AFFDL-TR-65-120
PART I

FLIGHT CONTROL DATA AND INFORMATION EXCHANGE PROGRAM

PART I. INVESTIGATION OF NEED AND FEASIBILITY

PLANNING RESEARCH CORPORATION

SYSTEMS TECHNOLOGY, INCORPORATED

FOREWORD

The report presents the result of a study to investigate the need for and potential success of a permanent flight control data and information exchange program. The reported work was performed during the period June 1964 to April 1965 by Planning Research Corporation under subcontract to Systems Technology, Incorporated. This study was conducted as one of two specified tasks under Air Force Contract No. AF33(615)-1818 and was administered by the Air Force Flight Dynamics Laboratory under Task No. 821904 of Project No. 8219. Mr. R. O. Sickeler and Mr. A. J. Connors successively were the Project Engineers for the Flight Dynamics Laboratory.

Mr. D. E. Johnston monitored the study for STI and rendered invaluable assistance to the effort. The PRC personnel participating in the study are H. M. Dye, C. E. Bloomquist, and C. H. Wilmot.

The study team gratefully acknowledges the numerous flight control specialists throughout the industry who responded to the mail and telephone inquiries and freely conveyed their considered opinions on the various aspects of a potential flight control data and information exchange program.

The manuscript of this report was released March 1965 for publication as an RTD technical report.

This technical report has been reviewed and is approved.

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ABSTRACT

This document reports the result of a study to investigate the need for a permanent flight control data and information exchange program. Direct mail questionnaires were used to solicit the opinions of the flight control specialist. The results of the opinion survey are summarized. Three major abstracting and announcement media were critically examined from the standpoint of identifying information relevant to flight control systems. A literature survey was also conducted to determine the current status of technical documentation and dissemination. A group of specialized information centers of interest to the flight control specialist is described. Based upon these findings, the general structure and guidelines are presented for a specialized information center designed solely to satisfy the information needs of the flight control specialists.

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INTRODUCTION

Over the past several years, the need for more effective communication of advanced technical information and data has been recognized throughout the aerospace community. Effective communication among flight control system (FCS) engineers has been challenged by the growth in volume and increases in the number of sources generating FCS information and data. The growth in volume and in source count reflects the increased system complexity, the larger number of organizations associated directly or indirectly with FCS, and, of course, the relative newness of space vehicles.

The Air Force Flight Dynamics Laboratory has conducted a continuing program to promote the timely interchange of data, information, and techniques useful in the preliminary design of FCS. Several of the studies sponsored under this program have been directed specifically toward the compilation, analysis, and presentation of state-of-the-art FCS data and information. References 1 through 11 are examples of the technical documentary reports that summarize the results of these survey studies.

Within the time span of these studies, several formal information and data exchange programs have been established, including the Interservice Data Exchange Program (IDEP), the Failure Rate Data (FARADA) Program, the Electronic Component Reliability Center (ECRC), the Parts Reliability Information Center (PRINCE), and the Transducer Information Center (TIC). These formal data exchange programs are primarily concerned with reliability, design, and test data, and were founded to implement the concept of "contribute and be contributed to." The referenced studies sponsored by the Flight Dynamics Laboratory were conducted upon a similar philosophy, "contribute your data and profit from a collective analysis."

However, pursuit of the survey-type studies, at least until the present, also has involved a high level of coordinated collection activity, as opposed to the more passive role of acting as an exchange agency. Indeed, some of the more valuable results in the referenced studies have come from raw data in the form of failure reports, test records, technical memoranda, etc. --certainly not the type of documentation that would find its way into a formal exchange activity.

Furthermore, although the formal data exchange programs indicated above provide a valuable service to the aerospace industry at large, the results are rather indirect so far as satisfying the FCS designer's needs. The referenced studies sponsored by the Flight Dynamics Laboratory are essentially the only programs especially devoted to FCS needs.

At the same time, information exchange via technical documentation and dissemination has been stepped up through the recent activities of the Department of Defense, NASA, and other Federal agencies, and various

technical societies.[1] The scope of the information exchange programs includes both direct distribution of technical reports, papers, and related material and also the publication of abstracts, digests, or reviews that announce the availability of specific documents. Unfortunately, a significant amount of technical information does not reach the exchange programs. For example, the Defense Documentation Center (DDC) estimates that it receives "no more than 40 percent" of the information generated at DOD expense (Reference 13).

The present study was undertaken to investigate the need for and the potential success of a permanent information exchange program, devoted solely to the FCS area, which would provide the mechanism for direct interchange of technical reports, reliability data, disturbance data, component test data, etc. If applicable, the study was also to formulate means of implementing a program at a planning level. It was decided at an early stage that the study should investigate the potentialities of an FCS data and information exchange[2] rather than be restricted to FCS data exchange in the classical sense.

Two approaches were taken in this study. First, opinions of the potential users of the contemplated FCS data and information exchange program were solicited. Second, the current status of technical information services was examined; this effort included a survey of contemporary literature and also a specific attempt to select technical documents relevant to FCS from the more widely available abstracting and announcement media.

The results of the FCS specialist opinion survey and findings on the current status of technical information services are utilized to recommend the general structure and guidelines of a permanent FCS data and information exchange program.

The results of the opinion survey are presented in Section II. Section III summarizes the findings on the current status of information exchange programs. Finally, the recommendations for an FCS data and information exchange program are presented in Section IV.

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[1] Readers interested in the current status of technical information exchange are referred to two recent reports: (1) Science, Government and Information, by the President's Science Advisory Committee (Reference 12); and (2) Documentation and Dissemination of Research and Development Results, by the Select Committee on Government Research of the House of Representatives (Reference 13).

[2] It is recognized that data and information are often used synonymously. As used here, however, the term data carries the connotation of being primarily of a quantitative nature (e.g., failure rates, test results, design calculations, etc.), while the term information carries the connotation of being primarily narrative (e.g., general operational experiences with equipments, discussions of experiences with alternative designs, etc.).

SECTION II

SURVEY OF OPINIONS

As stated in the introduction, one of the objectives of this study is to investigate the need for a permanent flight control system (FCS) data and information exchange program. One of the approaches employed in this study was to query the potential users of such a program. The major questions posed to the FCS specialists may be summarized as follows:

Need

- How are you presently obtaining FCS data and information?
- Are your present methods satisfactory? If not, how can they be improved?

Material

- What is the subject content of information that you most frequently seek?

Support

- Are you willing to participate in a formal FCS data and information exchange program? If so, what is your preferred level of participation?

The purpose of this section is to describe the responding group and to summarize the collective answers given by the group to the above questions. Technical specialties, experience, and other background variables of the individuals represented in the surveyed group are recounted. First, the methods and procedures used in conducting this survey are outlined.

A. Survey Procedures

Direct mail questionnaires were used to canvass the opinions of individuals known to be engaged in research, development, manufacture, and/or use of FCS equipment. A list of some 130 FCS specialists was compiled from a roster of the A-18 committee of the Society of Automotive Engineers, and other individuals in industrial and governmental organizations who had assisted the study team in the conduct of the previous survey-type studies given as References 1 through 11 of this report.

Two different questionnaires were mailed; a copy of each is included in Appendix I. The first questionnaire was posted in September 1964 to the initial list of 130 FCS specialists. Of these, almost 20 percent were returned with annotations of "moved, no forwarding address" or "no longer in FCS." The second questionnaire, designed to clarify the ambiguity resulting from the returns of the first inquiry, was mailed in December 1964 to some 100 individuals. Telephone conversations were conducted with some respondents to discuss specific problems and points of ambiguity.

B. The Responding Group

Thirty completed responses were received from the first questionnaire; 11 of these returns were composite responses representing 2 to 5 FCS specialists within a given organization. Forty-three responses were returned from the second questionnaire. The completed returns for the two mailings were 23 percent and 43 percent, respectively. Twenty-one individuals or groups of individuals replied to both questionnaires. Thus, 52 different responding groups represent some 68 individuals. The overall response is roughly 68 percent of all those contacted. The percent response is indicative of the interest regarding FCS data and exchange, since direct mail questionnaires are generally considered successful when there is only a 20 percent response.

When these returns are categorized according to the respondents' employment, the following breakdown is obtained:

Industry	37
Government agencies	11
Nonprofit organizations	2
Universities	2

Since some of the returns from industry and government agencies were multiple responses originating from the same organizational group, it is of interest to examine how many different organizations are represented. The breakdown is as follows:

Industry	28
Government agencies	9
Nonprofit organizations	2
Universities	2

The 28 returns from industry are further classified into types of contractor organizations:

Airframe or weapon-system contractors	17
FCS contractors	10
Component supplier	1

Government groups represented include Air Force, Army, Navy, NASA, and the Federal Aviation Agency.

It is also of interest to examine the types of programs in which the respondents are presently engaged. With only one exception, all respondents stated that they are currently working on some aspect of a Government contract. The one non-Government project is specified as being a commercial endeavor within one of the leading airframe companies.

Of the Government contracts, 90 percent are specified as being segments of some space or weapon-system program. The remaining 10 percent are applied research projects. The following table shows the percentages of the responding group according to the types of programs with which they are presently associated:

Type of Program	Percentage of Group
Aircraft (fixed- and flex-wing)	46
Missiles and space boosters	24
Space vehicles	20
Applied research	10

Based upon the almost unanimous indication of participation in Government contracts, it is reasonable to assume that the overwhelming majority of the respondents have access to some Government-sponsored data and information exchange program.

The following four subsections summarize the opinions conveyed by this group.

C. Availability and Utilization of Existing Information Exchange Programs

A group of eight document dissemination, abstracting, and announcement services, and data exchange programs are listed on the questionnaire. Three of the eight programs are sponsored by the Department of Defense, three are part of the NASA scientific and technical information service, one is a Navy-sponsored data exchange program, and one is jointly supported by the Air Force and FAA. More detail on each of these programs is presented in Section III. The addressee is asked to indicate whether or not each service is available. Surprisingly, 10 percent of the respondents indicated that none of the services were available; in fact, that they had "never heard of it." Only 27 percent of the respondents checked that they had access to 3 services. Figure 1 shows the response of the group to the number of exchange services available.

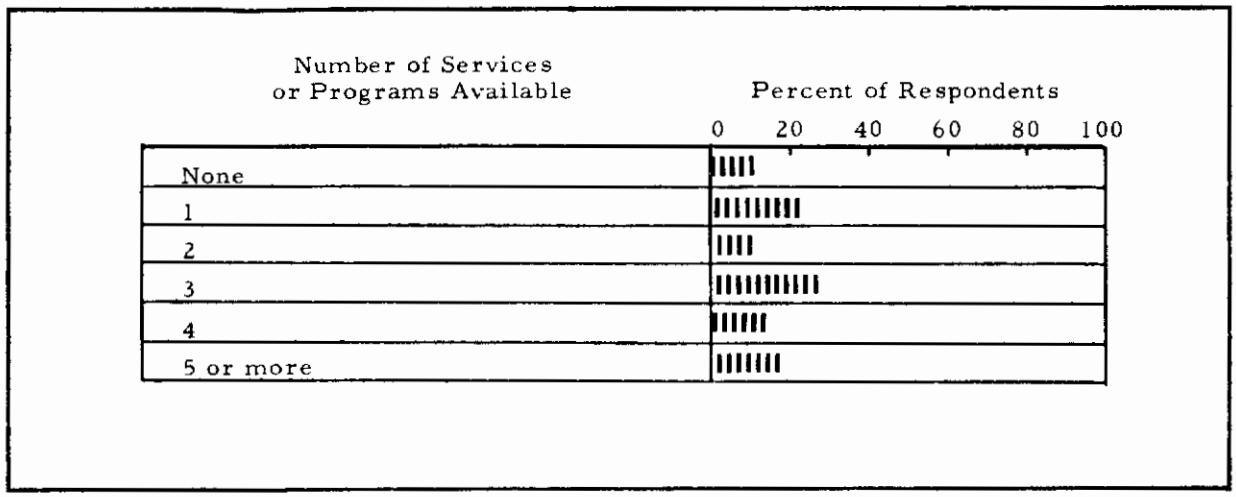


Figure 1. Indicated Availability of Data and Information Programs

The four most frequently checked programs are Defense Documentation Center (DDC), Advisory Group for Aeronautical Research and Development (AGARD), Scientific and Technical Aerospace Reports (STAR), and International Aerospace Abstracts (IAA). The table below shows the percentage of respondents indicating the availability of these programs:

Programs or Services	Percentage of Respondents
DDC	80
AGARD	53
STAR	50
IAA	47

The questionnaire also requested that the respondent indicate the frequency with which he obtained information pertinent to FCS from each of the programs or services available to him. Three categories--50 to 100 percent of time, less than 50 percent of time, and never--were established. Twenty-four percent of the respondents using DDC services indicated that over 50 percent of the time they were successful in obtaining information pertaining to FCS in DDC publications, while 21 percent of IAA users indicated that they never obtained FCS information from this source. The table below shows the distribution of the respondents' answers to this question:

	Frequency of Obtaining FCS Information			
	50-100%	<50%	Never	No Answer
Programs	Percent of Indicated Users			
DDC	24	66	0	10
AGARD	6	75	13	6
STAR	19	56	6	19
IAA	19	46	21	14

The relatively heavy responses on the "never" and "no answer" categories may well stem from the practice of some FCS specialists in large organizations of depending on their librarians to screen the announcement media as well as to do the ordering; consequently, many are not aware of the agency responsible for the abstract and announcement of the documents.

Finally, the respondents were requested to nominate their most valuable source of FCS information. Professional societies was the most popular category, with 21 nominations; of these societies, the Society of Automotive Engineers was specified 14 times. Air Force technical reports were mentioned by nine respondents; seven of the respondents identified them as "Wright Field" or "ASD" publications. The table on the following page shows the entire listing of the "most valuable source."

TABLE I. LIST OF MOST VALUABLE SOURCES

Most Valuable Source Specified	No. of Times Specified
Professional organization	21
Air Force technical reports	9
NASA reports	6
DDC reports	5
Own company library	4
Direct personal contact	4
Navy reports	3
Component supplier	2

D. Need and Desirability of a Specialized Exchange Program

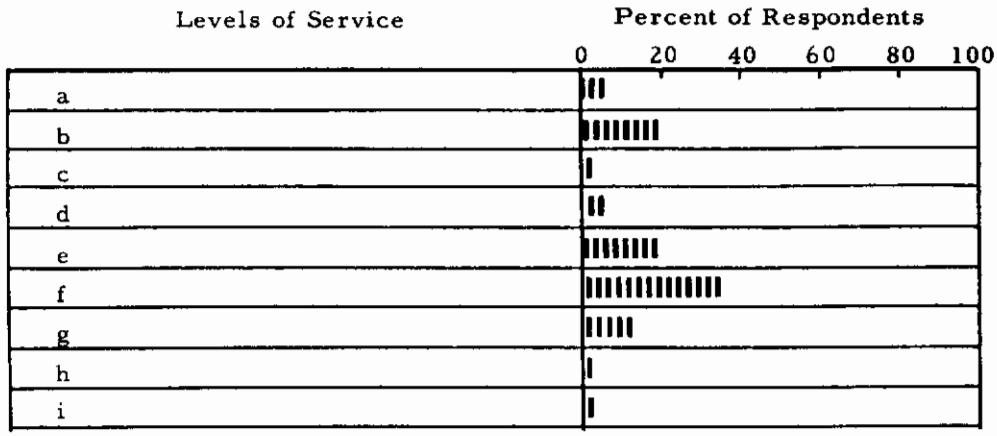
On the first survey, two questions were addressed to the FCS specialists to solicit their opinions on the present methods of disseminating FCS data and information, and to invite their comments on changes or improvements. Over 90 percent of the returns conveyed the opinions that "there are too many diverse sources," "information is too difficult to obtain," "existing indexing and classification methods are not adequately designed for efficient retrieval of FCS information," and "the lag time between generation and dissemination is too long." Recommendations for improvement included "establish a coordinated program," "develop report indexing and classification methods for FCS," "develop better screening methods," and "establish direct mail to FCS specialists announcing the availability of new documents."

As a result of this clear expression of the need for and desirability of improvement, a second questionnaire was designed which would better define the type of service preferred by the FCS specialists. The levels of service ranged from (a), annotated bibliography of reports, through (h), automatic distribution of collated and processed data reflecting all contributed information (see questionnaire 2 of Appendix I). The plurality first choice was indicated as level (f), the service which provided for an expanded annotated bibliography including reports, symposium proceedings, technical journals and magazine articles and the transmittal of copies of specific reports upon request. Some 20 percent of the respondents preferred to receive (b), the expanded annotated bibliography only; while another 20 percent chose (e), the report bibliography with provision for receipt of specific reports upon request. Figure 2 shows the distribution of the "first choice" indications on the types of services preferred by the FCS specialist.

The subject content of a potential FCS data and information exchange was also explored by the questionnaire method. Types of FCS information were listed under eight major subject headings, which were in turn broken down into multiple subheadings (question 9). The FCS specialist was requested to indicate how frequently he needed each type of information by checking the appropriate columns labeled--"daily," "weekly," "monthly," "occasionally," and "never."

Figure 3 depicts the summary of the responses; the highest frequency of need indicated by the respondents is summed for each subject category. Shading is used to portray the frequency of requirement. It is noted that almost 90 percent of the respondents require information on concepts, theory, and techniques; some 20 percent have indicated that this information is needed daily. Next in demand is the subject of FCS interfaces. The requirements in other subjects are ordered as follows: miscellaneous historical information, empirical data, mechanization, detailed design, testing, and fabrication. It is noted that the need for empirical data is expressed by some 75 percent of the respondents, but frequency of need is apparently lower.

Figure 4 shows the responses of the FCS specialists according to specific topics within the major subject categories. The figure shows that more FCS specialists seek information on simulation than any other type of information. However, analysis techniques are more frequently needed by more FCS analysts than any other information. Requirements for vehicle dynamics and characteristics closely approach those in the concepts, theory, and techniques.



Legend

a. Annotated bibliography of material available, periodic revisions (loose leaf or bound); material cataloged by subject, originating agency, year of release

b. Item (a) above expanded to include symposium proceedings, technical journal and magazine articles, etc.

c. Copy of specific reports upon request

d. Copy of all reports in a preselected area of interest without submitting specific requests

e. Combination of (a) and (c)

f. Combination of (b) and (c)

g. Combination of (a) and (d)

h. Automatic distribution of collated and processed data reflecting all contributed data and information

i. Other

Figure 2. Expressions of Desired Level of Service from FCS Information Exchange Program

Figure 4.B shows that the need for mechanization information is ordered as follows: systems, components, on-board computer, and ground-support equipment. The need for detailed design, fabrication, and testing information on systems, components, on-board computers, and ground-support equipment is distributed very similar to that depicted for mechanization and, hence, is not shown. The need for manual control information is indicated by 75 percent of the respondents (Figure 4.C). A similar fraction of the FCS specialists seek reliability and maintainability data; however,

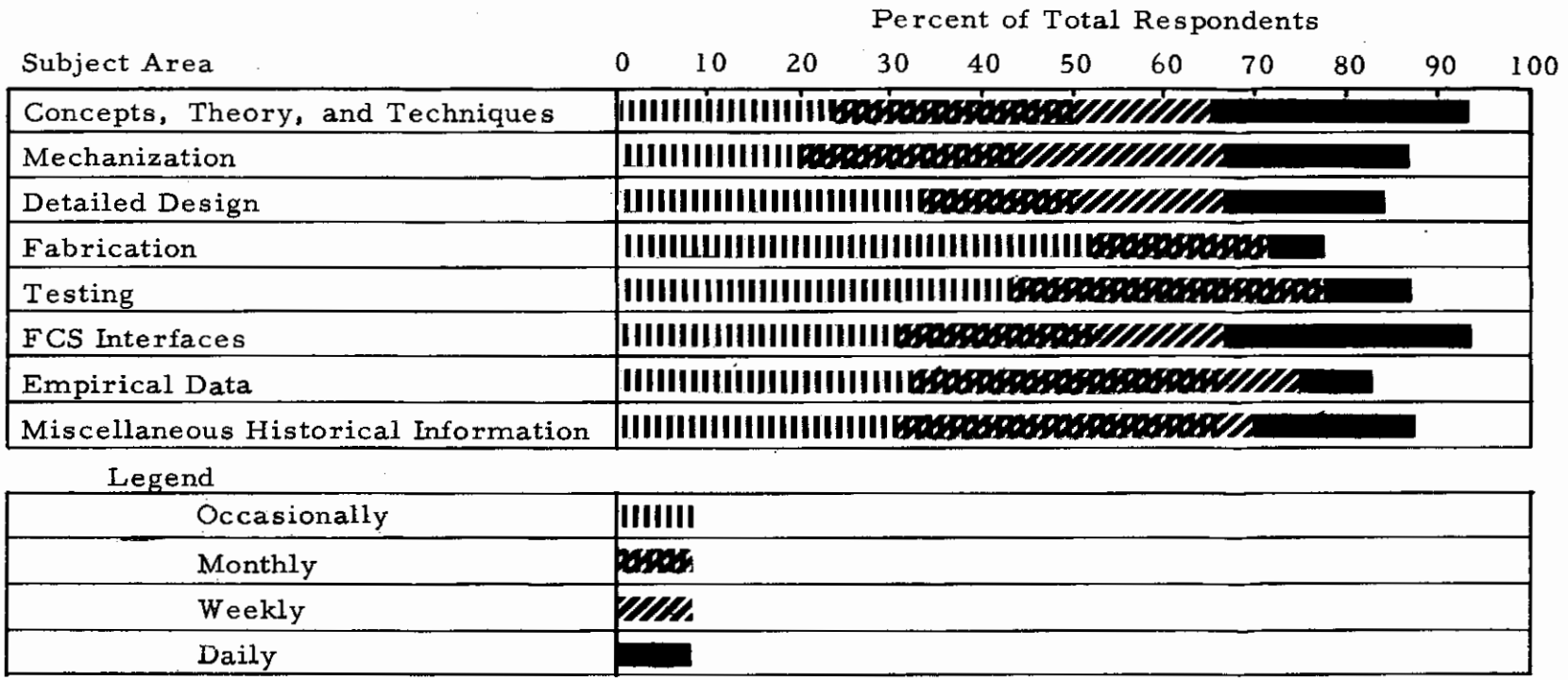


Figure 3. General Subject Areas of Information Needs

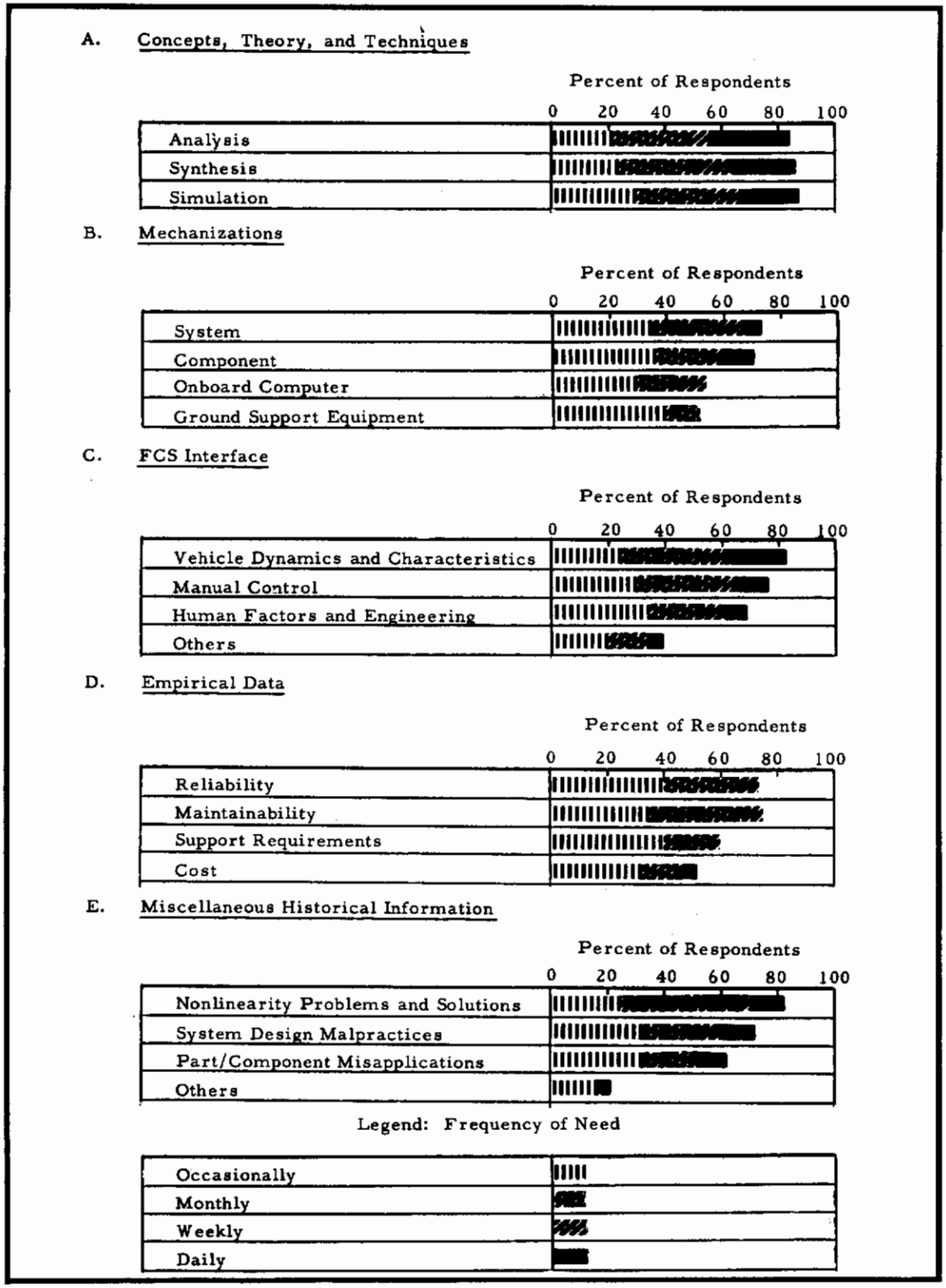


Figure 4. Types and Frequency of Information Needs

no respondent indicated a daily requirement. Approximately one-half of the group have some need for cost data (Figure 4.D).

The requirement for documentation on nonlinearity problems and solutions is expressed by some 80 percent of the FCS specialists surveyed. The graph shows that many respondents have daily needs for this type of information and also on design malpractices and parts misapplications.

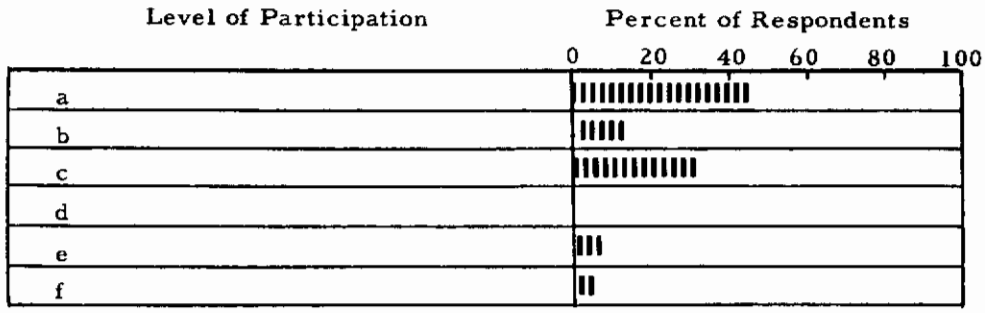
Another aspect of the FCS exchange program was explored by a four-part question on the lag time for document delivery (see question 7 of questionnaire 1, Appendix I). This question was included because of frequent pleas to "address it to me personally or I'll never get it." The responses are summarized as follows:

	Range	Average
Lag time for document delivery, if document personally addressed	1/2 to 7 days	1-3/4 days
Lag time if FCS document is published by agency other than professional society (time from publication to awareness of its existence)	2 days to 1 year	4 months
Lag time from library receipt of document to awareness of its availability	2 days to 6 months	1 month
Lag time from request to library for document to delivery to desk	1/2 to 60 days	2 days

These responses clearly show that there is a wide range of differences in the lag time estimated by the respondents. No doubt these lag times are dependent on the size of the organization and the procedures used for announcing and routing newly acquired documents. Probably the most significant time lag (from publication to the FCS specialist's awareness) that should be noted is the case of a technical report published by an agency other than a professional society. To ensure timely receipt, any announcement media should be personally addressed to the FCS specialist.

E. Anticipated Participation in an FCS Exchange Program

The responses to three separate questions will be summarized to determine the anticipated participation in the FCS exchange program. One of the questions asks the respondent to select his preference of what he "supplies" (see questionnaire 2, Appendix I). The first choice preference is shown as Figure 5. Some 45 percent of the respondents prefer to participate at level (a); i.e., supply abstracts, descriptors, or subject headings. The first choice for 30 percent of the group is level (c); i.e., supply one reproducible copy of each report generated to the exchange. Twelve percent would rather supply copies of reports directly to the requestors. It should be pointed out that the indicated preference in the level of participation falls short of the desired level of service. In order to achieve the level of desired service discussed in the previous subsection, more of the FCS respondents must be prepared to supply copies of their reports to qualified requestors or, alternatively,



Legend

a. Abstract of material, key descriptors or subject headings, security classification

b. Copies of reports, documents, etc., directly to requestors

c. One master (or reproducible) copy of each report or document generated to the exchange agency

d. Semiprocessed data (test results, operational results, failure reports, etc.) in standard format specified by exchange agency

e. List of subject areas of interest

f. Other

Figure 5. Expressions of Desired Level of Participation in FCS Information Exchange Program

a reproducible copy to the exchange, in addition to the corresponding abstracts, descriptors, etc.

The second aspect of anticipated participation was examined by the number of reports that may be contributed yearly by each of the respondents. Figure 6 shows the summary of the responses by broad subject areas. Comparing this figure with Figure 3, which depicts information needs, three observations can be made. First, the rank order of the subject areas of potential contributions correspond to the needs; i.e., the areas in which the highest potential volume of reports are to be contributed are also the subject areas where information is most frequently needed by the majority. Second, the volume of potential contributions from the FCS specialists responding to this survey is expected to be greatest on the subject of concepts, theory and techniques, and the lowest volume on the topic of fabrication. There is a definite bias in this sampling, as will be explained in subsection G.

A third observation that can be made is that, for any given subject area, the percentage of FCS specialists who anticipate report contributions is substantially less than the percentage who say they need the information. Figure 7 shows the general subjects broken down into more specific types of information.

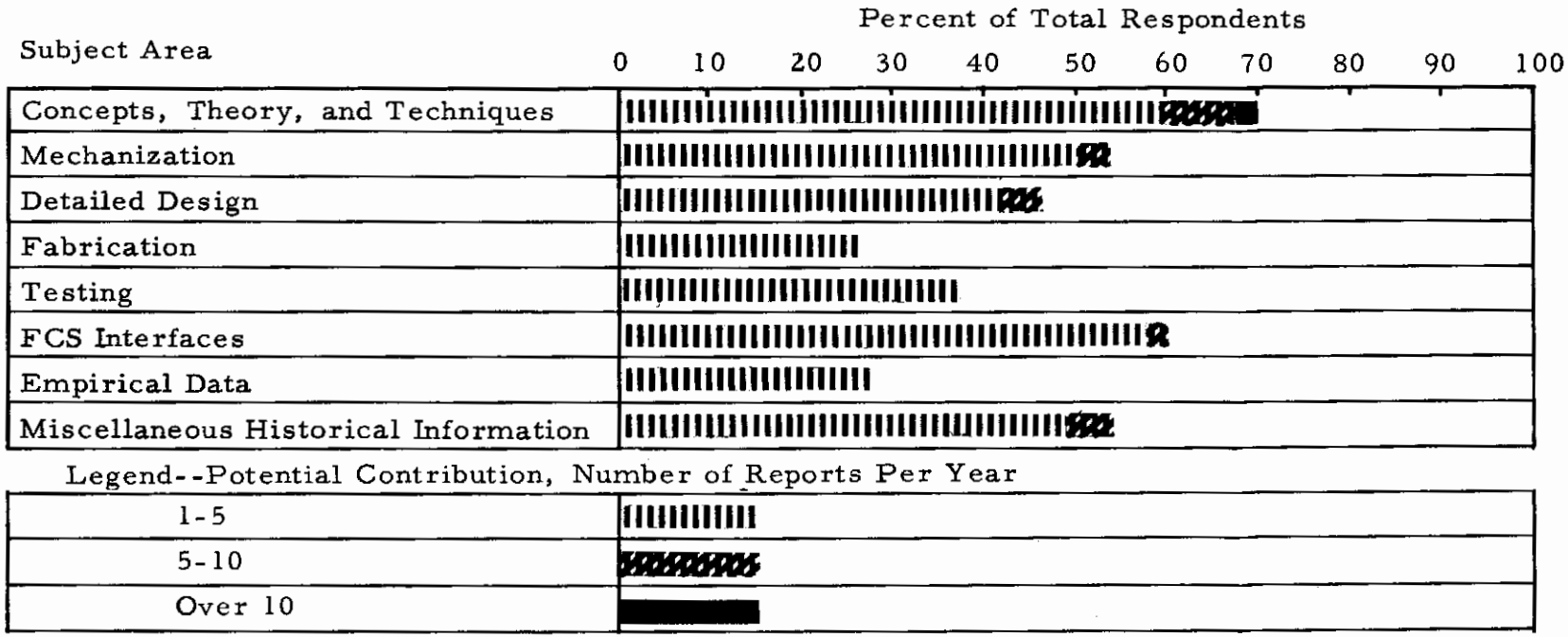


Figure 6. Indicated Potential Annual Contribution, By General Subject Areas

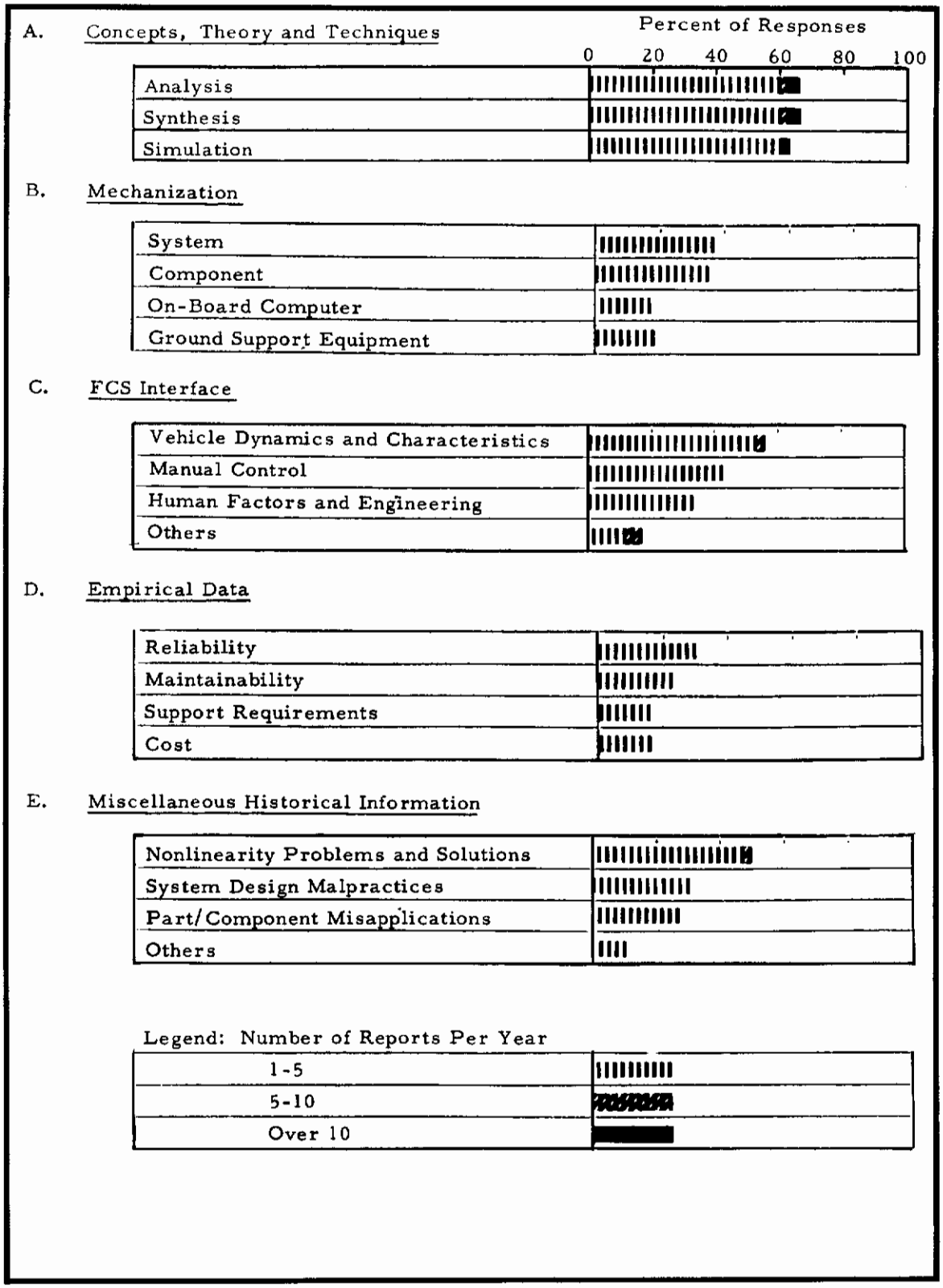


Figure 7. Indicated Potential Annual Contribution, By Information Type

Summing over the 30 respondents who completed this portion of the questionnaire, the potential annual volume was estimated, as shown on page 19. The tabulation covers only reports from the responding group. The total number of reports and papers from the FCS industry should be considerably larger than this sampling.

Subject Areas	Number of Reports Per Year
Concepts, theory, and techniques	206
Mechanization	123
Detail design	122
Fabrication	69
Testing	87
FCS interfaces	147
Empirical data	126
Miscellaneous historical information	109
Total	989

The FCS specialists were also asked to estimate the percentages of these documents that would be proprietary, security-classified confidential or security-classified secret. The following responses were tabulated:

Classification	Percentage of Documents
Company--proprietary	30
Security--confidential	28
Security--secret	7
Unclassified-nonproprietary	35

The final question on potential contribution was related to the form of the documentation. The responses to this question were as follows:

Condition	Percentage of Documents
Fully documented	66
Draft form	28
Require data reduction	16

Another aspect of participation in the FCS data and information exchange was related to the respondent's willingness to delegate a contact man. Sixty-seven percent of the respondents gave an affirmative answer when questioned on their willingness to delegate a contact man or program coordinator within their working group. Each of these positive responses was qualified by nominal or modest manpower level ranging from 2 percent to 20 percent of the man's time. Some 10 percent of the respondents felt that their present contract could not afford a coordinator for an FCS data and information exchange program. Another 10 percent of the respondents were definitely unwilling to participate; comments set forth were "against government administration," "no need for additional program," and "proprietary problems are

insurmountable." Others stated that a technical librarian could handle such a job and would prefer delegating the program coordination function to the company's library. The table below summarizes the group's responses to the question of delegating an in-house contact man for the FCS data and information exchange program.

Responses	Relative Frequency (Percent)
Yes, at nominal levels	67
Can't, no funds available	10
No, definitely against	10
Prefer to use library	7
No answer	6

F. Preference in Methods of Implementation

The FCS specialists were requested to express their preference in the methods of implementing a formal data and information exchange program. The most frequently indicated preference was for a government agency set up for exchange, supported by a group specializing in FCS. Association with a professional society was the second-ranking method of implementation. The conveyed preferences are summarized in Figure 8.

G. Profile of the Respondents

The first questionnaire included three specific questions concerning the respondent's technical speciality, length of experience in the FCS field, the level and areas of responsibility of his present position. The answers to these questions were requested in order to assist in the interpretation of the results of the survey. The following paragraphs summarize the descriptive information on the individuals included in the opinion survey.

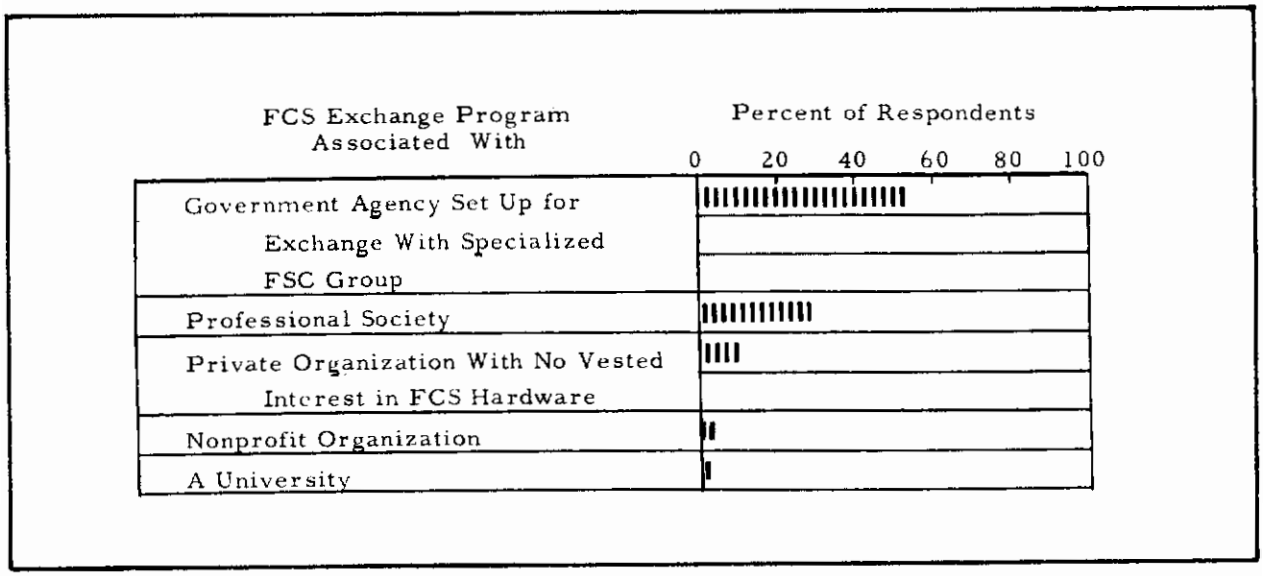


Figure 8. Expression of "First Choice" Method of Implementation

1. Levels of Responsibility

The levels of responsibilities were categorized into four groups: administrator, supervisor, designer-analyst, and other. The respondents were requested to indicate their primary level of responsibility. The table below shows the composition of the responding individuals or groups of individuals in relation to their primary level of responsibility. It is noted that individuals at the supervisory level predominate the group.

Level of Responsibility	Percentage of Respondents in Each Group
Administrator	27
Supervisor	60
Designer-analyst	13

It is also noteworthy that 90 percent of all respondents indicated that designer-analyst is their primary or secondary level of responsibility. This indication is significant in a survey of this nature, where opinions of the working engineer, the potential user of the exchange program, are being sought.

2. Years of Experience and Years with Present Organization

All respondents indicated 5 or more years of experience in the FCS field. The average of the total group is 14 years.

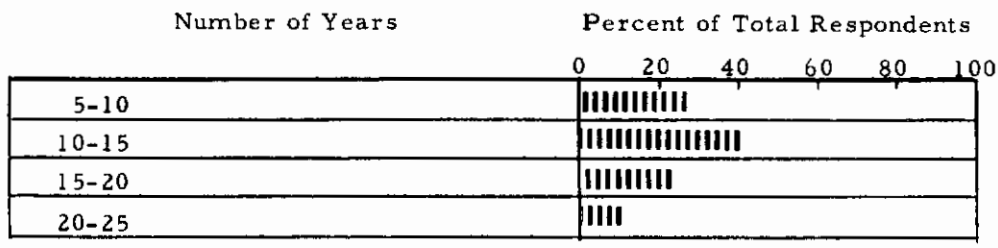


Figure 9. Years of Experience in FCS Field

Figure 9 shows the distribution of the respondents with respect to their years of experience. The table below shows the breakdown of years of experience according to the levels of responsibility.

	Years of Experience	
Levels of Responsibility	Range	Average
Administrators	13-25	17
Supervisors	5-22	13
Designer-analysts	6-24	11

The average number of years with the present organization is computed to be approximately 11 years.

3. Technical Specialties

The technical specialties represented in the sample group were explored by requesting each respondent to indicate his primary and secondary fields of specialization. It should be noted that multiple checks were permissible and were frequently used. Figure 10 shows the relative frequency of the specialties indicated by the responding group. System analysis and synthesis and interfaces of primary control system are checked more frequently than any of the other fields. Individuals interested in sales and fabrication are not well represented.

H. Summary of Opinion Survey

The direct-mail questionnaires were returned from an encouraging number of FCS specialists presently engaged in research, development, and manufacture of a variety of space and weapon systems. The responding group tended to be senior personnel having considerable tenure with their present organizations. Although the majority of the respondents now hold supervisory and administrative positions, many have had first-hand experience as working designer-analysts in searching for FCS data and information. Also, since almost all respondents are working under a Government contract, the sources of one or more Government-sponsored or supported information exchange programs are available to the majority of the responding group (see Figure 1). Their success in obtaining pertinent information through established formal exchange programs varies considerably. In fact, informal exchanges and distribution services such as professional organizations and Air Force technical reports are more frequently cited as their most valuable source of FCS information.

The opinions received in this study clearly expressed the need for improvements designed to facilitate and accelerate the identification and receipt of data and information pertinent to the FCS specialist. Specifically, the respondents wanted an annotated bibliography of material available which includes reports, papers, magazine articles, and symposium proceedings. In turn, the same number of respondents expressed a willingness to supply abstracts, descriptions, and reproducible copies of reports to the exchange agency. In addition, two-thirds of the respondents said they were willing to delegate a man within their organization to act as the point of contact, in the event that an FCS data and exchange program is established.

Based upon the estimates submitted by the respondents to the present inquiry, there will be some 650 fully documented reports; of these, some 230 will be classified, and 200 will contain company-proprietary information. These reports will cover many FCS areas; the completed returns of this survey show that documentation on concepts, theory, and techniques, and FCS interface information will predominate.

As anticipated, the subject area of interest and report generation corresponds to the technical specialties of the responding group. Also, as previously discussed, the expressions of need and services desired somewhat

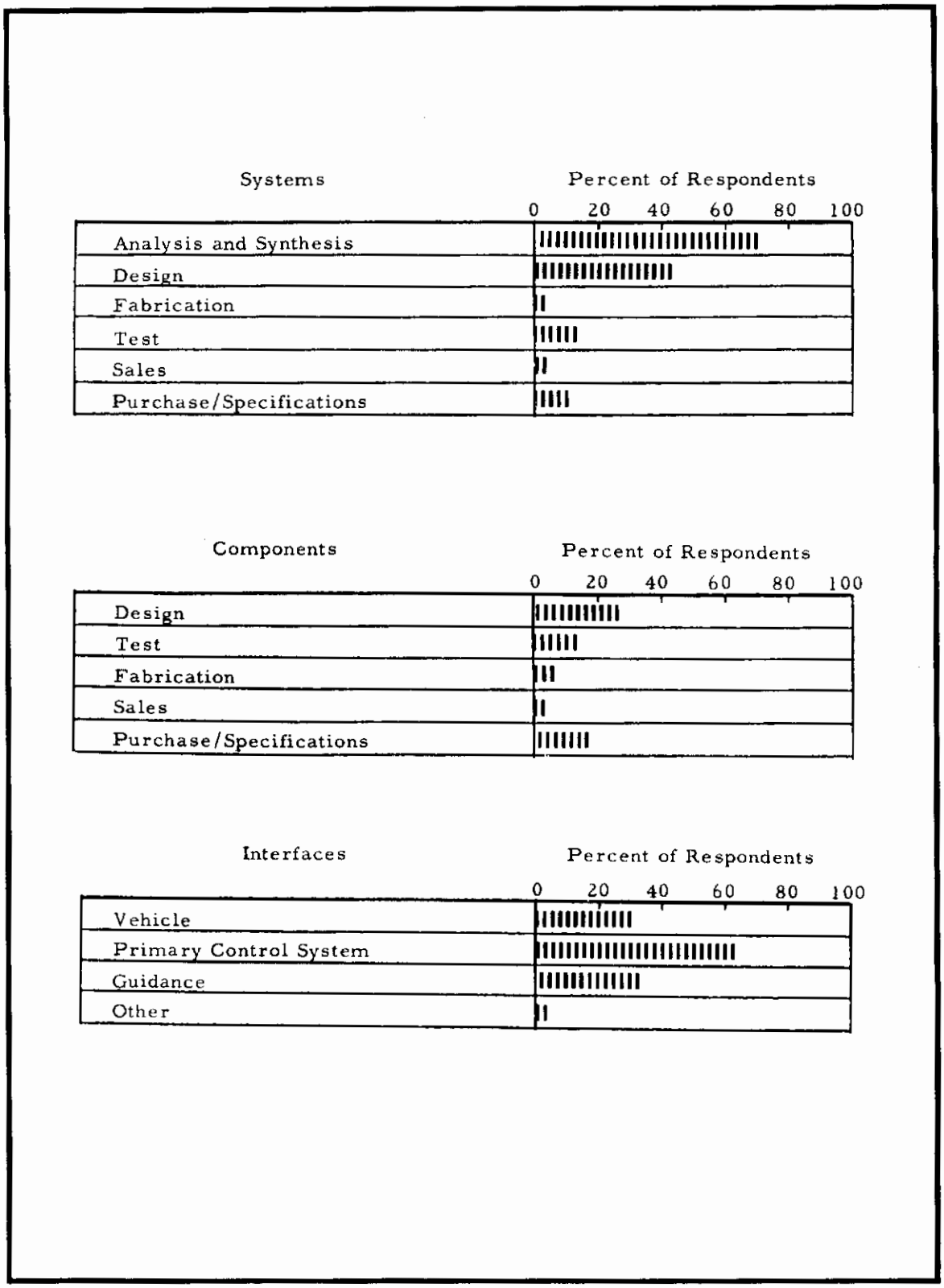


Figure 10. Primary Technical Specialties of the Respondents

exceed the expressions of contribution and participation; however, there is no apparent formidable "gap." In general, the spirit of cooperation and expressions of enthusiastic participation were conveyed in the comments returned in the questionnaire; many respondents made a special effort to express their ideas in letters accompanying the completed questionnaires.

SECTION III

SURVEY OF DATA AND INFORMATION SYSTEMS

In addition to the survey of potential user opinions, a literature review was conducted to investigate the status of current data and information exchange programs. Also since the majority of the respondents indicated the need for improved abstracting and announcement services, a special effort was devoted to utilizing three of the most widely available publications to determine how well these services meet the needs of the FCS specialist. This section summarizes the findings and describes some of the information systems particularly germane to the FCS specialist.

A. Critique of Three Information Services for FCS Usage

Since the majority of the respondents indicated a need for improved abstracting service insofar as FCS information is concerned, it was decided to check three of the four most frequently used abstract and announcement services (see Section II). The purpose of this investigation was threefold:

- To determine how well the organization and presentation of the information meets the FCS specialist's needs
- To seek any obvious shortcuts in screening the available abstracts for FCS and related information
- To seek means of improving existing or future data and information exchange programs

Three abstacting publications were reviewed: (1) International Aerospace Abstracts (IAA), published by AIAA and NASA; (2) Scientific and Technical Aerospace Reports (STAR), published by NASA; and (3) Technical Abstract Bulletin (TAB), published by DDC. The findings are summarized below.

1. IAA

The IAA primarily covers published material (e.g., papers, articles, and proceedings). The material in the IAA volumes is organized into 34 subject categories, of which some 14 can be expected to contain information of value to FCS specialists (or generalists). These are as follows:

Category	Title	Subject Material of Interest
01	General	Symposia or conference
04	Aircraft	Specific type and models of aircraft; flight tests; operating problems; safety devices and stability and control
06	Auxiliary systems	Hydraulic, pneumatic, and electrical control systems and actuators
09	Electronics	Circuit and circuit theory feedback control theory

Category	Title	Subject Material of Interest
11	Fluid mechanics	Turbulence
14	Human behavior	Piloting
15	Instrumentation and photography	Gyroscopes; sensors and transducers
20	Mathematics	Calculation methods and theory; computer
21	Meteorology	Lower atmosphere studies
22	Navigation and guidance	Autopilots; inertial platforms
30	Space vehicles	Launch vehicle-spacecraft combination; missile systems; operating problems; stability and control
31	Space vehicles (launch vehicles)	Boosters; clustered rockets and multistage rockets
32	Space vehicles (spacecraft)	Space capsules; satellites and space probes

There are two principal ways that the FCS engineer may utilize the IAA. One is to keep abreast of the material in one's field of interest; the second is conducting literature searches in specific subject areas.

Each semimonthly issue contains several pages of accession material under each category. The abstracts pertinent to a general category are presented by sequential accession number, while the subject material is quite random. Thus, it is necessary for the user to scrutinize each of the general categories which may contain information of interest. However, this is a time-consuming task. An alternate approach is to employ the alphabetized descriptor listings also contained in each issue. Here the "gist" of the abstract or document, as it pertains to the specific descriptor, is presented in roughly a dozen words. Unfortunately, the reader who is interested in the general field of FCS then finds that the information is likely to be found under any one (or several) descriptors (or synonyms), which may or may not be central to the report material.

Since the descriptors are keys to efficient information storage and retrieval, a typical cumulative index (Third Quarterly Cumulative Index, July-September, Volume 4, 1964) was screened to determine the major descriptors; i.e., the key words or combination of words which, if employed, would inform the reader for the maximum of material with a minimum of effort. In this issue, there were over 250 descriptors, under which some 477 separate articles containing information of possible interest in the general field of FCS could be found (exclusive of aerodynamic theory, materials, and/or manufacturing processes). This is also exclusive of the listings for specific vehicles by class, type, or model number. Of these, 36 descriptors, or 14.4 percent, covered 341, or 71.5 percent, separate and nonrepetitive listings (i.e., listings were made exclusive by reducing the multiple descriptor listings to the single most general descriptor per entry). Some 52 descriptors,

or 21 percent, likewise covered 389, or 81.5 percent, exclusive listings. Some 15 descriptors covered over 50 percent. Unfortunately, if a person were seeking information on, say, adaptive flight control systems, it would be necessary to look under Adaptive Control System, Automatic Control, Feedback Control System, and Self-Adaptive Control (to name a few) to be certain that all material pertaining to the subject was uncovered, since any given report might be listed under only one of the above.

A glance at other issues of the Cumulative Index indicates that additional descriptors are often employed in listing material pertaining to FCS. Thus, the above listing cannot be considered to be complete in any manner.

Obviously, not everyone would be interested in all of the subjects covered by the descriptors. The individual can narrow descriptors to his own specialized field of interest. But, again, one must wade through considerable chaff, including numerous synonyms, to get at the wheat.

It would appear, then, that the following conclusions may be reached:

- Considerable effort is required on the part of the FCS specialist to employ the IAA for either of the above purposes
- A sufficient percentage of the material contained in the IAA pertains to FCS, components, techniques, etc., to warrant a separate grouping equivalent to, say, Guidance and Navigation
- The FCS industry could help itself considerably by adopting and employing a standardized set of descriptors

2. STAR

The STAR abstracts are devoted primarily to documentation available as reports (industry, government, university, etc.). The material is organized and published in the same manner as described under IAA. It is intended that the same descriptors be employed.

A quarterly cumulative index (Scientific and Technical Aerospace Reports, Cumulative Index, July-September 1964, Volume 2, September 30, 1964) was also screened as previously to obtain an idea of the descriptor usage and material organization. In this issue there were 105 descriptors covering 277 exclusive listings. This is an average of 2.57 listings per descriptor, whereas in the IAA the average is 1.88. The above listing accounts for 39, or 37 percent, of the descriptors and covered 94 percent of the entries pertaining to FCS (again excluding aerodynamics, materials, and specific vehicle types or models). Here only 9 descriptors would catch 50 percent of the material. Although fewer descriptors are involved, the results and conclusions remain essentially the same as indicated for the IAA.

3. TAB

The TAB is published semimonthly by DDC. The principal subject divisions, so far as FCS is concerned, are as follows:

Code Number	Subject
1	Aircraft and flight equipment
7	Electrical equipment
12	Guided missiles
15	Mathematics
19	Navigation
28	Psychology and human engineering

Again, the applicable FCS material within the above divisions appears to be mixed among other material pertinent to the general subject area. The material also can be located by descriptors (much the same as the IAA and STAR).

Although the number of divisions appears to be less than either the IAA or STAR, in actuality it is approximately the same, since each division appears twice in each TAB bulletin. Divisions 1 through 28 present material readily available, while divisions 1A through 28A present material having limited distribution or other restrictions. Thus, to scrutinize all the entries on, say, Navigation, one must check both division 19 and division 19A.

It has been reported that there has been a significant growth in the volume of reports announced in TAB, from 36,000 entries in 1963 to 50,000 in 1964 (Reference 13). It is expected that the volume will continue to increase, thus further complicating the process of selecting the desired FCS abstracts.

Furthermore, a perusal of the dates of material contained indicates that considerable time lag often exists between original release of a report and the appearance of the abstract in TAB. For example, the 1 January 1965 issue lists reports of interest to FCS specialists:

p. 56	1 report	December 1959
p. 59	1 report	August 1961
p. 72	1 report	December 1958
p. 47	1 report	January 1959
	1 report	May 1957
		June 1959
		April 1957
		etc.

The time lags noted above appear to be exceptions rather than the rule, however, but they do provide an idea of time lags which can, and do, occur. The fault probably does not lie with the TAB in this case since these reports are all from a single company; hence, it probably reflects the fact that these reports have only recently been released to DDC. This, then, rather than a criticism of TAB, emphasizes the need for industry cooperation in making information available on a timely basis.

As a result of the above exercise, the following conclusions are made:

- Under the present format, it is definitely a difficult and time-consuming job to keep abreast of the FCS literature or to conduct an FCS literature search using IAA, STAR, or TAB. The man-hours required to keep abreast of the literature or conduct literature searches is considerable if one employs these sources.
- The format and descriptors used by the current abstract publication permit no reasonable way to shortcut the presently required effort without increasing the possibilities of overlooking available pertinent material.
- Having these agencies compile special bibliographies periodically will be of little value unless all possible descriptors (over 250) are employed or unless the specific subject is uniquely defined by a few descriptors. The former is obviously impractical, while the latter is unlikely.
- It appears that there is sufficient material pertinent to FCS in each publication to warrant a separate subject division on flight control systems.
- There is need for a standardized set of descriptors within the FCS field for use by authors and abstractors alike to facilitate rapid and efficient retrieval (either manual or machine) of material

B. Information Services Pertinent to FCS

The following paragraphs describe some of the informal and formal information services that may be of interest to the FCS specialist. First, a short discussion on the document dissemination of the Flight Dynamics Laboratory is presented; this is not an established program per se, but it is described here since many of the respondents of the opinion survey cited the Flight Dynamics Laboratory technical reports as being the "most valuable source."

1. Flight Dynamics Laboratory

The Air Force Flight Dynamics Laboratory publishes and distributes the final technical reports of all successfully completed research and development programs under their sponsorship. The distribution (automatic) varies from a few hundred to a few thousand copies of each report, depending on the subject matter. The reports are automatically distributed to libraries, companies, and individuals, based on the distribution lists. Separate distribution lists are maintained by each section of the Flight Dynamics Laboratory according to their specialized areas of research and development responsibility; these lists generally reflect those individual companies or other Government groups who are vitally interested in the specialized area.

The primary announcement medium of these reports is the Quarterly Index and Abstracts of Technical Documentary Reports, issued by the Air

Force Systems Command. The technical documentary reports that are submitted to the DDC are announced through that agency's semimonthly Technical Abstract Bulletin. Also, the unclassified portions of this bulletin are reprinted in the U.S. Government Research Reports, issued by the Office of Technical Services (recently renamed Clearing House for Federal Scientific and Technical Information), U.S. Department of Commerce, and may be purchased by the public from the Superintendent of Documents, Government Printing Office. Also, a significant number of the technical documentary reports are condensed for publication in the technical journals; others are presented at symposia of professional societies and become part of the proceedings. References 15 through 18 describe the present Air Force scientific and technical information activities, including the organization, subject fields of information, types of publications, methods of announcement of publications, and availability of services.

2. Large, Government Sponsored or Supported Services

Table II shows a list of some 21 typical information services; a brief description of each program is included in this table. Of those listed, 17 are directly or indirectly supported by the Government. The first three on this list--DDC, STAR, and IAA-- are abstracting and announcement services that contain a considerable amount of FCS information.

Both the IDEP and AGARD publications are used by some FCS personnel. AGARD is a long-standing publication, established since 1954; its value to the FCS field is attested by the fact that 81 percent of the respondents indicated they obtained some FSC information from this source.

The Selective Dissemination of Information (SDI) was recently implemented by NASA, and, because of many of the stated objectives of the NASA-SDI program (viz., personally addressed, selective screening of abstracts, and timely announcement and distribution of reports) coincide with the desirable requisites of an FCS information exchange as expressed in the opinion survey, it will be briefly discussed here. Under this program, an individual participant submits his subject area of interest by carefully compiling a list of descriptors. An interest profile is developed in terms of the subject descriptors. Using a computer program, the participant's profile is collated with the descriptors of the abstracts available. The matching abstracts are printed on an IBM card and are personally addressed to the participant. The participant reads the abstract and replies on the enclosed card by indicating one of the following responses.

Of interest, document requested

Of interest, document not requested

Of interest, have seen before

Of no interest

Since August 1964, 500 NASA and 200 Air Force personnel have been participants in the SDI pilot operation. Under the present setup, NASA and Air Force personnel receive the same abstract announcement service; however, the procedures for transmittal of requested documents differ. All

TABLE II. LIST OF REPRESENTATIVE INFORMATION SERVICES

Program Name	Sponsoring Agency	Proposal	Subject Content	Customers	Input Sources	Other Services	Status	Remarks
1. Defense Documentation Center (DDC) (formerly ASTIA, DSA)	DOD	Secondary distribution of scientific/technical reports	All aspects of science and technology	Certified government, industry, educational institutions, professional associations	Contractors; DOD; international, educational institutions; professional associations	Abstracts, bibliographical searches	Operational since 1947	
2. Scientific and Technical Aerospace Reports (STAR)	NASA	Abstracting and indexing service	Science and technology of aeronautics and space	NASA agencies and contractors	NASA and its contractors; Government agencies; international research, educational institutions	Literature searches, lends documents	Operational	May be purchased from Superintendent of Documents; classified reports are abstracted in CSTAR
3. International Aerospace Abstracts (IAA)	American Institute of Aeronautics and Astronautics, and NASA	Abstracting and indexing service	Aeronautics, space science and technology	No restrictions	Journals, periodicals, books, Government reports, symposia proceedings	Literature searches, lends documents, sells copies of reports, compiles bibliographies	Operational	
4. Interservice Data Exchange Program (IDEP)	DOD	Interchange of test reports among the three military services	Missile component test and reliability reports	135 contractors, 22 military activities	Contractors, military activities	Indexing	Operational	IDEP reports are announced through DDC-TAB
5. Advisory Group for Aeronautical Research and Development (AGARD)	NATO	Interchange of data between NATO participants	Aeronautical and space science and technology	NATO governments	Same as customers	Publishes bibliographies, and conference proceedings	Operational	AGARD reports are available through STAR
6. Selective Dissemination of Information Program (NASA SDI)		Abstracting and personally addressed selective dissemination	Science and technology of aeronautics and space	NASA agencies and contractors	STAR and IAA	Supplies NASA documents to NASA participants	Operational	Individual bibliographies prepared by computing machines
7. Documentation Access Retrieval of Engineering Data (DARE)	Army	Retrieval of missile drawings	Missile drawings	Army	Contractors and Army Missile Command	None	Implementation proposed for 1 April 65	See Reference 13
8. Micro-Miniaturised Engineering Data for Automated Logistics (MEDAL)	Air Force	Retrieval of engineering drawings	Engineering drawings of interest to Air Force	Air Force	Contractors in-house	None	Operational	See Reference 13
9. Engineering Data System (EDS)	Army	Automatic document retrieval system development	Engineering data, specifications; maintainability and reliability data; and packaging data	All Federal agencies, international, industry	Federal agencies, contractors, and industry	Drawings, PRINCE reports, and IDEP reports	Study complete; implementation considered	See Reference 13
10. PANEL 21	Air Force	Parts data bank	Resistor parts (see Remarks)	All Federal agencies, international, and industry	Air Force supply catalogs	None	Operational	May be expanded to include other standard parts; see Reference 13
11. Parts Reliability Information Center, PRINCE	NASA	Parts reliability information bank	Parts reliability data	NASA contractors	Contractors	None	Operational	
12. Failure Rate Data Program, FARADA	Navy	Failure rate data bank	Component failure rate data	Selected contractors	Same as customers	None	Operational	Participants selected by ability to contribute data
13. Electronics Components Reliability Center; Battelle Memorial Institute (ECRC)	Battelle Memorial Institute	Reliability information transfer	Electronic components	Electronic component users	Members and manufacturers	Indexes, state-of-the-art reports	Operational	
14. Research Triangle Institute	NASA	Abstracts and reviews	All aspects of reliability	Government contractors	Government reports, journals, and periodicals, and industrial literature	Literature search	Operational	
15. Transducer Information Center (TIC)	Air Force, through Battelle Memorial Institute	Information bank, inquiry service	Transducers	Government agencies, Government contractors	All possible sources	Document accession lists and state-of-the-art reports	Operational	
16. RAND Cost Analysis Department Data	RAND Corporation	Data bank	All aspects of cost analysis and cost information for military systems	RAND Corporation	Periodicals, manuals, regulations, military program documents and pamphlets	None	Operational	See Reference 19
17. Douglas System	Douglas Aircraft Co.	Technical library	Missile and space documents	Douglas Aircraft Co.		None	Operational	Automated by uniterm index; see Reference 20
18. National Referral Center for Science and Technology	Library of Congress	Referral to appropriate sources	All known information sources	Any worker in any field of science and technology	Voluntary	Bibliographic assistance	Operational	
19. International Bibliography of Automatic Control	International Federation of Automatic Control (IFAC)	Bibliography	All aspects of automatic control	By subscription, 25$/year	Worldwide, open literature	None	Operational	Published quarterly
20. Automation Express	International Physical Index, Inc.	Abstracts and excerpts	Translated Russian journal articles in Automation	By subscription	Russian journals		Operational	10 issues/year
21. Electrical Engineering Abstracts (Science Abstracts)	Institution of Electrical Engineers (Great Britain)	Abstracts	All engineering topics	By subscription	World literature		Operational	

requested material is directly sent from the SDI program to NASA personnel, while requests for all non-NASA documents by Air Force personnel are channelled to the originating agency. At present, only unclassified material is included in this program.

An average of about 4,000 documents are processed per month. Approximately 30,000 abstract cards are mailed each month (about 40 cards per participant). Some 27 percent of the mailed cards are returned with "of interest, document requested" notation; about 38 percent are returned as "of interest, document not requested." An immediate cost-reduction measure is to minimize the "of no interest" abstract mailings. Periodic reviews and checks are conducted to sharpen the participant's interest profile so that the profile more closely represents the participant's interest.

It is planned to provide tapes and computer matching programs to NASA centers within a few months. Future plans are believed to include the coverage of classified documents; however, the problems of recipient need-to-know, handling of classified abstracts, etc., have not yet been resolved. Also plans are understood to include the extension of the SDI service to major NASA contractors; this will probably be started by selected subject categories.

Programs 7, 8, 9, and 10 in Table II are also large, Government-sponsored data systems now operational or soon to become operational. The DARE, MEDAL, and EDS programs are primarily concerned with engineering data, and their contents consist of engineering drawings and configuration data sheets. The program presently labeled Panel 21 will be concerned with parts and component information, including performance parameters and reliability data.

3. Reliability Data and Information Exchange Programs

The PRINCE and FARADA are NASA and Navy programs, respectively. Both programs are devoted to the compilation and analysis of reliability data on parts and components. FARADA has been operational since 1960; the PRINCE is a relatively new program.

The Electronic Component Reliability Center is a privately sponsored research program. The program is conducted by Battelle Memorial Institute to collect and integrate reliability information on electronic components.

The 14th entry in the table is the abstracting and review service performed by the Research Triangle Institute for NASA. The scope of the program is limited to reliability papers, articles, reports, etc., published worldwide. This is purely an abstracting service; hence, requests for articles and reports must be addressed to the originating agency or author of the publication.

4. Transducer Information Center

The programs discussed thus far are definitely not tailored to the needs of the FCS specialist. It is recognized, however, that particular aspects of all 14 programs may at one time or another be useful to the FCS designer. The Transducer Information Center, listed as the 15th entry in the

table, was established to meet the needs of the FCS specialist. This TIC program is sponsored by the Flight Dynamics Laboratory to collect, analyze, store, and disseminate transducer information and data.

5. Cost Data Bank

The next entry is a cost data bank established by The RAND Corporation to satisfy its need for a comprehensive depository of cost and resource information covering most weapon and support systems in the military establishment. At the present time, it is primarily intended for internal use.

6. Company-Sponsored Selective Dissemination

The 17th entry is also an in-house program being conducted by the Space and Missile Division of Douglas Aircraft Company. This program is designed along the interest profile of specific personnel of the company and is patterned along the lines of the NASA-SDI program discussed above. At the present time, 14 users are included in the pilot operation; the program is conducted as an adjunct to their technical library services and utilizes the available spare time of an IBM 7090.

7. Referral Center

The National Referral Center for Science and Technology was recently established to operate within the Library of Congress, with the support of the National Science Foundation, to "provide a single place to which scientists and engineers may turn for advice on where and how to obtain (scientific or technical) information of any kind." This center does not answer technical questions nor does it furnish bibliographies. Its function is to act as an intermediary by directing those who need information to the correct sources.

8. Foreign and International Information Services

The International Bibliography of Automatic Control is a bibliography service covering worldwide open literature on automatic control. This service was recently offered on a subscription basis and is the official publication of the International Federation of Automatic Control. This bibliography will be published quarterly, and approximately 1,000 entries are anticipated per issue.

The Automation Express is an abstract and excerpt publication designed for control engineers. Its contents are translations of Russian literature on automatic control. Automation Express is published by International Physical Index Incorporated; 10 issues are offered annually. The material is organized under five major subject headings: (1) information theory and noise, (2) network theory, (3) digital and analog computers, (4) servomechanisms and components, and (5) control systems.

The last entry of Table II is the Electrical Engineering Abstracts, published by the Institution of Electrical Engineers of Great Britain. The material of interest to the FCS specialist appears under the major heading of

"Control Data Processing," which is further divided into five subheads: "Control Systems," "Servosystems," "Applications," "Telecontrol, Telemetering," and "Computers." This monthly publication covers over 150 journals, and each issue includes approximately 700 titles and references.

C. Current Status of Specialized Information Centers

At the present time, there are some 400 specialized data and information centers in the United States which have been established to retrieve the required information for their specialists. The number of these centers is growing even though some of them are phased out when the fields they serve no longer warrant their services. Many of the information centers evolved from data centers. DOD supports 145 facilities, of which 29 are information centers and 116 are research libraries. Twenty-two of the information centers were recently renamed "information analysis centers" by DOD Instruction 5100.45. The primary function of these centers is to disseminate evaluated, condensed, state-of-the-art reports. The Air Force operates 21 such facilities; of these, 4 are operated under contract--2 with nonprofit and 2 with profit-making organizations (Reference 12). Reference 13 reports on a critical survey taken in 1961 over 200 information centers. It was found that the functions of these centers varied widely. Some centers "obtain, store, reduce, and analyze data; others analyze interpretative reports rather than data." Some centers analyze and evaluate both data and interpretative reports.

In this survey, it was found that 56 of the information centers held classified information and 88 centers possessed proprietary information; 97 were Government-sponsored and 97 had no Government support. The remainder either were state-supported or were co-sponsored by Government and private industry. In general, the Government-sponsored centers were larger than the non-Government-supported centers.

Approximately 6,000 people are employed in the 221 information centers. Some 43 centers are mechanized and employ 381 computer personnel, with 66 of these personnel being part time. Over 160 centers reported no mechanized equipment. These were concerned with evaluating interpretative documents and issuing state-of-the-art type reports.

Based on 4,413 people employed full time in the 221 scientific information centers, the following breakdown of personnel is reported (from Reference 16):

Types of Personnel	Percentage
Information specialists	11
Scientists/engineers	32
Computer personnel	7
Semiprofessional	24
Nonprofessional	26

It is of interest to note the predominance of the scientists/engineers class; of the 1,491 part-time people counted in this survey, 681 or approximately 46 percent, are scientists/engineers (Reference 14).

The Select Committee on Government Research of the House of Representatives investigated the kinds of services the information facilities offered. It was found that 90 percent of the facilities publish or compile abstracts, bibliographies, and journals. Over half of the facilities distribute accession lists, newsletters, reviews, and special reports. The following is the breakdown of the kind of services offered by 259 information facilities (from Reference 13):

Services	Percent of Facilities
Abstracts	31
Bibliographies	47
Journals	14
Accession lists, newsletters, reviews, special reports	52

The ranking of critical problems experienced by the 221 information centers is shown on the following page (from Reference 14).

Critical Problems	Percent of Centers
None	28
Inputs	25
Money	23
Quantity of manpower	19
Quality of manpower	16
Retrieval	14
Use	10
Evaluation	9
Quantity of inputs	8
Security	4
Translations	1

Three interesting observations can be made from the above table. (1) Only 28 percent of over 200 information centers stated that they had no critical problem. (2) Problems of money and manpower were identified by 23, or 19 percent, of the sampled centers. Also of interest are the nine centers that stated security as being one of their critical problems. Since classified material was reportedly handled at 56 facilities, this represents 16 percent of those centers as identifying security as a problem area. (3) Of particular interest is the absence of problems on proprietary information, even though they were handled by 88 of the surveyed information centers.

This survey was conducted in July 1961; more detailed results can be found in Reference 14.

SECTION IV

DISCUSSION OF FCS DOCUMENTATION AND DISSEMINATION

A. General

It is quite apparent that the FCS information problem is twofold. One aspect is the need for improvements in transferring to the users data and information that are already published; the second is the need for measures to ensure that all worthy results from research and development projects are reported in the published literature. The duality of the problem in communicating technical information is not unique to the FCS field. In summarizing the present enigma on scientific and technical information, the following statements were recently made in a report to the Select Committee on Government Research:

> One of the amusing paradoxes of the contemporary scene is the coexistence of a frame of mind that has evidenced near panic at the magnitude of the literature explosion and at the same time is agitating for the enshrinement in formal publication of all informal scientific communications. (From Reference 13, excerpts from Report to the Select Committee on Government Research by National Institute of Health.)

The results of the opinion survey reveal that the majority of the FCS specialists were more concerned with screening pertinent material from the volume now available than they were with the possibility of not receiving all that might be useful. The present focus of concern is very understandable, since how can one really be concerned with what is missing if he is having difficulties in determining what is already contained in the literature? Based upon this reasoning, the authors recommend that the initial effort in the enhancement of communication among FCS specialists be directed toward improving the organization and presentation of information and data. The long-term objective, then, would be to promote more complete reporting and formal documentation of work performed in FCS research and development.

B. Suggested Immediate Improvements in FCS Information Dissemination

1. Coordination of Sources

A difficulty frequently mentioned by the respondents was that there are now too many diverse sources of FCS information. As discussed previously in Section III, even in abstracting and announcement media there are numerous publications that the FCS specialist must peruse to adequately cover the activities in his field of interest. At the present time, there is an active project in the Office of Technical Services to implement the concept of coordinated abstracting and announcement services. This office is working on a monthly, Government-wide Index to Scientific and Technical Reports, which will coordinate the contents in the following Government media:

- Scientific and Technical Aerospace Reports (STAR), sponsored by the National Aeronautics and Space Administration.

- o Technical Abstract Bulletin (TAB), sponsored by the Department of Defense.
- o Nuclear Science Abstracts (NSA), sponsored by the Atomic Energy Commission.
- o U.S. Government Research Reports (USGRR).

All four media listed above also will be published separately by their respective agencies (Reference 13).

The "collection under one cover" may be helpful, but it is certainly far from being the solution to the present problem. Also it is quite conceivable that the sheer added volume for any given issue may further discourage some FCS researchers. The more critical problem area is that the presentation of the material is not organized to permit rapid retrieval of FCS information.

2. Organization of FCS Information in Announcement Media

It was beyond the scope of this study to determine whether the present organization of the material in the major Government-sponsored abstract and announcement services satisfies the needs of the majority of users in general. However, it can be safely surmised that technical specialists in fields other than FCS are experiencing similar difficulties. For example, Reference 21 is a progress report by the Engineers Joint Council which is currently working on a program to improve indexing and to establish a Thesaurus of Engineering Terminology.

It should be recognized, however, that part of the difficulties experienced by the FCS specialists in efficiently utilizing the present publications may be attributable to the inherent characteristics of FCS information. Since FCS information is multidisciplinary and encompasses a number of sciences and technologies, the FCS specialist, and certainly the generalist, must repeatedly examine a wide cross section of discipline-oriented subject headings (physics, electronics, mathematics, etc.) in order to maintain continuous awareness of the achievements of his fellows. Also FCS information tends to be mission-oriented (manned aerodynamic, unmanned aerodynamic, manned space, unmanned space, etc.). Since information generated for one mission is often quite useful for another, the FCS designer-analyst feels the need to examine at least a representative sample of mission-oriented and even program-oriented information.

An immediate remedial measure might be to convince the agencies responsible for the major Government-supported announcement media to add a specific subject heading of "Flight Control," which would contain all material relevant to FCS regardless of the originating discipline or mission. If such an addition can be made, the job of identifying potentially useful documents would be facilitated.

3. Standardization of FCS Terminology

To effect a significant improvement over the prevailing situation, individual authors must assume considerable responsibility in the preparation of the report title and abstract. Each contributing writer must see that the report title is informative and that the abstract adequately conveys

the content. It is suggested that the FCS specialists also make a concerted attempt to supply standardized keywords or descriptors with their publications. A special effort is warranted to investigate the applicability of FCS terminology to the engineering thesaurus currently under preparation by The Engineers Joint Council (Reference 21). Experience has shown that some fields which have strong "interdisciplinary implications" do not lend themselves to standardized keyword classification (Reference 12).

4. Information Retrieval

Reference is made to the immediately remedial measure of adding a "Flight Control System" subject heading to the large Government-supported abstracting and announcement publications.

Discounting the remote possibility of resistance to change on the part of the cognizant agencies, the suggested remedial measure may be quite difficult to implement properly. The basic question still remains: who is to decide whether a document will be useful in FCS application? True, for many reports, the title and abstract, if properly worded, will be self-explanatory for subject indexing. However, very frequently the information content, not the document itself, is the important element to be transferred to the user. The restatement, interpretation, and critical review of technical writing is the job of the engineer, not the documentarian.

The recent trend has been to assign the roles of a centralized, document depository to the major Government information programs, e.g., the renaming of the Armed Services Technical Information Agency (ASTIA) to Defense Documentation Center to better describe their function; also the redesignation and assignment of the Office of Technical Services to the name and role of Clearing House for Federal Scientific and Technical Information. As document depository centers, their primary function is to announce the availability of the reports acquired and supply copies of appropriate documents upon request. Their function is to accept, store, and retrieve documents; information retrieval is definitely a different function. Many specialized data and information centers have been established to perform this function. These centers attempt to compile all published material pertinent to a special field. The types of services rendered by these centers was described in subsection III.C.

5. FCS Information Center

To supply the preferred level of service indicated by the FCS specialist responding to the opinion questionnaire, a focal point of responsibility is required. It is conceivable that an existing specialized information center can be assigned this additional responsibility. The authors believe that the central depositories are already too large to be need-sensitive to a specialized group. As noted in subsection III. C, the scientists and engineers constitute the largest category on the staff at the specialized information centers. These personnel are charged with the responsibility of maintaining continuous awareness of the changing needs of the working specialists whom they serve to foster proper liaison with the users of their services; many of the specialized information centers have been established at locations where relevant research work is being performed. In discussing the location of new

specialized information centers, the President's Science Advisory Committee made the following recommendations (Reference 12):

> The Panel. . . urges that new information centers be established at public and private technical institutions, not as adjunct of general libraries, or of publishing ventures, or of central depositories. Where research and development is done for the Government--at Government laboratories, national laboratories, universities, or industrial laboritories--information centers in related fields ought to find a congenial atmosphere.

The results of the opinion survey and the review of literature did not indicate the desirability or necessity of establishing a totally separate and new center for FSC information. The authors recommend that inquiries first be made to explore the possibility of sharing an existing facility already set up with reproduction, mailing, storage, and other essential equipment. It is understood that two information programs are now operational at Wright-Patterson Air Force Base (Reference 22). Since information programs are often phased out when the demand for their services diminishes, the possibility of retrofitting the facility of such a program should be explored.

In contrast to the rather austere viewpoint on physical facility, the authors recommend a strong manning scheme even during pilot operation. It is estimated that at least two to three FCS engineers are required to attain a successful program. They will need the support of a part-time librarian and a full-time clerk-typist. Frequent mailings of bibliographies, accession lists, newsletters, reviews, etc., are particularly desirable during pilot operation to inform the potential users of the availability of their specialized services.

Concerning the organization to conduct the FCS center, the authors recommend that the "first choice" preference indicated by the surveyed group be honored--a Government organization cognizant of FCS. Although security problems have plagued some centers, it is suggested that classified material be included in the collection; the results of the survey show that 35 percent of FCS reports may be security-classified. The initial effort of the FCS information center should be directed toward the improvement in organization and presentation of information to the working FCS specialist.

The authors strongly recommend that no capital investments be made in mechanizing the information retrieval system until further studies are completed on the critical problems of computer equipment and program language incompatibility now prevailing among the various Federal agencies.

C. Suggested Long-Term Objectives

Once the available literature is presented in the most usable form to the FCS engineers, the group responsible for the FCS information center can attend to the problems of improving the flow of technical information from the originating source to the exchange. As was mentioned previously, the Defense Documentation Center receives no more than 40 percent of the information generated at DOD expense. One of the underlying reasons for this incomplete reporting may stem from the traditional attitude of some contractors who feel that they are selling hardware, not information. "If the

equipment works, why bother with the report?" The current policy of DOD is to withhold 10 percent of the contractor's fee until the reporting requirements have been satisfied. This policy, no doubt, will encourage the flow of technical information.

The results of the opinion survey indicated that 30 percent of the reports that represent potential contributions may contain company-proprietary information. Contractors proprietary rights have always limited the volume of useful information. However, this is a problem that cannot be resolved by a specialized information center. The entire subject of proprietary, nonpatentable rights is under careful study.

It is interesting to note that in certain information fields proprietary material represents no problem. In subsection III.C, 88 information centers reportedly handled proprietary information, but no center indicated that problems existed in the handling of the privileged information.

Standardizing format and improving the quality of technical writing may well become some of the other long-term goals for the group cognizant of the FCS information exchange program.

SECTION V

CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are made as a result of this study.

1. Improvements are needed in the communication of FCS information and data.

2. The FCS specialists recognize this need and expressed willingness to support a formal FCS data and information exchange.

3. The apparent immediate need is in the enhancement of communication among FCS specialists and is best directed toward improving the organization and presentation of data and information.

4. A separate major subject heading of "Flight Control" is needed in all large Government-supported abstracting and announcement media.

5. Under the heading of "Flight Control" it is desirable to present all relevant material regardless of the originating discipline or mission.

6. The participation of FCS specialists in the preparation of the Thesaurus of Engineering Terminology is desirable.

7. All FCS writers need to be aware of the importance of informative titles and abstracts for their reports.

8. In order to accomplish the long term objective, a focal point of responsibility for FCS information should be established.

9. The group responsible for FCS information should explore the possibility of sharing the facility of an existing information center.

10. At least two to three engineers are needed to operate the FCS information center.

11. The FCS information group should be physically located near an activity engaged in research and development of FCS.

12. A Government agency equipped to handle security-classified material is best suited as the cognizant agency of the FCS information exchange.

13. No capital investments in mechanized equipment should be made at this time.

14. The FCS information group can promote the achievement of long-term objectives (e.g., more complete flow of technical information, standardizing report format, improving the quality of technical report writing).

APPENDIX

QUESTIONNAIRE I

FLIGHT CONTROL SYSTEM (FCS) INFORMATION EXCHANGE QUESTIONNAIRE AND OPINION SURVEY

1. Are you currently working on a government contract? Yes____ No_____
   If yes, please specify program name_____

2. Do you feel that essential information on flight control systems (FCS) is being adequately disseminated? Yes____ No_____
   Comments_____

3. What has been your most valuable source of FCS information?

4. Listed below are some of the existing data and information exchange programs. Please check those programs from which information is available to you. Also, please indicate how frequently you obtain information pertinent to FCS.

Data and Information Exchange Programs	Never Heard of it	Available		Frequency of Obtaining FCS Information		
		No	Yes	50 to 100% of Time	Less than 50% of Time	Never
IDEP						
FARADA						
DDC						
STAR						
IAA						
RTI Abstract						
SST Data Interchange						
AGARD						
Others (please specify)						

5. What are your recommendations for increasing the utility of the above programs to the FCS specialists?

_____

_____

_____

6. Is a microfilm reader conveniently available for your use? Yes____ No___

   Is a microfilm printing service conveniently available to you? Yes____ No___

7. (a) If a document is personally addressed to you, what is the lag time from mailroom receipt to delivery to your desk? _____days

   (b) If an FCS document is published or released by an agency other than a professional society, what is the average lag time before you are aware that the document exists? _____days

   (c) If an FCS document is received by your library, what is the average lag time before you are aware that the document is available? _____days

   (d) If an FCS document is forwarded from your library, what is the average lag time from your request to delivery to your desk? _____days

8. The following are possible methods of implementing a formal FCS data and information exchange program. Please indicate your preference in implementation (1 = most preferable, ···, 7 = least preferable).

   _____association with a professional society

   _____association with an established data exchange program

   _____association with a government agency cognizant of FCS

   _____association with a nonprofit organization

   _____association with a university

   _____association with a private organization with no vested interest in FCS hardware

   _____other (please specify)_____

9. On the following two pages is a list of data and information that may be cogent to the FCS designer. Please indicate by checks (a) how often you have had a need for such information, and (b) approximately how much original material you are willing to contribute to an exchange program (reports, working papers, tab runs, etc.).

QUESTIONNAIRE I (Continued)

	Frequency of Need for Information					Potential Contribution (number of items annually)			
	Daily	Weekly	Monthly	Occasionally	Never	More than 10	5 to 10	1 to 5	None
A. Concepts, Theory, and Techniques									
(1) Analysis									
(2) Synthesis									
(3) Simulation									
B. Mechanization									
(1) System									
(2) Component									
(3) Onboard Computer									
(4) Ground Support Equipment									
C. Detailed Design									
(1) System									
(2) Component									
(3) Onboard Computer									
(4) Ground Support Equipment									
D. Fabrication									
(1) System									
(2) Component									
(3) Onboard Computer									
(4) Ground Support Equipment									
E. Testing									
(1) System									
(2) Component									
(3) Onboard Computer									
(4) Ground Support Equipment									

	Frequency of Need for Information					Potential Contribution (number of items annually)			
	Daily	Weekly	Monthly	Occa-sion-ally	Never	More than 10	5 to 10	1 to 5	None
F. FCS Interfaces									
(1) Vehicle Dynamics and Characteristics									
(2) Manual Control									
(3) Human Factors and Engineering									
(4) Others									
G. Empirical Data									
(1) Reliability									
(2) Maintainability									
(3) Support Requirements									
(4) Cost									
(a) R and D									
(b) Production									
(c) Operational									
(d) Retrofit									
H. Miscellaneous Historical Information									
(1) Nonlinearity Problems and Solutions									
(2) System Design Malpractices									
(3) Part/Component Misapplications									
(4) Others									

10. Of the original material indicated as potential contributions in the previous table,

    (a) What percentage would be company proprietary and therefore unavailable to an exchange program? _____%

    (b) What percentage would be classified? Confidential _____%

    Secret _____%

    (c) What percentage would be usable by FCS specialists outside your own organization?

    Fully documented material _____%

    Material in draft form _____%

    Material requiring data reduction _____%

Answers to the following questions (11-14) are requested to assist us in the interpretation of the results of this survey.

11. Please indicate by checks your primary and secondary levels of responsibility and technical specialty in the FCS field.

Level of Responsibility	Primary	Secondary
(1) Administrator		
(2) Supervisor		
(3) Designer-Analyst		
(4) Other		
Technical Specialty		
(1) Systems		
(a) Analysis and synthesis		
(b) Design		
(c) Fabrication		
(d) Test		
(e) Sales		
(f) Purchase/specification		
(2) Component		
(a) Design		
(b) Test		
(c) Fabrication		
(d) Sales		
(e) Purchase/specification		
(3) Interfaces		
(a) Vehicle		
(b) Primary control system		
(c) Guidance		
(d) Other		

QUESTIONNAIRE I (Continued)

12. How long have you been in the FCS field? _____yrs.
    How long have you been with your present organization? _____yrs.

13. What is the division of FCS responsibility within your company?

	Your Dept. or Group	Another Dept. or Group
Advanced design		
Dynamic analysis.		
Simulation		
Detail design.		
Fabrication.		
Test		
Applied research		

14. Would you, as a supervisor, be willing to delegate one of your men as a data and information exchange contact man (assuming that a data exchange program were to be established)?
    Yes____ No____

Comments_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

If you are interested in the results of this survey, please indicate your mailing address below.

Name_____

Organization_____

Address_____

_____

Survey of Scope Preference

Please indicate your preference on the level of service desired:
1 - first choice, 2 - second choice, 3 - third choice, etc.

YOU SUPPLY		Order of Preference	YOU RECEIVE		Order of Preference
a.	Abstract of material, key descriptors or subject headings, security classification	_____	a.	Annotated bibliography of material available, periodic revisions (loose leaf or bound). Material catalogued by subject, originating agency, year of release.	_____
b.	Copies of reports, documents, etc., directly to requestors	_____	b.	Item (a) above expanded to include symposium proceedings, technical journal and magazine articles, etc.	_____
c.	One master (or reproducible) copy of each report or document generated to the exchange agency	_____	c.	Copy of specific reports upon request	_____
d.	Semi-processed data (test results, operational results, failure reports, etc.) in Standard format specified by exchange agency.	_____	d.	Copy of all reports in a preselected area of interest without submitting specific requests	_____
e.	List of subject areas of interest	_____	e.	Combination of (a) and (c)	_____
f.	Other: _____	_____	f.	Combination of (b) and (c)	_____
	_____	_____	g.	Combination of (a) and (d)	_____
	_____	_____	h.	Automatic distribution of collated and processed data reflecting all contributed data and information	_____
			i.	Other: _____	_____
				_____	_____
				_____	_____

REFERENCES

1. Kelsey-Hayes, Control Specialists Division, WADC-TR-57-688, A Summary of Component Failure Rate and Weighting Function Data and Their Use in Systems Preliminary Design, D. E. Johnston and D. T. McRuer, December 1957

2. Systems Technology, Inc., WADD-TR-60-330, A Compilation of Component Field Reliability Data Useful in Systems Preliminary Design (U), D. E. Johnston and T. S. Durand, March 1961 (Secret)

3. Systems Technology, Inc., Aeronautical Systems Division, WADD-TR-60-330, Supplement 1, A Compilation of Component Field Reliability Data Useful in System Preliminary Design, D. E. Johnston, K. A. Ferrick, and E. L. Alexander, November 1961

4. Systems Technology, Inc., ASD-TR-61-501, Performance Criteria for Linear Constant-Coefficient Systems With Deterministic Inputs, J. Wolkovitch et al., February 1962

5. Systems Technology, Inc., ASD-TR-62-470, Performance Criteria for Linear Constant-Coefficient Systems With Random Inputs, J. Wolkovitch and R. Magdaleno, April 1962

6. Planning Research Corporation, ASD-TDR-62-219, Compilation and Analysis of Reliability Data on Selected Flight Control Components, Flight Control Laboratory, Aeronautical Systems Division, Air Force Systems Command, Wright-Patterson Air Force Base, October 1962

7. Lockheed-Georgia Company, ASD-TDR-62-347, Stochastic Disturbance Data for Flight Control System Analysis, J. E. Hart et al., September 1962

8. Planning Research Corporation, ASD-TDR-62-751, Investigation of Techniques for Predicting the Development Cost and Development Time of Automatic Flight Control Systems, Flight Control Laboratory, Aeronautical Systems Division, Air Force Systems Command, Wright-Patterson Air Force Base, October 1962

9. Planning Research Corporation, AD-607-283, RTD-TDR-63-4064, Investigation of Techniques for Predicting the Development Cost and Development Time of Automatic Flight Control Systems, February 1964

10. Systems Technology, Inc., WADC-TN-58-159, Summary and Review of Aeromechanical Devices and Possible Application, I. Ashkenas, June 1958

11. Systems Technology, Inc., AFFDL-TR-65-119, Compilation and Analysis of FCS Command Inputs, D. H. Weir, March 1965 (to be published)

12. President's Science Advisory Committee, The Responsibilities of the Technical Community and the Government in the Transfer of Information, 10 January 1963

13. Select Committee on Government Research of the House of Representatives, 88th Congress, 2nd Session, House Report No. 1932, Study No. IV, Documentation and Dissemination of Research and Development Results, November 1964

14. Simpson, G. S., Jr., "Scientific Information Centers in the United States," American Documentation, Vol. 13, No. 1 (January), 1962

15. National Science Foundation, NSF 63-45, "U.S. Air Force - Part I," Scientific Information Activities of Federal Agencies, No. 22 (January), 1964

16. National Science Foundation, NSF 62-17, "U.S. Air Force - Part II, Office of Aerospace Research," Scientific Information Activities of Federal Agencies, No. 15 (September), 1962

17. National Science Foundation, NSF 63-16, "U.S. Air Force - Part IV, Air Force Systems Command," Scientific Information Activities of Federal Agencies, No. 17 (May), 1963

18. National Science Foundation, NSF 64-13, "Department of Defense - Part II, Defense Documentation Center," Scientific Information Activities of Federal Agencies, No. 27 (October), 1964

19. The RAND Corporation, P-2985, The RAND Cost Analysis Data Bank, S. C. Slivinski, September 1964

20. System Development Corporation, SP-1702, The Information Center: Some Selected Examples, E. H. Holmes, August 1964

21. Engineers Joint Council, Progress Report No. 4, Action Plan for Improved Dissemination of Engineering Information, E. Wall, 1 July 1963

22. ASD 1963 Science and Engineering Symposium, ASD-TDR-63-695, System Components Information Center, M. G. Toll, September 1963

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13. ABSTRACT

This document reports the results of an investigation of the need for a permanent flight control data and information exchange program. Direct mail questionnaires were used to solicit the opinions of flight control specialists. The results of the opinion survey are summarized. Three major abstracting and announcement media were critically examined from the standpoint of identifying information relevant to flight control systems. A literature survey was also conducted to determine the current status of technical documentation and dissemination. A group of specialized information centers of interest to flight control specialists are described. Based upon the findings, the general structure and guidelines are presented for a specialized information center designed solely to satisfy the information needs of flight control specialists.

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
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Data						
Information Exchange						

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