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Determining the Number of Terminals Required for an On-Line Catalog through Queueing Analysis of Catalog Traffic Data

Introduction

Many libraries are in the process of closing their card catalogs and replacing them with microform or on-line catalogs. This change in catalog format in turn requires several important changes in catalog generation and support: (1) all cataloging data must be recorded in machine-readable form; (2) different equipment must be used, e.g., terminals are needed instead of typewriters, and microform readers or computer terminals are needed instead of card catalog cabinets; (3) the sorting sequence must change from a manual filing-rules sequence to a machine-generated sorting sequence; (4) staff must be trained both in the procedures to create machine-readable records and in the use of the catalog format; and (5) patrons must be taught to use the new catalog format.

It is the change in equipment needed in libraries that is dealt with in this paper, specifically, determining the number of terminals required for an on-line catalog. The change in catalog access equipment, from card catalog cabinets to microform readers or computer terminals, means a major change in the method of access to the contents of the catalog. Currently, only one complete card catalog set is needed for normal catalog traffic in any one location. Since the card file is divided into many discrete access units (file drawers), patrons rarely have to wait for access to the desired section of the catalog, even at peak periods. With microform readers and terminals, however, the entire catalog is available through one single equipment item, and access is such that only one person at a time can enter the catalog through that piece of equipment. Therefore, multiple microform copies of the catalog or multiple terminals are required to serve multiple users.

To house the new catalog format, large equipment purchases are likely to be necessary. Thus, budgeting and planning become major management concerns. Sufficient equipment must be purchased to assure prompt user access, even during peak use periods. Yet, expensive terminals and readers should not sit idle for long intervals during slow use periods.

Background of the Study

In assessing equipment needs for the conversion to an on-line catalog, the Dallas Public Library initiated a study of current catalog use, with plans to incorporate the findings from the investigation into its design and planning process. This investigation was limited by the available data. The data collected on current card catalog use were analyzed and used to project equipment requirements for an on-line catalog. Usage levels and patterns for the new catalog were assumed identical to those of the present card catalog. While there will be significant changes in both level and patterns of catalog use with the implementation of an on-line catalog, until such changes can be quantified there is no way to incorporate them into the study.

Dallas Public Library is a large metropolitan library system with a central library and seventeen branches (plus an eighteenth under construction), with an annual circulation of 4 million items, and with holdings of 2.5 million volumes. The library has been automating its services, in stages, since 1971. When completed, the total automated system will include: an on-line, optical character recognition (OCR)-based circulation system that will post circulation status information to the on-line catalog; a library materials acquisition and accounting system; and a film-booking system. All program development and equipment support has been done by the City of Dallas Data Services Department. As of early 1980, the automated circulation system is operational with an on-line delinquent patron file, an on-line circulation statistics subsystem, and a batch transaction card check-out/check-in system. Much of the circulation system presently in use has been operational since 1973. The on-line catalog has been operational and publicly accessible with partial holdings since February 1978. The catalog contains fixed-length, non-MARC records of all central library monographic holdings, plus branch library holdings added since February 1978. Retrospective conversion of branch library holdings is expected to be complete in 1982.

The on-line catalog was made available to all library agencies in February 1978 through the circulation system terminals located behind circulation desks in all branches and the central library. When initially implemented, the on-line catalog could be searched by author, title,

author/title combination, or call number (Dewey Decimal system). In late 1979, a subject search based on Library of Congress Classification subject headings was added. Starting in mid-1978, additional CRT terminals were provided in public service areas to be exclusively used for access to the on-line catalog. By early 1980, every Dallas Public Library branch had at least two terminals, one in the public service area and one in the workroom for retrospective conversion of holdings. Additional terminals for public service usage will be added throughout the 1980/81 and 1981/82 fiscal years.

The next major project will be completion of the circulation system, upgrading it to a full on-line system with a patron database and links to the on-line catalog, so that circulation status information can be posted to catalog records. The first stage in design of the acquisitions system has been completed, but no programming has yet been done on that system. The film-booking system will be the last project to be completed. The central library will move to a new, much larger downtown facility in 1982, and the on-line catalog and circulation system will be operational when the new building opens.¹

Strategy of the Study

Early in the planning stages for the automated systems, the need for a fairly precise estimate of equipment requirements became apparent. The investigation was initiated by soliciting opinions from the public service librarians in the branch libraries and the central library. Their opinions showed great variance, so a scientific approach was sought.

Aware that other libraries had already made the conversion to microform and on-line catalogs, the study team decided to survey other libraries to learn the means used to determine the number of pieces of equipment required. We were not able to identify other public libraries that had already converted to on-line catalogs, so the survey was restricted to public libraries which had converted to microform catalogs. Because microform and on-line catalogs both require one station per concurrent user, we assumed that the quantity of equipment required for each would be the same. We were aware that there are qualitative differences between microform and on-line catalogs, but no data were available to indicate the effect that these differences would have on the number of stations required. We chose to make the assumption of equality, unless some useful data for distinguishing between microform and on-line equipment needs were later discovered.

For the purposes of a mail survey, lists of microform catalog users were obtained from microform catalog vendors. The survey was restricted to

public libraries with microform catalogs. The results of the unpublished survey were inconclusive for the purpose of obtaining quantitative data on how the number of microform readers was determined. Libraries generally said the number was determined by "guesstimate," or by "buying as many as we could with the money available." One library stated, "the more we buy, the more they get used." The only quantitative formula given was one from a study done by Butler, West and Aveney.² A brief review of the project and formula are given by Aveney and Ghikas.³

As neither the informal internal survey nor the mail survey provided the needed data, the Dallas Public Library decided to do its own study. The study was based on card catalog usage systemwide, sampling both traffic at the catalogs and the duration of the search time at the catalogs. The library hoped to gather enough data to determine the number of terminals required both to maximize equipment usage and to minimize patron waiting time.

It was not practical to do a detailed traffic study at each of the library's catalogs. The Dallas Public Library has a large number of card catalogs. The central library has a union catalog for the library system, plus individual catalogs for each of four subject divisions. Each of the seventeen branches has at least one card catalog (combined adult and youth holdings); most have separate catalogs for adult and youth materials. Therefore, representative catalogs were chosen for the study, based on collection size and rate of circulation. The main union catalog was included in the study as it is unique in the system, and one of the four subject division catalogs was selected to represent those four catalogs. Branches were divided, by holdings and circulation, into three classes: large, medium and small. Two branches were selected from each of the three classes. The following catalogs were chosen for study:

Central Library:

Central library main catalog: This is the union catalog for the Dallas Public Library system.

History and Social Sciences catalog: This catalog contains records for the 109,000 volumes held by this division of the central library.

Large Branches:

Audelia Road Branch catalogs: This branch holds 84,250 volumes and has an annual circulation of 345,000 items.

Park Forest Branch catalogs: This branch holds 71,000 volumes and has an annual circulation of 304,750 items.

Medium Branches:

Lakewood Branch catalogs: This branch holds 65,200 volumes and has an annual circulation of 247,750 items.

Hampton-Illinois Branch catalogs: This branch holds 66,000 volumes and has an annual circulation of 240,750 items.

Black = Patron
Red = Staff

Tuesday
COUNTING USERS
ADULT CATALOG

Central
Branch/Agency MAIN CARD CAT

Patron	DATE	COUNTER (NAME)	TIME	COUNT (HASH MARKS)	Staff
16 ^v	5/19/78	Nancy Hamley	9:00-9:14	4	6
			9:15-9:29	2	7
			9:30-9:44	1	7
			9:45-9:59	9	1
21 ^v	33 ^v	JANE MANN	10:00-10:14	2	3
			10:15-10:29	7	4
			10:30-10:44	5	3
34 ^v	42 ^v	Celia Bills	10:45-10:59	6	2
			11:00-11:14	5	4
			11:15-11:29	8	2
63 ^v	77 ^v	NATALIE Brown	11:30-11:44	9	0
			11:45-11:59	12	2
			12:00-12:14	14	3
			12:15-12:29	21	3
49 ^v	65 ^v	JACK Smith	12:30-12:44	14	2
			12:45-12:59	14	3
			1:00-1:14	16	3
			1:15-1:29	12	3
15 ^v	27 ^v	Marjorie Carter	1:30-1:44	13	4
			1:45-1:59	8	4
			2:00-2:14	3	4
			2:15-2:29	3	1
15 ^v	24 ^v	Marjorie Carter	2:30-2:44	5	4
			2:45-2:59	4	3
			3:00-3:14	4	3
			3:15-3:29	5	3
8 ^v	20 ^v	WANDA Willis	3:30-3:44	5	2
			3:45-3:59	5	3
			4:00-4:14	1	2
			4:15-4:29	2	2
15 ^v	20 ^v	ROSE LESLIE	4:30-4:44	8	5
			4:45-4:59	3	3
			5:00-5:14	10	2
			5:15-5:29	5	3
17 ^v	20 ^v	RON MARKEL	5:30-5:44	5	1
			5:45-5:59	3	1
			6:00-6:14	6	3
			6:15-6:29	1	3
12 ^v	25 ^v		6:30-6:44	4	3
			6:45-6:59	6	3
			7:00-7:14	3	5
			7:15-7:29	2	4
12 ^v	17 ^v		7:30-7:44	7	4
			7:45-7:59	5	3
			8:00-8:14	5	1
			8:15-8:29	5	3
272 = 65.9%			8:30-8:44	2	1
			8:45-9:00	2	0

272 = 65.9%
Staff + Patrons = 413 = 108%

141
34.1%

Figure 1. Traffic at the Catalog

① Park Forest

TIMING USERS
 ④ 10-11 a.m., 3:30-5:30 p.m., and 7-8 p.m.
 - ② ADULT USERS

Counter (name): K. Crawford ③ 780510 Wed
 Date: May 10 - 78

User (description or notes)	Time Started	Time Stopped	Minutes
lady	10:09	10:10	1
lady in blue	10:15	10:17	2
man	10:19	10:23	4
lady with baby	10:24	10:26	2
lady in orange	10:28	10:31	3
lady with baby	10:30	10:31	1
" " "	10:34	10:35	1
lady in jeans	10:41	10:45	5
lady in pink	10:41	10:49	8
lady in blue	10:54	10:56	2
lady in brown	10:55	10:57	2
lady	11:10	11:14	2
lady in brown	11:14	11:15	1
lady in tan shirt	11:24	11:23	9
girl	11:23		
woman	3:31	3:34	3
woman in brown	3:33	3:36	3
man	3:34	3:35	1
woman	3:37	3:38	1
man in blue	3:37	3:38	1
librarian	3:37	3:44	7
woman - skirt	3:38	3:39	1
woman - jeans	3:38	3:39	1
man - jeans	3:40	3:41	1

① Park Forest
 ② Adult Users
 ③ 780510 Thu.
 ④ 3:30-5:30

Figure 2. Duration of Search Time

Small Branches:

Lancaster-Kiest Branch catalogs: This branch holds 65,900 volumes and has an annual circulation of 70,630 items.

Oaklawn Branch catalogs: This branch holds 29,500 volumes and has an annual circulation of 97,000 items.

The data were collected during one week in May 1978. Two different types of data—traffic at the catalog and duration of search time—were tracked on two different sets of data collection forms (see figs. 1 and 2).

Traffic at the catalog. Records were kept of how many people used the catalog, by 15-minute periods of the day. Data were collected for “one day” during the week: a full morning, full afternoon, and full evening were covered during the week, although not all fell on the same day. One complete Saturday also was covered. Breaking up the day this way was necessary, as only the central library is actually open morning, afternoon and evening on a single day. Central library hours are 9 A.M.—9 P.M. Monday through Friday, and 9 A.M.—6 P.M. Saturday. Branches are open 10 A.M.—6 P.M. some weekdays and 12 P.M.—9 P.M. on others, plus 10 A.M.—6 P.M. on Saturday. Breaking up the day in segments also simplified the scheduling of personnel to do the data collection.

Duration of search time. Three periods of the day were selected for this part of the study: 10 A.M.—11 A.M. (slow period), 3:30 P.M.—5:30 P.M. (peak period), and 7 P.M.—8 P.M. (peak period). During these three time periods, each person going to the catalog was clocked in and clocked out. This was done by jotting down brief descriptive notes about the person on the data collection form to keep track of all individuals using the catalog.

The data from each study were further subdivided by patron and staff usage at the central library (both the main catalog and the History and Social Sciences catalog) and by adult and youth catalog usage at the branch libraries. The latter subdivision was necessary as some of the branches have separate catalogs for adult and youth holdings. The division was made by catalog, rather than by individual; that is, a patron at the youth catalog was considered “youth” regardless of the person’s age. The division by patron and staff was at the request of the central library staff, and was kept for its own usage. Because the total data collection was small for staff and youth, those data were not aggregated. Day of the week, time of day, and location distinctions were made in the final data analysis.

Data collection was done both by Dallas Public Library staff and by library volunteers. A total of over 200 individuals were involved in the data collection. Library volunteers were very cooperative and some helped in different agencies from those in which they normally volunteered. We emphasized the fact that data would be extrapolated to represent the entire Dallas Public Library system, so that assistance given at any agency would benefit other agencies within the library system.

The data were manually tabulated by the library staff, showing patterns of usage and averages by time of day. Some correction to the data on

number of staff inquiries was made for the central main card catalog, based on usage of the on-line catalog terminal. At the time of the study, that was the only location that provided readily available access to the on-line catalog. No similar corrections were made in the branch library data collection.

The original intent of the study was to do further data analysis using queueing theory. It was found that the data manipulation required was too complex to perform manually, and that City of Dallas computer time was not readily available for the task. Copies of all of the raw data collection sheets, therefore, were provided to Neal Kaske of the OCLC, Inc., Research Department in June 1979 for analysis by computer, using queueing algorithms. The analysis which follows is a result of the work done at OCLC.

Data Analysis

The OCLC Research Department used a multiserver queueing model to analyze the data collected by the Dallas Public Library. This model assumes a common stream of patron traffic, a finite number of identical servers (terminals or readers), a common waiting line when all servers are busy, and a "first-in, first-out" selection from the waiting line. The particular multiserver model used was adapted from a model documented in the IBM publication, *Analysis of Some Queueing Models in Real-Time Systems*.⁴ A graphic representation of this multiserver queue is shown in figure 3.

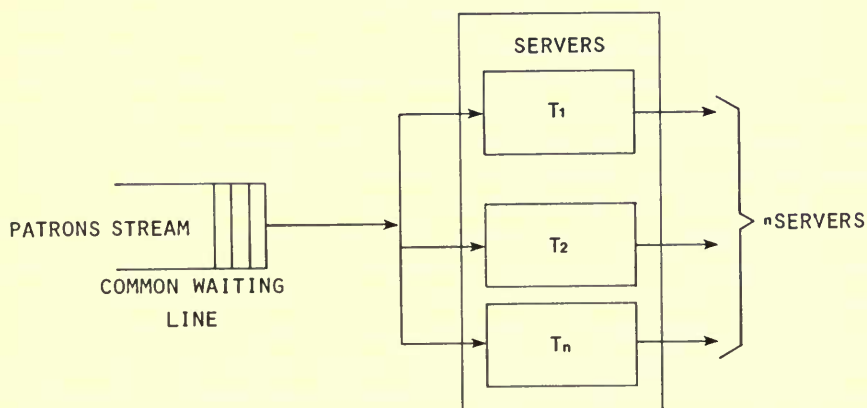


Figure 3. Model of Multiserver Queue

The first step of data analysis was to convert the tallies from the "Duration of Search Time" forms (fig. 2) to machine-readable format. Only complete data records (containing both a starting and ending time) were converted. Computer programs were then written to process these records and calculate the following values:

- mean service time (T_s)
- mean interarrival time (T_a)
- traffic intensity (T_i)

Traffic intensity is defined as

$$T_i = \frac{T_s}{T_a}$$

and represents the amount of system capacity in demand at any given time. The records were processed in sets by location, date and time of day. Then, a traffic intensity (T_i) value was calculated for each set.

Once traffic intensity was calculated, the data were tested to determine if they fit a Poisson distribution. If the data did fit the Poisson distribution (which they did when analyzed by hour blocks of catalog use), standard queueing formulas could be used to calculate the mean waiting line and time for a given number of servers at low, average and peak catalog use. Tables 1 and 2 report traffic intensity values and traffic parameters for these three levels of catalog use. The parameters computed were: (1) the probability that a patron will find a reader/terminal idle; (2) the mean length of the line of patrons waiting to use a reader/terminal; and (3) the mean time a patron will need to wait in line for a reader/terminal. Each of the parameters was calculated for one to eight servers for the catalog.

To make the data useful for Dallas Public Library management, a set of decision rules was established for use with the data. The decision rules were: (1) the patron must find a terminal/reader available 90 percent of the time; (2) there must be no waiting line for a terminal (on average less than one patron in line at any given time); and (3) the patron must wait in line thirty seconds or less. The effects of these decision rules are shown in table 3.

To enhance the usefulness of the data for library management, a sensitivity analysis was conducted. The sensitivity analysis provided a range of values for the measure of congestion (traffic intensity). For the analysis, the derived values for traffic intensity were doubled and halved, and the same three decision rules were applied to the values. The results for doubled and halved values are shown in tables 4 and 5, respectively. The problem of determining the number of terminals required is thus bounded.

TABLE I
TRAFFIC INTENSITY VALUES AND TRAFFIC PARAMETERS—CENTRAL LIBRARY

Central Library	Time	Date May 1978	Traffic Intensity	Number of Servers							
				1	2	3	4	5	6	7	8
<i>History and Social Sciences</i>											
Peak	10:00-11:00 A.M.	6	1.03	P L W	i 2.26 i 13.55	0.65 0.34 2.01	0.89 0.05 0.29	0.98 0.01 0.04	1.00 0.01 0.01	1.00 0.00 0.00	1.00 0.00 0.00
Low	3:30-5:30 P.M.	9	0.08	P L W	0.92 0.10 1.38	1.00 0.00 0.03	1.00 0.00 0.00	1.00 0.00 0.00	1.00 0.00 0.00	1.00 0.00 0.00	1.00 0.00 0.00
Average	(N=13)		0.34	P L W	0.66 1.37 10.48	0.94 0.10 0.74	0.99 0.01 0.01	1.00 0.00 0.00	1.00 0.00 0.00	1.00 0.00 0.00	1.00 0.00 0.00
<i>Main Catalog</i>											
Peak	3:30-5:30 P.M.	6	3.35	P L W	i i i	i i i	i 6.63 12.81	0.33 1.31 2.53	0.67 0.37 0.72	0.85 0.11 0.22	0.98 0.03 0.06
Low	10:00-11:00 A.M.	6	1.05	P L W	i 1.20 i 3.52	0.64 0.18 0.52	0.89 0.03 0.08	0.98 0.00 0.01	1.00 0.00 0.00	1.00 0.00 0.00	1.00 0.00 0.00
Average	(N=182)		2.17	P L W	i i i	i 3.00 i	0.47 3.00 6.51	0.78 0.58 1.25	0.92 0.14 0.29	0.97 0.03 0.07	1.00 0.01 0.02

P=the probability that a patron will find a reader/terminal idle
L=the mean length of the line of patrons waiting to use a reader/terminal
W=the mean time (in fractional minutes) a patron will need to wait in line for a reader/terminal
i=infinite

TABLE 2
TRAFFIC INTENSITY VALUES AND TRAFFIC PARAMETERS—BRANCH LIBRARIES

Branch Libraries	Time	Date May 1978	Traffic Intensity	Number of Servers								
				1	2	3	4	5	6	7	8	
<i>Audelia Road</i> Peak	3:30-5:30 P.M.	8	2.67	P	i	i	0.20	0.61	0.84	0.94	0.98	0.99
				L	i	i	9.75	1.16	0.28	0.08	0.02	0.01
				W	i	i	14.49	1.73	0.42	0.11	0.03	0.01
Low	10:00-11:00 A.M.	8	0.44	P	0.56	0.90	0.99	1.00	1.00	1.00	1.00	1.00
				L	1.73	0.14	0.01	0.00	0.00	0.00	0.00	0.00
				W	8.64	0.70	0.05	0.00	0.00	0.00	0.00	0.00
Average	(N=241)		1.78	P	i	0.16	0.63	0.87	0.96	0.99	1.00	1.00
				L	i	10.94	0.87	0.17	0.04	0.01	0.00	0.00
				W	i	17.88	1.42	0.27	0.06	0.01	0.00	0.00
<i>Park Forest</i> Peak	3:30-5:30 P.M.	11	1.45	P	i	0.39	0.77	0.93	0.98	1.00	1.00	
				L	i	2.54	0.35	0.06	0.01	0.00	0.00	
				W	i	4.02	0.55	0.10	0.02	0.00	0.00	
Low	10:00-11:00 A.M.	13	0.38	P	0.62	0.93	0.99	1.00	1.00	1.00	1.00	
				L	0.67	0.05	0.00	0.00	0.00	0.00	0.00	
				W	1.95	0.15	0.01	0.00	0.00	0.00	0.00	
Average	(N=201)		0.91	P	0.06	0.64	0.91	0.98	1.00	1.00	1.00	
				L	28.36	0.63	0.08	0.01	0.00	0.00	0.00	
				W	55.47	1.23	0.15	0.02	0.00	0.00	0.00	
<i>Hampton-Illinois</i> Peak	10:00-11:00 A.M.	13	1.31	P	i	0.48	0.81	0.95	0.99	1.00	1.00	
				L	i	1.84	0.27	0.05	0.01	0.00	0.00	
				W	i	3.45	0.51	0.09	0.01	0.00	0.00	
Low	10:00-11:00 A.M.	10	0.53	P	0.47	0.86	0.98	1.00	1.00	1.00	1.00	
				L	2.63	0.22	0.02	0.00	0.00	0.00	0.00	
				W	11.40	0.96	0.08	0.01	0.00	0.00	0.00	
Average	(N=163)		1.10	P	i	0.61	0.88	0.97	0.99	1.00	1.00	
				L	i	1.02	0.15	0.02	0.00	0.00	0.00	
				W	i	2.15	0.32	0.05	0.01	0.00	0.00	

<i>Lakewood</i> Peak	10:00-11:00 A.M.	13	1.47	P	i	0.38	0.76	0.93	0.98	1.00	1.00	1.00
				L	i	3.78	0.51	0.09	0.02	0.00	0.00	0.00
				W	i	8.34	1.13	0.20	0.01	0.01	0.00	0.00
Low	10:00-11:00 A.M.	9	0.42	P	0.58	0.91	0.99	1.00	1.00	1.00	1.00	1.00
				L	1.36	0.11	0.01	0.00	0.00	0.00	0.00	0.00
				W	6.03	0.48	0.03	0.00	0.00	0.00	0.00	0.00
Average (N=145)			0.79	P	0.21	0.72	0.94	0.99	1.00	1.00	1.00	1.00
				L	9.13	0.55	0.06	0.01	0.00	0.00	0.00	0.00
				W	27.29	1.64	0.18	0.02	0.00	0.00	0.00	0.00
<i>Lancaster-Kiest</i> Peak	7:00-8:00 P.M.	9	1.63	P	i	0.27	0.69	0.90	0.97	0.99	1.00	1.00
				L	i	14.01	1.56	0.29	0.06	0.01	0.00	0.00
				W	i	60.05	6.70	1.26	0.25	0.05	0.01	0.00
Low	10:00-11:00 A.M.	13	0.31	P	0.69	0.95	1.00	1.00	1.00	1.00	1.00	1.00
				L	0.71	0.05	0.00	0.00	0.00	0.00	0.00	0.00
				W	3.69	0.24	0.01	0.00	0.00	0.00	0.00	0.00
Average (N=67)			0.57	P	0.43	0.84	0.98	1.00	1.00	1.00	1.00	1.00
				L	4.10	0.34	0.03	0.00	0.00	0.00	0.00	0.00
				W	22.35	1.87	0.16	0.01	0.00	0.00	0.00	0.00
<i>Oaklawn</i> Peak	3:30-5:30 P.M.	13	0.97	P	0.03	0.62	0.91	0.98	1.00	1.00	1.00	1.00
				L	98.12	1.08	0.13	0.02	0.00	0.00	0.00	0.00
				W	291.72	3.20	0.39	0.05	0.01	0.00	0.00	0.00
Low	7:00-8:00 P.M.	9	0.12	P	0.88	0.99	1.00	1.00	1.00	1.00	1.00	1.00
				L	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
				W	1.54	0.04	0.00	0.00	0.00	0.00	0.00	0.00
Average (N=71)			0.41	P	0.59	0.91	0.99	1.00	1.00	1.00	1.00	1.00
				L	1.52	0.12	0.01	0.00	0.00	0.00	0.00	0.00
				W	8.08	0.63	0.04	0.00	0.00	0.00	0.00	0.00

P=the probability that a patron will find a reader-terminal idle

L=the mean length of the line of patrons waiting to use a reader-terminal

W=the mean time (in fractional minutes) a patron will need to wait in line for a reader-terminal

i=infinite

TABLE 3
DECISION TABLE SHOWING EFFECTS OF DECISION RULES

	To assure patron will find a terminal/reader free 90% of the time		Number of Servers Needed		To assure users wait in line ½-minute or less	
	Peak	Average	Peak	Average	Peak	Average
<i>Large Branches</i>						
Audelia Road	6	5	5	3	5	4
Park Forest	4	3	3	2	4	3
<i>Medium Branches</i>						
Hampton-Illinois	4	4	3	3	4	3
Lakewood	4	3	3	2	4	3
<i>Small Branches</i>						
Lancaster-Kiest	4	3	4	2	5	3
Oaklawn	3	2	3	2	3	2
<i>Central Library</i>						
Main Catalog	7	5	6	4	6	5
History & Social Sciences	4	2	3	2	4	3

TABLE 4
DECISION TABLE FOR TRAFFIC INTENSITY DOUBLED

	To assure patron will find a terminal/reader free 90% of the time			Number of Servers Needed			To assure users wait in line 1/2-minute or less			
	Peak	Average		Peak	Average		Peak	Average		
<i>Large Branches</i>										
Audelia Road	10	7		7	5		8	6		6
Park Forest	6	5		3	2		5	4		4
<i>Medium Branches</i>										
Hampton-Illinois	6	5		4	4		5	5		5
Lakewood	6	4		5	3		6	4		4
<i>Small Branches</i>										
Lancaster-Kiest	7	4		6	3		7	4		4
Oaklawn	5	3		4	2		5	3		3
<i>Central Library</i>										
Main Catalog	11	8		9	7		11	8		8
History & Social Sciences	5	3		4	2		6	3		3

TABLE 5
DECISION TABLE FOR TRAFFIC INTENSITY REDUCED BY HALF

	To assure patron will find a terminal/reader free 90% of the time		Number of Servers Needed		To assure fewer than one user in line at any given time		To assure users wait in line $\frac{1}{2}$ -minute or less	
	Peak	Average	Peak	Average	Peak	Average	Peak	Average
<i>Large Branches</i>								
Audelia Road	4	3	3	2	4	3		
Park Forest	3	3	2	2	3	2		
<i>Medium Branches</i>								
Hampton-Illinois	3	3	2	2	3	3		
Lakewood	3	2	2	2	3	2		
<i>Small Branches</i>								
Lancaster-Kiest	3	2	3	2	2	2		
Oaklawn	3	2	2	1	3	2		
<i>Central Library</i>								
Main Catalog	5	4	4	3	5	4		
History & Social Sciences	3	2	2	1	3	2		

Summary

The data collected for this study represented actual usage levels and patterns for specific agencies of the Dallas Public Library system. The data analysis determined how many terminals were required to support the same levels and patterns of usage for the on-line catalog that were evident for the card catalog. There are two limitations to this study:

1. The results of the data analysis are specifically applicable to the Dallas Public Library; a direct extrapolation of the data to other libraries, based on figures such as circulation, traffic, and holdings, may not be legitimate.
2. The usage of an on-line catalog will not be the same as the usage of a card catalog. On-line catalogs are not limited to all terminals being in one location, in the manner that all drawers of a card catalog must be in one location. Therefore, terminals may be scattered throughout the library, or in other buildings. More or less time per search may be required for the catalog with an on-line terminal. The card catalog (with the exception of the central library main catalog) contains records only for the library agency in which it is located; the on-line catalog, however, will be a union catalog for the library system, which will affect usage patterns. If printers are available for the terminals, users will print out the desired records rather than spending time at the catalog copying them. These changes in usage patterns are only the ones that are now anticipated, and it is expected that other changes will occur.

While the limitations to the study are significant, it is still a quantitative step forward. The early investigations showed that libraries have been guessing at the amount of equipment needed, without having any quantitative figures to support their guesses. The figures for terminal requirements obtained from this study provide a starting point for equipment purchase. Adjustments can be made from this point based on actual usage. The data obtained from the study show that in most cases, fewer terminals are required than were originally thought. In one case, there may be as many as five fewer terminals required to meet peak usage than the Dallas Public Library staff had originally estimated.

The Dallas Public Library is using this study to support the budget request for terminals in support of the on-line catalog. The library considers the results to be useful management information, and planning decisions will be made accordingly.⁵

REFERENCES

1. Christine L. Borgman was Systems Analyst at Dallas Public Library at the time this study was performed, and conducted the study in that capacity. See Borgman, Christine L. "Library Automation Development at Dallas Public Library." In Bernard M. Fry and Clayton A. Shepherd, comps. *Information Management in the 1980's: Proceedings of the ASIS Annual Meeting*. Vol. 14. White Plains, N.Y., Knowledge Industry, 1977, fiche 2, pp. A9-14; _____ . "The Role of Technology for the Dallas Public Library in Long Range Planning" (paper presented at the Dallas Public Library Long Range Planning Retreat, Waxahachie, Tex., May 12-14, 1977). (ED 153 698)
2. Butler, Brett, et al. *Library and Patron Response to the COM Catalog: Use and Evaluation*. Los Altos, Calif., Information Access, 1978.
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5. William Slaughter (Associate Director for Management Services, Dallas Public Library), to Borgman and Kaske, May 9, 1980.