

## MOD MEKKAWI

The ARL Library Index  
as a Decision-Making Tool

In May of 1980 the Association of Research Libraries (ARL) adopted new criteria for membership in the association based, in large part, on what is known as the ARL Library Index.<sup>1</sup> This index is derived from a model containing ten categories, or variables, which characterize library size.

While the Library Index model was developed as a measure of an institution's overall standing relative to the ARL membership, this author has found it to be useful, if properly employed, as a decision-making tool in short-term planning, programming, and budgeting in those operations affecting library size. This article describes the procedure for this application of the index.

## WHAT IS THE LIBRARY INDEX?

Until 1980, *ARL Statistics* described the size and rank of ARL member institutions separately in terms of holdings, expenditures, staffing, and interlibrary loan activity. While the institutions could be compared on these variables, one at a time, there was no summary measure of an institution's overall ranking in the association. The ARL model was designed to provide such a summary characterization.

The model is as follows:

$$\sum FSC_i (\log k_i - \log K_i) / s.d. K_i$$

where, in a given year:

- $FSC_i$  = Factor score coefficient of variable  $i$ ;  
 $k_i$  = Value of variable  $i$  for the study institution;  
 $K_i$  = Mean of variable  $i$ ;  
 $s.d. K_i$  = Standard deviation of variable  $i$ .

The ten variables included in the model are defined as:

1. Volumes held, excluding microforms and government documents;
2. Volumes added (gross), excluding mi-

croforms and government documents;

3. Microforms held, including microfilm reels, microcards, microprints sheets, microfiches;

4. Current serials received, including periodicals;

5. Expenditures for library materials, including books and serials;

6. Expenditures for binding;

7. Expenditures for salaries and wages, including student assistants' wages, but omitting fringe benefits;

8. Other operating expenditures;

9. Number of FTE professional staff; and

10. Number of FTE nonprofessional staff.

Thus for XYZ university library (a hypothetical institution), the index score will be calculated by substitution of the variables in the model with their corresponding values for this library. Using the 1979/80 ARL model, we calculate XYZ's index as shown in table 1. As it turns out, some of the calculated component scores are negative, which indicates areas in need of improvement if XYZ institution wishes to score higher in ARL.

Given certain characteristics of the ARL model and the current conditions at XYZ, how can this institution achieve a certain improved index score most economically? Note that in 1979/80, the scores of the ARL members ranged from a low of -1.93 (Oklahoma State) to a high of +3.00 (Harvard), with -.38 for the university median.

MANAGEMENT APPLICATION  
OF THE ARL MODEL

The library administration will set a goal to achieve a certain index score within a given time framework—for instance, one year. Given the library's current component values, its costs of increasing each independent variable (book, serial, microform) by one unit, the costs of increasing the depen-

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TABLE 1  
PROCEDURE FOR CALCULATING THE LIBRARY INDEX, XYZ UNIVERSITY LIBRARY, 1979/80

Component Variable	$FSC_i$	$k_i$	$K_i$		$\frac{s.d.}{K_i}$	=	Component Score
1. VOLHELD	.12108	(log 1116396)	-6.2916)	/	.2172	=	-0.135897
2. VOLADDED	.11940	(log 57902)	-4.8412)	/	.2025	=	-0.046290
3. MIC FORM	.07509	(log 1165076)	-6.0950)	/	.1763	=	-0.012200
4. CT SERIALS	.12253	(log 13156)	-4.3432)	/	.2341	=	-0.117283
5. MAT EXPEND	.12553	(log 1894321)	-6.2333)	/	.1636	=	0.033879
6. BINDING	.11266	(log 34132)	-5.0480)	/	.2475	=	-0.234350
7. TTL SALARIES	.12581	(log 3609365)	-6.4675)	/	.2103	=	0.053801
8. OPER EXPEND	.10592	(log 625014)	-5.6773)	/	.2635	=	0.047670
9. PROF STAFF	.12347	(log 83)	-1.8281)	/	.1968	=	0.057079
10. NONPROF	.12970	(log 124)	-2.1512)	/	.2046	=	-0.031902
Total score (Library Index)							-0.385493

dent variables (materials expenditures, binding, salaries and wages, other operating expenditures) caused by one unit increase in the dependent variables, and the weight of the dependent and independent variables in the ARL model, one can apply linear programming principles to find the best use of the library's resources.

Because this problem involves not only product mixing (books/serials/microforms), but also changes in the dependent components as the products are increased in certain ratios and quantities, formal linear programming techniques can be unnecessarily complex. The author has therefore worked out a shortcut procedure that may well yield the optimization effect sought in a formal linear programming solution.

Before looking at the procedure, let us state the major requirements of the problem:

1. There must be an objective the library wants to achieve. Obviously, its major objective, in terms of ARL standing, is to maximize the total contribution of the components in the ARL model. The component contributions, or scores, add up to the Library Index.

2. There must be alternative courses of action, one of which will achieve the above objective. In what ratio should the library increase its book/serial resources—1:1? 3:1? 0:1? Some other ratio?

3. Dollar resources are limited. One serial may cost twice as much as one book. Consequently, the more money that is spent on serials, the less there will be to spend on additional books.

4. The ratio of book:serial and the amount of books and/or serials additions needed to achieve the objective (a target

ARL score) depend (beside costs and proportion of serial subscriptions going into the collection as volumes added) on the component score coefficients, or weights, in the ARL Library Index model.

#### PROCEDURE

The computational routine is an iterative process. In working toward the target score, the routine is repeated over and over, in a systematic pattern, until the preestablished score value has been reached.

Of the three independent variables in the model—books, current serials received, and microforms—we shall use, to simplify the problem, two "products" only, namely books and serials. In what ratio should these variables be increased?

Assume lower and upper limits of 0 and 9 for either element in the relation. That is, in the extreme cases, the book:serial ratio can be 0:9 or 9:0. There are fifty-seven alternative exclusive ratio combinations: 0:1, 1:0, 1:1, 1:2, 1:3, etc.

Assume also that all new serial additions are bound and added to the collection, and that one serial title produces one bound volume on the average. Thus, increasing books and serials by one unit each (1:1 ratio) will increase volumes added and volumes held by two units each. Similarly, a 4:1 ratio will increase volumes added and volumes held by five units each.

At the same time, expenditures for materials, binding, total salaries, other operating items, and the quantity of manpower needed to carry the additional work loads, are all increased by appropriate amounts for each one serial or monographic addition. These amounts are displayed in table 2.<sup>2</sup>

TABLE 2  
INPUT DATA CAUSED BY ADDITION OF  
ONE MONOGRAPHIC OR SERIAL UNIT  
TO THE COLLECTION

Component Variable	Item Added	Additional Unit Cost per Item
MAT EXPEND	Book	\$25.0
	Serial	50.0
BINDING	Book	0.0
	Serial	7.0
SALARIES	Book	20.0
	Serial	23.0
PROF STAFF	Book	.00059 manyear
	Serial	.00059 manyear
NONPROF	Book	.00073 manyear
	Serial	.00093 manyear

Note: The personnel and salaries data are based on (1) known work-load factors for library operations and (2) estimated annual salaries and wages of \$20,000 and \$12,000 for professionals and nonprofessionals, respectively.

Before we begin the computations, we must adjust the basic data for XYZ by adding initially to its VOLHELD a quantity equal to the number of volumes added in 1979/80. The assumption here is that XYZ will add to its collection in the projected year, books and serials in the proportions and quantities reported in the previous year. All other additions, needed to improve the index score, will be over and above the initial increments. The rate of serial binding is again assumed to be 100 percent. Thus, for XYZ, the value of volumes at the start of the computational routine is 1174396 (1116396 + 58000).

Using the adjusted statistics and the input data from table 2, the PL/1 program given in appendix 1 develops solutions to this problem. For each of the eleven ARL target scores, ranging from 0 to 1.0, the program

produced fifty-seven tables, a sample of which is given in table 3. The optimal solution for each target score is that that corresponds to the lowest amount of total additional expenditures shown at the foot of each table. The book:serial ratio can be easily determined from the input data printed above the table, where the second item represents volumes added (monographs plus serials), and the third item units of serials added in each loop. Hence, the book:serial ratio in table 3 is 1:3.

For XYZ library, the optimal book:serial ratio is 0:1 for each of the eleven alternative score targets: that is, if a certain target score were to be achieved most economically, all additional funds would have to be allocated to increasing the number of current serials received, while book additions remained at the previous level.

What if the proportion of additional serials that are bound into volumes was less than 100 percent? Table 4 shows that the book:serial ratio of 0:1 remains the optimal product mix at every rate of binding except zero, that is, when none of the additional serial titles is bound at year's end. At the same time, the cost of achieving the given target score increased as the rate of binding dropped from one to zero. Except for binding expenditures, which obviously decreased as the proportion of serials sent to bindery decreased, all the other expenditures increased as more serials had to be added to reach the same score. This observation is quite instructive. It indicates that a certain score can be reached less expensively when most, if not all, of the current se-

TABLE 3  
SAMPLE RESOURCE ALLOCATION TABLE FOR IMPROVED INDEX SCORE  
(LI = 0.100000 DATA = 4 4 3 175 20 21)

Component	Current	Value Target	Increase	Target Score
VOLHELD	1174396	1184676	10280	- 0.121520
VOLADDED	57902	68182	10280	- 0.004434
MICROFORMS	1165076	1165076	0	- 0.012201
CT SERIALS	13156	20866	7710	- 0.012431
MAT EXPEND	1894321	2344071	449750	0.104875
BINDING	34132	88102	53970	- 0.046891
TOTAL SALARY	3609365	3839637	230272	0.069869
OPER EXPEND	625014	676414	51400	0.061470
PROF STAFF	83	89	6	0.076295
NONPROF	124	133	9	- 0.015017
TOTAL				0.100015

Total Additional Expenditures = 785392. Binding Rate = 1.0



scriptions involve long-range financial commitment.

Nevertheless, the ARL model's usefulness in planning and budgeting is not seriously diminished. It provides the library administration with a scientific budgeting tool by identifying alternative means of achieving an established objective and their associated costs.

*tive Relationships in the ARL*, a report by Kendon Stubbs for the Committee on ARL Statistics (Washington, D.C.: ARL, 1980).

- The cost factors shown in table 2 represent the actual costs at the XYZ institution. The work-load factors for library operations are calculated from Robert M. Hayes and Joseph Becker, *Handbook of Data Processing for Libraries* (2d ed.; Los Angeles, Calif.: Melville Publ. Co., 1974), p.118. While the work-load factors are based on a "careful review of the literature and have been compared with the actual costs in several libraries as well as with a functional analysis of the operations themselves," the cost factors pertain to the XYZ institution and are used here for illustration only. The individual library must compare these rates with those reported by its own cost-accounting system.

#### REFERENCES

- The Library Index is briefly explained in *ARL Statistics, 1979-80* (Washington, D.C.: ARL, 1980); a full description of the index may be found in the *ARL Library Index and Quantita-*

#### APPENDIX 1: PL/I PROGRAM

The following PL/I program is used to develop alternative solutions to achieve an established Library Index score.

```
SCORES: PROC OPTIONS(MAIN);
DCL X(2)FLOAT(15),
(A1,A2,A3,A4,A5,A6,A7,A8,A9,A10,A11,A12,A13,A14,A15,A16,A17,A18,A19,A20)
FLOAT(15),
(K,L,M,N,P,Q,T,U,V)FLOAT(15),
(S1,S2,S3,S4,S5,S6,S7,S8,S9,S10,S11,S12,S13,S14,S15,S16,S17,S18,S19,S20,S21,
S22,S23,S24,S25)FLOAT(15),
(R)FLOAT(15);
DCL (I,J,MAX) FIXED BIN(15);
MAX=2;
/* READ VALUE OF TARGET SCORE(S) */
DO I = 1 TO MAX;
GET LIST (X(I));
END;
/* LIBRARY SIZE VALUES:
A1, A11= VOLHELD; A2, A12= VOLADDED; A3, A13= CT SERIALS;
A4, A14= MATEXPEND; A5, A15= OPEREXPEND; A6, A16= MICROFORM;
A7, A17= BINDING; A8, A18= TOTALSALARY; A9, A19= PROFSTAFF;
A10, A20= NONPROF */
A11=1174396; A12=57902; A13=13156; A14=1894321; A15=625014;
A16=1165076; A17=34132; A18=3609365; A19=83; A20=124;
/* R= RATE OF SERIAL BINDING */
R=1;
DO I= 1 TO 57;
A1=1174396; A2=57902; A3=13156; A4=1894321; A5=625014;
A6=1165076; A7=34132; A8=3609365; A9=83; A10=124;
/* READ THE QUANTITIES TO BE ADDED IN EACH LOOP:
K= BOOKS, BOUND SERIALS ADDED TO VOLHELD;
L= BOOKS, BOUND SERIALS ADDED TO VOLADDED;
M= SERIAL SUBSCRIPTIONS ADDED TO CT SERIALS;
N= INCREASE IN MATEXPEND CAUSED BY THE ADDITIONAL BOOKS/SERIALS;
P= INCREASE IN OPEREXPEND CAUSED BY THE ADDITIONAL BOOKS/SERIALS;
Q= INCREASE IN BINDING EXPENDITURES CAUSED BY THE ADDITIONAL BOOKS/
SERIALS;
T= INCREASE IN TOTAL SALARIES CAUSED BY THE ADDITIONAL BOOKS/SERIALS;
U= INCREASE IN PROFESSIONAL STAFF CAUSED BY THE ADDITIONAL BOOKS/
SERIALS;
V= INCREASE IN NON-PROFESSIONAL STAFF CAUSED BY THE ADDITIONAL BOOKS/
SERIALS */
```

```

GET LIST (K,L,M,N,P,Q);
T= ((L-M)*20.60)+(M*23.0);
U= ((L-M)*.00059)+(M*.00059);
V= ((L-M)*.00073)+(M*.00093);
K=K-M+(M*R);
L=L-M+(M*R);
Q=Q*R;
/* COMPUTE THE SOLUTIONS FOR EACH TARGET SCORE */
DO I = 1 TO MAX;
/* SET TABLE HEADING */
PUT EDIT ('LI=',X(1),',';','DATA:',K,L,M,N,P,Q)
(COL(1),A,COL(5),F(9,6),COL(16),A,COL(20),A,COL(25), 6 F(6));
PUT EDIT (' (60)'-' ) (COL(1),A);
PUT EDIT ('VALUE')(COL(30),A);
PUT EDIT ('(31)'-' , 'TARGET')(COL(17),A,COL(53),A);
PUT EDIT ('COMPONENT', 'CURRENT', 'TARGET', 'INCREASE', 'SCORE')
(COL(1),A,COL(18),A,COL(29),A,COL(40),A,COL(53),A);
PUT EDIT (' (60)'-' ) (COL(1),A);
S11= 0;
/* COMPUTE LIBRARY INDEX AND TEST IF TARGET SCORE IS REACHED */
DO WHILE (S11-> X(I));

A1=A1+K;      A2=A2+L;      A3=A3+M;      A4=A4+N;      A5=A5+P;
A7=A7+Q;      A8=A8+T;      A9=A9+U;      A10=A10+V;

S1=.121079*(LOG10(A1)-6.29159)/.217199;
S2=.119399*(LOG10(A2)-4.84119)/.202499;
S3=.122529*(LOG10(A3)-4.34319)/.234099;
S4=.125529*(LOG10(A4)-6.23329)/.163599;
S5=.105919*(LOG10(A5)-5.67729)/.263499;
S6=.07509*(LOG10(A6)-6.0950)/.1763;
S7=.11266*(LOG10(A7)-5.0480)/.2475;
S8=.12581*(LOG10(A8)-6.4675)/.2103;
S9=.12347*(LOG10(A9)-1.8281)/.1968;
S10=.11297*(LOG10(A10)-2.1512)/.2046;
S11= S1+S2+S3+S4+S5+S6+S7+S8+S9+S10;
END;
/* COMPUTE THE AMOUNT OF INCREASE IN EACH COMPONENT VALUE, FROM CURRENT
TO TARGET (IMPROVED) */
S12=A1-A11;  S13=A2-A12;  S14=A3-A13;  S15=A4-A14;  S16=A5-A15;
S17=A6-A16;
S18=A7-A17;  S19=A8-A18;  S20=A9-A19;  S21=A10-A20;
S25= S15+S16+S18+S19;
/* PRINT SOLUTION TABLE */
PUT EDIT ('VOLHELD', A11,A1,S12,S1)
(COL(1),A,COL(15),F(10),COL(25),F(10),COL(36),F(10),COL(50),F(10,6));
PUT EDIT ('VOLADDED', A12,A2,S13,S2)
(COL(1),A,COL(15),F(10),COL(25),F(10),COL(36),F(10),COL(50),F(10,6));
PUT EDIT ('MICROFORM', A6,A16,S17,S6)
(COL(1),A,COL(15),F(10),COL(25),F(10),COL(36),F(10),COL(50),F(10,6));
PUT EDIT ('CT SERIALS', A13,A3,S14,S3)
(COL(1),A,COL(15),F(10),COL(25),F(10),COL(36),F(10),COL(50),F(10,6));
PUT EDIT ('MATEXPEND', A14,A4,S15,S4)
(COL(1),A,COL(15),F(10),COL(25),F(10),COL(36),F(10),COL(50),F(10,6));
PUT EDIT ('BINDING', A17,A7,S18,S7)
(COL(1),A,COL(15),F(10),COL(25),F(10),COL(36),F(10),COL(50),F(10,6));
PUT EDIT ('TOTALSALARY', A18,A8,S19,S8)
(COL(1),A,COL(15),F(10),COL(25),F(10),COL(36),F(10),COL(50),F(10,6));
PUT EDIT ('OPEREKPEND', A15,A5,S16,S5)
(COL(1),A,COL(15),F(10),COL(25),F(10),COL(36),F(10),COL(50),F(10,6));
PUT EDIT ('PROFSTAFF', A19,A9,S20,S9)
(COL(1),A,COL(15),F(10),COL(25),F(10),COL(36),F(10),COL(50),F(10,6));
PUT EDIT ('NONPROF', A20,A10,S21,S10)
(COL(1),A,COL(15),F(10),COL(25),F(10),COL(36),F(10),COL(50),F(10,6));
PUT EDIT ('TOTAL',S11)(COL(3),A,COL(50),F(10,6));
PUT EDIT (' (60)'-' ) (COL(1),A);
PUT EDIT ('TOTAL ADDITIONAL EXPENDITURES=', S25, 'BINDING RATE=', R)(COL(1),
A,COL(32),F(8),COL(43),A,COL(58),F(2,1));
PUT SKIP(2);
END;
END;
END SCORES;

```



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