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## **BELL LABORATORIES ON-LINE CIRCULATION CONTROL SYSTEM: ONE YEAR'S EXPERIENCE**

An on-line, real-time computer circulation system has been in use by the Technical Information Libraries of the Bell Telephone Laboratories since March 1968. In its initial configuration the BELLREL (Bell Laboratories Real-Time Loan) system links two terminals in each of the company's three largest libraries—at Holmdel, Murray Hill and Whippany, New Jersey—to an IBM 360-40 computer at Murray Hill. The system is designed to process loans, returns, reservations and a range of information queries with real-time immediacy and responsiveness; in addition, batch operations provide multiple reports and other products necessary to the effective control and management of library resources. Basic to the objectives and performance of the whole system is a computer-stored record of the major publication resources of the participating libraries.

During the first year of operation, with not all the total collection complete on disk, BELLREL handled over 105,000 loans and 250,000 transactions (i.e., loans, returns, reservations, and queries) in real-time. This paper reviews the objectives and principal features of the system and describes its performance, uses, problems and impact during the first twelve months of daily service.

### **SYSTEM ENVIRONMENT AND OBJECTIVES**

Any effective system must be a good servant in its environment, and even a brief consideration of a system requires some exposure to the context in which it functions. The environment for which BELLREL was designed is characterized by a large population of library users; rapidly mounting information demands; dispersed collections and operations; a heavy volume of mail,

telephone, and recorded message requests; and a major commitment to computer-aided systems. More specifically, the Technical Information Libraries network includes eighteen library units serving some 16,000 Bell Laboratories people in nine states and at Kwajalein Island in the Pacific. Nine of these libraries are jointly operated with the Western Electric Company (the manufacturing and supply unit of the Bell System) and also serve Western engineers at these sites. Total circulation in the library system is now close to half a million items per year, including one-way computer documents, technical reports and other publications. The three libraries first linked into the BELLREL system handle about 75 percent of all this traffic, generate over 40,000 overdue notices per year, hold 92 percent of all the book and journal titles in the library system and serve on-site (but not exclusively) some 12,000 Bell Laboratories people.

The many reasons which compelled investigation of a computer-aided replacement for the manual charge system used by Bell Laboratories Libraries for some forty years have been given in an earlier paper<sup>1</sup> and will not be detailed here. Perhaps it will be sufficient to observe that the imperatives were significant. The objectives established for the new system merit restatement, however, since they bear directly on the selected design and its subsequent performance.

Library management concluded in 1965 that any new system had to:

1. Meet the long-range needs of the major libraries in Bell Laboratories and be extensible to other units in the library network as traffic, costs and experience warranted.
2. Provide not only a more effective means for handling circulation operations within the walls of any one library but also an instrument for knocking walls down, for bringing the combined resources of the dispersed libraries to bear on any information need.
3. Give up-to-the minute accounting for all items off the shelves *and* locate copies still available for use:
4. Handle all types of materials, bound or unbound, and all types of requests whether in person, by mail, direct telephone or Telereference (i.e., recorded message) service.
5. Hold reservations against system resources and follow up on reserve queues automatically, directing the first copy available anywhere to the first person waiting, wherever located.
6. Identify all items currently or formerly charged to a borrower.
7. Reduce circulation staff labor and refocus it, where possible, on more personal service to library users.
8. Monitor circulation traffic in depth and provide feedback, sufficiently rich, meaningful and timely, to enable management to react appropriately.
9. Integrate satisfactorily with other computer-aided systems in use or planned in the libraries.
10. Above all, improve the total response of the Library to the user.

Translation of these objectives into practice dictated not only a real-time system for recording items on loan or demand but one built around the use of on-line accessible records of pooled bibliographic resources.

It is interesting to note that in a recent paper Audrey Grosch of the University of Minnesota lists the benefits which would accrue from an on-line circulation system having "at its heart a file structured to handle both bibliographic and operational data."<sup>2</sup> All seven benefits which she mentions are included in the objectives given above. All have been realized in the BELLREL system.

Before discussing the actual performance of the system, however, a brief review of its principal characteristics would be appropriate. Since BELLREL has been described in some detail in an earlier paper<sup>1</sup>, what follows is a summary of only the salient features.

## PRINCIPAL FEATURES OF THE BELLREL SYSTEM

### Network Configuration

Library terminals: total of six IBM 1050 terminals, each incorporating a 1052 keyboard-printer and a 1056 card reader for maximum flexibility in handling all types of transactions

Telecommunications links: Western Electric 103A Data-Sets using voice grade telephone lines

Computer: IBM 360-40 with 262K byte core memory, in the comptroller's division at Murray Hill

Network distances: one-quarter mile, twelve miles and thirty miles.

### Computer Usage and Programs

Computer sharing: BELLREL on-line operations and heavy batch processing (for comptroller's division purposes) run concurrently

Operating mode: MFT (Multiprogramming with a Fixed Number of Tasks), i.e., the dynamic area of core, as distinct from the 360 Operating System area, is partitioned into four segments, each of which is independent with respect to job scheduling, initiation and termination. The partitions are assigned processing priority. A job in a given partition gains control when another job in another partition must wait for the completion of some event, such as reading records from tape. A job in a lower priority partition, (e.g., Partition 3-batch processing) is suspended when a higher priority job is ready to resume. The BELLREL on-line system is assigned the highest priority, using Partition 0 (the teleprocessing logic of the IBM Queued Teleprocessing Access Method) and Partition 1 (message editing and BELLREL applications packages). Viewed from the library end, BELLREL appears to own the computer.

BELLREL programs: about thirty-two real-time and twenty-three batch programs. Input-output and message processing programs are written in Basic Assembly Language and the balance in COBOL level F.

### On-Line Man File

Purpose: through man number, to supply all necessary information about an actual or potential borrower and his current loans, if any

Coverage: 19,000 people and thirty-six special non-personal borrower codes for sister libraries, internal operations (e.g., binding, new book shelf, missing), etc.

Update frequency: daily

Storage medium: IBM 2316 disk pack

Access method: index sequential on five-digit man (payroll account) number

Record elements: 161 characters including man number, name, address, department, occupational class, loan data, keys to overflow trailers, etc.

### On-Line Publication File

Purpose: through title number, to supply all necessary bibliographic and transaction data for loans, reserves and resource queries

Coverage: initially, four classes of publications\*

Books (Class 1)—35,000 titles, 66,000 volumes

Journals (Class 2)—2,700 titles

Suppliers' Catalogs (Class 3)—5,000

College Catalogs (Class 4)—1,000

} when conversion  
} is complete

Update frequency: weekly

Storage medium: IBM 2316 disk pack

Access method: for books, direct on six-digit title number, the first digit of which is a 1; for other publications, index sequential

Book record elements: 188 characters including book number, forty-three characters of author-title, call number, copies by location, maintenance change data, three loans, two reserves, trailer keys, etc. Lqan fields give borrower number, copy, date due, loan status, etc.

Journal record elements: 155 characters including journal number, forty-three characters of title, maintenance change data, two loans, one reserve and trailer keys. Unlike books, records of all copies and volumes of each title are not permanently stored. Bound volumes and unbound issues are recorded on this record only while on loan or reserve. Punch cards and labels have been computer-produced for over 20,000 volumes.

Other publication records: comparable to journal records except that each separate supplier or college catalog is specifically identified and recorded.

### History File

Purpose: to provide statistics, user analyses and other management information

Coverage: all completed loan transactions

Update frequency: daily transfer from the publication disk file of completed loan data

Storage medium: magnetic tape

Record elements: item number, author-title data, call number, number of loans, date returned, copy number, man number (or non-personal code such as "Lost"), department, occupational class, etc.

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\*A fifth class, originally established for cataloged continuations and multiple-volume titles cataloged as sets, has been restructured and combined with books.

## On-Line Transactions

Input message elements: transaction code plus item number and/or man number, depending upon the transaction

Input method: All message elements are normally keyed except when a publication punch card is available, i.e., for loans and returns.

Transaction codes: Ten codes exist for loans, returns, reservations and renewals. The use of three of these codes is shown in Figure 1. Twelve codes are available for queries about publications or people. Three queries are shown in Figure 2. Additional codes provide for inter-terminal communication and obtaining statistical logs of traffic (Figure 3) at each terminal.

Error detection: Each input item number and man number is translated, after disk lock-up, in the returned response. Numerous diagnostics are also returned for invalid codes, items, input sequences, etc. Samples are given in Figure 4.

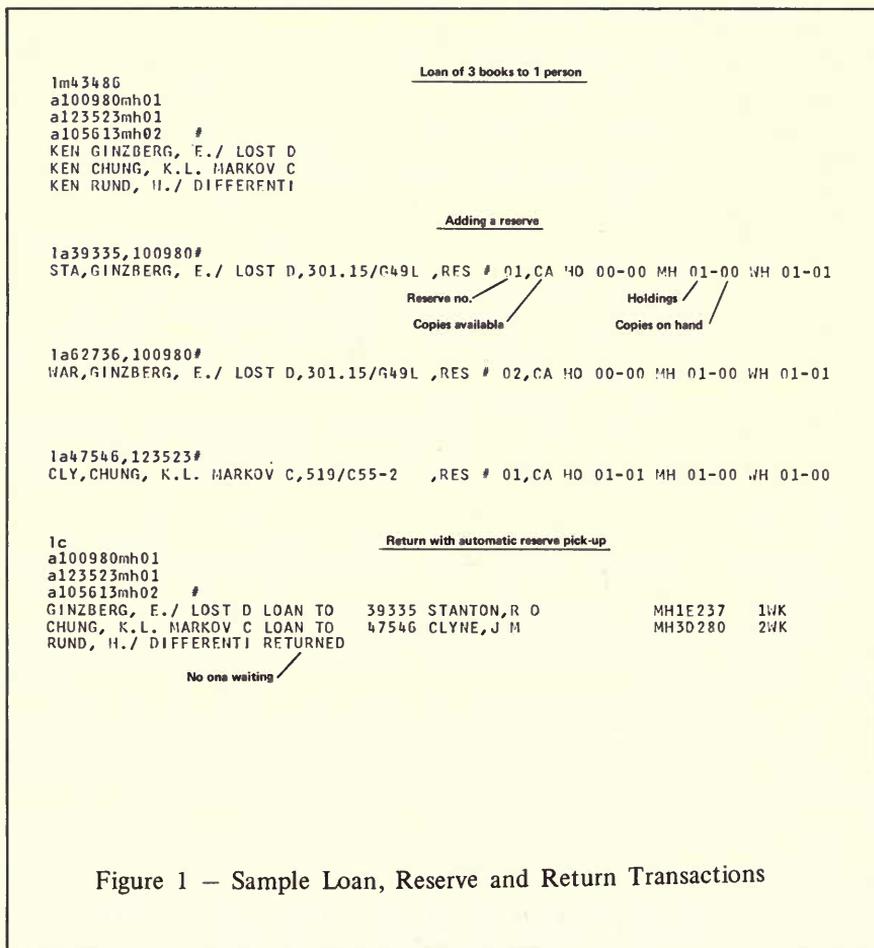


Figure 1 — Sample Loan, Reserve and Return Transactions

What is on loan to ... ?

1q166364#

SHR  
 120922, DELMONTE, J. PLASTIC,  
 120923, DELMONTE, J. PLASTIC,  
 130359, HARRIS, C.M. / SHOCK ,  
 239328, J APPL MECH , 16-7/49-50  
 130358, HARRIS, C.M. / SHOCK ,

114864, TIMOSHENKO, S. / FLEM,  
 130515, MORROW, C.T. SHOCK A,  
 66364, SHROFF, J R, MH1E219 , MH 4130, 006 BOOKS 001 OTHER

Who has ... ?

1qw105976#

DIXON, W.J. / INTROD , 519.7/D62-2  
 HQ 03-02 MH 03-03 WH 02-00 # RES 00

WH01 STAFFORD, A WH7A261 5759 69084  
 HQ03 O NEILL, L HQ3E209 4264 69999  
 WH02 SEIDELMAN, WH3E207 3215 69078  
 THATS ALL

Who is waiting for ... ?

1qx135498#

DINN, H.F. ESTIMATIO, , T1/D58  
 HQ 01-00 MH 00-00 WH 00-00

RES# 01, GOTZ, B , 58627, HQ3B510 , 2540, 02 WEEKS OLD  
 RES# 02, SEIDMAN, L , 46356, WH2B242 , 6218, 01 WEEKS OLD  
 RES# 03, HEFFES, H , 50870, WH1M217 , 2835, 01 WEEKS OLD  
 THATS ALL

Figure 2 — Sample of Three Queries

!?	HO1	HO2	MH3	MH4	WH5	WH6	MON	TOTAL
A	58	9	48		21	20		156
B	11	11	1	55	3	3		84
C	46	29	20	72	48	20		235
D	2			3				5
G	9	4	6	4	22	5		50
K								
M	40	11	31	5	50			137
N	4				1			5
P	3	1						4
R	7	4						11
QN						1		1
QM	2		1		2	3		8
QL	1	2	1					4
QR								
QC	5	20			1			26
QS	8	1	1	2	41	12		65
QD		1		6	2			9
QE							1	
QQ								
QW	2	1	14	1				18
QX	1							1
TOTAL	199	94	123	148	191	64	1	819
ER	1	3		6		1		11
?		1		1				2

GOOD AFTERNOON    TODAY IS 68348

Figure 3 — Log of Transactions by Terminal

### BELLREL AT WORK

Some appreciation of the uses to which BELLREL is put may be gained from the repertoire of on-line commands and the variety of batch products (see Figure 5). In our earlier paper we also described standard procedures for making loans, handling returns and processing reservations. The degree in which the new system has altered old procedures and become an integral element in library services may be better conveyed, however, by reviewing some typical operations.

#### Locating a Book

A scientist cannot find a given book on the shelves. He inquires at the circulation desk. Pre-BELLREL, the clerk checked the loan cards, consulted the union card catalog to determine what copies were held and where, called one or more libraries as appropriate, relayed the scientist's name and address if a copy were found or, if all were in use, decided which library should add his name and address to its reserve list, etc.

1q177989#  
INVALID HAN NO 77989

1qc138214#  
INVALID ACCESS NO 138214

1a43486 123456#  
INVALID TRANSACTION-COMMA MISSING  
A43486 123456

1m43486,123456mho1#  
INVALID TRANSACTION BAD LOAN PERIOD  
M43486,123456MH01

1m43486,2,123456#  
INVALID TRANSACTION BAD LOCATION CODE  
M43486,2,123456

1a43486,127257#  
ITEM # 127257 PURGED

Figure 4 - Sample Error Messages

1. OVERDUE NOTICES	DAILY
2. LOAN LISTS	DAILY
3. CARDS AND LABELS	WEEKLY
4. BOOK & JOURNAL CATALOGS	QUARTERLY
5. CATALOG SUPPLEMENTS	WEEKLY
6. CIRCULATION STATISTICS	MONTHLY
7. TITLES IN DEMAND	WEEKLY
8. RESERVE QUEUE AGING	WEEKLY
9. GET OFF THE SHELF	WEEKLY
10. MISSING ITEMS	BIWEEKLY
11. LOANS BY USING DEPT.	MONTHLY
12. LOANS BY SUBJECT	MONTHLY
13. SUBJECT USAGE BY DEPT.	MONTHLY
14. ZERO ACTIVITY LIST	SEMIANNUAL

Figure 5 — Some Batch Products of BELLREL

In the on-line system, the clerk finds the book's control number in one of the BELLREL printed catalogs before him and then keys in the reservation code with man number and book number. The computer responds in three to five seconds giving book data and call number, the holdings and, as of that moment in time, the number of copies available in each of the three libraries (Figure 1). It also identifies where the requester stands in the waiting queue, if there is one. If all copies are in use, then the requester knows where he stands in the queue and what the system resources are to meet his need. And if he must see a copy promptly, the on-line LQW command (Figure 2) will identify all borrowers, their locations and telephone numbers, thus permitting him to get in touch with the nearest one. If, however, a copy is reported to be available in another library, then that library is asked, by telephone or terminal message, to send call number such-and-such "out." The holding library gets the book from its shelves and cancels it. This charges the requester with the book, assigns him the correct loan period, and identifies him. The dispatch follows.

As a result the on-line system eliminates two or more card file look-ups, provides up-to-date facts on holding (What large library has not a filing backlog for its card catalog?), determines exactly where copies are available at the moment of need, gets the nearest one on its way to him or insures (as the manual system simply could not) that his need will be met from automatic reserve queue follow-up on any copy returned anywhere in the system.

### Handling Library Bulletin Requests

One of the library's eight regular current awareness bulletins is the *Library Bulletin* announcing, among other publications, several hundred books each month. Requests for these books are submitted on tear sheets, citing item numbers. Over 600 requests are received in the first few days after *Bulletin* issue. In pre-BELLREL practice, a clerk in each library had to identify the book associated with the item number and write each requester's name and address on the charge card (if held locally) or if not, on an inter-unit request card. In this inter-unit interchange request priorities got badly disturbed, charge records were duplicated and system resources were used inefficiently. Further, while each library attempted to scan the card files and flag high-demand titles for additional purchases, follow-up tended to be slow, incomplete, uncoordinated and needlessly duplicative.

In the BELLREL system, *Library Bulletin* request forms supply both the BELLREL item numbers and the requester's number. The processing clerk posts batches of requests, using the on-line reserve transaction, and ignoring, pro tem, the computer responses concerning copy availability. He then takes the print out (one of several reasons for selecting typewriter response rather than cathode ray tube display) and proceeds to act on the messages. Books available locally are collected, cancelled in lots of five using the BELLREL cancel or return command and thereby are automatically charged and directed to the queued requesters. For books available elsewhere in the system, he can send the flagged print out, or a copy, to one or more of the libraries; alternatively, if the weekly *Get Off the Shelf List* (Figure 6) is due, he takes no

action on these items because this list, which goes to each library, will identify all cases where copies are available and someone is waiting. It will be apparent that this list is also a persistent machine follow-up on any human failure to retrieve a needed book from the shelves.

The *Titles in Demand List* (Figure 7) is also a very powerful tool in getting new books promptly to the waiting audience. This is a weekly report which documents all titles for which there are more than five people waiting. Both the frequency and the threshold can, of course, be altered as required. The list, in classification order, identifies each title, each library's holdings,

GET OFF THE SHELF		03/21/69	
COMPUTER DESIGN FUNDAMENTA	510-783/C55	HD 04-03 MH 01-01	WH 02-01 RESERVES WAITING 1
DIFFERENTIAL CALCULUS	517/F96	HD 01-01 MH 01-01	WH 00-00 RESERVES WAITING 1
THEORY OF CONFORMAL REPR	517.8/K75	HD 01-01 MH 02-02	WH 00-00 RESERVES WAITING 1
PROBABILITY, RANDOM VARIABLES	519/P21	HD 03-00 MH 03-01	WH 00-00 RESERVES WAITING 1
PAPERS ON NOISE AND STOCH	519/M35	HD 00-00 MH 01-01	WH 02-01 RESERVES WAITING 1
ALGEBRA OF OBSERVATIONS	519/M59-4	HD 01-01 MH 02-02	WH 02-01 RESERVES WAITING 1
MATHEMATICAL STATISTICS	519.7/M68-2	HD 01-00 MH 01-01	WH 01-00 RESERVES WAITING 1
STATISTICS OF GROUPS VI	530.5/K12-E	HD 01-01 MH 01-01	WH 01-01 RESERVES WAITING 1
PROCESSES AND THEIR SAM	531.36/I89	HD 01-00 MH 01-00	WH 01-01 RESERVES WAITING 1
HYDRODYNAMIC STABILITY	532.5/L73	HD 00-00 MH 00-00	WH 02-02 RESERVES WAITING 1
WAVES IN LAYERED MEDIA.	534.2/B83	HD 01-01 MH 00-00	WH 01-00 RESERVES WAITING 1
PHYSICS OF OPTICS	535/B73-3	HD 02-02 MH 00-00	WH 01-01 RESERVES WAITING 1
LECTURES ON ELECTRICITY.	537.22/E31	HD 01-01 MH 00-01	WH 01-01 RESERVES WAITING 1
PHYSICS OF MAGNETISM.	538/C53	HD 01-01 MH 01-00	WH 00-00 RESERVES WAITING 1
EFFECT AND RELATED PHENOM	539.9/P98	HD 00-00 MH 02-00	WH 01-01 RESERVES WAITING 1
SOLIDS, SYSTEMS AND COMMUNICAT	T1/L35	HD 03-01 MH 02-01	WH 03-00 RESERVES WAITING 1
ENGINEERING EXAM 0 AND A	620.76/L21-2-2	HD 01-01 MH 01-00	WH 02-01 RESERVES WAITING 1
GUIDED WAVE RADAR SYSTEMS.	T49/S62	HD 01-01 MH 01-00	WH 04-01 RESERVES WAITING 1
PHYSICS ANALYSIS	658.54/M16	HD 00-00 MH 02-01	WH 01-00 RESERVES WAITING 1
THEORY OF GENERAL PURPOSE C	658.01/C55	HD 01-01 MH 01-01	WH 01-01 RESERVES WAITING 1
TELECOMMUNICATIONS TECHNOLOGY.	510.78/M66	HD 02-01 MH 00-00	WH 00-00 RESERVES WAITING 2
MANUAL FOR CERTIFICATE	E4004/M36	HD 01-00 MH 01-00	WH 02-01 RESERVES WAITING 1
OF PROBABILITY AND SA	629.4.35/G791	HD 00-00 MH 01-00	WH 01-01 RESERVES WAITING 3
7 NEW YORK	651.26/G33R-3	HD 00-00 MH 00-01	WH 00-00 RESERVES WAITING 2
AND THE UNIVERSE.	519/F89	HD 01-00 MH 00-00	WH 01-01 RESERVES WAITING 3
STATIST AND PROBAB PR 1950	535/S977	HD 01-00 MH 01-01	WH 01-00 RESERVES WAITING 1
LIVE ENCYCLOPEDIA	521/K88-E	HD 00-00 MH 00-00	WH 00-01 RESERVES WAITING 4
US AND RELIABILITY.	523.85/M86	HD 01-00 MH 00-01	WH 01-00 RESERVES WAITING 4
CELESTIAL MECHANIC	519.7/B51	HD 01-00 MH 01-01	WH 00-00 RESERVES WAITING 1
AND THE UNIVERSE.	629.2/M91	HD 00-00 MH 01-01	WH 01-00 RESERVES WAITING 1
STATIST AND PROBAB PR 1950	658.562/O88	HD 01-00 MH 01-00	WH 00-01 RESERVES WAITING 3
LIVE ENCYCLOPEDIA	530/Y72F	HD 01-01 MH 01-01	WH 01-00 RESERVES WAITING 7
US AND RELIABILITY.	658.01/M675	HD 01-00 MH 02-01	WH 00-00 RESERVES WAITING 1
CELESTIAL MECHANIC	510.5/M42	HD 01-00 MH 01-01	WH 01-00 RESERVES WAITING 2
NUMERICAL MATRIX IN	510.783/A35	HD 01-00 MH 00-00	WH 01-01 RESERVES WAITING 1
ED A WORKING DIGITA	029.5/C84P	HD 01-00 MH 00-01	WH 01-01 RESERVES WAITING 4
S OF INFORMATION ST	128/K78	HD 01-00 MH 01-01	WH 01-01 RESERVES WAITING 4
MACHINE.	510.783/A35	HD 01-00 MH 00-01	WH 01-01 RESERVES WAITING 5
UNIVERSITY OF CALIFORNIA			

Figure 6 — Get Off the Shelf List

TECHNICAL INFORMATION LIBRARIES

TITLES IN DEMAND

WEEK ENDING 03/21/69

AUTHOR-TITLE	RESERVES WAITING		COPIES HELD		RATIO	TOTAL	LOANS
	HO	MM	HO	MM			
TTMOSHENKO, S. AS I REMEMBER	2	1	10	1	1	1	14
*BOYLESTAD, R.L. INTRODUCTORY CIRCUIT ANALYS	4	4	4	1	1	4	3
CRUZ, J.B./ INTRODUCTORY SIGNALS AND CIRCUIT	1	2	5	1	1	5	3
SCHILLING, D.L./ ELECTRONIC CIRCUITS	10	1	1	2	1	3	16
*THORN, D.C. INTRODUCTION TO GENERALIZED CIR	2	4	4	1	1	6	1
*PEDERSON, D.C./ INTRO. TO ELECTRONIC SYSTEMS	7	1	2	3	1	7	6
CHEMINTZ, H.R. CIRCUIT DESIGN FOR INTEGRAT	7	1	1	1	2	3	7
HERSKOWITZ, G.J. COMPUTER-AIDED INTEGRATED	4	2	1	1	1	4	5
NECOMBS, R.W. ACTIVE INTEGRATED CIRCUIT SYN	1	1	5	1	1	8	5
ABRAHAM, J.R. SEMICONDUCTOR CIRCUITS	2	5	1	1	1	3	8
COHLES, L.G. TRANSISTOR CIRCUITS AND APPLIC	4	2	1	4	1	4	10
KING, G.J. SERVICING TRANSISTOR EQUIPMENT	6	1	1	1	1	6	6
MACHINE DESIGN BASIC COURSE IN SOLID-STATE	6	4	2	3	1	3	3
PHILCO CORP FUND OF TRANSISTOR ELECTRONICS.	4	4	2	3	1	13	1
PRIDHAM, G.J. ELECTRONIC DEVICES VI	4	2	1	1	1	7	1
LEWIS, J.D. HANDBOOK OF OSCILLOSCOPES	7	4	2	4	2	3	15
CARLSON, A.B. COMMUNICATION SYSTEMS	4	4	2	4	1	4	3
GALLAGER, R.G. INFORMATION THEORY AND RELIA	5	2	3	4	1	3	10
MEGER, C.L. ELEMENTS OF DETECTION AND SIGNA	3	2	5	5	2	8	8
HAWKER, J.P. AMATEUR RADIC TECHNIQUES.	8	1	3	1	1	10	2
BECHM, R. LASERS	5	1	18	1	1	2	7
AMER RADIO RELAY MOBILE MANUAL FOR RADIO AM	5	1	2	1	1	8	7
OT FRANCO, J.V./ RADAR DETECTION.	5	1	2	2	1	6	5
COLEMAN, R.W. COLOR TELEVISION	8	2	9	1	1	19	6
ENNES, H.E. TELEVISION SYSTEMS MAINTENANCE.	5	1	1	1	1	6	6
SINGH, J. GREAT IDEAS OF OPERATIONS RESEARC	8	2	4	1	1	4	9
*AMER SOC FOR CYBERNETICS ANNU SYMP 1ST 1967	2	4	1	1	1	5	7
I E E WORKSHOP PATTERN RECOGNITION. 1966	8	2	2	1	1	4	3
ULION, G. AUTOMATIC INFORMATION ORGANIZATI	1	3	1	2	1	7	3
B.-J. BASIC TRAINING IN JOURNALISM.	1	3	1	2	1	7	3
... ON THE DEVELOPMENT OF MEMORY AND IDENT	5	1	1	1	1	8	6
... TEMPORARY THEORY AND RESEARC	11	2	31	5	2	10	30
... FIVE-DAY COURSE IN THINKING.	3	3	1	2	1	6	3
... MECHANISMS OF MEMORY.	6	2	13	1	1	22	5
... ENT BY MOTIVATION.	6	2	18	1	1	18	5

Figure 7 - Titles in Demand List

and the number of people waiting by location (including locations other than the BELLREL libraries). It also flags items listed for the first time and, most importantly, shows the ratio of requests to copies available. When the three library supervisors receive this list, they set up a telephone conference session and decide what additional copies shall be ordered immediately, by which libraries, to meet the demonstrated demand.

The results of all these changes hardly need emphasis: faster service; coordinated, prompt and economic buying to meet real need; more complete exploitation of the collection; reduced clerical effort and record-keeping, and so on.

### Controlling the Collection

In the manual system, missing items were recorded by signaling charge cards, if available, or writing the facts on a card used to designate missing items. Periodically these cards were assembled in shelflist order, checked against the shelves, rechecked, etc.—a cumbersome and imperfect procedure. Overdue notice procedures were particularly tedious involving card signaling, pulling, Xeroxing on forms, refileing, etc. Clearing departing employees involved no systematic record-checking; it was impossible without a borrower's file.

The computer system has had a major impact on all of these accountability operations. As soon as an item is reported as missing, it is recorded on-line using one of two codes: ME9, if the borrower cannot locate it, and MS9 for all other missing conditions. Every two weeks the system produces a *Missing Items List* (Figure 8) in shelflist order, giving all the appropriate details. Items new to the list are flagged. Each library uses a copy of the list to search the shelves, keeping an eye open for any copies from another library which may have wandered. After several iterations of this process, items are located, or new orders placed, or charged to lost. The "lost" codes are equivalent to the "missing" codes, resulting in a history tape record permitting further analysis, as desired.

Generating overdue notices (Figure 9) is completely automatic each day, on a three-cycle basis. Determining a borrower's charges is immediate, using an on-line query code. If an employee should leave without returning all library items, a report is produced automatically by the man file maintenance program.

### Managing Information Resources

Each library supervisor in Bell Laboratories is responsible for meeting the differing literature needs of the researchers at his location. Each must also buy, shift and purge publications in the context of total system resources. Without adequate feedback on who is using what, where, and how often, decisions may too often be guesses. A range of systematic and comprehensive reports is now available to aid decision-making. The *Titles in Demand List* is one of a family of these tools. The weekly *Reserve Queue Aging* report identifies unfilled requests in terms of a sequence of waiting times. The *Loans by Subject* report records the sum of all uses of each four-digit Dewey subject class. Since this identifies the borrower's base location, rather than a specific

TECHNICAL INFORMATION LIBRARIES

MISSING\_ITEMS\_LIST

03/24/69

PR	LOC	COPY	AUTHOR-TITLE	VAR-DATA	BORROWER	COPIES HELD	DUE
						HO MH WH	
	NH	01	MURDOCH, D.-C. LINEAR ALGEBRA		MS00009	1 1	69057
	NH	01	MURDOCH, D.-C. LINEAR ALGEBRA		MS00009	1 1	69052
	NH	01	*FERMAN, S./ NUMBER SYSTEMS		MS00009	1 1 2	69085
	NH	02	GANTMAKER, F.-R. THEORY OF MATRICES		MS00009	1 1 2	69080
	NH	02	GERE, J.-M./ MATRIX ALGEBRA FOR ENGINEERS.		MS00009	1 1 2	68207
	NH	01	HADLEY, G. NONLINEAR AND DYNAMIC PROG		MS00009	1 1 1	69064
	NH	01	HOHN, F.-E. ELEMENTARY MATRIX ALGEBRA.		MS00009	1 1	69080
	NH	02	PIPES, L.-A. MATRIX METHODS FOR ENGINEERING.		ME00009	1 3	68264
	NH	02	SCHWARTZ, J.-T. INTRODUCTION TO MATRICES AND VECTO		ME00009	1 2 1	68306
	NH	01	LYUBARSKII, G.-YA. APPLICATION OF GROUP THEO		MS00009	1 1 1	69036
	HC	01	LIPSCHUTZ, S. SCHAUM'S OUTLINE OF THEORY		MS00009	3	69028
	NH	01	ROCKAFELLAR, R.-T. MONOTONE PROCESSES OF CON		ME00009	1	69009
	NH	01	AIKEN, D.-J./ ALGEBRA. ITS BIG IDEAS AND		MS00009	1	69080
	NH	01	GAXETER, H.-S.-M. REGULAR POLYTOPES.		MS00009	1	69042
	NH	01	AKHIEZER, N.-I./ THEORY OF LINEAR OPERATORS		MS00009	1 1	69042
	NH	01	HALMOS, P.-R. FINITE-DIMENSIONAL VECTOR SPAC		MS00009	3 2 1	69049
	NH	01	AUSLANDER, L./ INTRODUCTION TO DIFFERENTIAL		ME00009	1 1 1	68341
	NH	01	BERGE, C./ TOPOLOGICAL SPACES		ME00009	2 1 1	68341
	NH	01	*BROWN, P. ELEMENTS OF MODERN TOPOLOGY.		MS00009	1 1	69064
	NH	01	BROWN, R. ELEMENTS OF MODERN TOPOLOGY.		MS00009	1 1	69066
	NH	01	PERVIN, W.-J. FOUNDATIONS OF GENERAL TOPOLOG		ME00009	1 1 1	69023
	HC	01	ROSENSTIEHL, P. THEORY OF GRAPHS.		MS00009	1 1	69028
	HD	01	SYMP THEORY OF GRAPHS 1963		MS00009	1 1	69049
	NH	01	BORISFNKO, A.-I./ VECTOR AND TENSOR ANALYSI		ME00009	1 1 1	69027
	NH	01	JEGERS, M./ VECTOR GEOMETRY AND LINEAR ALGEB		ME00009	1 1 1	68232
	NH	01	UBERHETTINGER, F.-/ ANHEND DER ELLIPTISCHEN		MS00009	1	69063
	NH	01	MIKHLIN, S.-G. INTEGRAL EQUATIONS		MS00009	1 1	68283
	NH	02	MUSKHELISHVILI, N.-I. SINGULAR INTEGRAL EQUA		ME00009	1 1	69041
	HC	01	*COLE, J.-D. PERTURBATION METHODS IN APPLIED		ME00009	1 1 2	69086
	NH	01	FERI, T./ DIFFERENTIAL EQUATIONS.		ME00009	1 1 1	69020
	NH	01	MIKHLIN, S.-G./ APPROXIMATE METHODS FOR SOLU		ME00009	1 1 3	68117
	NH	01	SALVADORI, M.-G./ DIFFERENTIAL EQUATIONS IN		MS00009	2 1 1	68354
	NH	01	SPiegel, M.-P. APPLIED DIFFERENTIAL EQUATION		MS00009	1 1 2	68346
	NH	01	AMES, W.-F. NONLINEAR PARTIAL DIFFERENTIAL E		MS00009	1 1 2	69083
	NH	01	*DENNEMEYER, R. INTRODUCTION TO PARTIAL DIFFERENTI		ME00009	1 2 2	68235
	NH	01	WARDS, G.-C. FUNCTIONAL ANALYSIS		ME00009	1 1 2	68333
	NH	01	EXAMPLES IN		ME00009	1 1 2	68333

Figure 8 - Missing Items List

BELL TELEPHONE LABORATORIES  
TECHNICAL INFORMATION LIBRARIES

03/24/69

2ND NOTICE

To: ANDRAULT DE LANGERON, D 63771  
MHLE240

According to our records, the following publication which is charged to you is NOW OVERDUE.

100740 MH01 CHERRY, C. / ON HUMAN COMMUNICA 158/C52-2

PLEASE TAKE ACTION CHECKED BELOW:

OTHER EMPLOYEES ARE WAITING. Please return the publication to your local library immediately.

If you have further need for the publication, please ask your library at once for a possible renewal or later loan. Otherwise, please return the item promptly.

MURRAY HILL 1F-108 X4636

THANK YOU

1-506 9 67

Figure 9 — Overdue Notice

library's traffic (as the complementary *Circulation Statistics* report does), it enables the librarians to determine when and where subject collections should be shifted to meet on-site browsing needs. The *Subject Usage by Department* report identifies the use made by each center and laboratory of each subject class. With these latter data, each library supervisor knows whom to consult to get advice on purchases and purges. For the latter purpose, he has an additional tool, the *Zero Activity List*, a semi-annual report on all titles which have had no recorded use during that time, plus the total of previous uses, if any.

### SOME ON-LINE USAGE DATA

During the first year of operations, with data files still incomplete, BELLREL handled an average of 1,000 on-line transactions per day—more than two per minute. Loads have been as high as 1,900 transactions per day. Many of the transactions have been of the multiple-entry type, handling one to five items in one input.

A sampling of 5,500 transactions gives the following distribution by major class of operation: loans—25 percent, returns—25 percent, queries—18 percent, reserves—18 percent, and renewals—14 percent.

Of the approximately 180 queries per day, 75 percent are concerned with publications and 25 percent with people. The number of queries is expected to increase significantly as the full capabilities of the system become more completely appreciated by the clerical staff.

Transactions which are input in incorrect format or with incomplete data are intercepted by the message edit program and returned to the sender (Figure 4). These errors amount to about 1 percent of all on-line inputs.

### PROBLEMS

Since the system has become an integral part of library operations and impinges on numerous activities, any down-time is unwelcome. It is, of course, inevitable. On one occasion, the system was inoperative all day. Two hours down-time out of 42.5 hours per week has not been uncommon during the first year of system de-bugging, modification, training and conversion to a new 360 Operating System. Many of the causes have been trivial (e.g., a broken type head or drive belt on the master console) or localized (e.g., card reader errors). Surprisingly few difficulties have been the product of BELLREL programming, although in one notable case, date due miscalculations near the end of the 1968 leap year had interesting effects. On the whole, down-time has been more than expected but rarely troublesome. Circulation operations continue, using down-time logs which are immediately entered into the re-activated system.

Few problems have been encountered with the operators. Staff members, particularly those with no previous library experience, have adapted rapidly. Early cases of inattention to BELLREL responses have largely disappeared. Some tendency to consult the card catalog or the daily loan list (essentially a system back-up) rather than to invoke the full query powers of the system still exists. The effective error rate continues to be very low, largely due to the programmed responses to each input. Free key-boarding of bibliographic data for unbound journal issues is the greatest single error-prone operation, calling for care in both charges and returns. Other publications and transactions present no problem.

### COSTS

The verdict on total costs of the on-line system versus the displaced manual system is not yet in. The operation costs of BELLREL are clearly higher than the manual system but comparative cost/benefit ratios are another

matter entirely. The new system has resulted in some substantial labor and materials savings but its total influence on library operations and services is so extensive and, in some respects, subtle, that a complete assessment has not yet been possible. To cite an example, one of three book catalogs generated by BELLREL is a Dewey-ordered record of all the book holdings of the three major libraries. The availability of this quarterly catalog, up-dated by weekly cumulations, has allowed these three libraries to discontinue shelflist maintenance in the card catalog, with known, appreciable savings. Copies of these book catalogs are also provided to eleven more distant libraries which heretofore had no record of the resources of the libraries holding 92 percent of all the titles. The reaction to these precursors to a system-wide printed book catalog has been enthusiastic; the value for cost calculations is indeterminable, as are speed of service, record accuracy, enriched feedback and other intangible benefits.

Further observations about costs are given in our earlier paper.<sup>1</sup> Cost studies are continuing. BELLREL, however, is only one component in a developing, integrated computer-aided system involving acquisitions, cataloging, announcement and access. The interactions between these functions will call for new costing perspectives.

BELLREL is an attempt to control, or solve, a complex of troublesome problems in a particular library environment, in one segment of time, with off-the-shelf equipment, and at acceptable cost. Within that environment its impact has been sharply manifest. It has been doing what it was designed to do—and more; unanticipated by-product benefits continue to emerge.

The servo-mechanistic force of the system is naturally most obvious to the library people who manipulate it. A little input generates a lot of response. Things happen more quickly—from knowing when to buy added copies, to following up on reserve queries, to obtaining information about holdings. Tedium is down; productivity is up; service is improved; and, as the wealth of user and traffic data accumulates, decision-making in the interests of making a tighter correlation between information needs and resources will, we believe, be greatly enhanced.

What BELLREL has meant to the individual library user is less well known. Many scientists and engineers have expressed strong technical interest. Many understand how the system works for them. Others, it seems, would accept conveyor belts or carrier pigeons, as long as information needs were met. But while some library users do not yet perhaps fully realize what the system is doing, or can do, for them, there is clearly a wide appreciation that, in on-line computer technology, library service has acquired a powerful helpmate whose enlarging future is assured.

## References

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