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**AN EVALUATION OF THE
GODDARD SPACE FLIGHT CENTER
LIBRARY**

**A Report to the
Goddard Space Flight Center,
National Aeronautics and Space Administration**

Contract NAS5-25140

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INTRODUCTION

In July 1978, a contract (NAS5-25140) was awarded to Herner and Company to analyze and determine the character and degree of coincidence between the current and future missions, programs, and projects of the Goddard Space Flight Center and the current and future collections, services, and facilities of the GSFC Library. The ultimate goals or products of the project were to produce recommendations or evaluations as to the following (paraphrased from the Request for Proposals):

- o Methods of increasing compatibility between GSFC needs and Library holdings, services, and facilities.
- o Methods of early detection of diminution and increase in holdings requirements as reflected in mission/program/project changes.
- o Methods of early anticipation of activities which will require acquisition, service, or facility support.
- o Match between the existing Library collections and GSFC missions/programs/projects, with characterizations of significant divergencies.
- o Effects of inflation on the purchasing power of the Library over the five years prior to the study and the five years following it.
- o Probable impact of near-future GSFC programs on the holdings, services, and facilities furnished by the Library.

The following interview procedures, as well as other techniques, were used to elicit information regarding the foregoing topics:

- o Structured interviews with a proportionally-stratified sample of 324 persons drawn from the 2,923 comprising the professional and technical staff of GSFC.
- o Structured interviews with 14 on-site contractor personnel.
- o Structured interviews with 25 on-site NAS Resident Research Associates.
- o Structured interviews with 37 study scientists and project scientists from the Sciences Directorate (Code 600) and the Applications Directorate (Code 900) not interviewed in the main sample of 324 or as regular library users (below).*
- o Structured interviews with two groups of 28 individuals identified as being regular users of all of the Library's services and not interviewed in the main sample of 324 or as study or project scientists (above).
- o Discussions with the heads of the nine Directorates or their designees.
- o Discussions with 24 program "directors" from Codes 600 and 900 not otherwise interviewed.*
- o Discussions with the members of the GSFC Library Users' Committee not otherwise interviewed.
- o Discussions with the members of the Library staff.

* The supplementary interviews with the 37 study and project scientists and the 56 regular library users were performed at the request of the project Technical Officer. The basic sample of 324 included 39 persons from the Sciences Directorate (Code 600), 36 from the Applications Directorate (Code 900), and 58 from the Administration and Management Directorate (Code 200). However, it was felt by the Technical Officer and her advisors that these individuals did not adequately reflect their Directorates and that the basic sample, although randomly drawn to ensure representativeness and eliminate biases, was not a true proportionately-stratified cross section of the professional and technical GSFC staff. The discussions with the 24 program "directors" were also performed at the request of the Technical Officer, and were supplementary to structured interviews with similar personnel who were part of the basic sample.

In addition to the interviews, the following "unobtrusive" analyses were performed to elicit information as to the subjects of the literature sought or used by the scientific and technical staff:

- o Library circulation data, 1976, 1977, January-June 1978.
- o Sources cited by Goddard authors.
- o Xeroxed journals.
- o User requests for book purchases.
- o Interlibrary loans, 1974, 1976,
- o RECON searches.
- o LC classification of the subjects dealt with by the interviewees.

The purposes of the structured interviews and the "unobtrusive" approaches, and the analysis and interpretation of their results, were (1) to produce answers to the questions set forth in the project work statement, (2) to seek corroborative evidence as to the responsiveness of the Library to its stated and perceived missions, (3) to detect changes in use-patterns and requirements over time, and (4) to establish methods and bases for continuing analyses of current and future requirements and the Library's response to them.

The nature of the information gathered by the various means set forth is, perforce, uneven in that some is based on the subjective judgment of interviewees, some is based on concrete statistics, and some is based on a mixture of the two. Wherever possible, even where subjective value judgments were involved, an effort was made to detect trends or consensuses. As will be noted in the appended tabulations of the structured-interview survey results, many subjective opinions, stated repeatedly and independently by interviewees, proved to be very informative and persuasive. This is all the more so in cases where we were able to find corroboration in evidence derived from different means.

Another important, though subjective, source of intelligence is the responses to "open-ended" questions in the structured interviews. Certain of these responses (questions 26, 30, 31, 45, 48, 49) were tabulated. Others--not lending themselves to ready categorization and tabulations--are listed as recorded by the interviewers. Still another important source of insight is the information gleaned from discussions with the heads of the GSFC Directorates or their designees, program "directors" from Codes 600 and 900, the Library Users' Committee, and the Library staff. While the discursive nature of these discussions precludes their formal tabulation or recapitulation, their results are reflected in various sections of this report.

As will be shown in the text and tabulations that follow, the health of the Library and the esteem in which it is held by the GSFC professional and technical staff are generally high. There are problems and areas of indicated improvement in the kind and degree of coincidence between user needs and the Library's collections, services and facilities. But these (from our viewpoint at least) are easily remedied.

THE STRUCTURED INTERVIEWS

As noted, structured interviews, based on pretested interview protocols, were administered to five different groups: an ordered-random, proportionally-stratified sample of 324 drawn from a computer printout of the then-current professional and technical staff; 14 on-site contractor personnel; 25 on-site NAS Resident Research Associates; 37 Code 600 and 900 study scientists and project scientists not included in main sample of 324; and 56 "heavy" users of the Library--users not otherwise interviewed. Thus, a total of 456 persons received structured interviews. A copy of the interview protocol is attached as Appendix I. The interview responses are tabulated and listed (for open-ended questions and volunteered remarks) in Appendices II-VI.

It is important to caution that the interpretations that follow are merely highlights of the survey findings. In order to understand the full context of these interpretations, and the complete results of the interview survey, it is necessary to read the text of this section of the report in conjunction with the tabulations and listings in the appendices.

General Observations

Three sets of data are most revealing of the relative role of the Library as a source of information within GSFC and its perceived effectiveness in performing this role. These are the series of questions regarding most-recent cases of consciously-sought information (questions 17, 18, 19), a question on the use of various publications and information sources (question 16), and a set in which the interviewees were asked to rate the Library with respect to its collections, services, and facilities

(questions 28-43). Among the five groups of interviewees, the three primary sources of consciously-sought information were as follows:

	<u>Gen. Sample</u>	<u>S & P Scientists'</u>	<u>Con-tractors</u>	<u>NAS</u>	<u>"Heavy" Users</u>
Materials in Own Office	39%	14%	29%	16%	27%
Personal Contacts	24%	41%	21%	24%	25%
GSFC Library	19%	41%	29%	36%	27%

With respect to types of publications and other information sources used, the most heavily cited were books, journals, reports (documents), standards and specifications, equipment/instruction manuals, handbooks, and dictionaries. As shown below and in the tabulations of the responses to question 16, the Library is by far the most important source of books and journals and (not surprisingly) a lesser source of other types of information media. This table shows the percentages of the interviewees who obtain the major types of publications from the Library.

	<u>Books</u>	<u>Reports</u>	<u>Manuals</u>	<u>Journals</u>	<u>S&S</u>	<u>Handbooks</u>	<u>Diction-aries</u>
Gen. Sample	51%	7%	1%	39%	0%	16%	4%
S&P Sci.	84%	11%	0%	87%	5%	40%	19%
Contractors	57%	0%	7%	43%	0%	14%	7%
NAS	96%	4%	0%	89%	0%	20%	13%
Users	53%	13%	0%	54%	1%	16%	6%

Perhaps the most telling measure of the Library's overall use and effectiveness is shown in Appendix VII which is a tabulation of user-ratings in eight areas of its operation. The ratings (more fully explained in the interview protocol) are on a scale of 1 to 4. As a means of developing an

Index of Effectiveness for the eight areas, each "1" rating was given a weight of 4, each "2" a weight of 3, each "3" rating a weight of 2, and each "4" a weight of 1. The total number of respondents who rated a given area "1" was multiplied by 4, the total 2s by 3, the total 3s by 2, and the total 4s by 1. The four products in each case were then added and divided by the number of respondents who rated the Library as to the given attribute. This produced the Index of Effectiveness for each attribute.

As will be seen from Appendix VII, the Library rated significantly above 3.0 (out of a maximum of 4.0) in each of the eight areas. The overall Index of Effectiveness, encompassing all eight areas, is 3.57. Although well above 3.0, the lowest-scoring area was the book collection. We shall be discussing problems and possible solutions with respect to the book collection, as well as other areas of consideration, in this report.

The significance of the Index, and the measures of perceived quality or effectiveness that it represents, are demonstrated by the closeness of the ratings among the different sample groups. For instance, among the interviewees in the general sample, the Index for the journal collection was 3.50; among the "heavy" Library users, it was 3.59. In the general sample, the Index for the book collection was 3.24; among the "heavy" Library users it was 3.25.

Analyses of Open-Ended Comments and Suggestions

Another indicator of the perceived role and effectiveness of the Library is the responses to questions 44 and 54 in the structured interview survey. These are summarized in Appendix VIII and listed verbatim in Appendices II-VI. Question 44, which followed immediately the ratings of the

eight aforementioned areas/attributes, solicited additional suggestions or comments about the Library. Question 54, in the structured interview survey, simply asked: "If you could add anything [you want] to the Library, what would you add?"

As will be noted in Appendix VIII, the three most common comments/suggestions related to Library hours, the need for more information regarding the Library's services, collections, and policies, and the content and currency of the collection. These comments/suggestions, as well as others, are spelled out in greater detail in Appendices II-VI.

With respect to Library hours, the impression one gleans from the structured interviews, as well as the discussions with senior staff members, "heavy" Library users, and members of the Library Users' Committee is that the curtailment of hours of operation, due in large measure to required economies resulting from budget cuts, has had a profound effect on the Library's overall utility. Apparently certain selected users, particularly in the Sciences and Applications Directorates, do have after-hour access to the Library. However, various interviewees--in other Directorates--have difficulty getting to the Library during the regular workday. Some, in fact, state that they are specifically discouraged from doing so.

Satellite Libraries

The question of access to the Library can be related to some degree to the small satellite libraries on the Goddard campus, although it is by no means the only reason for their existence. Of the 456 persons who participated in the formal interviews, 57 (12.5%) had used other on-campus libraries in the previous six months, regardless of whether they also used the GSFC

Library. The satellite libraries specifically named as having been used are the following (verbatim, as named by the interviewees):

- Computer manual library, Bldg. 1
- GLAS library, Bldg. 22
- IUE library
- Landsat library, Bldg. 23
- Legal Branch library, Bldg. 8
- Network Procedures & Evaluation Division library, Bldg. 12
- TDRSS library, Bldg. 12
- Library on parts, Bldg. 6
- MMS documents library, Bldg. 7
- Nimbus reference material, Bldg. 6
- Code 391 sub-library, Bldg. 6
- ST library, Bldg. 11
- Networks Directorate document services libraries, Bldgs. 9 and 12
- Library, Bldg. 25
- Computer manual library, Bldg. 23
- Product Assurance library, Bldg. 6
- Network Operations Control Center library, Bldg. 14
- Reading room for Laboratory for High Energy Astrophysics, Bldg. 2
- Space Telescope Project documentation library, Bldg. 11
- Library on ocean topics, Code 911, Bldg. 22

Not all of the respondents gave reasons for use of these collections, but of those who did, 19 used satellite collections because of the availability therein of project-specific materials; 13 for reasons of convenience (e.g., "it's next to the coffee room"); 4 because the GSFC Library was judged

deficient (in its collection of books, textbooks, and/or technical reports on a given subject); and 2 because the satellite collection "has the information that I use." Closer examination of the first set of responses showed that the project-specific material contained in satellite libraries would not be material that the GSFC Library would be expected to own. Examples are parts catalogs, technical manuals, software documentation pertaining to a specific contractor's computer equipment, progress reports, and procurement documents pertaining to a particular project.

Discussions with directors permitted further exploration of the nature and use of these collections. Two program directors who were instrumental in establishing a satellite collection emphasized that these collections exist for reasons of convenience and should not be considered a criticism of the GSFC Library. They are intended to supplement the Library, not to compete with it. Although the program directors recommended longer hours for the central Library, the size of the Goddard campus appears to be a primary reason for the establishment of satellite libraries. For current periodical reading and for day-to-day reference needs, satellite libraries provide convenient service to persons who do not have the time to travel to Building 21. As one program director said, "The Library couldn't be expected to provide door-to-door service... You have to be more motivated to go to another building." Another program director admitted that "If we were located in Building 21, we probably wouldn't have any [subscriptions of our own]." Since the GSFC Library no longer purchases materials for permanent loan, the number of satellite collections may increase as programs and branches purchase materials that their staff members need to have at hand. However, whether these materials are pur-

chased as permanent loan materials by the Library or as satellite collection materials by units within Goddard, the net effect on the GSFC collection and the availability of the materials to their users will be essentially unchanged.

Shortcomings/Suggestions Regarding the Book Collection

As noted, while rated 3.24 out of a possible 4 in the Library Effectiveness Index, the book collection scored lowest among the eight Library attributes that were rated by the interviewees. The LC classes of the primary subjects dealt with by the 169 respondents who rated the book collection less than "1" (good as is) broke down as follows:

GC	1.44%*
HD	2.88
HF	8.63
KF	0.59
QA	20.86
QB	23.02
QC	34.53
QE	5.04
T	2.88
TJ	2.88
TK	21.58
TL	38.13
TS	0.72
Z	0.72

As will be noted, the respondents who rated the book collection lower than "1" are representative of nearly the entire span of GSFC subject interests. The major classes are QA (computer science), QB (astronomy), QC (physics), TK (electronic engineering), and TL (astronautics). The three most frequently suggested improvements among these respondents (paraphrasing) were: "Add more titles in my field," "Need more recent titles," and "Need more copies of books."

* The sum is greater than 100 percent because the subjects dealt with by the interviewees fell into more than one LC class.

Following are the subject interests, by LC class, of the respondents who suggested the need for additional titles in their fields:

GC	1.76%
HD	2.96
HF	4.73
KF	0.59
QA	11.83
QB	16.59
QC	25.44
QE	3.55
T	1.76
TJ	1.76
TK	11.83
TL	17.75
TS	0.59
Z	0.59

Following are the subject interests of the respondents who wanted more recent books in their fields:

GC	1.18%
HD	1.18
HF	0.59
QA	8.88
QB	11.83
QC	17.16
QD	1.18
QE	0.59
TJ	1.18
TK	12.43
TL	14.79
TS	0.59

Following are the subject interests of respondents wanting more copies of books:

HF	1.18%
QA	3.55
QB	7.69
QC	7.69
QD	0.59
QE	0.59
T	0.59
TK	2.96
TL	4.14

While no firm conclusions can be drawn from these figures, they may be taken as indicative of areas and kinds of potential improvement in the book collection. At first glance, the types and quantities of suggestions/recommendations in each subject-interest area could be interpreted as reflecting (a) the number of interviewees working in that area or (b) the level of Library use by persons in that area. These are undoubtedly partial factors, but if one compares the LC classes of the persons making the suggestions/recommendations against the LC classes of the 456 persons who were interviewed (Appendix IX), it is evident that there are significant differences which would warrant ameliorative action. For instance, there is a strong indication of the need for improved coverage in mathematics (particularly computer science), astronomy, physics, electronics, and astronautics. Heavy Library use and large group-size (and therefore competition for Library holdings in their fields) undoubtedly are factors in the suggestion of need for more copies of publications.

STATISTICAL ANALYSES

Five types of statistical analyses, in addition to the tabulation and interpretation of the data from the structured interview survey, were performed for the purposes of corroborating (or contradicting) the survey results and producing useful information that is not readily attainable through survey methods. The five bodies of statistics that were analyzed are the following: Library circulation records for 1976, 1977, and the first six months of 1978; a sample of publications produced by members of the GSFC staff; records of Xeroxed copies of publications for 1976; records of incoming interlibrary loans for the sample years of 1974, 1976, and 1978; and records of RECON searches.

As noted in the Introduction, we had contemplated performing a sixth type of statistical analysis, based on records of user requests for publication acquisitions, and we did in fact complete such an analysis, for the years 1977 and 1978. Since our purpose, as in our other analyses, was to measure demand within LC classes, we focused only on those requested items that had been cataloged.

During 1977, a total of 243 items were requested. Of these, 134 had been cataloged at the time of our analysis. In the first 10 months of 1978, there were 300 requests, of which 87 had been cataloged. From discussions with members of the Library staff, it appears that part of the discrepancy between items requested and items cataloged is explained by the fact that some were obtained through interlibrary loan. However, another apparent reason is the slowness with which materials, once earmarked for acquisition, are actually purchased and processed. This point was raised earlier in the

discussion of interviewee suggestions for improving the book collection. One frequent suggestion was for more current books.

On the other hand, in fairness to the Library, it should be pointed out that new publications are frequently obtained on request and sent directly to the requestor, without cataloging, because they are urgently needed. Such items are cataloged at a later date. There are also cases where requests for publications are cancelled for a variety of reasons.

Analysis of Circulation Records

The purpose of the analysis of circulation was (1) to measure the relative activity in the various LC classes and (2) to probe for changes in this activity over time. The analysis is necessarily limited, first, because periodicals are not circulated by the Library, and, second, because the available records cover only the previous two and a half years. In addition, certain classes of books, such as reference and bibliographic works, are used only in the Library. There is also a reserve copy of each circulating title, which is for in-Library use only. Our analysis focuses only on the circulating portions of the collection. However, despite these limitations, the results are very informative.

A theoretical basis or hypothesis underlying our analysis of the Library's circulation statistics is that each copy of each title in each class number has an equal probability of use. A corollary ideal or goal is that the percentage of the total collection devoted to a given class should be equal or close to the percentage of the total circulation represented by books in that class.

As will be noted from the table below, even if one eliminates classes which are primarily non-circulating (e.g., "Z"), there are few classes that attain this parity. On a macro level, percentages of holdings versus percentages of items circulated break down as follows:

<u>LC Class</u>	<u>% of Collection</u>	<u>% of 1976-77 Circulation</u>	<u>% of 1978 Circulation</u>	<u>1977 Use Compared with 1976 Use*</u>	<u>1978 Use Compared with 1977 Use*</u>
A	.38	0	0	=	=
B	.19	.16	.52	=	+
C	.17	.30	.66	+	+
D	.15	.06	.07	+	+
E/F	.13	.06	.05	-	-
G	1.78	1.75	2.50	+	+
H	3.26	4.71	5.17	-	+
J	.72	.31	.82	-	+
K	.13	.07	.01	+	-
L	2.22	.77	.30	-	-
N	.04	.02	.01	=	-
P	.91	.41	.42	-	+
Q	54.90	65.24	63.17	-	-
R	.54	.24	.18	-	-
S	.41	.32	.52	+	+
T	31.04	24.39	25.07	-	+
U	.16	.09	.07	-	-
V	.23	.15	.09	-	-
Z	2.64	.33	.22	+	-

* (+) indicates a rising class, (-) a declining class, and (=) indicates no change.

Five out of the 19 classes exceeded holdings/circulation parity. These were B, C, H, J, and Q. Thirteen classes were below parity. These were D, E/F, G, K, L, N, P, R, T, U, V, and Z. Class A was not only significantly below parity, but no materials in this class had been circulated in the period 1976-June 1978.

Four of the classes, C, D, G, and S, had successive rises in circulation between 1976 and 1977 and between 1977 and 1978. Class B showed no rise between 1976 and 1977, but a substantial rise between 1977 and 1978. Classes H, J, P, and T dropped in circulation between 1976 and 1977 and rose between 1977 and 1978. Classes E/F, L, Q, R, U, and V had successive drops in circulation during the two periods.

If one were to base decisions regarding acquisition emphasis on the foregoing macro analysis, an obvious class in which purchases should be made would be C, since it has a positive holdings/circulation ratio and a constant rise in circulation between 1976 and 1978. A second choice would be G, in which the holdings/circulation ratio is approximately 1 and the 1976-78 circulation rise is constant. Third would be Q, in which the holdings/circulation ratio is positive, but circulation, while high, shows a slight falling off during 1976-78. However, as will be seen from the discussion immediately following, it is in fact impractical to base decisions on performance at the most general class level.

For instance, class CB (History of civilization) accounts for practically all the circulation in class C and definitely warrants limited, selected augmentation (its total circulation being quite small). GA (mathematical geography), with a holdings/circulation ratio of slightly less than 3, and a constant increase in circulation, should definitely be aug-

mented. HB (economic theory), a rising class with a holdings/circulation ratio of 2.4, warrants acquisition emphasis, as do HD (theory of management), and HF (commerce). JF (constitutional history), while part of a class with a negative ratio, itself has a strongly positive ratio and should be augmented.

Two classes, Q and T, warrant special scrutiny. Between them, they constitute about 86 percent of the collection. Q has a strongly positive holdings/circulation ratio, but has shown a slight diminution in circulation between 1976 and 1978. T has a negative ratio, but a slightly rising circulation. In both cases, single subclasses are dominant.

As shown in the table immediately following, one class in the Qs, QA (mathematics, including computer science), is the single most heavily circulated class and has a strongly positive holdings/circulation ratio. As previously noted, one of the primary areas in which users thought that the Library collection should be improved was computer science. Thus, there is a strong indication of need for increased acquisition activity. Another Q class, QC, in which the ratio is approximately 1, but which constitutes about one-fifth of the book collection, should be kept at about its present level of acquisition. The remainder of the Qs, all with negative ratios, should be added to only with the greatest possible selectivity and proof of need.

One class in T, TK (including electronics), warrants augmentation because of heavy circulation, a positive holdings/circulation ratio, and a rising circulation. Other classes with positive ratios (although of lesser significance, since they constitute much smaller parts of the overall collec-

tion) are TH (construction) and TJ (mechanical engineering). One class, TF (railroad engineering) did not circulate at all during 1976-78.

Another measure or indicator of the responsiveness of the book collection is the ratio of the percentage of personnel whose work is categorized in a given LC class and the percentage of circulation within that class. By this measure, QA represents 17 percent of the user-population and 28 percent of the circulation, for a ratio of 1.6. This is obviously an extremely active class. By contrast, QB represents 15 percent of the users and 9 percent of the circulation for a ratio of 0.6; TL represents 51 percent of the population and 4 percent of the circulation, for a ratio of 0.08. Obviously, there is little pressure for acquisition in these two classes. (See Appendix IX).

<u>Class</u>	<u>Holdings</u>	<u>Circulation</u>
	%	%
Q (General)	2.63	1.68
QA	15.13	28.07
QB	9.03	9.45
QC	20.54	21.15
QD	3.50	1.23
QE	2.18	2.40
QH	1.12	0.81
QK	0.24	0.16
QL	0.11	0.04
QM	0.01	0.01
QP	0.32	0.20

<u>Class</u>	<u>Holdings</u>	<u>Circulation</u>
	%	%
QR	0.09	0.05
T (General)	1.64	1.39
TA	4.53	2.67
TC	0.18	0.13
TD	0.53	0.37
TE	0.02	0.00
TF	0.02	0.00
TG	0.08	0.01
TH	0.38	0.42
TJ	2.08	2.20
TK	10.75	11.60
TL	8.27	4.14
TN	0.81	0.43
TP	0.87	0.36
TR	0.49	0.37
TS	0.42	0.29

Sources Cited by Goddard Authors

The analysis of published sources cited in the publications of GSFC staff members complements the analysis of circulation records in that it provides a means of determining the kind and level of use of periodicals, which are not circulated by the Library. Actually, a total of eight types of publications were cited by Goddard authors. These were as follows:

<u>Publication</u>	<u>Number of Citations</u>	<u>% of Total Citations</u>
Journal Articles	1494	73.8
Books	201	10.0
Reports	134	6.7
Conference Proceedings	106	5.2
Private Communications	37	1.8
Theses	30	1.5
Preprints	20	1.0
Patents	2	0.1

These figures are based on a random (presumably representative) sample of 66 recent journal articles by Goddard authors. As expected, journal articles were overwhelmingly predominant in the types of publications cited. For this reason, the remainder of the discussion of citations focuses on journal articles.

The 1494 citations of journal articles came from a total of 163 journal titles. The 65 most-cited journals (three times or more) are as follows:

	<u>Citations</u>
Astrophysical Journal	378
Journal of Geophysical Research	220
Astronomy and Astrophysics	65
Royal Astronomical Society, London. Monthly Notices (including Geophysical Supplement)	56
Journal of the Atmospheric Sciences	43
ICARUS	40
Nature	37
Planetary and Space Science	31
Science	27
Solar Physics	24
Physical Review	22
Astronomical Journal	21
Optical Society of America. Journal	21
Journal of Chemical Physics	19
Space Science Reviews	18
Astrophysics and Space Science	16
Astronomy and Astrophysics. Annual Review	15
Geophysical Research Letters	15
Applied Optics	14
Astronomical Institute of the Netherlands. Bulletin	12
Astronomicheskii Zhurnal	12
Journal of Quantitative Spectroscopy and Radiative Transfer	12

	<u>Citations</u>
Applied Physics Letters	11
Astronomical Society of the Pacific. Publications	11
American Astronomical Society. Bulletin	10
Physical Review Letters	10
Radio Science	10
Reviews of Geophysics and Space Physics	9
Journal of Molecular Spectroscopy	8
IEEE Transactions	7
Journal of Physics (A & B)	7
Earth and Planetary Science Letters	6
Acta Astronomica	5
Journal of Marine Research	5
Moon	5
Publications of the Dominion Astrophysical Observatory	5
Astronomical Society of Southern Africa. Monthly Notes	5
Royal Society of London. Philosophical Transactions	5
Space Research	5
Annales de Geophysique	4
Astronomische Nachrichten	4
Astronomy and Astrophysics. Supplement Series	4
EOS. American Geophysical Union. Transactions	4
Geological Society of America. Bulletin	4
Journal of Atmospheric and Terrestrial Physics	4
Optics and Spectroscopy	4

	<u>Citations</u>
Reviews of Modern Physics	4
Zeitschrift fur Astrophysik	4
Annals of the New York Academy of Science	3
Bulletin of the Vilnius Astronomical Observatory	3
Chemical Society. London. Journal	3
Communications of the Lunar Planetary Laboratory	3
Geology	3
International Astronomical Union. Minor Planet Circulars	3
Izvestiya Glavnoi Astronomicheskoi Observatorii v Pulkove	3
Izvestiya Krymskoi Astrofizicheskoi Observatorii	3
Journal of Physical Oceanography	3
Kosmicheskie Issledovaniia	3
Memorie della Societa Astronomica Italiana	3
National Bureau of Standards. Circulars	3
Physics of the Earth and Planetary Interiors	3
Publications of the Astronomical Obser- vatory of Leningrad	3
Pure and Applied Geophysics	3
Space Science Instrumentation	3
Zhurnal Eskperimentalnoi Teoreticheskoi Fizika	3

Two titles, Astrophysical Journal and Journal of Geophysical Re-
search, accounted for over 40 percent of the journal citations. The first
six journals in the list accounted for over half of these citations. With
the exception of a few relatively obscure titles, all of the most-cited
periodical titles are in the Library collection.

Following is a breakdown of the ages of the cited publications:

<u>Year of Publication</u>	<u>Number of Citations</u>	<u>% of Citations</u>
1974 - 1978	879	43.43
1969 - 1973	600	29.64
1964 - 1968	269	13.29
1959 - 1963	99	4.89
1954 - 1958	61	3.01
1949 - 1953	36	1.78
1944 - 1948	13	.64
1939 - 1943	7	.35
1934 - 1938	14	.69
1929 - 1933	14	.69
1924 - 1928	8	.40
1919 - 1923	3	.15
1914 - 1918	4	.20
1909 - 1913	12	.59
1904 - 1908	2	.10
1899 - 1903	0	.00
Pre - 1899	3	.15
	<hr/> 2024	<hr/> 100.00

As will be noted, 43 percent of the publications cited were five years old or less, 73 percent were 10 years old or less, 86 percent were 15 years or less, and 91 percent were less than 20 years old. Title-by-title examination of ages of citations might serve as a partial guide in formulating retention and binding policies, particularly with respect to

the more common journals which are duplicated among libraries in the D.C. area and those which are rarely used or cited. This could help stretch the available Library budget without materially affecting the availability of required materials.

Xerox Copies of Publications

There are a number of interesting similarities and dissimilarities between the publications (primarily periodicals) cited by Goddard authors and those obtained via Xerox copies. The analysis of citations was based on 66 recent journal articles (ca. 1976-78); the analysis of Xerox copies was based on 1976 records (actually an analysis of these records performed by the Library in 1976).

In both cases, the primary publications (most cited or most copied) were the Astrophysical Journal and the Journal of Geophysical Research. However, in the case of citations, these two journals represented over 40 percent of the journals cited, and these and four other titles accounted for more than half of the citations. In the case of the Xeroxed items, there was considerably more scatter; the Astrophysical Journal and the Journal of Geophysical Research accounted for only 16 percent of the Xeroxed items, and there was a less sharp distinction between the most-copied and least-copied titles.

The difference may be explained, at least partially, by the reasons behind citation and copying. When an author cites a publication, he does so to make a point which may be corroborative, refutative, or to show the state of the art in a given area. Copying (especially with the advent of xerography) tends to be more speculative; a person may make no specific

use of a copied publication (indeed, in most cases does not), but feels that it contains potentially useful information. This lesser focus or direct application could help explain the greater scatter in copied as opposed to cited publications. It also indicates that, anomalously, if a library primarily serves authors, who are traditionally the heaviest users of the scientific and technical literature, it requires fewer periodical titles than if its primary clientele is non-authors. A related factor is the "write and cite" phenomenon: authors tend to contribute papers to and cite papers from very narrow groups of publications within their fields.

With respect to age of publications, there was a high convergence between cited and copied items. In the case of citations, 43 percent of the items were five years old or less, and 73 percent were 10 years old or less. In the case of Xeroxed copies, 50 percent were three years old or less, and 78 percent were less than 10 years old, indicating that Xeroxed materials tend to be slightly more current than cited materials. This would suggest the need for great selectivity in the retention of older periodicals, and in the decision to bind for retention.

Incoming Interlibrary Loans

For purposes of inter-year comparison, we analyzed the Library's incoming interlibrary loan records for 1974, 1976, and 1978. After correcting for the fact that the 1978 records were only for the first nine months of the year, we obtained the following numbers:

	<u>1974</u>	<u>1976</u>	<u>1978</u>
Total Loans	728	818	837
Books/Monographs	380	410	358
Periodicals	348	408	479

Thus, there was a rise and then a fall in book loans between 1974 and 1978, and a gradual rise in periodical loans during this period. The rise in books borrowed between 1974 and 1976 was eight percent; the fall in book loans between 1976 and 1978 was 15 percent. The rise in periodical loans was 17 percent between 1974 and 1976, and 17 percent between 1976 and 1978. In general, despite the gradual rise in incoming loans of periodicals, these figures would appear to indicate that the Library's collections are generally responsive to the needs of its users. This conclusion is supported by the fact that of a total of 13,651 loan transactions by the Library in 1978, only 837 involved interlibrary loans. There are, as noted, areas of need and indicated improvement, but, although significant and warranting amelioration, these can be easily remedied.

Following is an LC class breakdown of incoming interlibrary loans of books and monographs in 1974, 1976, and 1978.

Class	<u>1974</u>		<u>1976</u>		<u>1978</u>	
	<u>Books</u>	<u>Periodicals</u>	<u>Books</u>	<u>Periodicals</u>	<u>Books</u>	<u>Periodicals</u>
B	1.05%		.975%	.925%	1.39%	2.0%
C			.487%			
D	.526%				9.05%	
E			1.21%			
F			.243%			
G	2.10%	2.80%	1.21%	.308%	4.18%	1.20%

LC Breakdown of Incoming Interlibrary Loans (cont.)

Class	1974		1976		1978	
	Books	Periodicals	Books	Periodicals	Books	Periodicals
GB	.263%		.487%			
GC	3.94%	2.80%		1.54%		2.0%
H	2.10%					
HA					1.04%	
HB	.789%	.465%			1.04%	
HD	10.26%	6.54%	7.56%	6.79%	3.83%	24.09%
HE	1.84%		2.43%		.348%	.401%
HF	1.05%		.731%	.925%	.348%	
HJ			.487%			
HM	.263%	.467%	.243%			
HQ					.348%	
HT					.348%	
HV			.487%			
HX			.731%			
J			3.65%	1.23%	1.74%	1.20%
K			.731%	.308%	.696%	.401%
L	2.10%		.243%	.308%	.696%	
N			.243%			
PE	.263%		.243%			1.60%
PZ	.263%					
Q	3.42%		.731%	1.85%		
QA	12.10%	11.21%	12.43%	10.49%	12.89%	7.22%
QB	6.05%	21.49%	10.24%	5.55%	6.96%	6.02%
QC	12.10%	11.68%	9.26%	12.34%	16.02%	11.24%
QD	2.10%	5.14%	2.19%	6.17%	4.18%	6.02%
QE	3.94%	4.67%	4.63%	8.33%	2.43%	7.22%
QH	1.84%	2.80%	3.90%	6.48%	.348%	2.40%
QK	.263%	.467%	.731%	2.16%	.348%	
QL				.308%		
QP			1.46%	.617%		
QR			1.46%	.617%		
QV			.243%			

LC Breakdown of Incoming Interlibrary Loans (cont.)

<u>Class</u>	<u>1974</u>		<u>1976</u>		<u>1978</u>	
	<u>Books</u>	<u>Periodicals</u>	<u>Books</u>	<u>Periodicals</u>	<u>Books</u>	<u>Periodicals</u>
R	1.84%	8.87%	2.43%	3.39%	1.39%	1.60%
S	4.21%	6.54%	5.36%	3.39%	3.83%	1.20%
T	2.10%		.731%	2.16%	1.04%	2.0%
TA	2.63%	7.47%	2.43%	.925%	2.78%	2.40%
TC			.487%			
TD	.263%			1.85%	.348%	
TH	.789%				1.74%	2.0%
TJ	3.42%		3.17%	3.08%	5.92%	2.40%
TK	12.10%	4.20%	9.51%	8.33%	8.71%	11.64%
TL	1.84%	2.33%	6.09%	4.01%	4.52%	3.21%
TN	.789%		.487%		.348%	
TP	.789%		.731%	.617%	.696%	
TR			.731%	1.54%		
TS				.308%		
V	.263%			.617%		
Z	.526%		.243%	2.77%		.401%

There are a number of interesting coincidences between the previously-discussed circulation statistics and interlibrary loan statistics. For instance, class H was the third most-circulated class and third among interlibrary transactions during the three test years. Class Q (taken as a whole), was the most active in our analysis of circulation, and also the most active in incoming interlibrary loans. This activity was concentrated primarily in sub-classes QC (physics), QA (mathematics, including computer science), and QB (astronomy), in that order.

In 1976-77, class H (taken as a whole), represented 4.71 percent of book circulation; in 1976 class H books represented 13 percent of those obtained via interlibrary loans. In 1978, circulation increased to 5.17 percent, but interlibrary loans decreased to 7 percent, indicating responsive growth in the book collection.

In our analyses of circulation and other data, we found need for strengthening the book collection in the following areas: mathematics (especially computer science), economic theory, management, commerce, optics, meteorology, climatology, and telecommunications. This was generally supported by holdings/circulation and personnel/circulation ratios. With the exception of HF (commerce, especially personnel management), these conclusions were also corroborated by the interlibrary loan statistics. For the reason suggested, there was a falling-off in interlibrary borrowings of books on management and personnel. However, there was a considerable increase in incoming interlibrary loans of journals in this area. This rose from 6.54 percent of such loans in 1974, to 6.79 percent in 1976, to 24.09 percent in 1978. This would appear to indicate that periodicals have not fared as well as books in the buttressing of the collection in management-related areas. On the other hand, there was a distinct falling-off in interlibrary loans of periodicals in QA and QB, perhaps indicating heavier acquisitions emphasis on periodicals in these two active areas.

These inferences are supported by a 1978 analysis of Library journal holdings, performed by J. J. Boggess of the Library staff, in which it was shown that the Library received 117 physics journals (QC), 68 mathematics journals (QA), 62 electricity and electrical engineering journals (QC and TK), and 7 management journals (HD, HF). In general, the percentages of

journals in the various disciplines parallel the work activities and interests of the GSFC staff. However, this is not so in the case of management journals, where the numerical and percentage holdings are disproportionately low.

RECON and SCAN

Excluding author searches and searches of non-NASA databases, there was a total of 218 RECON searches in 1974, 311 in 1976, and 215 in 1978. This is similar to the interlibrary borrowings of books in 1974, 1976, and 1978. It is distinctly dissimilar from incoming loans of periodicals, in which there was a steady rise over the three test years. Appendix X is a breakdown of the subjects of RECON searches, by LC class.

In general, there was little change in the number of RECON searches among LC classes over the three test years. However, there was a big drop in class TL, which constituted 23.4 percent of the searches in 1974 and 14.9 percent in 1978. There was a large rise in class QC, which went from 14.7 percent in 1974 to 25.1 percent in 1978. A detailed analysis of RECON searches by LC classes is given in Appendix X.

These changes could be attributed, at least partially, to changes in program emphasis. But a more likely explanation is the relative familiarity with, and dependence on, the Library among persons involved in TL- and QC-related activities. In response to question 50 in the interviews, having to do with the use of computer searching services, 24 percent of the interviewees in the general sample had made use of such services. This is in contrast with the 68 percent of the interviewees in the "heavy" users sample. The "heavy" users tend to be concentrated among the more basic sciences--the Qs. The "lighter" users tend to be among the more applied fields--primarily the

Ta. From the comments following the responses to question 50 (q. 51), there is the distinct impression that the two overwhelming reasons for non-use of computer searching services is lesser dependence on the literature for information and, as a consequence, smaller use of the Library and less familiarity with its resources, facilities, and services. Computer searches (and any others, for that matter), in order to be effective, require a reasonable knowledge of the collections or databases to be searched and close cooperation and interaction between the requestor and the Library. Proximity puts the "heavy" user of the Library in a distinctly advantageous position. Familiarization of the lesser users would undoubtedly have some positive effect on their use of RECON and other services offered by the Library.

Essentially the same rationalization could be applied to NASA SCAN, which, owing to limited use and sparse data, was not analyzed in detail. From the comments regarding the mode and purpose of use of SCAN (q. 53), and the general comments in the interviews (q. 44, 54), it is clear that lack of understanding or familiarity is a factor in the small use of this service, both among the "light" and "heavy" users of the Library. Thus, some familiarization or educational effort could be beneficial. However, as demonstrated in various other contexts, SDI systems in general tend to be limited in their use and appreciation. The problem seems to be that the heaviest users of the literature do for themselves what SDI services are set up to do: to keep them currently aware of useful literature in specified areas of interest. As a matter of fact, in terms of currency and germaneness the heavy users who serve themselves generally do it better. Ironically, the smaller users of the literature, who could theoretically be helped

the most by SDI services, are less likely to get their information from the literature. From interviewee comments, it appears that there is yet another factor: when a person receives a SCAN notice (or a reference in a bibliography) he has to go to the Library and perform various time-consuming steps to obtain a copy of the cited item. If this item is only potentially or speculatively useful, he will frequently forego it, or perhaps forego the entire SDI process.

ANTICIPATION OF CHANGING NEEDS

In the previous sections, we have examined and applied various methods of measuring current adequacies and inadequacies in the Library's collections, facilities, and services. Most prominent indications are for better immediate book coverage in computer science, economic theory, commerce, optics, meteorology, climatology, and telecommunications; better periodical coverage in management; extension of Library hours; and better publicizing of Library resources, facilities, and services.

Program vs. Methodological Changes as Indicators

Some of these indications of need for improvement--particularly those pertaining to the collections--arise from new or changing programs and projects; others result from policy and attitudinal changes. An example of the latter is the increasing interest in management publications, which evidences itself in comments/suggestions made in the interviews and in circulation and interlibrary loan records. One thing is clear from our study: there is no single way to evaluate Library adequacy or inadequacies or to measure probable future needs. Inevitably, such evaluations and measurements must be based on current and longitudinal records and writings and querying or otherwise communicating with policy makers and users.

Longitudinal Indicators

We have already pointed out areas of increasing and decreasing activity and presumed indication of need for change in the Library collection. These have come primarily from the interviews, where specific needs or suggestions were articulated, the analysis of circulation records, and the analysis of incoming

interlibrary loans. While impersonal and indirect, the latter two sources are kept on an annual basis, thus providing a useful means of detecting trends and changes over time.

Users as Indicators

Underlying the major techniques we have used to detect current and future needs and the Library's responsiveness to them is the premise that, ultimately, any changes in GSFC scientific and technical programs--regardless of their origin--will affect the Library via changes in the use made of it by the individuals involved. It can be argued that communications with the initiators of these changes provide the earliest and best intelligence on impending near- and longer-term changes in demands on the Library, and this is certainly true. However, the individuals and small groups immediately responsible for the execution of the components of the programs and projects are the most direct day-to-day users of information relating to them. Knowledge of their current and changing information-gathering habits--the kinds of publications they seek and acquire, the services and facilities they use and how and when they use them--are, ultimately, the best indicators of what the Library should do to be responsive.

Program Documents as Indicators

This is not to say that we did not communicate with the planners and initiators of programs and projects. We did in fact communicate with them directly, via face-to-face discussions, and indirectly, through analyses of their written records and statements.

In addition to the 324 structured interviews with representative members of the GSFC scientific and technical staff (including study and

project scientists and "heavy" Library users), we conducted open-ended discussions with the heads of all of the Directorates or their designees, structured interviews with 37 additional study and project scientists from the Sciences and Applications Directorates (those making the greatest use of the Library), structured interviews with 56 "heavy" Library users (regardless of GSFC location) not included in the main sample of 324, discussions with the members of the Library Users' Committee, and discussions with the Library staff.

With few exceptions, the information obtained from the structured interviews beyond the basic 324 confirmed or amplified our original findings. The open-ended discussions--particularly with the members of the Library staff--provided important insights. These are reflected in the findings and interpretations derived from our various analyses. While very useful in providing historical perspective, and administrative policy, the discussions with non-Library personnel tended toward generality and were less easily applied to the purposes of the study.

Examination of Written Records and Statements

At the onset of the project, we were provided, inter alia, with the three most recent volumes of the GSFC Research and Technology Annual Report and with the Research and Technology Objectives and Plans Summary (RTOPS) for FY 1979. The intent in furnishing us with these materials was to help provide further bases for assaying current and future Library support requirements of GSFC programs and projects.

The Annual Report does indeed provide significant intelligence regarding current and near-term future project and program activities. Translated into

subjects or subject headings, this information could be a source of qualitative guidance to the Library in its current and future acquisitions. For instance, in the FY 1977 Report the following regarding TDRSS is certainly indicative and informative: "In the future, the objective of studies in this area and will be to provide an optimized design for the ground stations of the 1980's. This design, due to start in Fiscal Year 1978 ... " Unfortunately, in order to be optimally useful to the Library, sources such as the Annual Report must provide quantitative as well as qualitative information, indicating not only current and future program and project topics, but also levels of effort, preferably in terms of contemplated staffing. Thus, while indicative, its usefulness in guiding the Library is limited.

If analyzed carefully, RTOPS comes somewhat closer to the goal of qualitative and quantitative indications. The FY 1979 Summary contained descriptions of 72 GSFC projects. Following are the primary terms under which these projects are indexed in the 1979 Summary (limited to terms under which Goddard projects are posted three or more times):*

Terms with 6 projects posted

Computer programs
Data processing
Planetary atmospheres

Terms with 5 projects posted

Atmospheric chemistry
Communications satellites
Image processing
Mission planning
Spectrometers
Spectroscopy

* The terms by which Goddard projects are indexed in RTOPS FY 1979 are listed alphabetically in Appendix XI.

Primary Index Terms (Continued)

Terms with 4 projects posted

Atmospheric physics
Calibrating
Comets
Cost reduction
Data systems
Lasers
Magnetosphere
Mass spectrometers
Plasmas (physics)

Terms with 3 projects posted

Airborne/spaceborne computers
Auroras
Astrophysics
Atmospheric conductivity
Atmospheric models
Balloon-borne instruments
Bandwidth
Imaging techniques
Infrared astronomy
Line spectra
Magnetic fields
Mesosphere
Molecules
Oscillators
Payloads
Radio frequencies
Stratosphere
Tracking networks
Upper atmosphere

There is an interesting parallel between relative postings of GSFC projects under index terms and the comparative circulation of books under various LC classes. In both cases, mathematics (particularly computer science), physics, electronics, and chemistry dominated. The advantage of the analysis of RTOPS/Goddard term postings over circulation (and interlibrary loan) records is that it is more specific and therefore more informative as to subjects which warrant

Library coverage. The ranking of postings provides insights as to relative degree and priority of coverage, which is extremely important where budgets are limited. Annual updatings of the RTOPS/Goddard term-postings analysis could provide indications of impending near- and long-term upward and downward changes in GSFC subject emphases. Two crucial data that are missing from the RTOPS project descriptions are length of duration and staffing levels, both of which would be useful in determining warranted degrees of Library support. However, these figures would appear to be readily attainable (the descriptions give the names and telephone numbers of the project leaders).

It would be useful if the Library could receive or obtain Goddard RTOPS forms as they are completed and approved. It is our understanding that such forms are prepared within each of the Directorates and, upon approval (presumably by the head of the Directorates), are forwarded directly to NASA-STIF. Receipt of approved RTOPS forms, on a current basis, could greatly enhance the Library's ability to anticipate new projects, and to take the necessary steps to make available germane publications on a timely basis.

Congressional Documents as Indicators

In terms of the desired combination of quantitative as well as qualitative indications of subject emphasis, the annual budget request that NASA submits to Congress is perhaps the best available guide to changing Library requirements. One very important attribute of this source is that it deals primarily with the future. The following table, taken from the FY 1979 Goddard budget request, is illustrative. It is particularly valuable for our purposes in that its numbers represent civil service positions, rather than dollars, allocated to each major Goddard program.

	<u>1978</u>			
	<u>1977</u> <u>Actual</u>	<u>Budget</u> <u>Est.</u>	<u>Current</u> <u>Est.</u>	<u>1979</u> <u>Budget Est.</u>
<u>Space Transportation Systems</u>	<u>125</u>	<u>143</u>	<u>135</u>	<u>126</u>
Space Shuttle	36	31	40	47
Space flight operations	1	16	10	10
Expendable launch vehicle	88	96	85	69
<u>Space Sciences</u>	<u>1,165</u>	<u>991</u>	<u>1,080</u>	<u>1,066</u>
Physics and astronomy	1,071	919	1,025	1,013
Lunar and planetary exploration	94	72	55	53
<u>Space and Terrestrial Applications</u>	<u>783</u>	<u>790</u>	<u>814</u>	<u>836</u>
Space applications	774	781	805	826
Technical utilization	9	9	9	10
<u>Aeronautics and Space Technology</u>	<u>59</u>	<u>77</u>	<u>59</u>	<u>64</u>
Space research and technol.	58	76	58	64
Energy technol. applications	1	1	1	--
<u>Tracking and Data Acquisition</u>	<u>655</u>	<u>674</u>	<u>615</u>	<u>612</u>
Subtotal Direct	2,287	2,675	2,703	2,704
<u>Center Mgt. and Opt. Support</u>	<u>838</u>	<u>950</u>	<u>845</u>	<u>844</u>
<u>Total Permanent Positions</u>	<u>3,625</u>	<u>3,625</u>	<u>3,548</u>	<u>3,548</u>

As will be seen, the only major area that shows significant growth is space applications. Two areas that show significant diminution (deemphasis?) are expendable launch vehicles and (less definitely) lunar and planetary exploration. On a macro level at least, comparing year-to-year changes in the numbers in this program/staffing table can be extremely useful in anticipating indicated change in acquisitions emphasis and pinpointing upward and downward trends over time. Equally important, the estimated staff allocations for the

year to come furnish direct and accurate intelligence regarding requirements over the near-term future, in terms of the types and numbers of persons who will be affecting that future insofar as use of the Library is concerned.

Formula for Guiding Future Allocations of Library Budget

A useful formula or model for roughly allocating portions of the Library budget among the subjects dealt with by GSFC projects (from RTOPS indexing or indexing by the Library staff) is the following:

$$I = \frac{(C)}{(S_1)} (S_2)$$

where I = the index of utility; C = the number of times books on this subject (the nearest LC class) were circulated in the previous year; S₁ = the number of persons working on projects dealing with this subject in the previous year (working back from the RTOPS or Library indexing to the project leaders); and S₂ = the number of persons working on projects dealing with the subject in the coming year (RTOPS or Library indexing and project leaders).

The percentage of budgetary allocation for each subject is obtained by (1) adding up the Is for all subjects under which projects are indexed and (2) calculating the percentage of the resulting sum taken up by each subject.

Using "computer programs" as an example, and assuming that books on this subject circulated 500 times in the previous year (C), that 95 persons were employed on projects dealing with this subject in the previous year (S₁), and 150 persons are to be assigned to these projects in the coming year (S₂), the equation works out as follows:

$$I = \frac{(500)}{(95)} (150)$$

$$I = (5.3) (150)$$

$$I = 795$$

Assuming a prior-year circulation of 600, prior-year staffing of 50, and anticipated staffing of 70 for "planetary atmospheres," we get the following:

$$I = (12) (70) = 840$$

From this it is evident that a greater proportion of the publication budget should be allocated to "planetary atmospheres" than to "computer programs." The exact relative proportions would be determined by summing the Is for all subjects and determining the percentage for each.

This proposed approach, based on relative probable use and demand is easily implemented and, most important, is easily updated to provide for the near-term future. It can be used to determine both impending relative increases and decreases in budgetary allocations to each of the subjects dealt with at GSFC from year to year.

A technical question that arises in the use of this method is whether it is sufficient to assume that all staff members assigned to a project are concerned with all of the subjects involved in it (or under which it is indexed). Ideally, it would be best to base computations on the exact numbers of persons working on each subject dealt with in a project. However, these specific figures are generally difficult to come by. Given this limitation, it is sufficient to assume that all persons working on a project have an equal probability of being concerned with the subjects with which it deals, or that different subject emphases cancel one another out if each individual on a project is assumed to be concerned with all the subjects subsumed within it.

Role of the Library Users' Committee

The Library Users' Committee has (or should have) an obvious role in guiding the Library with respect to current and future acquisitions, as well as services and facilities--from the viewpoint of the user population. In its original mandate, taken from an October 4, 1966, memorandum from the Chief of the Laboratory for Theoretical Studies to the Director of GSFC (and approved by the Director), the purpose of the Library Users' Committee was to "communicate directly from the people using the Library to the people running the Library and trying to achieve a smooth operation with a minimum of problems."

In the original constitution of the Committee, an attempt was made to have at least one representative from each of the Directorates whose personnel were likely to make significant use of the Library. Presumably, this was to ensure that the Library needs of each of the Directorates were made known to the Library in a timely and organized manner. From the remarks and comments of interviewees and discussants of all types and levels, the Committee is not implementing its mandate, at least insofar as serving as an efficient channel for the communication of staff Library needs is concerned. One apparent problem (or indicator) is that many, if not most, members of the GSFC staff do not know the makeup of the Library Users' Committee or what the Committee does.

If, indeed, the Committee is supposed to serve as a channel of communication for the personnel of the Directorates it represents, this fact should be made generally known. The personnel in each Directorate should be made aware of its representatives on the Committee, and should be explicitly encouraged to contact them regarding current and impending needs for Library resources, facilities, and services. The Committee should meet with the

Library staff at least once a month to convey needs that have come to its attention and to ensure the timeliest possible response. Special or emergency needs should be conveyed to the Library as soon as they become known, regardless of meeting schedules. These steps can be immediately beneficial to the Library users and to the Library staff which is seeking to serve them as effectively as possible.

Another related problem has to do with the tenure of the members of the Committee. At the present time, there is no apparent policy regarding length of service on the Committee. This lacuna should be remedied as soon as possible. Members should serve for fixed periods of such a length as to permit turnover and representation of each division of each Directorate on the Committee at least every two years. In this way, greater timeliness, dynamicism, and balance will be injected into the activities of the Committee, and it will be in a better position to keep the Library informed as to what is happening, what is going to happen, and, in many instances, what to do about it.

EFFECTS OF INFLATION ON THE LIBRARY'S PURCHASING POWER

In a memorandum from the Director of Sciences and the acting Associate Director of Applications to the Deputy Director of GSFC, dated November 17, 1977, it was pointed out that the book and periodical budget of the Library is not keeping pace with rising costs. The memorandum cited an increase of 89 percent in the price of books and an increase of 383 percent in the price of periodicals between 1967-68 and 1976 (figures taken from the 1977 Bowker Annual). During this period, the Library's book budget remained constant at \$50,000 per year (actually less in 1972, 1973, and 1974) and the periodical budget increased by 115 percent to \$154,000.

Probable Increases in Cost of Publications

Despite fluctuations in degrees of annual increase in the cost of publications, there is little likelihood of parity between available funds and costs in the near-term future, unless budget increases are instituted. King et al, in their study, The Journal System of Scientific and Technical Communication in the United States (1978), project a 20 percent increase in the subscription price of periodicals to institutions between 1980 and 1985 in 1978 dollars.

But, based on diminutions in the purchasing power of the dollar between 1974 and 1978, the average rate of increase in the cost of periodicals in subjects of interest to GSFC will probably be in the vicinity of 13 percent per annum. (cf. Brown, N.B., Library Journal, 103, 1356-61, July 1978).

We were unable to locate any projections on the probable rise in the price of books between 1980 and 1985. However, extrapolation from the rise between 1970 and 1975 indicates a probable increase of 39 percent in the

price of hardcover books between 1980 and 1985 (cf. Compaine, The Book Industry in Transition, p. 31).

Assuming that the foregoing figures are close to correct, a modest annual increase in the book budget (perhaps five to ten percent) would appear to be sufficient to permit the Library to maintain its present level of book acquisitions. However, the periodical budget would require a 13 percent annual increase if parity is to be maintained.

Non-Budgetary Remedies for Increasing Costs

The problem of rising costs and diminishing dollars could be partially ameliorated by increasing access to the Library's collections through extension of its hours of operation. In a sense, extending the hours that people may use the Library is the equivalent of purchasing more copies of books and periodicals (another frequent recommendation). While wrought of necessity (or seeming necessity), the curtailment of Library hours may in fact be a false economy, and all the more so if one of the reasons why publications are being purchased for office and satellite collections is that they are not conveniently available from the Library.

Another defensive measure that might be considered (one which might meet with strenuous objection in some quarters) would be not to purchase books or subscribe to journals which, from their sparsity of use, might be better acquired through interlibrary loans. There are a number of indications of possibilities in this direction. Palmour, among others, has studied the relative costs of borrowing as opposed to owning publications (cf. Palmour, Bellassi, and Wiederkehr, Costs of Owning, Borrowing, and Disposing of Periodical Publications, 1977). In summary, the decision of

whether to borrow or buy is a function of (a) the cost of a book or periodical subscription, (b) the cost of binding and/or storing, and (c) frequency of use. When cost per use (cost divided by number of times used) of a given book or periodical is higher for purchase or subscription and retention than borrowing, it should be borrowed rather than purchased.

There are, of course, cases where publications are used for browsing or current awareness, and the reader does not know he will benefit from a given book or issue of a periodical until he reads or scans it. However, as indicated from our structured interviews (survey q. 22), the Library's analysis of Xerox copies of journal articles (1976), and our analysis of periodicals cited by Goddard authors, only a small core of titles are actively used either for current awareness or retrospectively. Consideration should be given to dropping marginally-used periodicals and investing the resulting savings in additional copies of the more heavily-used titles. It is, of course, possible that back issues of certain periodicals are used on the Library premises, and since periodicals are not circulated there would be no record of this. Samplings of "leavings" of materials read in the Library would help prevent false identification of marginal titles. This could be especially significant in the case of abstracting and indexing publications and other reference and bibliographic tools, which, while very important for both current and retrospective awareness, are rarely Xeroxed and are used only in the Library.

LEAST COST OPTIMIZATION

In various sections of this report--particularly the section immediately preceding, dealing with the effects of inflation--suggestions were made for optimizing the use of the Library's limited financial resources from the viewpoints of both management and the user-population. Two areas of the Library's operations bear closer examination for optimization potential, first because of high probable payoff and second because of the relative ease with which they can be optimized. These areas are: borrowing versus purchasing of periodicals and cost per use of publications. The significance of optimizing the costs of periodicals is evident from the fact that this is the most costly and inflation-prone segment of the Library's collections.

Borrowing vs. Purchasing of Periodicals: Eleven Factors

As noted earlier, only a fraction of the total number of periodical titles received by the Library are heavily consulted for either current awareness or retrospective purposes. The remainder are used occasionally. The same is true for books, although with books the situation is less critical because of lower overall costs.

A logical question is whether and when it pays to purchase, process, and retain a periodical (or book) which is used only occasionally. Prior studies, such as that by Palmour, have attempted to answer this question on a general or normalized basis. However, as a guide to specific decisions, a

title-by-title approach is necessary. Using periodicals as an example, the purchase cost factors to be considered for each title are the following:*

1. Initial cost of ordering and cataloging a new title.
2. Subscription costs.
3. Cataloging, receiving, recording, and shelving or display costs.
4. Collation and binding costs.
5. Reshelving costs.
6. Storage or display space costs.
7. Disposition or weeding costs.

The borrowing cost factors are the following:

8. Interlibrary loan, search, verification, request, and recording costs.
9. Interlibrary loan notification, delivery, and return costs.

Items 1, 8, 9, and probably 7 are more or less constant, not varying materially with the given title. The remaining five cost factors are variable among titles. However, all are readily measurable or ascertainable.

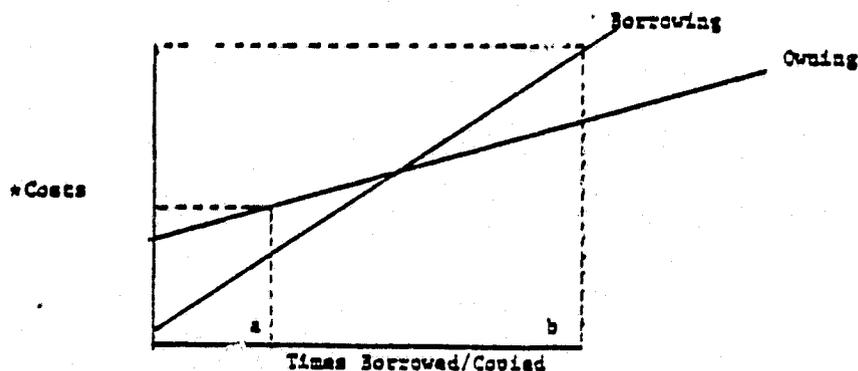
A tenth factor, to be considered for each periodical title held by the Library, is how many times it would have to have been borrowed, and the resulting costs, if it were not present in the collection. The answer is obvious for recent issues (five years old or less) of the most actively

*These should be viewed as minimal costs. There could be additional costs associated with both purchasing and borrowing periodicals, depending on various qualitative and quantitative factors. For instance, where records of periodical receipts and holdings are maintained and updated via computer, there would be, inter alia, computer time charges, tape costs, and keyboarding costs. In the case of borrowed items, there could be photocopying charges, certified mail costs for returns, royalty charges for copying of more than five articles from issues of a given periodical which are less than five years old (CONTU "Guidelines," 1977), and the amortization of the costs of such interlibrary loan support materials as union lists of serials, which can be quite expensive. Where applicable, these costs have to be taken into account in purchase/borrow decisions.

read, cited, or copied titles (e.g., the list of journals on pages 18, 19, and 20 of this report and tabulations of responses to interview questions 22 and 23 in Appendices II through VI). The cost of borrowing these "core" periodicals will inevitably exceed the cost of owning them. The position becomes less clear in the case of core journals over five years old, and even more so for non-core journals. However, assuming that Xeroxed titles would have to have been borrowed if they were not in the Library, it is possible to determine--on the basis of how many times in the immediately preceding calendar year items from a title were copied--whether it would have been cheaper to own than to borrow it.

An eleventh factor, based on the interlibrary loan records for the preceding calendar year, is whether, on a title-by-title and year-by-year basis, it would have been cheaper to borrow than to purchase journals not presently in the Library collection. This would be facilitated by arranging interlibrary loan records by periodical title and the number of times each title was borrowed in the preceding year.

Depicted graphically, the model we are discussing is as follows:



*These are fixed initial costs, which are obviously higher for purchase than for borrowed items. As shown, once an item is purchased, processed, etc., cost per transaction (lending, etc.) is less than the cost per interlibrary loan of the item. The question is which, for each title, is cumulatively cheaper.

Box (a) represents a publication which is borrowed or copied so few times that it is cheaper to borrow than to own it. Box (b) is a case where the cost of borrowing, due to high frequency (and possibly ensuing copying) is higher than the cost of purchasing, and therefore purchase is indicated. Applied on a title-by-title basis for periodicals, the model can provide a reasoned rationale for purchase/borrow decisions.

To illustrate the use of the model as a guide for a purchase/borrow decision, let us assume the following hypothetical (and somewhat arbitrary) annual figures for a given monthly periodical title:

Initial cost of ordering/cataloging	1.5 hrs. @\$10.00 = \$15.00/yr.
Annual subscription	25.00/yr.
Receiving/recording/shelving	12 x 5 min. @ 7.50 = 7.50/yr.
Collation/binding	20 min. @ 7.50 + 15.00 = 17.50/yr.
Reshelving	1 hr. @ 5.00 = 5.00/yr.
Storage/display	2 linear feet @ 4.00 = 8.00/yr.
Disposition/weeding	0.25 hr. @ 7.50 = 1.88/yr.
IL search, verif., request, record	0.75 hr. @ 10.00 = 7.50/yr.
IL notification, delivery	0.6 hr. @ 5.00 = 3.00/yr.
IL return	0.6 hr. @ 5.00 + 5.00 postage = 8.00/yr.

Let us assume further that the specific periodical in question is not presently in the collection (as will be the case where most purchase/borrow decisions have to be made), and that it and/or titles closely similar to it have been borrowed 15 times in the most recent 12-month period. If we add up the costs of each borrowing transaction, we get a figure of \$18.50

per transaction. Multiplying this by 15 transactions, we get a total annual borrowing cost of \$277.50. Adding up the annual costs of owning this title, we get a figure of \$79.88. In this case, it is obviously cheaper to own it than to borrow it. However, if it or titles closely similar to it had been borrowed four or fewer times in the previous 12-month period it would have been cheaper to borrow than purchase it. Four transactions (actually 4.25) is the "cross-over" point between borrowing and purchasing in this case. This point will of course vary from title to title.*

Two Other Purchase/Borrow Considerations

There are two other factors that could affect purchase/borrow decisions. In recent years, recognizing the rising labor, processing, and communication costs involved in outgoing interlibrary loans, a growing number of libraries have begun to charge for such services. These charges could significantly increase the costs of incoming interlibrary loans and tip purchase/borrow decisions in the direction of purchase. However, this is not likely in the case of the GSFC Library, which does most of its borrowing from Government or government-sponsored organizations that are not likely to institute charges.

The second supplementary factor is the negative effects on productivity of delays in the availability of required work-related publications. The problem here is that such costs are extremely difficult to detect and measure. Ultimately, they must be treated subjectively: if a user says that he has an urgent and continuing need for a given publication, and its cost is within the normal range of the publications it routinely acquires, the library should probably purchase it forthwith, on the assumption that it

*See footnote, p.50.

would be less costly in the long run to have it regularly on hand than to borrow it as it is needed. One catch is that different users perceive and articulate urgency and permanence of need differently. This can only be adjudicated on a case-by-case basis.

Cost Per Use

A much-neglected area of cost optimization is based on the simple premise that, in terms of cost-per-use (CPU), a seldom-used publication is more expensive than a frequently-used publication of the same initial cost. If we add in the case of books, the cost of acquisition, processing, and storage to the purchase price, the high price of little-used materials is dramatized, as is the low price of heavily-used materials. If one considers the nine basic cost variables involved in periodical acquisitions, the point is even clearer.

The current practice of purchasing the same numbers of copies of most book titles, regardless of frequency of use, inevitably results in excessively high and excessively low costs per use. Ideally, there should be a standardized or average cost per use. Using books as an example, the total circulation in 1978 (extrapolating from January-June 1978 figures) was approximately 49,000. Assuming that half of the 60,000 books in the collection were on reserve, the average book circulated 1.6 times per year. Assuming an average price of \$20.00, processing and storage costs of \$10.00, and an active useful life of five years per book, the typical circulating book in the GSFC Library would cost \$3.75 per use per year.

$$\left(\frac{20 + 10}{5} \right) \div 1.6 = \$3.75 \text{ (CPU)}$$

Applying the same method and time period to class GA (mathematical geography), in which 33 books (half of a total of 66) were circulated about 130 times, for an average of 4.0, we get the following:

$$\left(\frac{20 + 10}{5} \right) \frac{1}{4} = \$1.50 \text{ (CPU)}$$

Assuming that the numerical bases for the average CPU of \$3.75 are reasonably correct, the CPU for class GA is lower by a factor of 2.5, and is a "good buy." Incidentally, as noted earlier (p.14), class GA also has a strongly positive holdings/circulation ratio and a steadily rising circulation trend--another indication that it is a "good buy."

IMPLICATIONS, CONCLUSIONS, AND RECOMMENDATIONS

The implications, conclusions, and recommendations that follow are cast in terms of the original statement of project goals or products which was summarized in the Introduction. Where indicated, additional topics, such as library hours, are included as separate sections.

Compatibility Between Needs and Holdings, Services, and Facilities

With relatively rare exception, the holdings, services, and facilities of the Library are generally perceived to be compatible with the needs of the Library's users, as reflected by their responses to a series of questions in the interview survey in which the respondents were asked to rate the Library's journal and book collections, interlibrary loan, reference, literature search, and translation services, and physical facilities and equipment. The overall rating, stated as an "Index of Effectiveness," was 3.57 out of a possible 4. The two areas that scored significantly below the average were translations (3.34) and the book collection (3.24).

The explanation of the low rating of the translation service appears to be unfamiliarity rather than actual comparative inadequacy. Traffic in translations was so small that few of the interviewees had ever actually used this service.

The main reasons that the book collection is rated below the overall average are: insufficient coverage in the more active and dynamic subjects (computer science, physics, electronic engineering, astronomy, and astronautics); insufficient currency of books in these areas; and insufficient numbers of copies of books in these areas.

The question of improving subject coverage will be dealt with shortly in the discussion of anticipating needs. With respect to inadequate currency, the problem is explained at least in part by the policy of batching the ordering of most books rather than ordering them as they are published and found to be germane to the Center's programs and projects. The value of this batch ordering process, instituted to enable subject-specialist reviewers to weigh the relative merits of new books published within particular subject areas, should be carefully considered in light of the resulting delay in the timely provision of new books to readers.

Where possible, books that appear to be germane to GSFC needs should, within budgetary constraints, be purchased as they are published, or preferably before they are published. Advantage should be taken of examination or "on approval" offers, which are available from most publishers. The Library does already purchase on an anticipatory basis in maintaining standing orders of major serial reference works. This anticipatory approach should be expanded.

With respect to inadequate numbers of copies of books in active subjects, from both the budgetary and service viewpoints serious consideration should be given to not purchasing extra reserve copies of books in less-active subjects and using the resulting savings to purchase extra copies of books in the more active areas. Starting from a base of one copy per title, it would seem logical to compute relative numbers of copies of new titles among subjects as a function of their relative percentages of the total book circulation.

Library Hours

Another problem relating to the compatibility of needs and response to them has to do with the hours that the Library is open to the GSFC staff. As noted in Appendix VIII, the single most frequently volunteered comment/suggestion regarding the Library was that its hours of operation be extended. It appears that many potential users, because of the press of work, the distance between their work quarters and the Library, and other reasons, are unable to come to the Library during its present hours of operation. The fact that some staff members have keys to the Library to permit off-hour use is indicative of a need. From the comments/suggestions, it is evident that this need goes considerably beyond the relatively few individuals who now have off-hour access.

There is at least a slight relationship between Library hours and personal or non-Library collections (regardless of whether they are called satellite libraries or whatever). One frequently-stated reason for the use of such collections is physical convenience, and one type of such convenience is off-hour access.

Whether extending Library hours would actually diminish personal and satellite libraries is difficult to say with certainty; there are many reasons for such collections, not the least of which is idiosyncratic. But there is a strong possibility of improved cost effectiveness in such an extension. One mission of any library is to foster the greatest possible use of its holdings, facilities, and services. Only in this way can Library expenditures be amortized and justified to the maximum. From user remarks and suggestions, it would appear that a two-hour extension, during which the

Library is operated on a custodial, minimal-service basis, would serve the needs of the bulk of those who are unable to use it during the work day. Such an extension could be implemented through rotation of the existing Library staff.

While increasing the potential use of all of the collections, the extension of hours could be particularly salutary for the periodicals collection, which can only be read in the Library. It is generally agreed among the users that the periodical collection is an excellent one. This level of excellence is attained at a very high (and rising) annual cost, which can only be justified through maximum exploitation.

Methods of Early Detection and Anticipation of Changing Holdings Requirements

Based on our examination of sources available in the Library and elsewhere in GSFC, the following appear most likely to provide bases for timely predictions of upward and downward trends and indications of new areas (if any) in collection and holdings requirements: circulation/holdings records, circulation vs. user-subject interests, sources cited by Goddard authors, records of Xerox copies of publications, user requests for publications, interlibrary loan records, current Goddard RTOPS, Goddard RTOPS or RTOPS summaries in combination with manning levels and subject content of projects, subjects of RECON searches, and intelligence provided by the Library Users' Committee.

With respect to circulation/holdings records (by LC classes), this source, expressed as the numerical ratio of percentage of holdings to percentage of circulation and measured from year-to-year, can be a very sensitive indicator of upward and downward trends in activity within and among subjects.

Circulation/user-interest ratios can also be useful, although less direct, the one limitation (a very major one) being that it is difficult for the Library to profile the subject interests of the several thousand persons constituting its potential user group. It is even difficult to profile a significant sample of this body. Both require large-scale surveys of the professional and technical staffs.

Citations by Goddard authors, analyzed over time, can be useful indicators of where information collateral to research and writing comes from, the age of these sources, their form, and their specific titles. Two important drawbacks to this approach are that (1) it is limited to the information-gathering patterns and needs of that segment of the Goddard staff that writes for publication, and (2) it focuses almost exclusively on periodicals, which constitute nearly three-quarters of the items cited by Goddard (and most other) authors.

The same two limitations are true of records of Xerox copies of publications, which can also be indicative of changes in the forms, ages, and titles of sources used or sought by the Goddard staff. A third limitation, shared with circulation and other types of statistics, is that one does not know why the material was sought and whether and how it was applied to GSFC programs and progress. However, patterns and trends in copying, measured longitudinally, can be indicative.

Patterns of user requests for acquisition of publications by the Library are an obvious and direct guide, provided that all users and potential users are encouraged to submit requests as they feel the need. Our suspicion is that the bulk of requests come from a relatively narrow segment of the potential user population.

Interlibrary loan statistics, as in the case of acquisitions requests, can be longitudinal indicators of changing requirements. Unlike most other types of statistics, they are almost completely representative of forms, titles, ages, and origins of locally-unavailable publications which are sought or used by the Goddard staff. Analyzed for repetitive patterns, interlibrary loan statistics can provide important intelligence regarding needed augmentation of the collection.

RTOPS of Goddard projects, obtained as soon as possible after they are prepared, can provide important qualitative insights as to new areas of project interest. Combined with analyses of the subjects with which they will deal and staff-loading figures, RTOPS records can serve as an important guide to the nature of impending subject thrusts and the numbers of users who will be involved with them. Further, combined with recent circulation figures for the subjects involved, they can also be used as a basis for allocating publication budgets among subjects.

Topics of RECON search records and SCAN profiles, while useful indicators of trends and changes if analyzed over time, have some of the same limitations as references cited by Goddard authors and Xerox copies of publications: they focus primarily on the activities and needs of a very narrow segment of the users of the Library that makes the heaviest day-to-day use of it.

While not specifically discussed in the body of this report, because of their relative newness, there is a growing trend in the use of commercially available databases, such as those offered by SDC ORBIT and Lockheed DIALOG. Analyses of the databases consulted and the specific subjects

searched within them could be very important trend and activity indicators in the near-term future. There are upwards of 100 major databases offered by commercial vendors. The coverage of the sources ranges from the humanities through the natural, physical, and engineering sciences. They cover both bibliographic information and quantitative data, going far beyond the scope and content of RECON and SCAN. Careful surveillance of how these databases are invoked could provide important intelligence regarding new or impending areas of activity.

We and others have used commercially available databases for such predictive or anticipatory purposes. In addition, we have used them to determine, once increasingly searched topics are identified, what journals, in rank order, are most productive of papers on these topics.

Based on its original mandate, and on the fact that its membership represents all of the GSFC Directorates, the Library Users' Committee should have a strong role in keeping the Library informed of impending changes in programs and projects and related changes in information needs. However, this will require (1) better knowledge of their constituencies, and vice versa, and (2) more frequent rotation of membership to ensure that all parts of all Directorates are represented as currently and dynamically as possible.

Impact of Near Future Programs

With the exception of the changes or improvements noted, nothing came to our attention in the course of the study which would warrant significant alteration of the Library collections, facilities, and services as they now stand.

Needed Statistics

Implicit throughout this report is the very important role that various types of statistics, carefully collected, organized, and interpreted on a continuing or logitudinal basis, can play in the management and self-evaluation of the Library. Obviously, no single statistic or type of statistic can tell the whole story, but the following can be useful:

- o Circulation/holdings ratios are important indicators of upward and downward trends in activities among LC classes of books if collected longitudinally over time.
- o Citations by Goddard authors by LC class for books, title for periodicals, and date for both. Limited to authors' needs and primarily to periodicals, but important since periodicals account for three-quarters of publication-purchasing costs and since circulation records are not kept for periodicals.
- o Xerox copies of publications, by LC class, titles (for periodicals), and year. Primarily publications held by Library, but indicative of comparative utility, particularly of back periodicals.
- o User requests for publications, by LC class, title, and date. Repetitive requests within classes and among specific periodical titles (and dates within titles) can be indicators of needed action.
- o Interlibrary loan requests, by LC class, title, and date, can indicate upward and downward trends and needed action, particularly if collected longitudinally.

- o Numbers of subject index postings of RTOPS for GSFC projects provide a means of determining, from year to year, new and comparative subject emphases and deemphases, particularly if they can be related to the numbers of persons associated with each subject/project.
- o Topics of RECON, ORBIT, DIALOG, and (possibly) BRS searches, and the periodical titles and dates of periodical titles cited in response, can, with study of repetitive patterns, be important indicators of future needs.