines). The total cost for these operations becomes \$0.036 per entry, as shown in Table 6.

Table 6. Keyline Production Cost

<i>Computer</i>	<i>Entry Cost</i>
Reformat Master File Entries	\$00.009
Sort Reformatted Entries	00.00034
Print (Offline)	00.027
	<hr/>
TOTAL	\$00.036

For catalog printing, the computer generated keylines will be reduced photographically to 60 percent, and the reductions assembled for 16-up reproduction with approximately 100 entries per sheet (both sides). Initial book catalog production will be 400 copies of approximately 1,800 sheets. There are slightly more than 61,000 author entries which will receive full bibliographic data, call and LC order numbers, while the 120,000 title entries will present only author data and call number. The estimated total cost of printing is given in Table 7. The resultant cost per entry is \$00.186, regardless of the number of lines required.

Table 7. Catalog Printing Cost

Set-up	\$ 3,000
Plates	7,000
Run Time	6,000
Gather/Collate	2,000
Paper	4,000
Cover/Perfect Bind	350
	<hr/>
TOTAL:	\$22,350

As the printed and bound Book Catalog will not present the locations of the materials it lists, an off-line Locate List will be produced concurrent with catalog creation. This list will contain 120,000 numeric entries (LC order number, coded locations and price), and will be generated for Library use only. The cost of offline printing of this list (25 copies) is based on a historical print cost of \$0.014 per one-line entry extended to the number of entries, or \$1,680.00.

Summary of Computer Assisted Catalog Production Costs

The grand total cost per entry for all operations leading to the initial book catalog (based on initial data capture through file construction above) is given in Table 8. As shown in this table, the computer cost per

Table 8. Composite Cost Per Entry of a Computer Produced Book Catalog

<i>Operation</i>	<i>Cost</i>
File Construction	\$0.286
Keyline Production	0.036
Book Production	0.186
Locate List Production	0.014
	<hr/>
TOTAL	\$0.52

entry for the first 'edition' of the book catalog is \$0.52. This figure is comparable to the manual system figure of \$0.99 per entry derived earlier. However, the cost per entry figure for computer assisted file maintenance must also be derived before comparison with the total manual figure of \$1.71 per entry is possible.

Table 9. Cost of Posting and Printing Catalog Update Data

<i>Operation</i>	<i>Unit Cost</i>	<i>Total</i>
<i>Locate Update</i>		
Input	\$00.007	
Print Locate List (offline)	00.014	
	<hr/>	
Subtotal	00.021	
TOTAL for 133,000 actions		\$2,793.00
<i>Biblio Update</i>		
Reformat Master File Entry	00.009	
Sort Reformatted Entry	00.00034	
Print Biblio List (offline)	00.027	
	<hr/>	
Subtotal (rounded)	00.036	
TOTAL for 9,000 actions		324.00
		<hr/>
GRAND TOTAL (142,000 actions)		\$3,117.00

Computer File Maintenance

The figures developed in Table 9 establish a cost per entry for file maintenance, from keyboarding corrected data to the production of an offline printout of Biblio and Locate supplements. To understand their derivation, let us review the frequency of transactions. In Table 1, it can be noted that the 15,000 titles added to the collection annually will necessitate Master File location update for the volumes they represent. The locations for withdrawals will also require update. In combination, additions and withdrawals mean a total of 129,000 actions, plus 4,000 last copy withdrawals, or 133,000 updates yearly to keep the Master Locate File current. In contrast, only the 9,000 new titles will require bibliographic listing.

The Locate File update input cost is identical to that used for the entry of error correction data (Table 5). This is possible since approximately the same number of characters must be keyed to address an entry and enter updated location data (9 characters for record and card code, an action digit, and 2 numeric location characters for a total of 12 characters versus the 14 characters required for entry correction). Similarly, the offline print cost for Locate data remains the same as that indicated for the initial Locate List printout: \$0.014 per entry.

The Biblio File update costs are the computer keyline production figures presented in Table 6. To derive the cost per entry, both Locate and Biblio figures are extended to reflect the proportion of the final figure they represent, and reduced to a single cost per entry. In summation, \$0.0242 is the cost per entry for file maintenance for one year. However, this figure is of limited value without reference to either the frequency of supplemental production or total catalog reprint period. Therefore, the optimum frequency of supplement production and the period of maintenance are discussed below to bring this raw \$0.0242 per entry into perspective.

Optimum Frequency of Supplement Production and Catalog Reprints

The optimum frequency of bibliographic supplement production is based on the most timely reporting of new title disposition at the least cost. That is, a determination of the number of cumulative listings of new titles in concert with all location changes which can be produced before their production cost equals or exceeds the cost of total catalog reprint.

The most economical approach to reporting revised, new, or deleted bibliographic and location entries would be through listing only those entries which have been changed. The summary figures presented in Table 10 reflect only the cost per entry developed in Table 9 for the production of cumulative exception listings, assuming an equal monthly distribution of transactions. In addition, the annual cost per year, excepting the twelfth month, is tabulated to reflect overall cost where total reprint

would occur instead of last cumulative supplement cycle. A quarterly supplement production cycle is selected, as it best meets the optimum defined earlier (i.e., most timely reporting for the least cost).

Table 10. Cumulative Supplement Costs for Various Cycles

Computer Runs Per Year	Annual Cost @ \$0.0242/Entry	
	12th Month Included	12th Month Excluded
12	\$ 22,335.92	\$ 18,899.63
6	12,027.04	8,590.74
→ 4	8,590.74	5,154.44
3	6,872.26	3,436.30
2	5,154.44	1,718.15
1	3,436.30	

By extending the quarterly supplement production costs shown in Table 10 to represent recurring annual expenses and cumulating these annual expenses for comparison with the total cost of complete book catalog and Locate List product, the number of years between catalog reprints becomes obvious. This calculation is shown in Table 11, where 3 years is the optimum reprint cycle for the quarterly supplement costs selected.

Table 11. Catalog Reprint vs. Supplement Production Costs

Years	Supplement Cost		
	Annual	Cumulative 12th Month Excluded	(Year's End) Catalog Reprint
1	\$ 8,591	\$ 5,154	\$ 23,000
2	17,182	13,746	24,250
→ 3	25,773	22,337	25,500
4	34,364	30,928	26,750

COMPARISON AND CONCLUSION

To return to the cost per entry for catalog maintenance alone for optimum reprint cycle, there is a total outlay of \$47,837 for 3 years of cumulative supplements and a catalog reprint to report an average of 129,000 titles. From this base can be derived a cost per entry of \$0.37 for entry maintenance. This \$0.37 can then be summed with the \$0.52 cost per entry for the catalog "first edition", for a grand total of \$0.89 as the cost per entry for a computer assisted catalog production and maintenance system. Further, this cost per entry is realized in a document equal to 400 card catalogs! In terms of the manual system, maintenance was \$0.72 per entry, and some 26 files had to be maintained. Thus, it is possible to extend the single file maintenance cost to a systemwide average of \$18.72, plus the \$00.99 required for entry preparation, or a grand total of \$19.72 per entry, rather than the \$1.71 indicated earlier.

The lesson implied here is simple: manual cost per entry is dependent upon the number of manual files being maintained. This is of importance since it means a significant increase in outlay for file maintenance with the addition of each new branch; whereas, costing for a computer produced and maintained catalog is relatively independent of the number of service units accommodated.

Finally, a word of caution. There is a potential danger lurking in these figures for the small public library which has a limited number of branches. This is the fact that the cost per entry, even for the single shelf list/card-catalog comparison, has been calculated for an operating system serving a relatively large number of branches. The cost-per-entry method used in this paper does not include amortization of the capital outlay for "computerization" which, in this specific case, amounts to almost \$200,000 for design of system, procedures and forms, and for design, coding and debugging of programs. Although savings equal to this amount, or more, would be realized over a period of time because of reduced clerical operations and attendant burden, a large sum would still have to be earmarked for expenditure during a relatively short period with no immediate return.

Foreknowledge of this "one-shot" cost and its related cost-per-entry payoff should not be a deterrent. Rather, it should permit the administrator of a limited operation to deal effectively with increased clerical costs and to make meaningful decisions relative to service bureau overtures, library board interrogations, or the goals of a new library system.

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