THE COMPUTER-PRODUCED BOOK CATALOG: AN APPLICATION OF DATA PROCESSING AT MONSANTO'S INFORMATION CENTER

W. A. Wilkinson

Data processing techniques have been applied at Monsanto's Information Center for several reasons: (1) To lower operating costs, (2) To meet future growth requirements with minimum staff and budget, (3) To provide multiple copies of catalogs and other records for distribution to library users, (4) To use a systems approach in improving operations, and (5) To provide greater accuracy in all records.

The computer-produced book catalog of the Center illustrates many of these points.

A paper which appeared in Special Libraries[1] in 1963 described the semi-automated book cataloging system which Monsanto was using at that time. An efficient, successful system had been developed for producing the catalog via unit record (punched card) machines. And the catalog had proven itself to be a completely satisfactory index to the book collection.

What were Monsanto's problems? They were the inconveniences or weaknesses which are present in most unit record systems, as compared with computer systems, such as:

A. Large numbers of punched cards were handled, sorted, or filed.

B. While most of the sorting was done by machines, some hand filing was necessary.

C. Revisions to the punched card deck were time-consuming. The cards under each entry (authors, title, subjects) had to be removed from the file, revised, and replaced for any change in the body of an entry (a new edition for instance).

Why then had Monsanto started with the unit record approach and not a computer system? In the first place, a suitable computer was not available to them. Among the other reasons were:

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A. Because the library users had never seen a book catalog, its acceptance was unknown; therefore, Monsanto hesitated to invest in (expensive) computer programs at first.

B. It was not known at that time if the rate of additions would be great enough to justify (monthly) computer time.

C. Because Monsanto was in the process of learning to use punched cards, we hesitated to plunge into the intricacies of computer systems right away.

D. It was believed that a good semi-automated (unit record) system could be developed so that it could be converted later to a computer system without recreating the punched card input.

Systems Study

About eighteen months after the semi-automated system started, it was decided that it was time to study the feasibility of converting to a fully automated computer system. A preliminary design for an IBM 1401 computer system was made and cost estimates were prepared to show possible savings in keypunch time, card handling, and filing.[2] It was shown that sufficient savings would be obtained in these operations during the first year to pay for the cost of programming and computer time. (A total of six days per month would be saved in keypunching and filing operations.) Additional benefits which would be derived were:

A. Catalog entries could be revised more easily.

B. A shorter time would be required to produce the catalog and supplements, i.e., the catalog would always be more up-to-date.

C. The build-up of punched card files would be arrested.

D. There would be more flexibility available in the catalog format.

E. There would be greater filing accuracy via complete machine sorting.

IBM 1401 Cataloging System

The heart of Monsanto's cataloging system is the master file. This is a magnetic tape record in accession number order, consisting of one 285-position record for each book. The information on this tape might be likened to a file of unit catalog cards, in accession number order, with each card containing the descriptive cataloging

and tracings for one book. All additions, changes, and deletions in the book catalog are made via the master file.

A simplified flow chart has been prepared to show each step in the machine preparation of the book catalog (see Fig. 1). Two permanent tape records are maintained: the master file and the headings file. Content of the master file was explained above. The headings
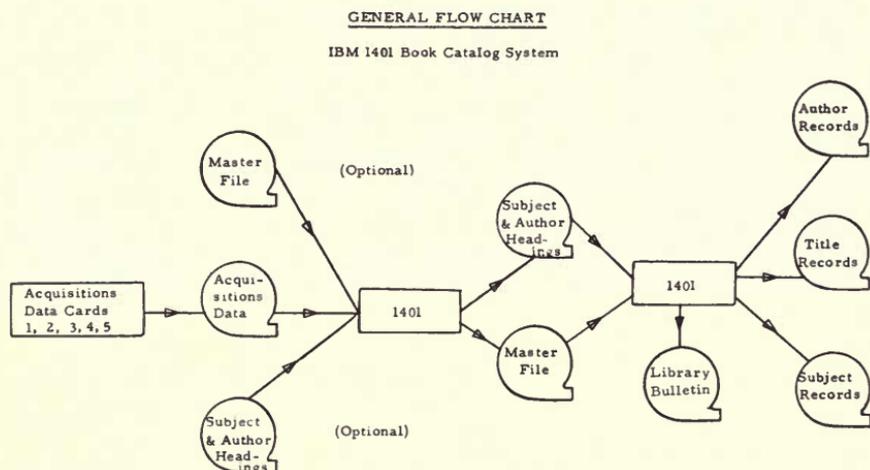

Figure 1

file is a record of all subject headings and cross references which have been used in the catalog. The master and headings files are brought up-to-date by processing new punched cards through the IBM 1401. Then a new, up-to-date catalog is created by extracting information from the master file and headings file to print author, title, and subject catalogs.

A pre-printed IBM card was designed to accept all punching for additions, changes, or deletions in the master and headings files (see Fig. 2). Three types of cards provide input to the master file: (1) A "1" card carries the call number and author information, (2) A "2" card carries the title information (title, edition, volume(s), publisher, date, and series note), and (3) A "3" card carries the subject and series tracings and location codes. In Figure 2, note the numbers 3, 2, and 1 in the right hand margin of the card. Reading across the card at each level, you can see the information that each different type of card contains. Common to each type of card is the information found in columns 1-13;

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PRE-PRINTED IBM CARD

Figure 2

Columns 1-2	"action"	51 = addition
		52 = change
		53 = deletion
Columns 3-8	accession number	
Column 9	card type	1 = author(s)
		2 = title, etc.
		3 = subjects, location
Columns 10-13	card count	Cols. 10-11 = total number of cards of a single type
		Cols. 12-13 = card number within total

The "action" code, which appears in columns 1 and 2, indicates whether the information in the card should be processed as an addition, change (replacement), or deletion. Any of these actions can be carried out selectively in the three different types of cards. For instance, a change in subject headings can be made by punching the revised subject tracings in a "3" card with the "52" (change) code punched in columns 1 and 2. There is no need in this case to resubmit the author and title information. This change feature is especially helpful when a second copy of a book already cataloged is added at another location. In this case, a "3" card is punched with the revised location code and processed into the master tape. Type "4" cards and type "5" cards provide input to the headings file. The former are used for subject headings, the latter for "see" or "see also" references.

A complete set of punched cards for one book is shown in Figure 3.

SET OF PUNCHED CARDS

FOR ONE BOOK

Figure 3

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Book Catalog Format

Sample author, title, and subject catalog pages are shown in Figures 4, 5, and 6. Based on our experience with the book catalog, we have made several changes in the over-all page format. One

SAMPLE AUTHOR CATALOG PAGE

PAGE A   13

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  CONWAY HM                                    551.5      CO         C
    WEATHER HANDBOOK   CONWAY PUB 1963
  COOKE NM & MARKUS J                          R621.3803  CO            O
    ELECTRONICS & NUCLEONICS DICTIONARY   MCGRAW HILL 1960
  COOLIDGE JL                                  519.1 *    CO         C
    INTRODUCTION TO MATHEMATICAL PROBABILITY   DOVER PUB 1962
  COOMBS WE                                    692.       CO         C
    CONSTRUCTION ACCOUNTING & FINANCIAL MANAGEMENT   FW DODGE 1958
  COOPER JD                                    658.39     CO         C
    HOW TO COMMUNICATE POLICIES & INSTRUCTIONS   BNA 1960
  COPPOCK JO                                   338.1      COP        C
    NORTH ATLANTIC POLICY THE AGRICULTURAL GAP   TWENT CENT FUND 1963
  COPSON DA                                    664.8      CO            O
    MICROWAVE HEATING   AVI PUB 1962
▷ COPSON HR  & LAQUE FL                        620.1122   LA         C
    CORROSION RESISTANCE OF METALS & ALLOYS   2 ED REINHOLD 1963 /ACS
    MONOGRAPH 158/
  COREY ER                                     658.8      CORE       C
    INDUSTRIAL MARKETING   PRENTICE HALL 1962
  COTTON FA                                    512.86     CO         C
    CHEMICAL APPLICATIONS OF GROUP THEORY INTERSCIENCE 1963
  COX EB                                       658.1145   CO         C
    TRENDS IN THE DISTRIBUTION OF STOCK OWNERSHIP   PENNSYLVANIA U 1963
  CRISP RD                                     658.8      CR         C
    MARKETING RESEARCH   MCGRAW HILL 1957
  CRISP RD                                     658.8      CRS        C
    SALES PLANNING & CONTROL   MCGRAW HILL 1961
  CROSFIELD LTD                                R338.4766  CRC        C
    CAUSTIC SODA & CHLORINE IN THE SOVIET UNION   CROSFIELD 1959 /EAST
    EUROPEAN CHEM IND 2/
  CROSFIELD LTD                                R338.4766  CRCO       C
    COST & PRODUCT DISTRIBUTION IN THE HUNGARIAN CHEMICAL INDUSTRY
    CROSFIELD 1962 /EAST EUROPEAN CHEM IND 8/
  CROSFIELD LTD                                R338.4766  CRE        C
    EASTERN GERMANY   CROSFIELD 1959 /EAST EUROPEAN CHEM IND 3/
  CROSFIELD LTD                                R338.4766  CR         C
    HUNGARY   CROSFIELD 1958 /EAST EUROPEAN CHEM IND 1/
  CROSFIELD LTD                                R338.4766  CRP        C
    POLANDS TRADE IN CHEMICALS 1958   CROSFIELD 1963 /EAST EUROPEAN CHEM
    IND 9/
  CROSFIELD LTD                                R338.4766  CRS        C
    SOVIET UNIONS CHEMICAL EXPORTS 1955- 1959   CROSFIELD 1960 /EAST
    EUROPEAN CHEM IND 4/
  CROSFIELD LTD                                R338.4766  CRSO       C
    SOVIET UNIONS CHEMICAL IMPORTS 1955- 1959   CROSFIELD 1961 /EAST
    EUROPEAN CHEM IND 5/
  CROSFIELD LTD                                R338.4766  CRSV       C
    SOVIET UNIONS CHEMICAL TRADE 1959-1960 CROSFIELD 1962 /EAST EUROPEAN
    CHEM IND 7/
  CROSFIELD LTD                                R338.4766  CRT        C
    TECHNICAL PROGRESS & ECONOMICS IN THE SOVIET NITROGEN INDUSTRY
    CROSFIELD 1961 /EAST EUROPEAN CHEM IND 6/
  CROSS PC  & ALLEN HC                         535.842    AL         C
    MOLECULAR VIBROTORS   WILEY 1963
  CROSSWELL CM                                 658.22     CR         C
    INTERNATIONAL BUSINESS TECHNIQUES LEGAL & FINANCIAL ASPECTS   OCEANA
    PUB 1963
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Figure 4

SAMPLE TITLE CATALOG PAGE

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CORPORATE REVOLUTION IN AMERICA CROWELL COLLIER 1962
   MEANS GC                                      338.74    ME      C
CORPORATION & ITS PUBLICS   WILEY 1963
   RILEY JW & FOUND RES HUMAN BEHAVIOR           659.111   RI      C
CORPORATIONS IN CRISIS   DOUBLEDAY 1963
   SMITH RA                                      338.74    SM      C
CORROSION & CORROSION CONTROL   WILEY 1963
   UHLIG HH                                      620.1122  UH      C
▷ CORROSION RESISTANCE OF METALS & ALLOYS  2 ED REINHOLD 1963 /ACS
   MONOGRAPH 158/
   LAQUE FL & COPSON HR                          620.1122  LA      C
COST & PRODUCT DISTRIBUTION IN THE HUNGARIAN CHEMICAL INDUSTRY
   CROSFIELD 1962 /EAST EUROPEAN CHEM IND 8/
   CROSFIELC LTD                                 R338.4766 CRCO    C
COST ACCOUNTING  2 ED RONALD PR 1963
   SCHIFF M & BENNINGER LJ                       657.4     SC      C
COST CONTROLS FOR INDUSTRY   PRENTICE HALL 1962
   DUDICK TS                                     657.4     DU      C
COST OF LIVING IN THE UNITED STATES 1914-1936   NICB 1936 /NICB STUDY
   228/
   BENEY MA                                      339.42    BE      C
COSTS OF ATTENDING COLLEGE  GPO 1958
   US DEPT HEALTH ED WELFARE                     378.3     US      C
COURSE IN PROCESS DESIGN  MIT PR 1963
   SHERWOOD TK                                   660.284   SHE     C
CREATIVITY IN INDUSTRIAL SCIENTIFIC RESEARCH  AM MAN ASSOC 1961 /AMA
   MANAGEMENT BULL 12/
   HINRICHS JR                                   607.2     HIN     C
CRESCENT DICTIONARY OF MATHEMATICS MACMILLAN 1962
   KARUSH W                                      R510.3    KA      C
CRIME & THE AMERICAN PENAL SYSTEM ANNALS AAPSS JAN 1962 /ANN AAPSS
   V339/
   AM ACAD POL SOC SCI                           364.      AM      C
CRUSHING & GRINDING A BIBLIOGRAPHY   CHEM PUB CO 1960
   DEPT SCI IND RES                              660.28422 DE        I
CRYOGENICS   VAN NOSTRAND 1963
   SITTIG M                                      660.2968  SI      C
CRYSTAL ORIENTATION MANUAL   COLUMBIA U 1963
   WOOD EA                                       548.      WO      C
CULTURAL AFFAIRS & FOREIGN RELATIONS   PRENTICE HALL 1963
   BLUM R                                        327.      BL      C
CURRENT WORK & CONTROVERSIES 2  AM ASSOC ARTS SCI SUMMER 1962
   DAEDALUS                                      300.      DA      C

                        *D D D D D*

DAG HAMMARSKJOLD LIBRARY BIBLIOGRAPHICAL STYLE MANUAL   UN 1963
   UNITED NATIONS                               R010.      UN      C
DARTNELL INTERNATIONAL TRADE HANDBOOK   DARTNELL CORP 1963
   DARTNELL CORP & LEWIS LL                      R382.     DA      C
DECADE OF SYNTHETIC CHELATING AGENTS IN INORGANIC PLANT NUTRITION   A
   WALLACE 1962
   WALLACE A                                     581.1335  WA      C
DECISION MAKING AN ANNOTATED BIBLIOGRAPHY   CORNELL U 1958 /MCKINSEY
   FOUND ANNOT BIBL/
   WASSERMAN P & SILANDER FS                     658.      WAS     C
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Figure 5

seemingly minor change was to move the page number from the
bottom to the top of the page. This small change resulted in an in-
crease of several lines of print per page and an over-all reduction
of almost 10 per cent in the total size of the catalog. A limitation in
the automatic page numbering routine while printing numbers at the
bottom of the page had caused the short pages. Incidentally, you will
note that each section of the catalog carries a prefix in the page
number, "a" for author, etc. This feature was added after pages 35

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*AIR TRANSPORTATION*

TRANS WORLD AIR- LINES                          908.      TRW       C
    THIRTY YEARS OF SERVICE  TWA 1955

    *AIRCRAFT*

AM SOC TEST MAT                                 629.1345  AM        C
    SYMPOSIUM ON FATIGUE TESTS OF AIRCRAFT STRUCTURES LOW CYCLE FULL
    SCALE & HELICOPTERS 1962  ASTM 1963 /ASTM SPEC TECH PUB 338/
SOC AUTOMOTIVE ENG                              629.135   SO        C
    RELIABILITY CONTROL IN AEROSPACE EQUIPMENT DEVELOPMENT   MACMILLAN 1963
    /SAE TECH PROG SER V4/

    *ALGEBRA*

MOSTOW GO & OTHERS                              512.      MO        C
    FUNDAMENTAL STRUCTURES OF ALGEBRA  MCGRAW HILL 1963

    *ALLOYS*

BRENNER A                                       671.732   BR        C
    ELECTRODEPOSITION OF ALLOYS  ACADEMIC 1963 2V
HULTGREN R & OTHERS                             R669.94   HUL       C
    SELECTED VALUES OF THERMODYNAMIC PROPERTIES OF METALS & ALLOYS  WILEY
    1963
▷ LAQUE FL & COPSON HR                          620.1122  LA        C
    CORROSION RESISTANCE OF METALS & ALLOYS  2 ED REINHOLD 1963 /ACS
    MONOGRAPH 158/
LOWE EW & BIEHL HR                              671.37    LO        C
    MICROSTRUCTURE OF BRONZE SINTERINGS  ASTM 1962 /ASTM SPEC TECH PUB
    323/

    *ALUMINUM*

AM SOC TEST MAT                                 669.72    AM        I
    ASTM STANDARDS ON LIGHT METALS & ALLOYS 6 ED ASTM 1961

    *AMERICAN CHEMICAL SOCIETY MONOGRAPHS*

EGLOFF G & OTHERS                               547.41    EGL       C
    ISOMERIZATION OF PURE HYDROCARBONS  REINHOLD 1942 /ACS MONOGRAPH 88/
LAQUE FL & COPSON HR                            620.1122  LA        C
    CORROSION RESISTANCE OF METALS & ALLOYS  2 ED REINHOLD 1963 /ACS
    MONOGRAPH 158/

    *AMERICAN ECONOMICS SERIES*

LUMSDEN KG                                      330.153   LU        C
    FREE ENTERPRISE SYSTEM  MCGRAW HILL 1963 /AM ECON SER BOOK 1/

    *AMERICAN MANAGEMENT ASSOC MANAGEMENT BULLETINS*

AM MAN ASSOC                                    351.711   AM        C
    TECHNICAL PLANNING IN THE DEFENSE INDUSTRY  AMA 1963 /AMA MANAGEMENT
    BULL 25/
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Figure 6

and 36 of the author and title catalogs had been inadvertently inter-
changed in the first edition by the bindery.

    In earlier editions of the catalog, it was felt that it would be
wise to approximate card catalog format for the convenience of li-
brary users. For this reason the call number had always been

placed on the left, beginning on the first line of each entry. This is no longer the case. There are two reasons for the change. First, it was believed that it would be logical for the first word in each entry to be the filing word, and all other information would follow.[3] As you can see, this is now the case in each part of the catalog. Second, there are two pieces of information in each entry which together tell where the book is shelved: the call number and the location (library branch) code. This information was separated when the call number was at the beginning of the entry, but now can be found in one area at the right. Monsanto finds that it is a good reminder to catalog-users that it is a union catalog and that they must note both call number and location.

Several features which have been programmed to appear automatically in each entry even though they are not punched into the input cards are:

A. Asterisks are inserted at both ends of each subject heading to make the heading stand out better on the page.
B. Joint authors are punched with two blank columns between them in the "1" card (see Fig. 3). The program causes the authors to appear once in this order and once in reverse order as two separate entries in the catalog. Also, during the print program an ampersand is inserted between them.
C. No decimal is punched in the classification number. It is inserted automatically during the printing step.

Schedule of Operation

A completely revised catalog is produced yearly. Cumulative supplements are issued every two months. A subject listing of new books is issued every month. During the month, a card file is maintained in the library to locate cataloged books not yet listed in the catalog or supplements. This schedule is flexible, so that revisions or supplements can be made more or less often depending on the need. It is felt that the present schedule is quite satisfactory.

During the month, as new books are cataloged, punched cards are prepared for the monthly run. On the eighteenth working day of each month (generally about the twenty-fifth day of the month) all additions, changes, and deletions cards are processed against the master and heading files (tapes). Then all new records are selected to produce the listing of new books, which is distributed widely as Monsanto's monthly Library Bulletin at the end of the month. Selection of records from the master tape is controlled by "keys" in the master record for each book, one for the monthly new book listing and one for the year-to-date supplement. The keys are erased after

the new book listing and the final year-to-date supplement are issued.

After the listing of new books has been made, the year-to-date supplement is printed, during alternate months. In the twelfth month, a complete revision of the catalog is prepared, instead of a year-to-date supplement. Provision has been made via a control card, for adding older books to the master file without selecting them for the new book listing.

Copies of the monthly Library Bulletin are distributed to about 500 individuals, departments, and libraries within Monsanto. About seventy-five copies of the book catalog (and supplements) are distributed to libraries, departments, laboratories, and some individuals. Those who have the catalog keep a copy of the Library Bulletin for reference during the alternate months when no supplements are issued.

Conversion to the Computer System

As part of the systems evaluation study, consideration was given to the conversion of existing punched card records into a format acceptable to the computer system. If it had been necessary to re-punch the records for the 7,000 volumes already cataloged, justification of the change would have been more difficult. Programming for the conversion turned out to be almost as difficult as writing the operating programs.

Monsanto's problems resulted from devices which had been used in programming efficiently for unit record equipment, especially the Document Writer (IBM 870 Document Writing System). The most serious of these was a lack of complete card control in the existing punched cards. A "1" punch in column 1 of the first card in each set of cards and a "2" punch in column 1 of all other cards in the set for each book had been used. This had been done because of the very limited ability of the Document Writer to recognize controls. If one thing was learned from the whole project, it was the importance of adequate card control.

Another problem encountered was the elimination of card control characters which had been punched into the original cards to control printing on the Document Writer. For instance, a non-printing %symbol had been punched at the end of the title to cause a carriage return. These special characters were not needed in the new system, and had to be removed. They were removed during an editing and move-up step in the conversion program.

Many other problems were solved during the conversion either by programmed routines or by error messages. Where very complicated programming and/or an unreasonable amount of machine

time would have been necessary to correct problems in a small number of entries, provision was made to recognize the problems and print messages to say where they were. Then corrections were made later to the master file by the normal change card routine.

Future Plans

Plans were made several months ago to integrate the cataloging system back to the purchasing step. A flow chart was developed and a five-part purchase order was designed and ordered in cooperation with Washington University School of Medicine Library, St. Louis, Mo. (see Fig. 7). The forms have been received now and a board has been wired for the Document Writer. As this paper is being

PURCHASE ORDER FORM

Figure 7

prepared, Monsanto is preparing to start the purchase order routine on an experimental basis.

Under the new system for writing purchase orders, punched cards are created as the first step in ordering, instead of typing purchase orders. The cards are punched in the format necessary

for the cataloging system with the exception that at this stage the call number, accession number, and subject tracings are not yet available. An additional card is punched with all the information specific to the purchase order (vendor, order number, number of copies, etc.). By feeding the cards to the Document Writer, purchase orders are written with ccpies for vendor, requester, order record, follow-up, and a cataloger's work copy. The latter is on card stock and eventually becomes the shelf list card.

After the book has been received, the cataloger verifies the information already printed on the work copy (author, title, etc.) and adds the call number and subject tracings. This added information is keypunched into the original cards, the accession number added, and the cards are ready for addition to the catalog. While this system looks good on paper (eliminates two typing steps), it remains to be proven in actual use. Other projects planned or under way include:

A. The addition of the complete holdings of three branch libraries to the catalog. (At present, only books added to the branches since 1961 are included.)

B. Editing certain subject headings, "see" and "see also" references and abbreviations of corporate authors for more consistency.

C. Optimizing publication schedule and methods of printing and binding to suit needs.

Conclusions

Although most of the lessons that Monsanto has learned have already been indicated, some deserve another mention in closing:

A. Use fixed fields in the card format if at all possible.

B. Provide adequate card control by card identification and card count.

C. Data control is extremely important. Many hours of programming or machine time can be wasted by careless errors in input data.

D. These problems can be reduced by programmed checks of input data with error messages when appropriate.

E. Use a "systems" approach; do not just automate existing methods.

F. Know your costs. It would be bad to build a heavily automated system on a weak cost structure, subject to withdrawal later when costs are re-examined.

And lastly, plan your system with both an immediate and a long-range goal. It is not possible to wait for the ultimate system; one area should be isolated and worked on at a time. When all the

problems in that area have been solved, move on to another, always keeping the long-range goal in mind. In that way, benefits of improved methods are obtained all along the way, disruptions in library operations are minimized, and encouragement will be gained from each success.

REFERENCES

1. Wilkinson, W. A. "A Machine-Produced Book Catalog: Why, How and What Next?" Special Libraries, 54:137-143, March 1963.

2. All of the computer programs for Monsanto's Information Center were written by W. A. Shank of Monsanto's Business Systems Department. Without his courage, patience, and thorough knowledge of programming, "3" by "5" cards might still be typed.

3. Also suggested by F. W. Holzbaur, IBM Data Systems Division. Personal communication, July 16, 1963.

Additional References

1. Technical Reports Index. This is a computer-based system which produces coordinate indexes in book form. It has been described in the following article: Logue, Paul. "Deep Indexing Technical Reports," Journal of Chemical Documentation, 2:215-219, Oct. 1962.

2. KWIC Indexes. Using the KWIC (Keyword-In-Context) indexing technique, an index to Monsanto Marketing Reports has been prepared and revised. Other KWIC indexes are in preparation.

3. Monsanto List of Serials. This publication is in its fourth edition (since 1958) and includes the holdings of nine Monsanto libraries.

4. Subscription and Standing Orders List. A punched card record for each title includes information such as expiration data, supplier, cost, frequency, where shelved, how checked in, retention, whether cataloged, etc. Renewal lists, budgets, expiration check lists, check in records, etc. are prepared from these cards.

Appendix

Since accurate cost information was not available when the manuscript was written none was included in the paper. The following costs have been gathered and are now added to make the paper more complete.

Annual Cost of Book Catalog System*

1. Amount of IBM 1401 Computer Time Used:

Library Bulletin	6 hours/year	
Catalog Supplements	5 hours/year	
Annual Catalog Revision	4 hours/year	
Total	15 hours/year	@$50.00 hr.

Annual Cost of Computer Time = $750.00

2. Other Cost:

Keypunching Time	$500.00
Keypunch Rental	$600.00

3. Total Yearly Cost $1850.00

*Provides monthly Library Bulletin, bimonthly cumulative supplements to catalog, and annual complete revision of three-part book catalog. Does not include cataloger's time. Current rate of new additions about 1,500 titles per year.

Discussion

W. A. Kozumplik*

Cost consideration, it is my belief, determines utilization of machines for library operations. The costs we have in mind are concerned with labor, equipment, and space. Of these, labor is by far the most critical, which is the reason mechanization efforts have been so widely applied in our civilization.

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When ways in which to mechanize library operations are considered, there is no doubt that it is the cataloging product which, more than any other operation, holds exceptional promise for cost-reduction. This has been Monsanto's experience. Of all library operations, Monsanto placed initial focus on cataloging, conquered the problem in two phases, which led it from a semi-automatic to a fully automated product, and then set sights on further areas to mechanize. We all look forward to knowing of Monsanto's further experience on the latter in terms of cost and effectiveness of product.

With respect to mechanizing the cataloging product, some libraries have employed the computer to deliver catalog cards as the product. In so doing, 30 per cent savings were achieved over the best available manual method of catalog card producing (utilizing the electronic typewriter).

Monsanto eschewed this step, going directly from catalog card to printed page. When it did this, it achieved additional savings in equipment and space; these are not identified by William A. Wilkinson. Considering equipment alone, savings in the order of 30 to 1 are effected when one supplants card-catalog cases by shelves—even wood shelving, which is double the cost of metal shelving. Savings in space are not so spectacular, being only in the order of 3 to 1. (For a fuller treatment of such comparative costs, one may read the article by Fred Heinritz,[1] which is a condensation of his doctoral dissertation submitted in 1963 to Rutgers University.) To summarize: respecting only equipment and space, the codex catalog is immeasurably less expensive than the card catalog.

You will recall that in 1963 Wilkinson reported Monsanto's comparative costs of manually produced catalog cards versus machine production of the codex catalog.[2] It is my belief that cost considerations were again the dominant determinant in Monsanto's decision to convert its codex catalog production from a semi-automatic system to one fully automated (computer based). Then late in 1963, cost estimates showed Monsanto that possible savings in keypunch time, card handling, and card filing would, in the first year of operation alone, more than pay the programming costs. While Wilkinson does not state it, my conjecture would be that Monsanto was also prompted by two other considerations in deciding to effect this conversion, namely, the potential spin-offs that were so highly desirable and attainable at no extra cost (see Wilkinson's items D and E under "Systems Study") and the attainable improvements in existing products (see Wilkinson's items A, B, and C under "Systems Study").

Cost, not concern for or interest in the reaction of the scientist or engineer to use of the codex catalog, determined the institution and refinement of machine methods at Monsanto. It would be interesting to know how Monsanto's users of technical information reacted

to the codex form. A few undoubtedly grumbled over the change. What we do in such cases is to take these individuals aside and tell them that the codex catalog is what they, as traditionalists, really should be fighting for, not against, because a codex represents a return to the state of affairs before Melvil Dewey. It was his card catalog, you remember, which supplanted the codex catalog in the fourth quarter of the nineteenth century. If there is any doubt that this is not a precious example of the concept "coming full circle," let me remind you that the card catalog was instituted for reasons of economy. Librarians were definitely cost conscious in those days. And resting on our laurels, we found ourselves complacently asleep, from which sleep outsiders chiefly have been trying to arouse us, or at least they have been making the most noise. Clinics like this attest in part to the fact that our profession is indeed aroused and is forging ahead in the role of leadership.

Were we to pursue considerations of cost to their logical end, we should expect that Monsanto would be thinking about taking another step in utilizing computers for its technical information center operations, namely, the storage and retrieval of bibliographic retrieval points in depth. Monsanto may have already thought along these lines and may have discarded the challenge on a cost basis, possibly because of current and forecast low-volume use. In any event, it would appear wise to wait, before any serious, final independent attempt is made along these lines, until the Library of Congress reaches a decision to automate its operations and writes system and hardware specifications. While not expecting to be fully operational until 1972, the Library of Congress system will set the national pattern towards automating research libraries for generations to come. It appears rather mandatory, therefore, for the smaller research library—and this covers about all industrial libraries and all but a handful of university and college libraries—to reconsider expending dollars for systems and hardware that would automate resources, services, and operations. It appears clear that existing programs must be compatible with the system evolved by the Library of Congress if the vast potential for effective utilization of existing national resources (interlibrary cooperation) is to be realized.

In our society, scientific and technical writing constitute a national resource; this resource only becomes effective when it is placed under effective bibliographic control. In the area of scientific and technical disciplines, printed contributions are proliferating at the rate of one magnitude each fifty years.

In fiscal 1963, the Federal Government spent $15 billion for research and development (R&D). The National Science Foundation has reported that the generating federal agencies in 1963 expended $1.5 billion on STINFO (scientific and technical information). So that you are not misled, let me point out that these STINFO dollars

include expenditures for four services or capabilities, namely, (1) publication costs—editing, art work, typing, printing, distribution; (2) travel costs—attending society meetings and sponsoring symposia or clinics (like this one) in order to "acquire" information; (3) library costs—procurement and organization of recorded knowledge, circulation, reference, and literature search services; and (4) computer or data processing costs—development and production of mechanized capability to store and retrieve information rapidly and reliably.

Obviously, there is a need to control literature. Effective bibliographic control, together with timely availability of the literature, should prevent repeated reinvention of the wheel. It was over six years ago, you remember, that L. H. Flett produced the challenging statistics in Information Resources—A Challenge to American Science and Technology[3] that 45 per cent of the R&D expenditure is wasted. Flett's reason is that recorded knowledge was not effectively utilized. I have not personally checked these findings, but if Flett's figures are any indication of the magnitude of the problem, it would appear that several billion dollars are going down the drain annually.

Bibliographic control costs money; such costs will be astronomical by 1975 should we continue to use the traditional methods of cataloging, indexing, storaging, and retrieving. These costs would even be excessive today if it were not for our practice of discarding certain works, thus exercising judgment not to catalog for admittedly arbitrary reasons; one overworked reason which you will easily recognize rests on format, particularly that associated with the concept of ephemera.

We just cannot afford to go the route—the rut—of tradition. In a very few years, the cost problem will have been pre-empted by the bigger problem of the chaotic, accelerating, and inundating, "publish-or-perish" paper storm, wherein backlogs of uncataloged (bibliographically unorganized) materials will mount. Recorded knowledge could not possibly be put to effective use; unwanted duplication will abound. It is in such an environment of rising costs and mounting backlogs that computer technology thrives. In an automated system, backlogs normally do not accrue, and the items, as well as their contents, will be under excellent bibliographic control at a cost per title much less than what can be achieved through traditional systems. In addition, computer technology insists on a systems approach which inevitably identifies other technical information center operations that are amenable to mechanization. It has already happened in this fashion at Monsanto, where the semi-automated codex catalog of 1962 has been programmed for fully automated (computer) production in 1963. It is the system analysis approach which quite likely produced Monsanto's decision "to integrate the cataloging system back to the purchasing step," according to Wilkinson. The fact

that the new purchase routine is on a semi-automated basis should not belittle the efficacy of the systems analysis approach. The plain fact is that certain library operations will continue to be accomplished more economically by manual or semi-automated methods; not all stand the cost-test for going fully automatic.

Of the latter variety, two functions and their computer application come to mind: (1) who needs what, that is, the selective dissemination of information (SDI) based on up-to-date user-interest profiles; and (2) deeper and broader identification of contents, that is, a program to store and to retrieve information to a high degree of specificity, almost as though we would be indexing and not cataloging. I should like to hazard the guess that the reason Wilkinson did not mention those two programs was because of their cost, due in part to the size of the collections and to the volume and kind of use which did not warrant deeper specificity and more rapid retrieval at this time.

If this is the case, we once again note that cost rules. But we also note that user needs appear to be receiving more serious consideration.

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