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ABSTRACT

Data collected from an exploratory study concerned with the technical communications practices of aerospace engineers and scientists were analyzed to test the primary assumption that aerospace managers and nonmanagers have different technical communications practices. Five secondary assumptions were established for the analysis: (1) that the importance of communicating technical information effectively is equally significant to aerospace managers and nonmanagers; (2) that the use and production of technical information and technical information products are different for managers and nonmanagers; (3) that the content for an undergraduate course in technical communications should be viewed differently by both groups; (4) that the use of libraries, technical information centers, and on-line (electronic) databases differs for managers and nonmanagers; and (5) that the use and importance of computer and information technology differs for aerospace managers and nonmanagers. Results indicated that aerospace managers and nonmanagers were found to have different technical communications practices for second, fourth, and fifth of the five assumptions tested. However, the evidence was neither conclusive nor compelling that the presumption of "difference" in "practices" could be attributed to the duties performed by aerospace managers and nonmanagers. (Twenty-seven tables of data are included, and an appendix containing the survey instrument is attached.) (KEH)

NASA Technical Memorandum 101625

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An Analysis of Managers' and Nonmanagers' Responses

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CONTENTS

LIST OF TABLES

TECHNICAL COMMUNICATIONS IN AERONAUTICS: RESULTS OF AN EXPLORATORY STUDY

AN ANALYSIS OF MANAGERS' AND NONMANAGERS' RESPONSES

INTRODUCTION

This exploratory study investigated the technical communications practices of aeronautical engineers and scientists. The study, which utilized survey research in the form of a self-administered mail questionnaire, had a twofold purpose: (1) to gather baseline data regarding several aspects of technical communications in aeronautics and (2) to develop and validate questions that could be used in a future study concerning the role of the U.S. government technical report in aeronautics.

The study had five specific objectives: first, to solicit the opinions of aeronautical engineers and scientists regarding the importance of technical communications to their profession; second, to determine the use and production of technical communications by aeronautical engineers and scientists; third, to seek their views about the appropriate content of an undergraduate course in technical communications; fourth, to determine aeronautical engineers' and scientists' use of libraries, technical information centers, and on-line databases; and fifth, to determine the use and importance of computer and information technology to them. The study, which spanned the period from July 1988 to November 1988, was conducted in

conjunction with Old Dominion University under Contract NAS1-18584, Task 28, to help ensure the objectivity and confidentiality of the data and to obtain research skills not readily available to the project.

RESEARCH DESIGN AND METHODOLOGY FOR THE EXPLORATORY STUDY

Data were collected by means of the self-administered mail questionnaire shown in the Appendix. The questionnaire was developed within the project team; circulated to selected technical communicators for review and comment; and pretested at the NASA Ames Research Center, the NASA Langley Research Center, and the McDonnell Douglas Corporation in St. Louis.

Members of the American Institute of Aeronautics and Astronautics (AIAA) comprised the study population. The sample frame consisted of approximately 25 000 AIAA members in the United States with either academic, government, or industry affiliations. Simple random sampling was used to select 2000 individuals from the sample frame to participate in the exploratory study. Six hundred and six (606) usable questionnaires (30.3 percent response rate) were received by the established cut off date.

The questionnaire used in the study contained 35 questions: 25 questions concerned technical communications in aeronautics, 8 questions concerned demographic information about the survey respondents, and 2 open-ended questions allowed survey respondents to comment on the topics covered in the questionnaire

and to offer suggestions for improving technical communications in aeronautics.

The data were analyzed by using the Statistical Package for the Social Sciences-X (SPSS-X) designed for use with a personal computer. Cross tabulations were prepared to explore the relationships between the responses to the 25 questions and the respondent's organizational affiliation. Affiliations included "academic" (both academic and not-for-profit organizations), government (NASA and non-NASA), and industry. The Chi-Square and one-way ANOVA (Analysis of Variance) at the 0.05 level of statistical significance were used as the nonparametric and parametric tests for relationships between the responses to the 25 questions and the organizational affiliations of the respondents. The results of the exploratory study are presented in NASA Technical Memorandum 101534, Parts 1 and 2 (Pinelli, et al. 1989).

BACKGROUND FOR THE ANALYSIS OF MANAGERS' AND NONMANAGERS' RESPONSES

This report represents an analysis of the management and nonmanagement responses to the data collected in the exploratory study. These responses were analyzed to test the primary assumption that aerospace managers and nonmanagers have different technical communications practices.

Many technical communicators believe that managers and nonmanagers have different technical communications practices. This assumption of differences is based on the presumption that

the duties of managers and nonmanagers are fundamentally different. Consequently, these two groups would develop different information use and production strategies that would, in turn, manifest themselves as distinctive technical communications practices.

There is, however, little empirical evidence to support the presumption that managers and nonmanagers, in general, and aerospace managers and nonmanagers, in particular, have different technical communications practices. For example, Pinelli, et al. (1984) found little difference in the choice of report components used by aerospace managers and nonmanagers to decide to read a NASA technical report. Additionally, there was little difference in the order in which the components of a NASA technical report were read. Furthermore, aerospace managers and nonmanagers expressed little difference in their preferences regarding the production (i.e., format and layout) of NASA technical reports (Pinelli, et al. 1982).

The assumption of differences is stated as a research question, "Do aerospace managers and nonmanagers have different technical communications practices?," rather than a research hypothesis for the following reasons:

1. The study is exploratory in nature and, as such, has certain limitations.

2. The low response rate of 30.3 percent, which is fairly typical for mail surveys, prohibits generalizing the findings to the "nonrespondents" and the population being studied.

3. The available related research and literature regarding the technical communications practices of managers and nonmanagers does not provide a sufficient research foundation.

Assumptions

Five secondary assumptions were made regarding the 5 study objectives. These assumptions, which are given below, were tested and were used to answer the research question.

1. The importance of communicating technical information effectively is equally significant to aerospace managers and nonmanagers. A significant difference in the reported responses of aerospace managers and nonmanagers regarding "importance" would support the presumption of different technical communications practices between the two groups.

2. The use and production of technical information and technical information products are different for aerospace managers and nonmanagers because of the different duties performed by the two groups. A significant difference in the reported responses of aerospace managers and nonmanagers regarding "use and production" would support the presumption of different technical communications practices between the two groups.

3. The content for an undergraduate course in technical communications should be viewed differently by aerospace managers and nonmanagers. A significant difference in the reported responses of aerospace managers and nonmanagers regarding "content" would support the presumption of different technical communications practices between the two groups.

4. The use of libraries, technical information centers, and on-line (electronic) databases differs for aerospace managers and nonmanagers because of the different duties performed by the two groups. A significant difference in the reported responses of aerospace managers and nonmanagers regarding "usage" would support the presumption of different technical communications practices between the two groups.

5. The use and importance of computer and information technology differs for aerospace managers and nonmanagers because of the different duties performed by the two groups. A significant difference in the reported responses of aerospace managers and nonmanagers regarding "use and importance" would support the presumption of different technical communications practices between the two groups.

PRESENTATION AND DISCUSSION OF MANAGERS' AND NONMANAGERS' RESPONSES

The data in this report are presented for each survey objective and discussed in terms of management/nonmanagement responses. Background data collected as part of the survey revealed that approximately 76 percent of the respondents held nonmanagement positions and approximately 24 percent held administrative/managerial positions.

The Chi-Square and t-test for a difference between two independent means were used as the nonparametric and parametric tests for relationships between the responses to the 25 questions and the management and nonmanagement respondents. Attempts were made to establish the extent to which the characteristics of the population may reasonably be inferred from the attributes of the sample. Such inference is then subject to various conventions regarding statistical significance. The appropriate application of such conventions to the primary effort (n=606) is called "Estimate of Parameters." The population parameter, in this case a population proportion (P), is estimated from a sample proportion (p). Such estimates are dependent in part upon sample size, the overall response rate, and the sample size (response) for each question.

Given the general range of sample sizes and the nature of the sampling distribution of proportions, it can be stated that at the 95 percent confidence level, the true population proportion (P) for managers lies within $\pm$8.4 percent of the sample proportion (p) and the true population proportion (P) for nonmanagers lies within $\pm$4.8 percent of the sample proportion (p).

Although a confidence and tolerance level can be established, readers are cautioned that while a random sample of AIAA members were sent questionnaires, no assurances of randomness can be made regarding the questionnaires that were returned. Because the overall response rate was less than 50 percent, which is traditionally considered to be "representative," the figures given above should be used with caution when making generalizations about the population.

Survey Objective 1: The Importance of Technical Communications

To determine the importance of technical communications in aeronautics, survey respondents were asked to indicate the importance of communicating technical information effectively, the number of hours spent each week communicating technical information to others, the number of hours spent each week working with technical communications received from others, and

how professional advancement has affected the amount of time they spend communicating technical information to others and working with technical communications from others.

Approximately 99 percent of the managers and nonmanagers surveyed (Table 1) indicate that the ability to communicate technical information effectively is important. Fewer than 1.0 percent indicate that this ability is not at all important.

Table 1. Importance of Technical Communications

How Important	Managers		Nonmanagers	
	No.	%	No.	%
Very	129	89.6	411	89.8
Somewhat	14	9.7	45	9.8
Not at all	1	.7	2	.4
Total	144	100.0	458	100.0

Managers spend an average of 13.6 hours per week communicating technical information to others (Table 2), and nonmanagers spend an average of 14.0 hours per week. Based on a 40-hour work week, both groups spend approximately 35 percent of their work week communicating technical information to others.

Table 2 Time Spent Communicating Technical Information to Others

Time Spent Per Week, Hour	Managers		Nonmanagers	
	No	%	No.	%
5 or less	22	15.6	79	17.7
6 to 10	48	34.1	140	30 9
11 to 20	58	41.1	179	39 5
21 or more	13	9 2	55	11.9
Total	141	100 0	453	100 0
Mean	13 6		14.0	

Managers and nonmanagers spend approximately 13 hours a week working with technical communications received from others (Table 3) which is approximately 31 percent of their 40-hour work week.

Table 3. Time Spent Working With Technical Information Received From Others

Time Spent Per Week, Hour	Managers		Nonmanagers	
	No.	%	No.	%
5 or less	14	9.9	111	24.6
6 to 10	65	46.2	156	34.3
11 to 20	54	38.3	143	31.5
21 or more	8	5.6	44	9.6
Total	141	100.0	454	100.0
Mean	13.0		12.5	

Considering both the time spent working on the preparation of technical information and the time spent working with technical information received from others, technical communications takes up approximately 66 percent of the manager's and nonmanager's 40-hour work week.

Approximately 59 percent of the managers and 76 percent of the nonmanagers indicate that as they advanced professionally, the amount of time they spent communicating technical information to others increased (Table 4). Approximately 11 percent of the

Table 4. Professional Advancement and Amount of Time Spent Communicating Technical Information to Others

Time Spent Communicating	Managers		Nonmanagers	
	No.	%	No.	%
Increased	84	58.7	349	*76.0
Stayed the same	15	10.5	76	16.6
Decreased	44	*30.8	34	7.4
Total	143	100.0	459	100.0

* Differences between managers and nonmanagers are significant at $p < 0.05$.

managers and 17 percent of the nonmanagers indicate that the amount of time spent communicating technical information to others stayed the same. Approximately 31 percent of the managers and 7 percent of the nonmanagers indicate that the amount of time they spent communicating technical information to others decreased as they advanced professionally. In terms of the amount of time spent communicating technical information to others, nonmanagers were more likely to say that the amount of time has increased and managers were more likely to say it has decreased.

Approximately 63 percent of the managers and 61 percent of the nonmanagers indicate that as they advanced professionally, the amount of time they spent working with technical communications received from others increased (Table 5).

Table 5 Professional Advancement and Amount of Time Spent Using Technical Information Received From Others

Time Spent Using	Managers		NonManagers	
	No.	%	No.	%
Increased	89	62.7	278	61.0
Stayed the same	25	17.6	129	*28 3
Decreased	28	*19.7	49	10.7
Total	142	100.0	456	100 0

* Differences between managers and nonmanagers are significant at p < 0 05.

Approximately 18 percent of the managers and 28 percent of the nonmanagers indicate that the amount of time they spent working with technical communications received from others stayed the same as they advanced professionally. Approximately 20 percent of the managers and 11 percent of the nonmanagers indicate that

the amount of time they spent working with technical communications received from others decreased as they advanced professionally. Nonmanagers were more likely than managers to say that the amount of time they spent working with technical communications received from others had stayed the same, and managers were more likely than nonmanagers to say that it had decreased.

Survey Objective 2: The Use and Production of Technical Communications

Survey respondents were asked to indicate the amount and type of technical information products they produced and used as well as the sources of help they sought in producing technical information and in solving technical problems.

Memos, letters, and audio visual (A/V) materials are the technical information products most frequently produced by both managers and nonmanagers (Table 6). On the average, managers

Table 6. Production of Technical Information Products

Products	6-month average	
	Managers	Nonmanagers
Letters	*30.5	19.6
Memos	*49.0	22.6
Technical reports-Government	*2.1	1.4
Technical reports-Other	1.8	1.9
Proposals	*2.1	1.6
Technical manuals	0.3	0.3
Computer program documentation	0.5	*1.6
Journal articles	0.3	0.4
Conference/Meeting papers	*1.5	0.9
Trade/Promotional literature	*1.5	0.9
Press releases	*0.4	0.2
Drawings/Specifications	2.1	3.6
Speeches	*3.6	1.8
Audio/Visual materials	*9.6	5.6

* Differences between managers and nonmanagers are significant at $p < 0.05$.

produced 49 memos, 30.5 letters, and 9.6 A/V materials in a 6-month period. On the average, nonmanagers produced 22.6 memos, 19.6 letters, and 5.6 A/V materials. Based on average production, a list of the five technical information products most frequently produced by managers and nonmanagers follows:

Most Frequently Produced By Managers	Most Frequently Produced By Nonmanagers
Memos	Memos
Letters	Letters
A/V materials	A/V materials
Speeches	Drawing/Specifications
*Government technical reports, Proposals, and Drawing/Specifications	Other technical reports

*indicates a tie for these three products

The number of technical information products produced by both managers and nonmanagers were compared using a t-test to determine significant differences (Table 6). Of the 14 comparisons, 10 were significantly different. Managers prepared more letters, memos, government technical reports, proposals, conference/meeting papers, trade/promotional literature, press releases, speeches, and A/V materials. Nonmanagers prepared more computer program documentation.

Memos, letters, trade/promotional literature, and journal articles are the technical information products most frequently used by both managers and nonmanagers (Table 7).

Table 7. Use of Technical Information Products

Products	1-month average	
	Managers	Nonmanagers
Letters	*30.8	12.3
Memos	*38.7	19.8
Technical reports-Government	4.3	4.2
Technical reports-Other	*4.9	1.1
Proposals	*2.5	4.4
Technical manuals	1.1	*2.6
Computer program documentation	2.2	*3.2
Journal articles	5.8	*7.1
Conference/Meeting papers	4.0	*4.4
Trade/Promotional literature	7.2	5.3
Drawings/Specifications	*4.6	9.0
Audio/Visual materials	*6.8	5.2

* Differences between managers and nonmanagers are significant at $p < 0.05$.

On the average, managers used 38.7 memos, 30.8 letters, 7.2 trade/promotional literature, and 5.8 journal articles in a 1-month period. Nonmanagers used 19.8 memos, 12.3 letters, 7.1 journal articles, and 5.3 trade/promotional literature in a 1-month period. Based on average use, a list of the five technical information products most frequently used follows:

Most Frequently Used By Managers	Most Frequently Used By Nonmanagers
Memos	Memos
Letters	Letters
Trade/Promotional literature	Drawing/specifications
A/V materials	Journal articles
Journal articles	Trade/Promotional literature

The number of technical information products used by both managers and nonmanagers was compared by using a t-test to determine significant differences (Table 7). Of the 12 comparisons, 10 were significantly different. Managers used more letters, memos, other technical reports, proposals, drawings/

specifications, and A/V materials. Nonmanagers used more technical manuals, computer program documentation, journal articles, and conference/meeting papers.

Managers and nonmanagers seek the help of both people and other information sources to prepare technical information products (Table 8). Combining the "always" and "usually"

Table 8. Sources of Help Used To Write/Prepare Technical Communications

Sources of Help	Number of Respondents	Percent of Respondents			
		Always	Usually	Sometimes	Never
		Managers			
Other colleagues	143	7.7	40.6	51.7	0.0
Secretaries	144	32.6	29.2	27.8	10.4
Technical writers or editors	134	0.0	5.2	47.0	47.8
A thesaurus/dictionary	140	13.6	22.9	52.8	10.7
A style manual	136	0.7	4.4	30.2	64.7
A grammar hotline	134	0.0	0.7	2.3	97.0
		Nonmanagers			
Other colleagues	457	12.5	39.8	44.2	3.5
Secretaries	457	20.1	27.6	38.5	13.8
Technical writers or editors	442	2.0	4.5	38.1	55.4
A thesaurus/dictionary	453	23.8	31.1	38.5	6.6
A style manual	439	1.8	4.8	36.9	56.5
A grammar hotline	433	0.2	0.7	6.5	92.6

responses indicates that managers most frequently sought the help of secretaries, followed by other colleagues and a thesaurus/dictionary. Nonmanagers most frequently sought the help of other colleagues, followed by a thesaurus/dictionary and secretaries.

From the available data, it is difficult to determine why secretaries were used first by managers and last by nonmanagers as sources of help when producing technical information since memos and letters are the products most frequently produced by both groups. It is also difficult to determine if technical

both groups. It is also difficult to determine if technical writers and editors are so infrequently used because they are unavailable or for some other reason.

Managers and nonmanagers prepare artwork for their visual aids in various ways (Table 9). Approximately 50 percent of the

Table 9. How Artwork Is Produced

Production Method	Managers		Nonmanagers	
	No.	%	No.	%
Do own artwork without computer	12	3.4	50	11.0
Do own artwork with computer	34	23.8	172	*37.8
Graphics department does artwork	37	*25.8	61	13.4
Sometimes do it and sometimes graphics department does it	35	24.5	147	*32.3
Secretary does it	19	*13.3	19	4.2
Artwork is prepared elsewhere	6	4.2	6	1.3
Total	143	100.0	455	100.0

* Differences between managers and nonmanagers are significant at $p < 0.05$.

managers use a combination of self-preparation and a graphics department, whereas approximately 24 percent prepare their own artwork with a computer. Approximately 38 percent of the nonmanagers, on the other hand, do their own artwork with a computer followed by those who use a combination of self-preparation and a graphics department (32.3 percent). Nonmanagers were more likely to prepare their own artwork with a computer and were more likely to use a combination of self-preparation and a graphics department. Managers, on the other hand, were more likely to have the graphics department and a secretary prepare their artwork.

Managers and nonmanagers produce various types of technical information in the performance of their duties (Table 10).

Table 10. Types of Technical Information Produced
[n = 144 for managers; n = 456 for nonmanagers]

Types of Technical Information	Managers		Nonmanagers	
	No.	%	No.	%
Scientific and technical information	126	87.5	427	*93.6
Experimental techniques	47	32.6	222	*48.7
Codes of standards and practices	34	23.6	92	20.2
Design procedures and methods	63	44.1	219	48.1
Computer programs	55	38.2	288	*63.2
Government rules and regulations	25	17.5	66	14.5
In-house technical data	124	86.1	385	84.4
Product and performance characteristics	83	57.6	266	58.5
Economic information	71	*49.3	93	20.4
Technical specifications	82	56.9	276	60.5
Patents	26	18.1	82	18.0

* Differences between managers and nonmanagers are significant at $p < 0.05$.

A list of the five most frequently produced types of technical information follows:

Most Frequently Produced By Managers	Most Frequently Produced By Nonmanagers
Scientific and technical information	Scientific and technical information
In-house technical data	In-house technical data
Technical specifications	Computer programs
Economic information	Technical specifications
Design procedures and methods	Product and performance characteristics

Managers were more likely than nonmanagers to produce economic information. Nonmanagers, on the other hand, were more likely than managers to produce scientific and technical information, experimental techniques, and computer programs.

Both managers and nonmanagers use various types of technical information in the performance of their duties (Table 11).

Table 11. Types of Technical Information Used
[n = 144 for managers; n = 456 for nonmanagers]

Types of Technical Information	Managers		Nonmanagers	
	No.	%	No.	%
Scientific and technical information	139	96.5	443	97.1
Experimental techniques	73	50.7	290	*63.7
Codes of standards and practices	69	47.9	217	47.7
Design procedures and methods	78	54.2	258	56.7
Computer programs	100	69.4	385	*84.4
Government rules and regulations	117	*81.3	313	68.8
In-house technical data	136	94.4	407	89.3
Product and performance characteristics	103	71.5	331	72.6
Economic information	77	*53.5	138	30.3
Technical specifications	112	77.8	350	76.8
Patents	24	16.7	60	13.2

* Differences between managers and nonmanagers are significant at $p < 0.05$.

A list of the five most frequently used kinds of technical information follows:

Most Frequently Used By Managers	Most Frequently Used By Nonmanagers
Scientific and technical information	Scientific and technical information
In-house technical data	In-house technical data
Government rules and regulations	Computer programs
Produce and performance characteristics	Technical specifications
Technical specifications	Product and performance characteristics

Managers were more likely than nonmanagers to use government rules and regulations and economic information in performing their current duties. Nonmanagers were more likely than managers to use experimental techniques and computer programs in performing their present duties.

As shown in Table 12, managers and nonmanagers use a variety of information sources when solving technical problems.

Table 12. Sources of Technical Information Used to Solve Technical Problems

Sources of Technical Information	Number of Respondents	Percent of Respondents			
		Always	Usually	Sometimes	Never
		Managers			
Personal knowledge	142	35.9	48.6	15.5	0.0
Informal discussions with colleagues	143	16.8	59.4	23.8	0.0
Discussions with supervisors	141	6.4	27.7	55.3	10.6
Discussions with experts in organization	144	21.5	51.4	26.4	0.7
Discussions with experts outside of organization	*143	4.2	25.2	66.4	4.2
Technical reports-Government	143	2.8	20.3	69.2	7.7
Technical reports-Other	144	2.8	22.9	70.8	3.5
Professional journals/conference meeting papers	143	4.9	23.1	55.9	16.1
Textbooks	144	1.4	21.5	63.9	13.2
Handbooks and standards	140	2.9	14.3	67.9	15.0
Technical information sources, such as on-line data bases, indexing and abstracting guides, CD-ROM, and current awareness tools	139	0	6.5	43.9	49.6
Librarians/technical information specialists	141	0	9.9	65.2	24.8
		Nonmanagers			
Personal knowledge	456	44.5	45.4	10.1	0.0
Informal discussions with colleagues	456	21.1	56.6	21.9	0.4
Discussions with supervisors	451	11.3	37.5	45.2	6.0
Discussions with experts in organization	453	17.9	50.6	30.2	1.3
Discussions with experts outside of organization	455	6.8	17.4	66.2	9.7
Technical reports-Government	*455	6.8	29.7	58.0	5.5
Technical reports-Other	453	6.6	31.6	58.7	3.1
Professional journals/conference meeting papers	*452	10.6	26.5	52.7	10.2
Textbooks	*454	11.0	33.7	51.1	4.2
Handbooks and standards	*450	7.8	31.8	52.4	8.0
Technical information sources, such as on-line data bases, indexing and abstracting guides, CD-ROM, and current awareness tools	444	1.6	7.0	45.3	46 2
Librarians/technical information specialists	454	3.3	11.9	66.3	18.5

* Differences between managers and nonmanagers are significant at $p < 0.05$.

The "always" and "usually" responses, which appear as percentages in Table 12, were combined to form the following list of information sources used by managers and nonmanagers to solve technical problems, given in decreasing order of frequency:

SOURCES USED BY MANAGERS
TO SOLVE TECHNICAL PROBLEMS

Sources	Percent of Cases
1. Personal knowledge	84.5
2. Informal discussion with colleagues	76.2
3. Discussions with experts within the organization	72.9
4. Discussions with supervisor	34.1
5. Discussions with experts outside of your organization	29.4
6. Journals and conference/meeting papers	28.0
7. Technical reports - other	25.7
8. Technical reports - government	23.1
9. Textbooks	22.9
10. Handbooks and standards	17.2
11. Librarians/technical information specialists	9.9
12. Technical information sources such as on-line databases	6.5

SOURCES USED BY NONMANAGERS
TO SOLVE TECHNICAL PROBLEMS

Sources	Percent of Cases
1. Personal knowledge	69.9
2. Informal discussion with colleagues	.7
3. Discussions with experts within the organization	68.5
4. Discussions with supervisor	48.8
5. Textbooks	44.7
6. Handbooks and standards	39.6
7. Technical reports - other	38.2
8. Journals and conference/meeting papers	37.1
9. Technical reports - government	36.5
10. Discussions with experts outside of your organization	24.2
11. Librarians/technical information specialists	15.2
12. Technical information sources such as on-line databases	8.6

The managers and nonmanagers in this study display a preference for personalized, informal information sources. Both groups identified an informal search for information using personal contacts as their primary method, followed by the use of formal information sources. Only after they have completed an informal search followed by the use of formal information sources do they turn to librarians and technical information specialists for assistance.

Of particular significance, however, is the use of experts outside the organization by the two groups. Managers turn to experts outside the organization more frequently than do nonmanagers. Managers are more likely to use this information source than nonmanagers. On the other hand, nonmanagers were more likely than managers to use discussions with supervisors, government technical reports, journal articles and meeting papers, textbooks, and handbooks and standards.

Survey Objective 3: Content for an Undergraduate Course in Technical Communications

To obtain the views of managers and nonmanagers on the content for an undergraduate course in technical communications, survey respondents were asked if they had taken any course(s) in technical communications/writing, the degree to which the course(s) helped them communicate technical information, and their opinions regarding topics (i.e., principles and mechanics), on-the-job communications, and types of technical reports they

would recommend be included in an undergraduate technical communications course.

Approximately 26 percent of the managers and 24 percent of the nonmanagers had taken at least one course in technical communications/writing as undergraduates (Table 13).

Table 13. Courses Taken in Technical Communications/Writing

Technical Communications/Writing Coursework Taken	Managers		Nonmanagers	
	No	%	No.	%
Undergraduate	38	26.4	110	23.9
After graduation	29	20.1	90	19.6
Both undergraduate and after graduation	38	26.4	111	24.1
No	39	27.1	149	32.4
Total	144	100.0	460	100.0

Approximately 20 percent of the managers and nonmanagers had taken such a course after graduation and approximately 26 percent of the managers and 24 percent of the nonmanagers had done so both as undergraduates and post graduates. Approximately 27 percent of the managers and 32 percent of the nonmanagers indicated they had taken no such course.

Approximately 97 percent of the managers and nonmanagers who had taken any course(s) in technical communications/writing indicated that doing so had helped them to communicate technical information (Table 14). The managers and nonmanagers were fairly

Table 14. Helpfulness of Technical Communications/Writing Coursework

How Helpful	Managers		Nonmanagers	
	No.	%	No.	%
A lot	44	41.9	131	42.7
A little	58	55.2	165	53.7
Did not help	3	2.9	11	3.6
Total	105	100.0	307	100.0

evenly divided as to whether the course(s) helped them "a lot" (41.9 percent and 42.7percent respectively) or "a little" (55.2 percent and 53.7 percent respectively). Approximately 3 percent of the managers and 4 percent of the nonmanagers indicated that their course(s) had not helped them.

The percentage of "yes" responses to the list of principles to be included in an undergraduate technical communications course range from a high of 97.2 and 96.5 percent (developing paragraphs) respectively for managers and nonmanagers to a low of 49.6 and 52.1 percent (notetaking and quoting) respectively for nonmanagers and managers. (See Table 15.)

Table 15. Principles Recomended for Inclusion in Undergradate Technical Communications Course for Aeronautical Engineers and Scientists [n = 143 for managers; n = 459 for nonmanagers]

Principles	Managers		Nonmanagers	
	No.	%	No.	%
Defining the communication's purpose	130	90.9	416	90.8
Assessing readers' needs	116	82.9	372	81.2
Organizing information	139	97.2	442	96.5
Developing paragraphs (introductions, transitions, and conclusions)	126	88.1	393	85.8
Writing sentences (active vs. passive voice, parallel ideas, shifts in person or tense)	115	80.4	367	80.0
Using standard English grammar	113	79.0	354	77.3
Notetaking and quoting	74	52.1	225	49.6
Editing and revising	106	74.1	362	79.0
Choosing words (avoiding wordiness, jargon, slang, sexist terms)	117	82.4	372	81.0
Using information technology (video conferencing, electronic data bases, etc.)	87	60.8	277	60.7

Seven of the 10 topics (principles) received "yes" responses of greater than 75 percent from managers, and 8 of the 10 topics received "yes" responses of greater than 75 percent from nonmanagers.

These topics are listed in descending order of importance:

Topic	Managers Percentage Response	Nonmanagers Percentage Response
Organizing information	97.2	96.5
Defining the communication's purpose	90.9	90.8
Developing paragraphs	88.1	85.8
Assessing readers' needs	82.9	81.2
Choosing words	82.4	81.0
Writing sentences	80.4	80.0
Using standard English grammar	79.0	77.3
Choosing words	74.1	79.0

The percentage of "yes" responses of the list of mechanics to be included in an undergraduate technical communications course ranges from a high of almost 80 percent (punctuation) and 77 percent (references) for managers and nonmanagers respectively to a low of approximately 49 percent (abbreviations and numbers) for managers and nonmanagers respectively. (See Table 16.)

Table 16. Mechanics Recommended for Inclusion in Undergraduate Technical Communications Course for Aeronautical Engineers and Scientists
[n = 139 for managers; n = 452 for nonmanagers]

Mechanics	Managers		Nonmanagers	
	No.	%	No.	%
Abbreviations	67	48.6	236	52.2
Acronyms	68	48.9	226	50.0
Capitalization	91	65.9	269	59.5
Numbers	67	49.3	218	48.6
Punctuation	111	79.9	338	74.8
References	106	76.3	347	76.8
Spelling	98	70.5	286	63.3
Symbols	72	52.2	266	58.8

Five of the eight topics (mechanics) received "yes" responses of greater than 50 percent from managers and six of the eight topics received responses of greater than 50 percent from

nonmanagers. These topics are listed in descending order of importance:

Topic	Managers Percentage Response	Nonmanagers Percentage Response
Punctuation	79.9	74.8
References	76.3	76.8
Spelling	70.5	63.3
Capitalization	65.9	59.5
Symbols	52.2	58.8
Abbreviations	48.6	52.2
Acronyms	48.9	50.0

The percentage of "yes" responses to the list of topics (on-the-job communications) to be included in a undergraduate technical communications course range from a high of approximately 97 percent (oral presentations) and 95 percent (oral presentations) for managers and nonmanagers respectively to a low of 24 percent (newspaper articles) and 25 percent (newspaper articles) for managers and nonmanagers respectively. (See Table 17.)

Table 17. On-the-Job Communications Recommended for Inclusion in Undergraduate Technical Communications Course for Aeronautical Engineers and Scientists [n = 144 for managers; n = 449 for nonmanagers]

On-the-Job Communications	Managers		Nonmanagers	
	No.	%	No.	%
Abstracts	87	60.8	318	71.8
Letters	110	76.4	301	67.2
Memos	120	83.3	342	76.2
Instructions	80	55.9	259	58.2
Journal articles	57	39.6	216	48.3
Literature reviews	49	34.3	169	38.0
Manuals	64	44.4	222	49.6
Newsletter articles	36	25.0	106	24.0
Oral presentations	140	97.2	425	94.7
Specifications	72	50.3	257	57.5
Use of information sources	112	78.3	354	79.2

Seven of the 11 topics (on-the-job communications) received "yes" responses from more than 50 percent of the survey respondents. These 7 topics are listed in descending order of importance:

Topic	Managers Percentage Response	Nonmanagers Percentage Response
Oral presentations	97.2	94.7
Memos	83.3	76.2
Use of information sources	78.3	79.2
Letters	76.4	67.2
Abstracts	60.8	71.8
Instructions	55.9	58.2
Specifications	50.3	57.5

Respondents were asked to consider specific types of technical reports for inclusion in an undergraduate technical communications course. (See Table 18.) Progress reports and test reports were the first and second choices of managers and nonmanagers (82.0 percent and 80.3 percent for managers and 78.2 percent and 78.0 percent for nonmanagers respectively). As shown in Table 18, all types of technical reports, except for trouble reports, received "yes" responses from more than 50 percent of both managers and nonmanagers.

Table 18. Types of Technical Reports Recommended for Inclusion in Undergraduate Technical Communications Course for Aeronautical Engineers and Scientists [n = 133 for managers; n = 422 for nonmanagers]

Types of Technical Reports	Managers		Nonmanagers	
	No.	%	No.	%
Feasibility	86	65.2	257	61.3
Investigative	87	65.9	280	66.8
Laboratory	95	72.0	296	70.5
Progress	109	82.0	330	78.2
Test	106	80.3	329	78.0
Trip	80	60.2	221	52 4
Trouble	75	57.3	206	48.8

In an attempt to validate the findings regarding topics for an undergraduate technical communications course, the top five recommended on-the-job communications were compared with the top five (on the average) technical communications products "produced" and "used" by managers and nonmanagers.

Most Frequently Produced By Managers	Most Frequently Used By Managers	Most Frequently Recommended By Managers
Memos	Memos	Oral presentations
Letters	Letters	Memos
A/V materials	Trade/Promotional literature	Use of information sources
Speeches	A/V materials	Letters
*Government technical reports, Proposals, and Drawings/ Specifications	Journal articles	Technical reports

*indicates a tie for these three products

The list of topics most frequently recommended by managers compares quite favorably with the technical communications products "produced" and "used" by managers. Memos and letters are included in all three lists. Oral presentations, which rank first on the list of recommended topics, would include the use of A/V materials and the oral delivery (i.e., speeches) of the content, which rank third and fourth respectively on the list of products "produced." Considered as a group, technical reports would make the recommended topics list. Technical reports rank "fifth" in terms of products "produced" and "recommended."

The inclusion and relative importance (i.e., third) of "use of information sources" on the list of recommended topics is of particular interest. As can be concluded from Table 12, managers and nonmanagers tend to search for information themselves.

Therefore, would improving their ability to use information sources would better prepare managers to conduct their own search for the information needed to solve technical problems?

Most Frequently Produced By Nonmanagers	Most Frequently Used By Nonmanagers	Most Frequently Recommended By Nonmanagers
Memos	Memos	Oral presentations
Letters	Letters	Use of Information sources
A/V materials	Drawings/ Specifications	Memos
Drawings/ Specifications	Journal articles	Abstracts
Other technical reports	Trade/Promotional literature	Letters

The list of topics most frequently recommended by nonmanagers compares quite favorably with the technical communications products "produced" and "used" by nonmanagers. Memos and letters are included on all three lists. Oral presentations, which rank first on the list of recommended topics, would include the use of A/V materials and the oral delivery (i.e., speeches) of the content. A/V materials rank third and sixth on the list of products "produced" and "used" by nonmanagers. Considered as a group, technical reports would make the list of recommended on-the-job topics. Technical reports ranked sixth on the list of recommended topics, fifth on the list of products "produced," and sixth on the list of products "used" by nonmanagers.

The inclusion of "use of information sources," which ranked second on the list of on-the-job communications most frequently recommended by nonmanagers, supports the conclusion stated

earlier that nonmanagers tend to search for information themselves when solving technical problems. Consequently, improving their ability to use information sources would better prepare nonmanagers to conduct their own search for information when solving technical problems.

Survey Objective 4: Use of Libraries, Technical Information Centers, and On-Line Databases

To determine the use of libraries, technical information centers, and on-line databases, survey respondents were asked three questions. They were asked to indicate how often they used a library or technical information center, their use of on-line databases, and how they search the databases.

Approximately 92 percent of the managers and 95 percent of the nonmanagers use a library or technical information center (Table 19). The frequency rates vary among managers and

Table 19. Use of Library or Technical Information Center

Frequency of Use	Managers		Nonmanagers	
	No.	%	No.	%
Daily	1	0.7	11	2.4
Two to six times a week	9	6.3	50	11.0
Once a week	17	11.7	72	15.8
Two to three times a month	24	6.7	92	*20.2
Once a month	22	15.3	80	17.5
Less than once a month	59	*41.0	127	27.8
Do not use	12	8.3	24	5.3
Total	144	100.0	456	100.0

* Differences between managers and nonmanagers are significant at $p < 0.05$.

nonmanagers, however, with approximately 19 percent of the managers using a library or technical information center one or more times a week and approximately 29 percent of the nonmanagers

using a library or technical information center one or more times a week. Thirty-two percent of the managers and approximately 38 percent of the nonmanagers use a library or technical information center one or more times a month. Forty-one percent of the managers and approximately 28 percent of the nonmanagers use a library or technical information center less than once a month.

Fewer than one-third (31.2 percent) of the managers and fewer than one-half (48.1 percent) of the nonmanagers use on-line (electronic) databases (Table 20). Of those respondents who use

Table 20. Use of Electronic Databases

Use	Managers		Nonmanagers	
	No.	%	No.	%
Yes	45	31.2	219	*48.1
No	99	68.8	236	51.9
Total	144	100.0	455	100.0

* Differences between managers and nonmanagers are significant at $p < 0.05$.

databases, none of the managers and approximately 8 percent of the nonmanagers do all of their own searches (Table 21).

Table 21. How Electronic Databases Are Searched

How Searched	Managers		Nonmanagers	
	No.	%	No.	%
Do all searches yourself	0	0.0	18	* 8.3
Do most searches yourself	4	0.4	38	*17.5
Do half by yourself and half through an intermediary (e.g. librarian)	5	11 6	27	12 4
Do most searches through an intermediary (e.g. librarian)	17	39 5	75	34.6
Do all searches through an intermediary	17	39.5	59	27.2
Total	43	100 0	217	100.0

* Differences between managers and nonmanagers are significant at $p < 0.05$.

Fewer than 1 percent of the managers and approximately 18 percent of the nonmanagers do most of their own database searches. Approximately 12 percent of the managers and nonmanagers do one-half of their searches and have the other one-half done by an intermediary. Approximately 79 percent of the managers use an intermediary to do most or all of their electronic database searches, and about 62 percent of the nonmanagers use an intermediary to do most or all of their searches.

Survey Objective 5: Use and Importance of Computer and Information Technology

To determine the use and importance of computer and information technology, survey respondents were asked about their use of computer technology, whether computer technology has increased their ability to communicate technical information, and what types of computer and information technology they used.

Approximately 86 percent of the managers and 93 percent of the nonmanagers use computer technology for preparing technical communications (Table 22). Managers were fairly evenly divided

Table 22. Use of Computer Technology for Preparing Written Technical Communications

Frequency	Managers		Nonmanagers	
	No.	%	No.	%
Always	43	29.9	189	41.1
Usually	43	29.9	148	32.2
Sometimes	38	26.4	93	20.2
Never	20	13.8	30	6.5
Total	144	100.0	460	100.0

in terms of their degree of use: approximately 30 percent "always" use, approximately 30 percent "usually" use, and approximately 26 percent "sometimes" use computer technology for preparing technical communications. Approximately 41 percent of the nonmanagers "always" use, approximately 32 percent "usually" use, and approximately 20 percent "sometimes" use computer technology. Nonmanagers were more likely than managers tc use computer technology.

Approximately 90 percent of the managers and 96 percent of the nonmanagers who use computer technology indicate that it has increased their ability to communicate technical information (Table 23). Approximately 56 percent of the managers and approximately 63 percent of the nonmanagers indicate that computer technology has increased their ability to communicate technical information " a lot."

Table 23. Effect of Computer Technology on Increasing Ability To Communicate Technical Information

Increasing Ability To Communicate Technical Information	Managers		Nonmanagers	
	No.	%	No.	%
A lot	69	55.6	273	63.4
A little	43	34.7	140	32.6
Not at all	12	9.7	17	4.0
Total	124	100.0	430	100.0

Managers and nonmanagers use a variety of software for preparing written technical communications (Table 24).

Table 24. Use of Software For Preparing Written Technical Communications
[n = 123 for managers; n = 428 for nonmanagers]

Type of Software	Managers		Nonmanagers	
	No.	%	No.	%
Word processing	113	91.9	407	95.1
Outliners and prompters	11	9.0	48	11.3
Grammar and style checkers	16	13.1	46	10.8
Spelling checkers	73	59.3	274	63.9
Thesaurus	41	33.6	133	31.3
Business graphics	57	*46.7	140	32.9
Scientific graphics	68	55.7	285	*66.9

* Differences between managers and nonmanagers are significant at $p < 0.05$.

The percentage of "yes" responses ranges from a high of 91.9 percent (word processing) for managers and 95.1 percent for nonmanagers to a low of 9 percent (outliners and prompters) for managers and 10.8 percent for nonmanagers. A list of the five most frequently used types of software for preparing written technical communications follows:

Most Frequently Used By Managers	Most Frequently Used By Nonmanagers
Word processing	Word processing
Spelling checkers	Scientific graphics
Scientific graphics	Spelling checkers
Business graphics	Business graphics
Thesaurus	Thesaurus

Managers were more likely to use business graphics, whereas nonmanagers were more likely to use scientific graphics to prepare written technical communications.

More than half of the managers (59.8 percent) and nonmanagers (52.9 percent) never use an integrated graphics, text, and modeling engineering workstation for preparing written

technical communications (Table 25). Of those who do use

Table 25. Use of Integrated Graphics, Text, and Modeling Workstation for Preparing Written Technical Communications

Frequency	Managers		Nonmanagers	
	No.	%	No.	%
Always	8	6.6	31	7.3
Usually	13	10.6	48	11.3
Sometimes	28	23.0	121	28.5
Never	73	59.8	225	52.9
Total	122	100.0	425	100.0

such a workstation, approximately 17 percent of the managers and 28 percent of the nonmanagers "always" or "usually" use it, and 23 percent of the managers and approximately 29 percent of the nonmanagers "sometimes" use it for preparing written technical communications.

Approximately 53 percent of the managers and 61 percent of the nonmanagers use electronic or desk-top publishing systems for preparing written technical communications (Table 26). Of those

Table 26. Use of Electronic or Desk-Top Publishing Systems for Preparing Written Technical Communiations

Frequency	Managers		Nonmanagers	
	No.	%	No.	%
Always	9	7.3	56	13.2
Usually	27	22.0	85	20.0
Sometimes	29	23.5	118	27.7
Never	58	47.2	116	39.1
Total	123	100.0	425	100.0

who do use such systems, approximately 30 percent of the managers "always" or "usually" use them, and approximately 24 percent "sometimes" use them. Approximately 33 percent of the nonmanagers "always" or "usually" use electronic or desk-top

publishing systems, and approximately 28 percent "sometimes" use them.

Managers and nonmanagers use a variety of information technologies to communicate technical information (Table 27). The percentage of "I already use it" responses ranges from a high of 90.1 percent (FAX or TELEX) for managers and 82.5 percent

Table 27. Use, Nonuse, and Potential Use of Information Technologies to Communicate Technical Information

Information Technologies	Managers			
		I already use it	I don't use it, but may in the future	I don't use it, and doubt if I will
	No.	%	%	%
Audiotapes and cassettes	1.4	*28.4	26.9	44.8
Motion picture film	133	21.8	20.3	57.9
Videotape	141	*56.0	36.2	7.8
Desk-top/electronic publishing	138	44.2	44.9	10.9
Floppy disks	137	68.6	24.1	7.3
Computer cassette/cartridge tapes	131	21.4	42.0	36.6
Electronic mail	141	*58.9	35.5	5.7
Electronic bulletin boards	134	31.3	50.0	18.7
FAX or TELEX	141	90.1	7.1	2.8
Electronic databases	133	54.1	36.8	9.1
Video conferencing	127	20.4	59.9	19.7
Teleconferencing	138	67.4	25.4	7.2
Micrographics and microforms	130	18.5	43.0	38.5
Laser disk/video disk/CD-ROM	131	6.9	64.1	29.0
Electronic networks	135	34.8	51.1	14.1
	Nonmanagers			
	No.	%	%	%
Audiotapes and cassettes	446	17.7	30.5	*51.8
Motion picture film	440	20.2	25.9	53.9
Videotape	448	43.8	40.6	*15.6
Desk-top/electronic publishing	445	47.4	40.4	12.1
Floppy disks	453	76.4	17.4	6.2
Computer cassette/cartridge tapes	436	22.9	38.3	38.8
Electronic mail	445	42.7	*45.8	11.5
Electronic bulletin boards	439	23.9	54.7	21.4
FAX or TELEX	451	82.5	12.0	5.5
Electronic databases	442	49.1	41.6	9.3
Video conferencing	443	14.9	63.4	21.7
Teleconferencing	446	56.0	33.0	11.0
Micrographics and microforms	426	17.8	44.4	37.8
Laser disk/video disk/CD-ROM	438	5.9	65.3	28.8
Electronic networks	438	31.3	53.4	15.3

* Differences between managers and nonmanagers are significant at $p < 0.05$.

(FAX or TELEX) for nonmanagers to a low of 6.9 percent (laser disc/video disc/CD-ROM) for managers and 5.9 percent (laser disc/video disc/CD-ROM) for nonmanagers. A list of the information technologies most frequently used by managers and nonmanagers for communicating technical information follows:

Most Frequently Used By Managers	Most Frequently Used By Nonmanagers
FAX or TELEX	FAX or TELEX
Floppy disks	Floppy disks
Teleconferencing	Teleconferencing
Electronic mail	Electronic databases
Video tape	Desk top/electronic publishing

A further look at Table 27 reveals several information technologies for which a considerable number of "I don't use it, and doubt if I will" responses were recorded. The percentages of these responses range from a high of 57.9 percent (motion picture film) for managers and 53.9 percent for nonmanagers to a low of 2.8 percent (FAX or TELEX) for managers and 5.5 percent (FAX or TELEX) for nonmanagers. A list of the five information technologies receiving the highest percentage of "don't use it, and doubt if I will" responses follows:

Least Frequently Used By Managers	Least Frequently Used By Nonmanagers
Motion picture film	Motion picture film
Audiotapes and cassettes	Audiotapes and cassettes
Micrographics and microforms	Computer cassette/ cartridge tapes
Computer cassette/ microforms	Micrographics and cartridge tapes
Laser disc/video disc/ CD-ROM	Laser disc/video disc/ CD-ROM

Table 27 also indicates several information technologies for which a considerable percentage of "I don't use it, but may in the future" responses were recorded. The percentages of these responses range from a high of 64.1 percent (laser/disc/video disc/CD-ROM) for managers and 65.3 percent (laser/disc/video disc/CD-ROM) for nonmanagers to a low of 2.8 percent (FAX or TELEX) for managers and 5.5 percent (FAX or TELEX) for nonmanagers. A list of the five information technologies receiving the highest percentage of "I don't use it, but may in the future" responses follows:

Most Likely to be Used By Managers	Most Likely to be Used By Nonmanagers
Laser disc/video disc/ CD-ROM	Laser disc/video disc/ CD-ROM
Video conferencing	Video conferencing
Electronic networks	Electronic bulletin boards
Electronic bulletin boards	Electronic networks

Considering the 15 information technologies in the list, managers were more likely to say that they already use audiotapes and cassettes, videotape, and electronic mail. Nonmanagers were more likely to say that they doubt they will use audiotapes and cassettes and videotape, and they were more likely to say that they may use electronic mail in the future.

VALIDITY OF THE ASSUMPTIONS

The following conclusions are presented concerning the validity of the five study assumptions.

Assumption 1: The Importance of Communicating Technical Information Effectively Is Equally Significant to Aerospace Managers and Nonmanagers

The responses of managers and nonmanagers to the five questions associated with this assumption were very similar. The importance of communicating technical information effectively is significant to aerospace managers and nonmanagers alike. There is very little difference in the average amount of time the two groups spend communicating technical information to others and working with technical communications received from others. Nonmanagers were more likely than managers to say that the amount of time spent communicating technical information to others has increased, whereas managers were more likely than nonmanagers to say it has decreased. Nonmanagers were more likely than managers to say that the amount of time spent working with technical communications from others has stayed the same, whereas managers were more likely than nonmanagers to say that the amount of time spent working with technical communications from others has decreased. However, based on the overall responses to questions dealing with this assumption, the conclusion of **NO DIFFERENCE** in technical communications practices is reached for **ASSUMPTION 1.**

Assumption 2: The Use and Production of Technical Information and Technical Information Products Are Different For Aerospace Managers and Nonmanagers

The responses of managers and nonmanagers to the seven questions associated with this assumption were very different. Significant differences were found for 10 of the 14 types of technical information products produced and used. The magnitudes of difference were greatest for the numbers of memos, letters, drawings/specifications, and A/V materials produced and used. Significant differences existed for how managers and nonmanagers produce artwork and the sources they consult for help in preparing technical communications.

Significant differences also exist in the types of technical information produced and used by managers and nonmanagers in the performance of their duties and in the sources of technical information used to solve technical problems. Nonmanagers were more likely than managers to use experimental techniques and computer programs, whereas managers were more likely than nonmanagers to use government rules and regulations and economic information. Nonmanagers were more likely than managers to produce scientific and technical information, experimental techniques, and computer programs, whereas managers were more likely than nonmanagers to produce economic information. When solving a technical problem, nonmanagers were more likely than managers to use discussions with supervisors, government technical reports, other technical reports, journal articles, conference/meeting papers, textbooks, and handbooks/standards,

whereas managers were more likely than nonmanages to use experts outside the organization. Therefore, the conclusion of **DIFFERENCE** in technical communications practices is reached for **ASSUMPTION 2.**

Assumption 3: The Content For an Undergraduate Course in Technical Communications Should Be Viewed Differently By Aerospace Managers and Nonmanagers

The responses of mangers and nonmanagers to the six questions associated with this assumption were very similar. There is very little difference in the percentage of managers and nonmanagers who had taken technical communications coursework and in the percentages of managers and nonmanagers who indicated that such coursework had helped them to better communicate technical information. Further, there were very few differences in the types of principles, mechanics, on-the-job communications, and types of technical reports to be included in an undergraduate technical communications curriculum for aeronautical engineers and scientists. Therefore, the conclusion of **NO DIFFERENCE** in technical communications practices is reached for **ASSUMPTION 3.**

Assumption 4: The Use of Libraries, Technical Information Centers, and On-Line (Electronic) Databases Differs For Aerospace Managers and Nonmanagers

The responses of managers and nonmanagers to the three questions associated with this assumption were different. Nonmanagers were more likely than managers to use a library or technical information center and were more likely to use on-line (electronic) databases than managers. Nonmanagers were more

likely than managers to do all or most of their own searches. Therefore, the conclusion of **DIFFERENCE** in technical communications practices is reached for **ASSUMPTION 4.**

Assumption 5: The Use and Importance of Computer and Information Technology Differs for Aerospace Managers and Nonmanagers

The responses of managers and nonmanagers to three of the six questions associated with this assumption were different. Nonmanagers were more likely than managers to use computer technology for preparing technical communications and were more likely to say that the use of computer technology has increased their ability to communicate technical information "a lot." Nonmanagers were more likely than managers to use scientific graphics software and managers were more likely than nonmanagers to use business graphics software.

Managers were more likely than nonmanagers to "already use" audiotapes and cassettes, where as nonmanagers were more likely than managers to say that they "doubt if they will" use this technology. Managers were more likely than nonmanagers to "already use" video tape where as nonmanagers were more likely than managers to say that they "doubt if they will" use it. Managers were more likely than nonmanagers to "already use" electronic mail, whereas nonmanagers were more likely than nonmanagers to say they "don't but may" use it in the future. Therefore, the conclusion of **DIFFERENCE** in technical communications practices is reached for **ASSUMPTION 5.**

CONCLUDING REMARKS

Aerospace managers and nonmanagers have different technical communications practices for three of the five assumptions tested. Therefore, in response to the study's research question, it is concluded that aerospace managers and nonmanagers do have different technical communications practices.

However, while the results of this study provide empirical evidence regarding the technical communications practices of aerospace managers and nonmanagers, data supporting the presumption that the "difference" is attributable to the duties performed by aerospace managers and nonmanagers are neither conclusive nor compelling. The limitations of this exploratory study and the study's research design prohibit reaching that conclusion. Nevertheless, the implication that these differences arise from differing professional duties is hard to resist.

There are perhaps several explanations for both the similarities and the differences in the findings regarding the technical communications practices of aerospace managers and nonmanagers. One possible reason for the similarities is that the managers in this study have risen through the ranks and have retained many of the technical communications practices formed while they were nonmanagers. Another possible explanation is that many of the managers included in this study are actually working supervisors and, consequently, utilize technical communications practices common to both managers and nonmanagers.

The differences may be variously explained. One explanation can be attributed to a difference in the duties performed by the two groups. For example, it seems logical that managers would produce more economic information than nonmanagers and that managers would use more economic information and government rules and regulations than nonmanagers. Likewise, it seems logical that different duties would explain why nonmanagers produce and use significantly more experimental techniques and computer programs than do managers. Could other factors or variables (e.g., organizational affiliation) account for the different technical communications practices?

Accessibility or availability of support help may also explain certain technical communications practices among aerospace managers and nonmanagers. Managers are more likely than nonmanagers to seek the help of a secretary to prepare written technical communications. Likewise, managers are more likely than nonmanagers to use a secretary to help prepare their artwork. Does accessibility or availability explain why neither managers nor nonmanagers make extensive use of technical writers and editors? Could familiarity, experience, ease of use, or expense account for this finding?

Managers make greater use of experts outside of the organization to solve technical problems. One possible explanation is that managers have greater access to outside experts. Another is that the use of outside experts to solve problems is a fairly common practice among managers.

On the other hand, nonmanagers are far more likely than managers to use a variety of information sources when seeking solutions to technical problems. Is the use of various information sources by nonmanagers more an indication of the different type(s) of problems being solved? Both groups, however, display a preference for personalized, informal information sources when solving technical problems. This similarity may be more attributable to social/professional enculturation than to any other possible factor or variable.

Both managers and nonmanagers prefer personalized, informal information sources to libraries, technical information centers, and on-line electronic databases. This similarity may also be attributable to social/professional enculturation. On the other hand, the finding that nonmanagers are more likely than managers to use libraries, technical information centers, and on-line electronic databases may be attributed to a difference in the duties performed by the two groups.

Nonmanagers are more likely than managers to use computer technology for preparing written technical communications, a distinction that may be more dependent upon the lack of secretarial support for nonmanagers than differences in duties. Furthermore, the fact that managers are more likely than nonmanagers to use certain information technology may be dependent upon managers' access to the technology because of their position within the organization rather than because of differences in duties.

Although the results of this study add to a rather limited empirical knowledge base, more research regarding the technical communications practices of aerospace managers and nonmanagers is clearly needed. The data reported here offer limited but useful insight into the technical communications practices of aerospace managers and nonmanagers. Technical communications educators may find the results useful in curriculum planning, technical information managers may find the results useful when planning and providing for information policy and services, and researchers may find the results useful for planning a more indepth investigation of the topic.

APPENDIX

SURVEY INSTRUMENT

TECHNICAL COMMUNICATIONS IN AERONAUTICS

1 In your work, how important is it for *YOU* to communicate technical information effectively? Col

Very Important Somewhat Important Not at all Important

2 How many hours do *YOU* spend each week communicating technical information *TO* others? Hours 67

3. How many hours do *YOU* spend each week working with technical communications *FROM* others? Hours 8-9

4. As you have advanced professionally, how has the amount of time *YOU* spend communicating technical information *TO OTHERS* changed?

Increased Stayed the Same Decreased 10

5 As you have advanced professionally, how has the amount of time *YOU* spend working with technical communications received *FROM OTHERS* changed?

Increased Stayed the Same Decreased 11

6 Approximately how many times in the past *six months* did you write prepare

	times in the past **6 months**		
Letters		Journal articles	12-13
Memos		Conference Meeting papers	
Technical reports-Government		Trade Promotional literature	
Technical reports-Other		Press releases	
Proposals		Drawings Specifications	
Technical manuals		Speeches	
Computer program documentation		Audio Visual materials	

7 How many times in the past *one month* did you use materials written prepared by other people?

	# read used in past **1 month**		
Letters		Journal articles	14-15
Memos		Conference Meeting papers	
Technical reports-Government		Trade Promotional literature	
Technical reports Other		Drawings Specifications	
Proposals		Audio Visual materials	
Technical Manuals			
Computer program documentation			

8 When you write prepare technical communications, do you receive help from

	Always	*Usually*	*Sometimes*	*Never*	90-95
Other colleagues					
Secretaries					
Technical writers or editors					
A thesaurus dictionary					
A style manual					
A grammar hotline					

9 Which of the following statements *BEST* represents how the artwork for *YOUR* visual aids (charts, graphs) is prepared? (Check Only One)

1 ___ I do my own artwork without a computer
2 ___ I do my own artwork with a computer
3 ___ The graphics department does my artwork
4 ___ Sometimes I do it and sometimes the graphics department does it
5 ___ A secretary does it
6 ___ The artwork is prepared elsewhere

96

10. Have you ever taken a course(s) in technical communications writing?

1 Yes, as an Undergraduate | 2 Yes, after graduation | 3 Yes, both | 4 No (**Skip to Q. 12**)

97

11 How well did this course help *YOU* communicate technical information?

1 A Lot | 2 A Little | 3 Did not Help

98

12 In your opinion, which of the following topics should be included in an **undergraduate** technical communications course for aeronautical engineers and scientists?

Yes	*No*	*Principles*	*Yes*	*No*	*Mechanics*
		Defining the communication's purpose			Abbreviations
	2	Assessing readers' needs			Acronyms
		Organizing information			Capitalization
		Developing paragraphs (introductions, transitions, and conclusions)			Numbers
		Writing sentences (active vs passive voice, parallel ideas, shifts in person or tense)			Punctuation
		Using standard English grammar			References
		Notetaking and quoting			Spelling
		Editing and revising			Symbols
		Choosing words (avoiding wordiness, jargon, slang, sexist terms)			
		Using information technology (video conferencing, electronic data bases, etc.)			

99
116

13 Which of the following on-the-job communications should be included in an **undergraduate technical communications course** for aeronautical engineers and scientists?

Yes	*No*		*Yes*	*No*	*Reports*
		Abstracts			Feasibility
		Letters			Investigative
		Memos			Laboratory
		Instructions			Progress
		Journal articles			Test
		Literature reviews			Trip
		Manuals			Trouble
		Newsletter articles			
		Oral presentations			
		Specifications			
		Use of information sources			

117
134

14. Do *YOU* use computer technology to prepare technical communications?

1 Always | 2 Usually | 3 Sometimes | 4 Never (**Skip to Q. 19**)

135

15 Has computer technology increased *YOUR* ability to communicate technical information?

1 A Lot | 2 A Little | 3 Not at All

136

16. Do *YOU* use any of the following software for preparing written technical communications?

Yes	*No*		*Yes*	*No*		
		Word processing			Thesaurus	137 143
		Outliners and prompters			Business graphics	
		Grammar and style checkers			Scientific graphics	
		Spelling checkers				

17. Do *YOU* use an integrated graphics, text, and modeling engineering workstation for preparing written technical communications?

Always Usually Sometimes Never 144

18. Do *YOU* use electronic or desk-top publishing systems for preparing written technical communications?

Always Usually Sometimes Never 145

19. How do *YOU* view your use of the following information technologies in communicating technical information?

Information Technologies	*I already use it*	*I **don't** use it, but **may** in the future*	*I **don't** use it, and **doubt** if I will*	
Audio tapes and cassettes				146 160
Motion picture film				
Video tape				
Desk-top/electronic publishing				
Floppy disks				
Computer cassette/cartridge tapes				
Electronic mail				
Electronic bulletin boards				
FAX or TELEX				
Electronic data bases				
Video conferencing				
Teleconferencing				
Micrographics and microforms				
Laser disc/video disc/CD-ROM				
Electronic networks				

20 When faced with solving a technical problem, do you get technical information from

	Always	*Usually*	*Sometimes*	*Never*	
Personal knowledge					161 172
Informal discussions with colleagues					
Discussions with supervisors					
Discussions with experts *in* your organization					
Discussions with experts *outside* of your organization					
Technical reports-Government					
Technical reports-Other					
Professional journals/conference meeting papers					
Textbooks					
Handbooks and standards					
Technical information sources, such as on-line data bases, indexing and abstracting guides, CD-ROM, and current awareness tools					
Librarians/technical information specialists					

21. What types of technical information do you *USE* in performing your present duties?

Yes	*No*		
		Scientific and technical information	173
		Experimental techniques	174
		Codes of standards and practices	
		Design procedures and methods	
		Computer programs	
		Government rules and regulations	
		In-house technical data	
		Product and performance characteristics	
		Economic information	
		Technical specifications	
		Patents	

22 What types of technical information do you *PRODUCE* (or expect to produce) in performing your present duties?

Yes	*No*		
		Scientific and technical information	184
		Experimental techniques	185
		Codes of standards and practices	
		Design procedures and methods	
		Computer programs	
		Government rules and regulations	
		In-house technical data	
		Product and performance characteristics	
		Economic information	
		Technical specifications	
		Patents	

23 How often do you use the library or a technical information center? (Circle Choice) 195

1 — Daily
2 — Two to six times a week
3 — Once a week
4 — Two to three times a month
5 — Once a month
6 — Less than once a month
7 — Do not use

24 Do you use electronic data bases to find bibliographic citations and abstracts? 1 — Yes 2 — No **(Skip to Q. 26)** 196

25 Do you (Circle One) 197

1 — Do *all* searches yourself
2 — Do *most* searches yourself
3 — Do *half* by yourself and half through an intermediary (e g librarian)
4 — Do *most* searches through an intermediary (e g librarian)
5 — Do *all* searches through an intermediary

THIS DATA WILL BE USED TO DETERMINE WHETHER PEOPLE WITH DIFFERENT BACKGROUNDS HAVE DIFFERENT TECHNICAL COMMUNICATION PRACTICES

26 What is your gender? 1 — Male 2 — Female 198

27 What is your level of education? 199

1 — No degree
2 — Bachelors
3 — Masters
4 — Doctorate
5 — Other

28 How many years of professional work experience do you have? Years 200 201

29 Type of organization where you work? (Circle Only One Number) 202

1 — Academic
2 — Industrial
3 — Not-for-profit
4 — Government (Non-NASA)
5 — NASA
6 — Other

(OVER)

30. What are your present professional duties? (Circle Only *One* Number)

01 — Research
02 — Administration/Mgt. (for profit)
03 — Administration/Mgt. (not-for-profit sector)
04 — Design/Development
05 — Teaching/Academic
06 — Manufacturing/Production
07 — Private Consultant
08 — Service/Maintenance
09 — Marketing/Sales
10 — Other _____

203
204

31. What is your AIAA interest group? (Circle Only *One* Number)

1 — Aerospace Science
2 — Aircraft Systems
3 — Structures, Design, and Test
4 — Propulsion and Energy
5 — Aerospace and Information Systems
6 — Administration/Management
7 — Other _____

205

32. Is American English your first (native) language? 1 — Yes 2 — No

206

33. Are you an Engineer or a Scientist? 1 — Engineer 2 — Scientist

207

34. Are there comments you would like to add about topics covered in this questionnaire?

_____

_____

_____

_____

_____

_____

_____

35. What can be done to improve technical communications in aeronautics?

_____

_____

_____

_____

_____

_____

_____

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16 Abstract

Data collected from an exploratory study concerned with the technical communications practices of aerospace engineers and scientists were analyzed to test the primary assumption that aerospace managers and nonmanagers have different technical communications practices. Five assumptions were established for the analysis. Aeroapace managers and nonmanagers were found to have different technical communications practices for three of the five assumptions tested. Although aerospace managers and nonmanagers were found to have different technical communications practices, the evidence was neither conclusive nor compelling that the presumption of "difference" in "practices" could be attributed to the duties performed by aerospace managers and nonmanagers.

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