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ABSTRACT

Models are one of the tools of operation research which may have applications in the library field. This study is an attempt to establish a simple model for administrative purposes in a university library system. Two measures of a university library system were studied: (1) the cost of adding a volume to the collection and (2) the use of the collection on a per capita basis. The present study requires further analysis prior to computer manipulation and before full-scale models can be developed for solutions to decision-making problems, the development of considerable new data is required. (AB)

THE LIBRARY
UNIVERSITY OF GUELPH

DERIVATION OF A SIMULATION MODEL
OF A UNIVERSITY LIBRARY SYSTEM

BY

MARGARET BECKMAN

RESEARCH REPORT NO. 1 U-LIB-GLPH-RR-68-1

Guelph Univ. (Ontario) Library

RESEARCH REPORT

DERIVATION OF A SIMULATION MODEL OF A UNIVERSITY LIBRARY SYSTEM

I Introduction

"The principal job of an executive is to make choices between alternative courses of action by reading a future about which he is usually uncertain."(1) Although this statement was made in a business context it is equally true in the field of library administration. To lessen the degree of uncertainty involved in decision making, however, business has turned to techniques of scientific management - specifically operations research - developed during the last war. H. R. J. Grosch pointed out the need for similar techniques in libraries when he said, "Decision makers must have concrete, mathematically describable, arithmetically weighable objectives before they can make decent decisions. If we are going to talk about information handling in the large, using electronic gadgets, we have to make mathematical models of what we want". (2)

Models are one of the tools of operations research which may have applications in the library field. Although they can be used in any part of a system, this study is an attempt to establish a simple model for administrative purposes in a university library system.

II Definitions

For the purposes of this study, the following definitions have been used:

1. University

A university is defined by the Canadian Universities Foundation as an institution of post-secondary education, professional training and research, which awards first and advanced degrees in two or more faculti

An additional factor is an enrolment of over 1,000.(3)

2. System

A system is a regular, orderly arrangement of components or parts in a connected and inter-related series or whole.(4)

3. Simulation

Systems simulation is an "imitation of reality in an attempt to see what might happen under conditions of real operation by doing a test on paper or in some other artificially limited fashion".(5) Simulation can therefore be used to demonstrate to administration what behaviour could be expected under certain conditions, as a basis for more effective decision-making.(6)

4. Model

The model, whether physical or mathematical, "is an approximate or simplified representation of the operation of the actual system being studied. Its purpose is to help understand the system operation and to predict behaviour under particular chosen conditions."(7)

5. Measurement

"The use of a model relates to the measurement of the physical situation."(8) Measurement can be described as "the assignment of elements from some mathematical system to the set of physical objects or events of interest."(9) It must be realized, however, that measurement alone does not provide dependability in any conclusions reached. "Unmeasurable conditions - many forms of commitment being intangible are as often as not the decisive elements. A scientific treatment requires that we measure all the measurable things that are found

important and thus attain progressively higher degrees of precision in handling the data of a problem, and expressing a meaning. We strive by measurement to reduce the number of variables in our thinking."(10)

III Scope

University library statistics reported annually to the Dominion Bur of Statistics (D.B.S.) reveal a number of possible measures for a university library system.(11) Following the division made by D.B.S., and by the Canadi Association of College and University Libraries (CACUL) Standards,(12) librar of English speaking universities from two reporting groups were studied.

Group I. Institutions with an enrolment in 1964/65 of over 5,000. Six libraries, representing the total sample except for Sir George Williams University Library,(13) were used:

University of Toronto
McGill University
University of Manitoba
University of Saskatchewan
University of Alberta (Edmonton)
University of British Columbia

Group II. Institutions with a 1964/65 enrolment of between 1,500 a 5,000. Seven libraries were used as the basis for this group. The libraries not studied were either in universities established since 1960 (e.g. York), o were ones which did not report consistently to D.B.S. (e.g. Western).

University of New Brunswick
Carleton University
Queen's University
McMaster University
University of Alberta (Calgary)
Victoria University
Memorial University

Two measures of a university library system were studied:

1. The cost of adding a volume to the collection.
2. The use of the collection on a per capita basis.

The academic year 1962,'63 was used as the starting point for the analysis, since that is the last year that circulation figures were included i the D.B.S. report on academic libraries.

IV Method

The data[14] reported in the D.B.S. academic statistics was used to develop two indices or measures of the university library system: a cost inde and a service index. The cost index was determined by dividing the number of volumes added to the collection into the salary budget for a given year. The service index was derived by dividing the circulation by the full-time faculty and student enrolment.

Although many other factors - equipment, interlibrary loan, referenc service - could have been used to determine both a cost and service index, the limitations of the available data justify the use of such simple measures. Since the indices are used as comparative devices only, their application has validity.

Having established the cost and service indices, other variables in the system were studied, and the Spearman* coefficient of correlation was applied to indicate the relationship between each of the variables and the

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*Footnote

The Spearman coefficient of correlation is a statistical method base on ranking the variables being compared. Admittedly this is a very unsophisticated method, and the accuracy of the correlations would have been higher h regression analysis been used. However, for the purposes of this study, it w felt that the simpler device was adequate.

indices. Eliminating the variables which showed little relationship, models were established for each library, if this was possible. Further tests and averages of the models were then made.

V Libraries in Group 1, 1962/63

(a) Coefficients of correlation

Table I shows the establishment of the cost indices for the six libraries of Group I. The cost index was found by dividing Column 1 into Column 2.

TABLE I

Derivation of cost index, 1962/63, Group 1 Libraries

	1	2	
Library	Acquisitions, 1962/63	Salary Budget, 1962/63	Cost In
Toronto	57,636	$801,948	13.9
British Columbia	35,792	461,657	12.8
McGill	37,876	472,177	12.4
Manitoba	19,626	197,936	10.0
Saskatchewan	18,416	181,424	9.8
Alberta	34,515	339,902	9.8

It is interesting to note that the cost of indices of the libraries rank in descending order dependent on acquisitions, with only one slight discrepancy - University of British Columbia and McGill are interchanged - except for Alberta, which has a lower index than either Manitoba or Saskatchew despite a much larger number of acquisitions.

TABLE II

Derivation of Service Index, 1962/63, Group I Libraries

	1	2	3
Library	Circulation	Full time Faculty and Students	Service Index
Toronto	549,116	10,387	53
British Columbia	649,410	14,071	46
Alberta	402,000	10,056	39
McGill	337,978	9,247	37
Manitoba	300,762	5,421	35
Saskatchewan	199,251	6,172	30

As shown in Table II, the service index was derived by dividing the figure in Column 2 into Column 1. Except for Alberta, the service index ranks the libraries in the same descending order as the cost index.

Table III shows the data used for the measure of the variables which were thought to affect the two indices. This data was used to establish the coefficients of correlation as shown in Table IV.

TABLE III

Data for variables studied, Group I Libraries, 1962/63 *See Appendix A

	1	2	3	4	5	6	7	8	9	10
Library	Acquisit.	Coll. Size	Book Budget	% Salary	Prof. Staff	Cler. Staff	Under grad.	Grad.	Exp. as % of Institt.	Exp. per Student
Toronto	57,636	1,051,457	$272,538	67	60	144	7,842	1,390	4.19	113.21
U.B.C.	35,792	560,720	292,247	52	40	83	12,630	631	4.28	57.71
McGill	37,876	860,478	219,047	48	52	85	7,385	1,174	4.92	106.73
Manitoba	19,626	445,669	111,015	53	18	36	4,648	296	4.1[illegible]	62.30
Sask.	18,416	238,145	138,519	51	15	22	6,447	251	3.03	45.93
Alberta	34,515	315,267	275,574	47	29	56	8,700	656	5.69	69.23

TABLE IV

Coefficients of correlation, Group I Libraries, 1962/63

	1	2	3	4	5	6	7	8	9	10
Index	Acquisit.	Coll. Size	Book Budget	% Salary	Prof. Staff	Cler. Staff	Under-grad.	Grad.	Exp. as % of Instit.	Exp. per Studen'
Cost	.772	.886	.258	.715	.772	.772	.258	.515	-.085	.429
Ser-vice	.829	.829	.778	.315	.829	.829	.772	.772	.486	.486

The relationships which are shown by the correlation coefficients are particularly interesting in light of the CACUL Standards. It is stated in the Standards that student enrolment is the factor which most affects change in library budgets.(15) The low degree of relationship between cost and undergraduate enrolment, and the moderate degree of relationship between cost and graduate enrolment would certainly indicate that, if not incorrect, the statement is at least open to question and should be investigated further. Although the relationship of the enrolment to the service index has a high degree of correlation, it is not as marked as the correlation of the service index with the size of staff. The size of staff has a high correlation with the cost index as well.

It is also interesting to note that the Standards suggest that the per capita student library expenditure is an important figure for comparative purposes.(16) The relationship shown in Table IV is quite moderate for both indices, and would indicate that the importance of the per capita figure might also be reassessed.

The variable which shows the highest correlation with both the cost and service indices is the collection size. Figures I and II illustrate the

relationship of the cost and service indices to the size of the collection.

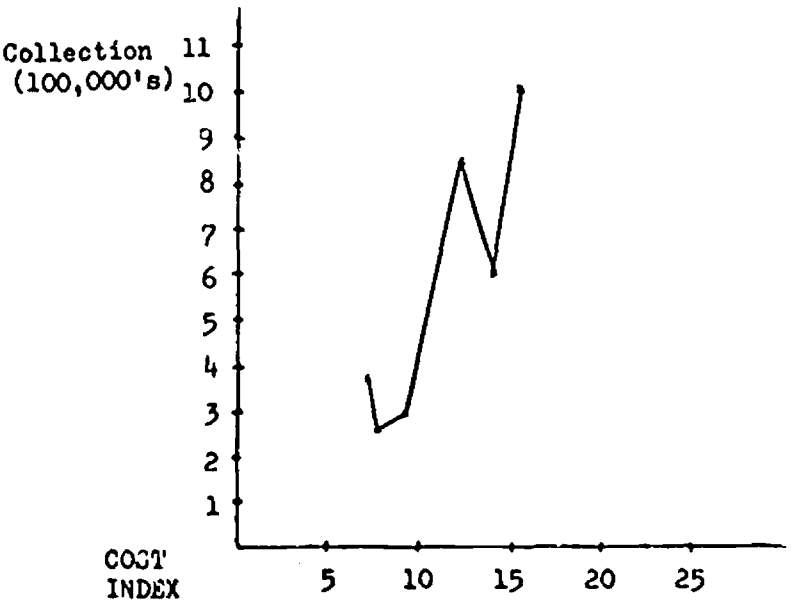

FIGURE I: COST INDEX

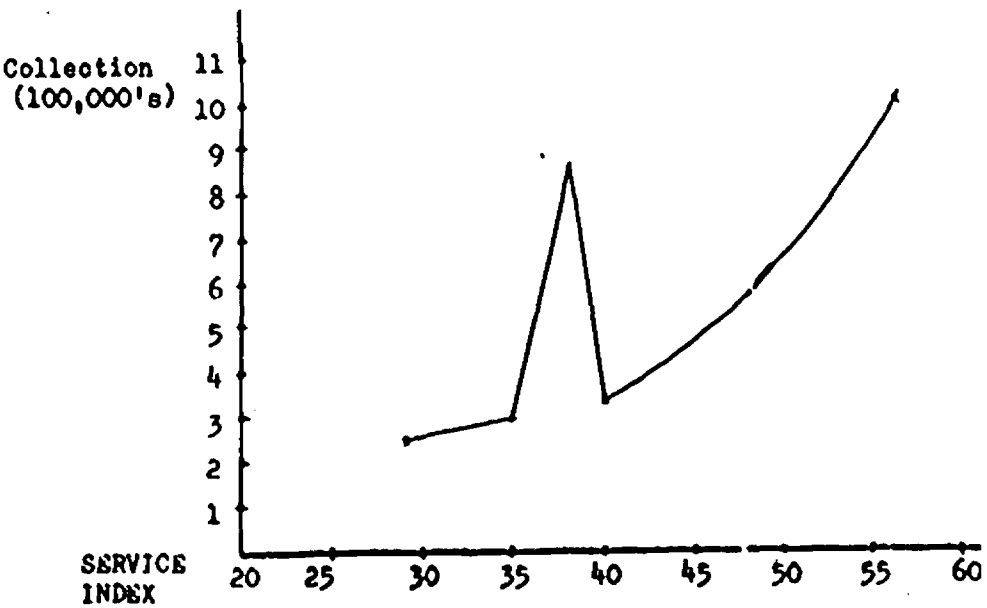

FIGURE II: SERVICE INDEX

Except for McGill, which had a lower per capita circulation than either British Columbia or Alberta despite a larger collection, the curve in Figure II is exponential, rising as the collection increases. The cost index shows a similar pattern, except for slightly lower costs in Alberta than in Manitoba or Saskatchewan, and for British Columbia's higher costs in relation to McGill. Both instances of wide variance from the curve might be explained by the particular situation at McGill. Quebec professional librarians' salaries have been lower than those in Ontario and the Western Provinces for several years, which might explain the lower cost index at McGill. In addition, the Redpath Library has been overcrowded and without adequate study space, and library use may have suffered as a result.

Another variable which deserves further analysis is the book budget.

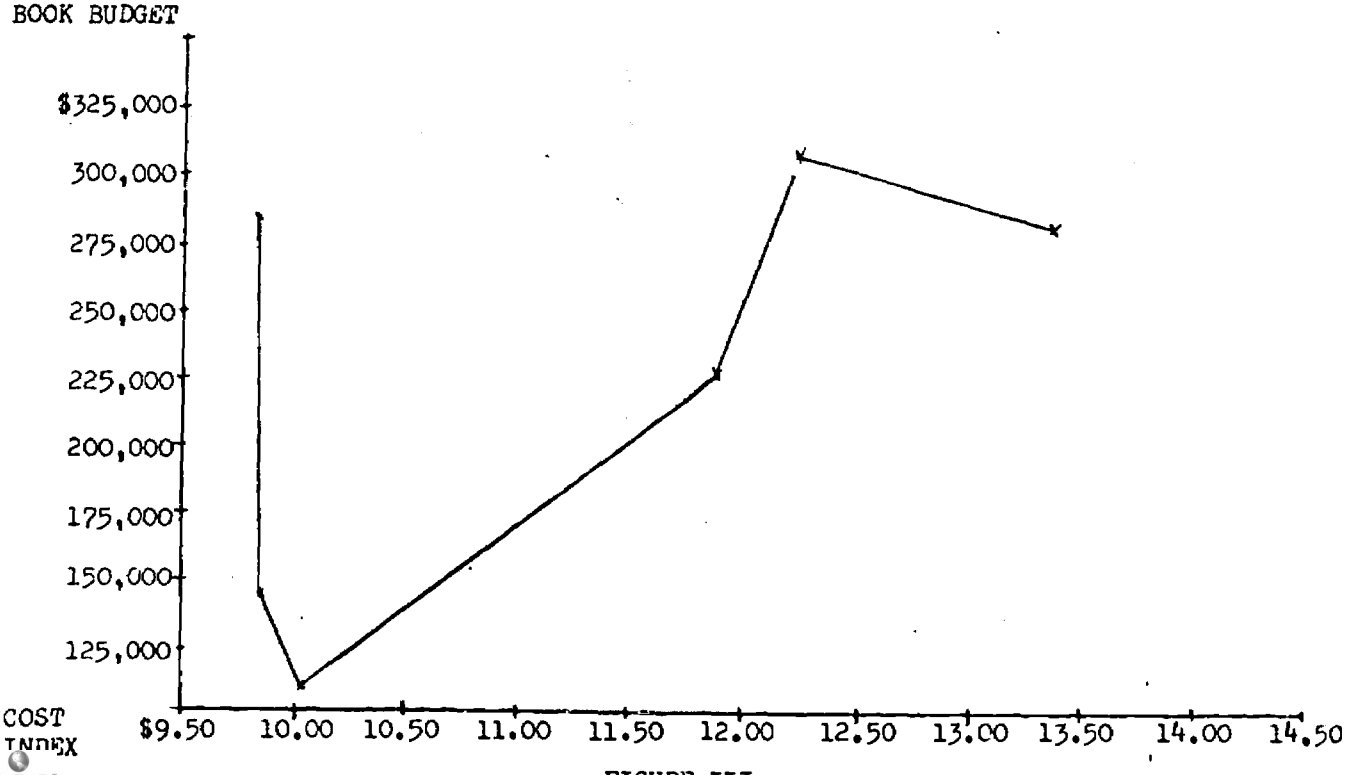

FIGURE III

The coefficient of correlation with the service index is moderately high at .778 which could indicate that as the book budget increases the per capita rate of circulation also becomes higher. However, it could be expected that the same relationship would hold true for costs: the larger the number of books being added the higher the costs. Figure III displays the actual situation.

Without investigating the circumstances in each library it is only possible to surmise the reason for the curve in Figure III. There appears to be little relationship between the actual processing of books as compared to the number of books bought. The University of Toronto Library, for instance, has been recataloguing to Library of Congress since 1960, and this fact must be considered. In addition, most large university libraries are spending their book budgets but accumulating a back-log of unprocessed material. So many other variables are present which affect the cost of adding volumes to the shelves, that the book budget cannot be the most important factor at any one time.

(b) *Establishing models*

In establishing the models, those variables which showed a degree of relationship of less than .4 were eliminated from the analysis. The cost and service indices were called x and assigned the values determined for 1962/63 rounded to the nearest whole number. Tables V and VII show the models for each university based on the cost and service indices. Tables VI and VIII show the average models which were then developed.

TABLE V

Models based on Cost Index, Group I Libraries, 1962/63

	1	2	3	4	5	6	7	8	9
Library	Cost Index	Value	Acquisit.	Coll. Size	% Salary	Prof. Staff	Cler. Staff	Grad.	Exp. per Student
Toronto	x	14	4,117x	75,000x	4x	4x	10x	100x	8x
U.B.C.	x	13	2,175x	43,000x	4x	3x	6x	48x	4x
McGill	x	12	3,156x	72,000x	4x	4x	7x	98x	9x
Manitoba	x	10	1,963x	41,500x	5x	2x	4x	30x	6x
Sask.	x	10	1,841x	23,800x	5x	2x	2x	25x	5x
Alberta	x	10	3,450x	31,500x	5x	2x	6x	66x	7x

TABLE VI

Average Model based on Cost Index, Group I Libraries, 1962/63

	1	2	3	4	5	6	7	8
Index	Value	Acquisit.	Coll. Size	% Salary	Prof. Staff	Cler. Staff	Grad.	Exp. per Student
x	11	2,800x	48,300x	4.5x	3x	6x	61x	6x

TABLE VII

Models based on Service Index, Group I Libraries, 1962/63

	1	2	3	4	5	6	7	8	9	10
Library	Index	Value	Acquisit.	Coll. Size	Book Budget	Prof. Staff	Cler. Staff	Under-grad.	Grad.	Exp. per Student
Toronto	x	53	1,087x	20,000x	5,145x	1.13x	2.7x	148x	26x	2.13x
U.B.C.	x	46	778x	12,200x	6,355x	.87x	1.8x	273x	14x	1.25x
McGill	x	37	1,023x	23,000x	5,920x	1.4 x	2.3x	172x	31x	2.88x
Manitoba	x	35	560x	8,600x	3,200x	.5 x	1.0x	132x	8x	2.88x
Sask.	x	30	613x	8,000x	4,600x	.5 x	.7x	197x	8x	1.53x
Alberta	x	39	885x	8,000x	7,100x	.74x	1.4x	223x	17x	1.77x

TABLE VIII

Average model based on Service Index, Group I Libraries, 1962/63

	1	2	3	4	5	6	7	8	9
Index	Value	Acquisit.	Coll. Size	Book Budget	Prof. Staff	Cler. Staff	Under-grad.	Grad.	Exp. per Student
x	40	824x	13,300x	5,386x	.85x	1.65x	191x	17x	2.07x

To apply the models thus established we could use the collection size that variable with the highest coeeficient of correlation with both indices - as a base, and hypothesize a library situation:

> If a collection size were approximately 500,000, and increased at the rate of 30,000 a year, it could be expected that the library would need 33 professional staff, 66 clerical staff, and would spend 50% of its total budget on salaries. The circulation could be expected to be 40 per capita, serving 7,500 undergraduate students.

VI Libraries in Group I, 1964/65

Rather than depend on one year as a base for the analysis, a study was made of the relationship between models developed for two different years. The academic year 1964/65 was used to study the cost index. Table IX shows the data used with libraries ranked in order of the cost index, and Table X shows the coefficients of correlation. The cost index was found by dividing Column 1 of Table IX into Column 10.

TABLE IX

Data for establishing Cost Index and Measurable Variables, Group I Libraries, 1964/65

	1	2	3	4	5	6	7	8	9	10	11
Library	Salary Budget	Cost Index	Acquisit.	Coll. Size	Book Budget	% Sal-ary	P. S.	C. S.	Under-grad.	Grad.	Exp. per Student
Toronto	$1,365,545.	15.71	86,891	1,211,647	656,698	62	89	264	9,287	2,324	$171.86
McGill	722,095.	15.65	46,141	973,110	346,890	61	59	108	9,359	1,431	103.94
Manitoba	294,394.	12.33	23,876	335,403	219,426	54	21	45	5,485	515	127.44
U.B.C.	516,153.	9.21	74,326	756,666	516,153	51	49	124	14,086	1,059	86.75
Alberta	493,737.	8.65	66,217	422,983	493,737	49	37	100	8,540	931	114.83
Sask.	315,966.	8.29	32,419	298,052	269,009	48	14	49	8,236	331	71.73

P.S. - Prof. Staff C.S. - Cler. Staff

TABLE X

Coefficients of Correlation, Cost Index, Group I Libraries, 1964/65

1	2	3	4	5	6	7	8	9
Acquisit.	Coll. Size	Book Budget	% Salary	Prof. Staff	Cler. Staff	Under-grad.	Grad.	Exp. per Student
.227	.829	.372	1.00	.829	.543	.315	.829	.886

TABLE XI

Comparison of Correlation of Cost Index, 1962/63, with Cost Index, 1964/65

	1	2	3	4	5	6	7	8	9
Year	Acquisit.	Coll. Size	Book Budget	% Salary	Prof. Staff	Cler. Staff	Under-grad.	Grad.	Exp. per Student
1962/63	.772	.886	.258	.715	.772	.772	.258	.515	.429
1964/65	.227	.829	.372	1.00	.829	.543	.315	.829	.886

Comparing the coefficients established for the two years (1962/63, 1964/65) as shown in Table XI, reveals results which need further study.

The size of the collection, which had the greatest degree of correlation for both service index and cost index in 1962/63, shows the same relationship for the cost indices for 1962/63 and 1964/65. The size of the professional staff in 1964/65 shows a greater relationship to the cost index than it had two years previously, but the degree of relationship with the clerical staff has decreased. The relationship of the cost index to the book budget and undergraduate enrolment is again very low, but the relationship to the graduate enrolment has increased from moderate to very high. The coefficient of correlation for the percentage of the budget spent on salaries increased from a marked degree to a perfect relationship. This would seem to indicate that as the library operation becomes larger, the collection size, and that percentage of the budget spent on salaries, maintains a high degree of relationship to the cost index; while the size of the professional staff and the graduate enrolment becomes increasingly important as compared to the size of the clerical staff and the undergraduate enrolment.

However, the behaviour of two of the variables - that of the relationship of the library acquisitions and the expenditure per student - do not follow a pattern that might have been anticipated. In the measure of library acquisitions, the University of Manitoba had a high cost index (ranking 3), but a low number of accessions for the year 1964/65. Determining the coefficient of correlation for 1964/65 without including Manitoba shows a resulting figure of .7, which is much closer to the .772 of 1962/63. An investigation of the particular situation at Manitoba in 1964/65 might reveal some of those factors such as reclassification, a library move, or drastic staff turn-over which cannot be reported and measured.

Since the library expenditure per student was suggested by the CACUL Standards as being an important comparative figure,[17] it was considered necessary to investigate the change in correlation from .429 in 1962/63 to .886 in 1964/65 in more detail. Using the D.B.S. statistics for 1960/61, the relationship shown in Table XII resulted.

TABLE XII

Comparison of Library expenditure per student

Year	Coefficient of correlation with cost index
1960/61	-.2
1962/63	.429
1964/65	.886

Whether this result indicates that the low or negative relationships shown in 1960/61 and 1962/63 are more consistent than the high relationship of 1964/65, or whether the pattern of increasing relationship with increasing size of the collection, enrolment, etc., is a true one, cannot be stated without more intensive study. This supports, however, the original conclusion that it is necessary to investigate further the statement about the importance of library expenditure per student made in the CACUL Standards.

Derivation of Models, 1964/65

Table XIII shows the models established, based on the cost index for 1964/65. Table XIV illustrates the comparison of the models for the two years under study.

TABLE XIII

Derivation of Models, based on Cost Index, Group I Libraries, 1964/65

	1	2	3	4	5	6	7	8
Library	Cost Index	Value	Coll. Size	% Salary	Prof. Staff	Cler. Staff	Grad.	Exp. per Student
Toronto	x	15.71	80,000x	4x	6x	17x	155x	11x
McGill	x	15.65	65,000x	4x	4x	7x	95x	7x
Manitoba	x	12.33	28,000x	4x	2x	4x	43x	.10x
U.B.C.	x	9.21	84,000x	5x	6x	14x	117x	10x
Alberta	x	8.65	37,000x	5x	4x	11x	103x	12x
Sask.	x	8.29	37,000x	6x	2x	6x	42x	9x
Average	x	11.7	55,000x	4.6x	4x	9x	91x	10x

TABLE XIV

Comparison of average model, 1962/63, 1964/65, based on Cost Index, Group I Libraries*

	1	2	3	4	5	6	7	8
Year	Cost Index	Value	Coll. Size	% Salary	Prof. Staff	Cler. Staff	Grad.	Exp. per Student
1962/63	x	11	48,300x	4.5x	3x	6x	61x	6x
1964/65	x	11.7	55,000x	4.6x	4x	9x	91x	10x

*Acquisitions not included because of low correlation with cost index, 1964

In every instance there is an increase in the figures shown in the models in Tables XIII and XIV, as measured variables in the system increased. This can also be demonstrated by using one library rather than several. Tabl XV illustrates this result.

TABLE XV

University of Toronto Library model based on Cost Index, 1962/63, 1964/65

	1	2	3	4	5	6	7	8
Year	Cost Index	Value	Coll. Size	% Salary	Prof. Staff	Cler. Staff	Grad.	Exp. per Student
1962/63	x	14	75,000x	4x	4x	10x	100x	8x
1964/65	x	15	80,000x	4x	6x	17x	155x	11x

Further Comparison of Service Index Based Model

Circulation statistics have not been reported consistently to D.B.S.. None have been included in the D.B.S. survey of academic libraries since 1962/63 and this appears to have been because not all libraries have collected circulation data. (e.g. Dalhousie has not reported circulation since 1961; others have done so for some years, but not for others.) With inadequate data, no further tests of the models based on the service indices could be made at this time.

VII Libraries in Institutions of under 5,000 Enrolment

Tables XVI to XIX show the derivation of the cost and service indices for 1962/63, the cost index for 1964/65, and the data for the variables measured. A service index could not be derived for 1964/65 due to inadequate data.

TABLE XVI

Derivation of Cost and Service Indices, Group II Libraries, 1962/63

	1	2	3	4	5	6
Library	Acquisitions	Salary Budget	Full time Enrolment	Circulation	Cost Index	Service Index
McMaster	15,299	$203,600.	2,421	102,827	13.30	42
Queen's	13,623	156,270.	3,799	112,246	11.47	29.5
Carleton	9,850	104,266.	2,088	103,442	10.58	49.5
U.N.B.	7,740	55,597.	2,520	79,837	7.18	32
Memorial	8,121*	57,380.	2,143	64,000	7.06	30
Calgary	18,069	96,469.	1,876	104,239	5.33	55.5
Victoria	25,136	124,057.	2,043	147,825	4.93	72

* 34,308 given in D.B.S. report as acquisitions, but this included 26,178 microtext, a category which was not included by the other reporting libraries.

The indices for 1962/63 were determined using Table XVI, dividing Column 1 into Column 2 for the cost index, and Column 3 into Column 4 for the service index.

TABLE XVII

Data used to measure variables, Group II Libraries, 1962/63

	1	2	3	4	5	6	7	8	9
Library	Coll. Size	Book Budget	% Salary	Prof. Staff	Cler. Staff	Under-grad.	Grad.	Exp. as % of Instit.	Exp. per Student
McMaster	151,019	111,966	59	15	29	1,920	241	6.47	111.33
Queen's	368,561	126,000	48.5	17	29	3,191	301	5.10	72.11
Carleton	102,101	74,881	55	5	20	1,851	103	6.76	87.59
U.N.B.	125,222	51,700	51	7	6	2,177	178	4.61	50.46
Memorial	103,180	80,280	38	6	8	1,964	34	3.52	32.77
Calgary	68,508	122,920	39.5	8	20	1,714	18	9.76	112.57
Victoria	117,838	161,950	40	9	25	1,861	0	14.49	142.19

TABLE XVIII

Derivation of Cost Index, Group II Libraries, 1964/65

	1	2	3
Library	Acquisitions	Salary Budget	Cost Index
McMaster	23,356	$307,080	13.14
Queen's	23,212	271,801	11.76
Memorial	10,268	88,700	8.63
Victoria	29,131	246,682	8.33
U.N.B.	14,660	106,157	7.92
Calgary	25,475	196,792	7.48
Carleton	37,135	187,778	5.06

TABLE XIX

Data used to measure variables, Group II Libraries, 1964/65

	1	2	3	4	5	6	7	8	9
Library	Coll. Size	Book Budget	% Salary	Exp. as % of Instit.	Prof. Staff	Cler. Staff	Under-grad.	Grad.	Exp. per Student
McMaster	194,154	337,145	43	8.54	16	52	2,917	412	168.81
Queen's	491,801	215,981	49	-	24	41	3,571	432	134.74
Carleton	161,698	148,867	50	8.64	11	34	2,467	223	116.16
U.N.B.	147,413	100,952	45	5.82	5	29	2,585	269	116.50
Memorial	123,865	99,698	46	6.99	8	13	2,601	51	69.92
Calgary	138,900	187,874	44	9.26	12	42	2,505	117	149.68
Victoria	173,898	231,689	43	15.40	21	42	2,460	0	220.79

TABLE XX

Coefficients of correlation with indices, Group II Libraries

	1	2	3	4	5	6	7	8	9
Year	Acquisit.	Coll. Size	Book Budget	% Salary	Prof. Staff	Cler. Staff	Under-grad.	Grad.	Exp. per Student
Cost Index									
1962/63	-.323	.429	-.476	.715	.310	.358	.286	.929	-.523
1964/65	-.428	.596	.631	-.095	.5	.227	.786	.548	.405
Service Index									
1962/63	.679	-.571	.286	.096	.072	.143	-.714	-.642	.762

The resulting correlation statistics shown in Table XX do not show t pattern that existed in the libraries of institutions of over 5,000 enrolment, as shown in Tables IV and X. The degree of correlation with the cost index is not greater than moderate - (i.e. under .6) except in the measures of graduate enrolment and the percentage of the budget spent on salaries, both in 1962/63. However, in 1964/65, these two figures drop from .929 to .548 and from .715 to .095 respectively, and the figures for the book budget and undergraduate enrolment relationships increase. The service index for the one year shown is equally inconclusive.

Several explanations can be suggested. During the years under study the Group II universities were undergoing great expansion, which some librarie were able to handle better than others. Some libraries were involved in reclassification - McMaster; others had extensive department libraries which needed expensive services - Queen's; while other institutions in the same grou had no department libraries or only one - Victoria, Calgary.

With such wide variations in the statistics reported above for the Group II Libraries, no attempt has been made to establish models as had been done for Group I. More extensive study into the causes of the variations

would be needed before any models for each library could be made and considered reliable.

However, using the largest library in Group II in 1964/65 - Queen's - a model was established and compared with the average model based on the cost index for Group I Libraries (Table XIV). This comparison is shown in Table XXI.

TABLE XXI

Comparison of Queen's University Library model with model based on Cost Index, 1964/65

	1	2	3	4	5	6	7	8
Model	Cost Index	Value	Coll. Size	% Salary	Prof. Staff	Cler. Staff	Grad.	Exp. per Student
Queen's	x	11.7	42,000x	4 x	2x	4x	38x	11x
Average	x	11.7	48,300x	4.6x	4x	9x	91x	10x

Except for the lower staff numbers and graduate enrolment at Queen's, the average model is quite close to the situation that existed at Queen's in 1964/65. This may indicate that as the smaller libraries reach a certain size the operations may become more settled, and they might expect to compare with the libraries in Group I. It would therefore appear plausible to apply the average model established for Group I to the Group II Libraries, rather than to establish separate models based on the unsettled situation revealed in the analysis of the Group II Libraries.

Conclusion

This has been a very limited study of the possibility of deriving a simulation model of a university library system. Further analysis would permit a more sophisticated manipulation of the models by computer. However, before university libraries can consider full-scale models as the solution to their decision making problems, the development of considerable new data is necessary. Columbia University began a project in 1964, to develop "a probabilistic simulation model of a library in the form of a computer program", with which it hopes to be able to tell the library how much it would cost to achieve a degree of satisfaction, and to develop a guide to the best course of action to achieve a particular goal. Warren J. Haas, Associate Director of Columbia University Library feels that to do this "will require an understanding of the mission of the library, a management team possessing the special skills and knowledge that will enable its members to use the new techniques, and the development of a system that will generate necessary management information as a by-product of every important operation".(18)

At the Second System Simulation Symposium in 1960, Donald Malcolm, speaking of the use of simulation models in business management said, "In the future it does not seem at all unlikely that management will have a computer model of its business, rich enough in detail and comprehensive enough in scope to permit experimentation with suggested policy change. Further, the model may well be able to administer policy more adequately and consistently than the human administrator. The decision maker will then be freed for the more important task, that of understanding the limitations of the model and searching imaginatively for beneficial innovation".(19) With more and more university libraries using the computer to process library data, it seems probable that the information necessary to develop sophisticated simulation models will be more

readily available. It would then be possible for university libraries to follow the lead of business, and Mr. Malcolm's predictions for scientific decision making could also apply to library administration.

APPENDIX A

Abbreviations, where used, are as follows:

Acquisit.	Acquisitions in number of volumes in the library in one year.
Coll. Size	Collection size is the total collection size for that year.
Book Budget	Book Budget is that portion of the total library budget used for books and periodicals as opposed to salaries or operating.
% Salary	Per cent of library budget which is used for salaries.
Prof. Staff	That part of the staff which is classed as professional.
Cler. Staff	That part of the staff which is classed as Clerical.
Undergrad.	Undergraduate student enrolment.
Grad.	Graduate student enrolment.
Exp. as % of Instit.	Library expenditure as a percentage of the institutional budget.
Exp. per Student	Library expenditure per student enrolment.
U.B.C.	University of British Columbia.
Sask.	University of Saskatchewan.
U.N.B.	University of New Brunswick.

Footnotes

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3. Canadian Association of College and University Libraries. Guide to Canadian university library standards; report. Ottawa? 1965. p. 47.

4. Wilson, I.G. and Wilson, M.E. Information, computers and system design. New York, Wiley, 1965. p. 3.

5. Robinson, P.J. Cases in simulation: A research aid as a management demonstration piece. In Schuchman, A., ed. Scientific decision making in business. New York, Holt, Rinehart and Winston, 1963. p. 426.

6. Ibid. p. 427.

7. Wilson, I.G., op. cit. p. 11.

8. Becker, J. and Hayes, R.M. Information storage and retrieval. New York, Wiley, 1963. p. 333.

9. Ibid.

10. Bowman, I. Geography in relation to the social sciences. New York, Scribners, 1934. p. 67.

11. Canada. Bureau of Statistics. Survey of libraries. Part II: Academic libraries. 1960/61, 1962/63, 1963/64, 1964/65.

12. Canadian Association of College and University Libraries. op. cit. p. 47.

13. Sir George Williams University enrolled the majority of its students as part-time or extension students. The pattern of library use is different from other university libraries.

14. Canada. Bureau of Statistics. Survey of libraries. op. cit.

15. Canadian Association of College and University Libraries. op. cit. p. 15.

16. Ibid.

17. Ibid.

18. Library of Congress. Information bulletin. January 27, 1964. In Appendix, p. 46.

19. Malcolm, D. The use of simulation in management analysis; a survey. In Second System Symposium, American Institute of Industrial Engineers, 1960. Report, pp. 11-26.

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