NASA Technical Memorandum 101626

Technical Communications in Aeronautics: Results of an Exploratory Study

An Analysis of Profit Managers' and Nonprofit Managers' Responses

Thomas E. Pinelli, Myron Glassman,
Rebecca O. Barclay, and Walter E. Oliu

OCTOBER 1989

NASA

NASA Technical Memorandum 101626

Technical Communications in Aeronautics: Results of an Exploratory Study

An Analysis of Profit Managers' and Nonprofit Managers' Responses

Thomas E. Pinelli
Langley Research Center
Hampton, Virginia

Myron Glassman
Old Dominion University
Norfolk, Virginia

Rebecca O. Barclay
Rensselaer Polytechnic Institute
Troy, New York

Walter E. Oliu
U. S. Nuclear Regulatory Commission
Washington, DC

National Aeronautics
and Space Administration

Langley Research Center
Hampton, Virginia 23665

Recommended Citation:

Pinelli, Thomas E.; Myron Glassman; Rebecca O. Barclay, and Walter E. Oliu. *Technical Communications in Aeronautics: Results of an Exploratory Study—An Analysis of Profit Managers' and Nonprofit Managers' Responses.* Washington, DC: National Aeronautics and Space Administration. NASA TM-101626. October 1989. 71 p. (Available from NTIS, Springfield, VA.)

CONTENTS

LIST OF TABLES

TECHNICAL COMMUNICATIONS IN AERONAUTICS:
RESULTS OF AN EXPLORATORY STUDY

AN ANALYSIS OF PROFIT MANAGERS' AND NONPROFIT MANAGERS' 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 2,000 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 cutoff date.

The questionnaire used contained 35 questions: 25 concerned technical communications in aeronautics, 8 concerned demographic information about the survey respondents, and 2 were open-ended to allow survey respondents to comment on the topics 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., February 1989). An analysis of the responses of managers and nonmanagers to the data collected in

the exploratory study is presented in NASA Technical Memorandum 101625 (Pinelli, et al., August 1989).

BACKGROUND FOR THE ANALYSIS OF PROFIT MANAGERS' AND NONPROFIT MANAGERS' RESPONSES

This report represents an analysis of responses from managers in profit and nonprofit organizations to the data collected in the exploratory study (hereafter referred to as profit and nonprofit managers). These responses were analyzed to test the primary assumption that profit and nonprofit managers in the aerospace community have different technical communications practices.

The basis for this assumption is that profit and nonprofit organizations have different communication goals. Consequently, these two groups of managers 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 profit and nonprofit managers, in general, and profit and nonprofit managers in the aerospace community, in particular, have different technical communications practices. Murray (1975) suggests the convergence of public and private organizations and a corresponding need to view management

strategies in all types of organizations "as a generic process." Rainey, Backoff, and Levine (1976), on the other hand, state that it is "premature to discount the significance of public and private differences" and the implications that these differences hold for the management of public and private organizations.

The literature clearly establishes that accepted management standards differ in the public and private sectors. (See, for example Lindblom, 1977.) Ring and Perry (1985) recognize basic distinctions between the public and private sectors and suggest that these distinctions "are critical to understanding differences in strategic management processes." Rainey, Backoff, and Levine (1975) reviewed the attributes of public vis-a-vis private organizations in terms of environmental factors, organization-environment transactions, and internal structures and processes and found "indications of a number of important differences between public and private organizations, which cannot be ignored in considerations of management research, training, and practice."

Few studies have compared the communications habits and practices of managers in science intensive organizations. Rather these studies have concentrated on nonmanagement

engineers and scientists in profit R&D organizations. (See, for example Allen, 1977.) Bozeman, Roering, and Slusher (1978), in their investigation of social structure and the flow of STI in public (nonprofit) agencies, speculate that while their are similarities in the information-gathering habits and practices of public (nonprofit) and profit managers and engineers and scientists, there are also incongruities which stem from the reasons the two groups seek and use information. For example, Bozeman and Blankenship (1979) found that like engineers in profit organizations, public (nonprofit) managers prefer informal, contacts with colleagues when seeking information. On the other hand, they point out that the information acquisition patterns are divergent in that the objectives for acquiring the information are typically quite different (Bozeman, Roering, and Slusher, 1978).

Although certain studies have compared the responses of managers and nonmanagers in specific disciplines (see, for example Pinelli et al., August 1989), few attempts have been made to discover if managers in science-intensive public (nonprofit) organizations have different technical communications habits and practices than their counterparts in private (profit) organizations.

The assumption of difference is stated as a research question, "Do profit and nonprofit managers in the aerospace community have different technical communications practices?," rather than as 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 profit and nonprofit managers do not provide a sufficient research foundation.

Assumptions

Five secondary assumptions were made regarding the five 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 profit and nonprofit managers in the aerospace community. A significant difference in the reported responses of profit and nonprofit managers 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 profit and nonprofit managers in the aerospace community. A significant difference in the reported responses of profit and nonprofit managers 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 profit and nonprofit managers in the aerospace community. A significant difference in the reported responses of profit and nonprofit managers 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 profit and nonprofit managers in the aerospace community. A significant difference in the reported responses of profit and nonprofit managers 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 differ for profit and nonprofit managers in the aerospace community. A significant difference in the reported responses of profit and nonprofit managers regarding "use and importance" would support the presumption of different technical communications practices between the two groups.

PRESENTATION AND DISCUSSION OF PROFIT MANAGERS' AND NONPROFIT MANAGERS' RESPONSES

The data in this report are presented for each survey objective and discussed in terms of responses from managers in profit and nonprofit organizations. Background data collected as part of the survey revealed that approximately 24 percent of the 606 respondents held management positions. Of those 145 respondents, approximately 64 percent (94) held administrative/managerial positions in the profit sector and 36 percent (51) held administrative/management positions in the nonprofit sector of the U.S. aerospace community.

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 responses of profit and nonprofit managers. 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 number of responses to 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 profit managers lies within $\pm$10.1 percent of the sample proportion (**p**) and the true population proportion (**P**) for nonprofit managers lies within $\pm$13.6 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.

One hundred percent of the profit managers and 98 percent of the nonprofit managers surveyed (Table 1) indicate that the ability to communicate technical information effectively is

important. Two percent of the nonprofit managers indicate that this ability is not at all important.

Table 1. Importance of Technical Communications

How Important	Profit Managers		Nonprofit Managers	
	No.	%	No.	%
Very	86	92.5	43	84.3
Somewhat	7	7.5	7	13.7
Not at all	0	0.0	1	2.0
Total	93	100.0	51	100.0

Profit managers spend an average of 13.5 hours per week communicating technical information to others (Table 2), and nonprofit managers spend an average of 13.9 hours per week. Based on a 40-hour work week, profit and nonprofit managers spend approximately 34 and 35 percent, respectively, of their work week communicating technical information to others.

Table 2. Time Spent Communicating Technical Information to Others

Time Spent Per Week, Hour	Profit Managers		Nonprofit Managers	
	No.	%	No.	%
5 or less	13	14.3	9	18.0
6 to 10	33	36.2	16	30.0
11 to 20	37	40.7	21	42.0
21 or more	8	8.8	5	10.0
Total	91	100.0	50	100.0
Mean	13.5		13.9	

Both groups spend an average of 13 hours a week working with technical communications received from others (Table 3), which is approximately 33 percent of their 40-hour work week.

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

Time Spent Per Week, Hour	Profit Managers		Nonprofit Managers	
	No.	%	No.	%
5 or less	8	8.7	6	12.0
6 to 10	42	46.2	23	46.0
11 to 20	36	39.6	18	36.0
21 or more	5	5.5	3	6.0
Total	91	100.0	50	100.0
Mean	13.0		13.0	

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 67 percent of a 40-hour work week for both groups.

Approximately 59 percent of the managers from both types of organizations indicate that as they advanced professionally, the amount of time they spent communicating technical information to others increased (Table 4). Approximately 9 percent of the profit managers and 14 percent of the nonprofit managers indicate that as they advanced professionally, the amount of

time they spent communicating technical information to others stayed the same.

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

Time Spent Communicating	Profit Managers		Nonprofit Managers	
	No.	%	No.	%
Increased	54	58.7	30	58.8
Stayed the same	8	8.7	7	13.7
Decreased	30	32.6	14	27.5
Total	92	100.0	51	100.0

Approximately 33 percent of the profit managers and 28 percent of the nonprofit managers indicate that the amount of time they spent communicating technical information to others decreased as they advanced professionally.

Approximately 65 percent of the profit managers and 59 percent of the nonprofit managers 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	Profit Managers		Nonprofit Managers	
	No.	%	No.	%
Increased	59	64.8	30	58.9
Stayed the same	13	14.3	12	23.5
Decreased	19	20.9	9	17.6
Total	91	100.0	51	100.0

Approximately 14 percent of the profit managers and 24 percent of the nonprofit managers indicate that the amount of time they spent working with technical communications received from others stayed the same as they advanced professionally. Approximately 21 percent of the profit managers and 18 percent of the nonprofit managers indicate that the amount of time they spent working with technical communications received from others decreased as they advanced professionally.

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 profit and nonprofit managers (Table 6). On the average, profit managers produced 54.8 memos, 31.9 letters, and 9.6 A/V materials in a 6-month period. On the average, nonprofit managers produced 38.6 memos, 28.1 letters, and 9.7 A/V materials.

Table 6. Production of Technical Information Products

Products	6-month average	
	Profit Managers	Nonprofit Managers
Letters	*31.9	28.1
Memos	*54.8	38.6
Technical reports-Government	2.0	2.4
Technical reports-Other	*2.4	0.8
Proposals	*2.7	0.9
Technical manuals	*0.4	0.2
Computer program documentation	0.7	0.3
Journal articles	*0.2	0.5
Conference/Meeting papers	*1.6	1.3
Trade/Promotional literature	*0.3	0.1
Press releases	0.3	0.4
Drawings/Specifications	*3.2	0.2
Speeches	*4.1	2.8
Audio/Visual materials	9.6	9.7

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

Based on average production, a list of the five technical information products most frequently produced by profit and nonprofit managers follows:

Most Frequently Produced By Profit Managers	**Most Frequently Produced By NonProfit Managers**
Memos	Memos
Letters	Letters
A/V materials	A/V materials
Speeches	Speeches
Proposals	Government technical reports

The number of technical information products produced by both profit and nonprofit managers were compared using a t-test to determine significant differences (Table 6). Of the 14 comparisons, 10 were significantly different. Profit managers prepared more letters, memos, other technical reports,

proposals, technical manuals, conference/meeting papers, trade/promotional literature, drawings/specifications, and speeches. Nonprofit managers prepared more journal articles.

Memos, letters, and trade/promotional literature are the technical information products most frequently used by profit managers; memos, letters, and A/V materials are the technical information products most frequently used by nonprofit managers (Table 7).

Table 7. Use of Technical Information Products

Products	1-month average	
	Profit Managers	Nonprofit Managers
Letters	*36.1	21.3
Memos	*45.7	25.9
Technical reports-Government	*3.4	6.0
Technical reports-Other	*4.8	5.1
Proposals	*2.1	3.4
Technical manuals	1.0	1.2
Computer program documentation	*2.8	1.2
Journal articles	*5.9	5.4
Conference/Meeting papers	*4.3	3.6
Trade/Promotional literature	*8.7	4.6
Drawings/Specifications	*5.7	2.6
Audio/Visual materials	6.5	7.4

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

On the average, profit managers used 45.7 memos, 36.1 letters, 8.7 trade/promotional literature in a 1-month period. Nonprofit managers used 25.9 memos, 21.3 letters, and 7.4 A/V materials 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 Profit Managers	Most Frequently Used By Nonprofit Managers
Memos	Memos
Letters	Letters
Trade/Promotional literature	A/V materials
A/V materials	Government technical reports
Journal articles	Journal articles

The number of technical information products used by both profit and nonprofit managers was compared by using a t-test to determine significant differences (Table 7). Of the 12 comparisons, 10 were significantly different. Profit managers used more letters, memos, computer program documentation, journal articles, and conference/meeting papers, trade/ promotional literature, and drawings/specifications. Nonprofit managers used more government technical reports, other technical reports, and proposals.

Profit managers and nonprofit managers seek the help of both people and other information sources to prepare technical information products (Table 8). Combining the "always" and "usually" responses indicates that profit managers most frequently sought the help of secretaries, followed by other colleagues and a thesaurus/dictionary. Nonprofit managers most frequently sought the help of secretaries, followed by a thesaurus/dictionary, and other colleagues.

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

Sources of Help	Number of Respondents	Percent of Respondents			
		Always	Usually	Sometimes	Never
		Profit Managers			
Other colleagues	92	6.5	45.7	47.8	0.0
Secretaries	*93	40.9	24.7	25.8	8.6
Technical writers or editors	88	0.0	5.7	48.9	45.5
A thesaurus/dictionary	90	7.8	23.3	55.6	13.3
A style manual	88	1.1	3.4	28.4	67.0
A grammar hotline	86	0.0	0.0	3.5	96.5
		Nonprofit Managers			
Other colleagues	51	9.8	31.4	58.8	0.0
Secretaries	51	17.6	37.3	31.4	13.7
Technical writers or editors	46	0.0	4.3	43.5	52.2
A thesaurus/dictionary	*50	24.0	22.0	48.0	6.0
A style manual	48	0.0	6.3	33.3	60.4
A grammar hotline	48	0.0	2.1	0.0	97.9

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

Sources of help used to prepare/write technical communications were compared using a t-test to determine significant differences. Profit managers were more likely to use a secretary as a source of help to write/prepare technical communications, whereas nonprofit managers were more likely to use a thesaurus/dictionary.

From the available data, it is difficult to determine why colleagues and a thesaurus/dictionary were used second and third by profit managers and third and second by nonprofit managers 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 writers and editors are so infrequently used because of unavailability or some other reason.

Profit managers and nonprofit managers prepare artwork for their visual aids in various ways (Table 9). Approximately

Table 9. How Artwork Is Produced

Production Method	Profit Managers		Nonprofit Managers	
	No.	%	No.	%
Do own artwork without computer	8	8.6	4	8.0
Do own artwork with computer	16	17.2	18	36.0
Graphics department does artwork	23	24.7	14	28.0
Sometimes do it and sometimes graphics department does it	25	26.9	10	20.0
Secretary does it	18	19.4	1	2.0
Artwork is prepared elsewhere	3	3.2	3	6.0
Total	93	100.0	50	100.0

27 percent of the profit managers use a combination of self-preparation and a graphics department, whereas approximately 17 percent prepare their own artwork with a computer. Approximately 36 percent of the nonprofit managers, 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 (20.0 percent). Nonprofit managers were more likely than profit managers to prepare their own artwork with a computer and were less likely than profit managers to use a combination of self-preparation and a graphics department. Profit managers, on the other hand, were more likely than nonprofit managers to have a secretary prepare their artwork.

Profit managers and nonprofit managers produce various types of technical information in the performance of their duties (Table 10).

Table 10. Types of Technical Information Produced
[n = 93 for profit managers; n = 51 for nonprofit managers]

Types of Technical Information	Profit Managers		Nonprofit Managers	
	No.	%	No.	%
Scientific and technical information	80	86.0	46	90.2
Experimental techniques	28	30.1	19	37.3
Codes of standards and practices	23	24.7	11	21.6
Design procedures and methods	48	*51.6	15	30.0
Computer programs	36	38.7	19	37.3
Government rules and regulations	5	*5.4	20	40.0
In-house technical data	82	88.2	42	82.4
Product and performance characteristics	61	*65.6	22	43.1
Economic information	49	52.7	22	43.1
Technical specifications	61	*65.6	21	41.2
Patents	22	*23.7	4	7.8

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

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

Most Frequently Produced By Profit Managers	**Most Frequently Produced By Nonprofit Managers**
In-house technical data	Scientific and technical information
Scientific and technical information	In-house technical data
*Technical specifications	*Economic information
*Product and performance characteristics	*Product and performance characteristics
Economic information	Technical specifications
Design procedures and methods	Government rules and regulations

*indicates a tie for third position

The types of technical information produced were compared using a t-test to determine statistical significance. Of the 11 comparisons, 5 were significantly different. Profit managers were more likely than nonprofit managers to produce design procedures and methods, product and performance characteristics, technical specifications, and patents. Nonprofit managers, on the other hand, were more likely than profit managers to produce government rules and regulations.

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

Table 11. Types of Technical Information Used
[n = 93 for profit managers; n = 51 for nonprofit managers]

Types of Technical Information	Profit Managers		Nonprofit Managers	
	No.	%	No.	%
Scientific and technical information	89	95.7	50	98.0
Experimental techniques	46	49.5	27	52.9
Codes of standards and practices	50	53.8	19	37.3
Design procedures and methods	59	*63.4	19	37.3
Computer programs	66	71.0	34	66.7
Government rules and regulations	75	80.6	42	82.4
In-house technical data	89	95.7	47	92.2
Product and performance characteristics	69	74.2	34	66.7
Economic information	54	58.1	23	45.1
Technical specifications	77	82.8	35	68.6
Patents	20	*21.5	4	7.8

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

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

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

*indicates a tie for 1st and 5th place, respectively

The types of technical information used by profit and nonprofit managers were compared using a t-test to determine significant differences. Of the 11 comparisons, 2 were significantly different. Profit managers were more likely than nonprofit managers to use design procedures and methods and patents.

As shown in Table 12, profit managers and nonprofit managers 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
		Profit Managers			
Personal knowledge	93	28.0	53.8	18.3	0.0
Informal discussions with colleagues	92	12.0	64.1	23.9	0.0
Discussions with supervisors	90	3.3	25.6	60.0	11.1
Discussions with experts in organization	93	19.4	57.0	23.7	0.0
Discussions with experts outside of organization	92	5.4	21.7	68.5	4.3
Technical reports-Government	92	1.1	15.2	71.7	12.0
Technical reports-Other	93	1.1	18.3	76.3	4.3
Professional journals/conference meeting papers	92	1.1	19.6	60.9	18.5
Textbooks	93	0.0	14.0	72.0	14.0
Handbooks and standards	90	2.2	13.3	71.1	13.3
Technical information sources, such as on-line data bases, indexing and abstracting guides, CD-ROM, and current awareness tools	91	0.0	6.6	41.8	51.6
Librarians/technical information specialists	90	0.0	5.6	66.7	27.8
		Nonprofit Managers			
Personal knowledge	*49	51.0	38.8	10.2	0.0
Informal discussions with colleagues	51	25.5	51.0	23.5	0.0
Discussions with supervisors	51	11.8	31.4	47.1	9.8
Discussions with experts in organization	51	25.5	41.2	31.4	2.0
Discussions with experts outside of organization	51	2.0	31.4	62.7	3.9
Technical reports-Government	51	5.9	29.4	64.7	0.0
Technical reports-Other	51	5.9	31.4	60.8	2.1
Professional journals/conference meeting papers	51	11.8	29.4	47.1	11.8
Textbooks	51	3.9	35.3	49.0	11.8
Handbooks and standards	50	4.0	16.0	62.0	18.0
Technical information sources, such as on-line data bases, indexing and abstracting guides, CD-ROM, and current awareness tools	48	0.0	6.3	47.9	45.8
Librarians/technical information specialists	51	0.0	17.6	62.7	19.6

* Differences between profit managers and nonprofit managers 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 profit and nonprofit managers to solve technical problems, given in decreasing order of frequency:

SOURCES USED BY PROFIT MANAGERS TO SOLVE TECHNICAL PROBLEMS

Sources	Percent of Cases
1. Personal knowledge	81.8
2. Discussions with experts within the organization	76.4
3. Informal discussions with colleagues	76.1
4. Discussions with supervisors	28.9
5. Discussions with experts outside the organization	27.1
6. Journal and conference/meeting papers	20.7
7. Technical reports - others	19.4
8. Technical reports - government	16.3
9. Handbooks and standards	15.5
10. Textbooks	14.0
11. Technical information sources such as on-line databases	6.6
12. Librarians/technical information specialists	5.6

SOURCES USED BY NONPROFIT MANAGERS TO SOLVE TECHNICAL PROBLEMS

Sources	Percent of Cases
1. Personal knowledge	89.8
2. Informal discussion with colleagues	76.5
3. Discussions with experts within the organization	66.7
4. Discussions with supervisors	43.2
5. Journals and conference/meeting papers	41.2
6. Textbooks	39.2
7. Technical reports - other	37.3
8. Technical reports - government	35.3
9. Discussions with experts outside of your organization	33.4
10. Handbooks and standards	20.0
11. Librarians/technical information specialists	17.6
12. Technical information sources such as on-line databases	6.3

The profit and nonprofit managers 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. Profit managers turn to experts outside the organization more frequently than do nonprofit managers. Nonprofit managers use textbooks more frequently than do profit managers. Statistically, however, nonprofit managers were more likely than profit managers to use personal knowledge to solve technical problems.

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

To obtain the views of profit and nonprofit managers 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. In addition, they were asked to indicate the degree to which the course(s) helped them

communicate technical information and to give their opinions regarding topics (e.g., principles and mechanics), on-the-job communications, and types of technical reports they would recommend be included in an undergraduate technical communications course.

Approximately 29 percent of the profit managers and 22 percent of the nonprofit managers 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	Profit Managers		Nonprofit Managers	
	No.	%	No.	%
Undergraduate	27	29.0	11	21.6
After graduation	17	18.3	12	23.5
Both undergraduate and after graduation	26	28.0	12	23.5
No	23	24.7	16	31.4
Total	93	100.0	51	100.0

Approximately 18 percent of the profit managers and 24 percent of the nonprofit managers had taken such a course after graduation and approximately 28 percent of the profit managers and 24 percent of the nonprofit managers had done so both as undergraduates and postgraduates. Approximately 25 percent of the profit managers and 31 percent of the nonprofit managers indicated they had taken no such course.

Approximately 96 percent of the profit managers and 100 percent of the nonprofit managers who had taken any course(s) in technical communications/writing indicated that the course(s) had helped them to communicate technical information (Table 14).

Table 14. Helpfulness of Technical Communications/Writing Coursework

How Helpful	Profit Managers		Nonprofit Managers	
	No.	%	No.	%
A lot	31	44.3	13	37.1
A little	36	51.4	22	62.9
Did not help	3	4.3	0	0.0
Total	70	100.0	35	100.0

Approximately 44 percent of the profit managers indicated that the course(s) helped them "a lot" and 51 percent indicated that the course(s) helped them "a little." Approximately 37 percent of the nonprofit managers indicated that the course(s) helped them "a lot" and 63 percent indicated that the course(s) helped them "a little." Only 4.3 percent of the profit managers and 0.0 percent of the nonprofit managers indicated that their course(s) had not helped them.

The percentages of "yes" responses to the list of principles to be included in an undergraduate technical communications course range from a high of 96.8 and 98.0 percent (organizing information) respectively for profit and nonprofit

profit managers and 56.0 percent (using information technology) for nonprofit managers. (See Table 15.)

Table 15. Principles Recomended for Inclusion in Undergradate Technical Communications Course for Aeronautical Engineers and Scientists [n = 93 for profit managers; n = 50 for nonprofit managers]

Principles	Profit Managers		Nonprofit Managers	
	No.	%	No.	%
Defining the communication's purpose	84	90.3	46	92.0
Assessing readers' needs	79	86.8	37	75.5
Organizing information	90	96.8	49	98.0
Developing paragraphs (introductions, transitions, and conclusions)	81	87.1	45	90.0
Writing sentences (active vs. passive voice, parallel ideas, shifts in person or tense)	71	76.3	44	88.0
Using standard English grammar	72	77.4	41	82.0
Notetaking and quoting	45	48.4	29	59.2
Editing and revising	63	67.7	43	*86.0
Choosing words (avoiding wordiness, jargon, slang, sexist terms)	76	81.7	41	83.7
Using information technology (video conferencing, electronic data bases, etc.)	59	63.4	28	56.0

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

Seven of the 10 topics (principles) received "yes" responses of greater than 75 percent from profit managers, and 8 of the 10 topics received "yes" responses of greater than 75 percent from nonprofit managers. These topics are listed on page 29.

Topic	Profit Managers Percentage Response	Nonprofit Managers Percentage Response
Organizing information	96.8	98.0
Defining the communication's purpose	90.3	92.0
Developing paragraphs	87.1	90.0
Assessing readers' needs	86.8	75.5
Choosing words	81.7	83.7
Writing sentences	76.3	88.0
Using standard English grammar	77.4	82.0
Editing and revising	*	86.0

*Only 67.7 percent of the profit managers recommended the inclusion of this principle.

Statistically, however, nonprofit managers were more likely than profit managers to recommend the inclusion of editing and revising in an undergraduate technical communications course.

The percentage of "yes" responses of the list of mechanics to be included in an undergraduate technical communications course ranges from highs of 76.4 percent (punctuation and spelling) for profit managers and 86 percent (punctuation) for nonprofit managers to a low of approximately 47 percent (abbreviations) for profit managers and 46 percent (acronyms) for nonprofit managers (Table 16).

Table 16. Mechanics Recommended for Inclusion in Undergraduate Technical Communications Course for Aeronautical Engineers and Scientists [n = 89 for profit managers; n = 50 for nonprofit managers]

Mechanics	Profit Managers		Nonprofit Managers	
	No.	%	No.	%
Abbreviations	41	46.6	26	52.0
Acronyms	45	50.6	23	46.0
Capitalization	59	66.3	32	65.3
Numbers	43	50.0	24	48.0
Punctuation	68	76.4	43	86.0
References	65	73.0	41	82.0
Spelling	68	*76.4	30	60.0
Symbols	49	55.1	23	46.9

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

Six of the eight topics (mechanics) received "yes" responses of greater than 50 percent from profit managers and five of the eight topics received responses of greater than 50 percent from nonprofit managers. A list of these topics follows:

Topic	**Profit Managers** Percentage Response	**Nonprofit Managers** Percentage Response
Punctuation	76.4	86.0
References	73.0	82.0
Spelling	76.4	60.0
Capitalization	66.3	65.3
Symbols	55.1	*
Abbreviations	**	52.0
Acronyms	50.6	*

*Only 46.9 percent and 46.0 percent of nonprofit managers recommended the inclusion of symbols and acronyms, respectively.

**Only 46.6 percent of profit managers recommended the inclusion of abbreviations.

Statistically, however, profit managers were more likely than nonprofit managers to recommend the inclusion of spelling in an undergraduate technical communications course.

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 highs of approximately 97 percent (oral presentations) and 98 percent (oral presentations) for profit managers and nonprofit managers respectively to lows of approximately 25 percent (newsletter articles) and 26 percent (newsletter articles) for profit managers and nonprofit managers respectively (Table 17).

Table 17. On-the-Job Communications Recommended for Inclusion in Undergraduate Technical Communications Course for Aeronautical Engineers and Scientists [n = 93 for profit managers; n = 51 for nonprofit managers]

On-the-Job Communications	Profit Managers		Nonprofit Managers	
	No.	%	No.	%
Abstracts	52	56.5	35	68.6
Letters	67	72.0	43	84.3
Memos	77	82.8	43	84.3
Instructions	49	53.3	31	60.8
Journal articles	30	32.3	27	*52.9
Literature reviews	28	30.4	21	41.2
Manuals	39	41.9	25	49.0
Newsletter articles	23	24.7	13	25.5
Oral presentations	90	96.8	50	98.0
Specifications	52	55.9	20	40.0
Use of information sources	73	78.5	39	78.0

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

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

Topic	**Profit Managers** Percentage Response	**Nonprofit Managers** Percentage Response
Oral presentations	96.8	98.0
Memos	82.8	84.3
Use of information sources	78.5	78.0
Letters	72.0	84.3
Abstracts	56.5	68.6
Instructions	53.3	60.8
Specifications	55.9	*
Journal articles	**	52.9

*Only 40.0 percent of nonprofit managers recommended the inclusion of specifications.
**Only 32.3 percent of profit managers recommended the inclusion of journal articles.

Statistically, however, nonprofit managers were more likely than profit managers to recommend the inclusion of journal articles in an undergraduate technical communications course.

Respondents were asked to consider specific types of technical reports for inclusion in an undergraduate technical communications course (Table 18). Progress reports and test reports were the first and second choices of profit managers (83.7 percent and 80.2 percent). Test reports and progress reports were the first and second choices of nonprofit

managers (80.4 percent and 78.7 percent). As shown in Table 18, all types of technical reports received "yes" responses from more than 50 percent of both profit and nonprofit managers.

Table 18. Types of Technical Reports Recommended for Inclusion in Undergraduate Technical Communications Course for Aeronautical Engineers and Scientists [n = 86 for profit managers; n = 47 for nonprofit managers]

Types of Technical Reports	Profit Managers		Nonprofit Managers	
	No.	%	No.	%
Feasibility	58	68.2	28	59.6
Investigative	57	67.1	30	63.8
Laboratory	63	74.1	32	68.1
Progress	72	83.7	37	78.7
Test	69	80.2	37	80.4
Trip	53	61.6	27	57.4
Trouble	50	58.8	25	54.3

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-verage) technical communications products "produced" and "used" by profit and nonprofit managers.

Most Frequently Produced by Profit Managers	Most Frequently Used by Profit Managers	Most Frequently Recommended By Profit Managers
Memos	Memos	Oral presentations
Letters	Letters	Memos
A/V materials	Trade/Promotional literature	Use of information sources
Speeches	A/V materials	Letters
Drawings/ specifications	Journal articles	Technical reports

The list of topics most frequently recommended by profit managers compares quite favorably with the technical communications products "produced" and "used" by profit 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 "seventh" in terms of products "produced" and "fifth" in terms of products "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, profit

and nonprofit managers tend to search for information themselves. Therefore, would improving their ability to use information sources better prepare managers to conduct their own searches for the information needed to solve technical problems?

Most Frequently Produced By Nonprofit Managers	**Most Frequently Used By Nonprofit Managers**	**Most Frequently Recommended By Nonprofit Managers**
Memos	Memos	Oral presentations
Letters	Letters	*Memos
A/V materials	A/V materials	*Letters
Speeches	Government	Use of
Government	technical reports	Information sources
technical reports	Journal articles	Abstracts
		Technical reports

*indicates a tie for second place

The list of topics most frequently recommended by nonprofit managers compares quite favorably with the technical communications products "produced" and "used" by nonprofit managers. 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 on the list of products "produced" and "used" by nonprofit managers. Considered as a group, technical reports would make the list of recommended on-the-job topics. Technical reports ranked fifth on the list of recommended topics, fifth on the

list of products "produced," and fourth on the list of products "used" by nonprofit managers.

The inclusion of "use of information sources," which ranked third on the list of on-the-job communications most frequently recommended by nonprofit managers, supports the conclusion stated earlier that nonprofit managers tend to search for information themselves when solving technical problems. Consequently, would improving their ability to use information sources better prepare nonprofit managers to conduct their own searches for information when solving technical problems?

Overall, the lists of products produced, used, and recommended by profit and nonprofit managers compare favorably. Letter, memos, and oral presentation and their components (i.e., A/V materials and speeches) are common to both groups. However, the technical report appears consistently on the nonprofit managers' "top five" lists of products produced, used, and recommended for inclusion, whereas it does not appear on the profit managers' "top five" lists.

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 88 percent of the profit managers and 98 percent of the nonprofit managers use a library or technical information center (Table 19). The frequency rates vary among

Table 19. Use of Library or Technical Information Center

Frequency of Use	Profit Managers		Nonprofit Managers	
	No.	%	No.	%
Daily	1	1.1	0	0.0
Two to six times a week	8	8.6	1	2.0
Once a week	8	8.6	9	17.6
Two to three times a month	17	18.3	7	13.7
Once a month	12	12.9	10	19.6
Less than once a month	36	38.7	23	45.1
Do not use	11	11.8	1	2.0
Total	93	100.0	51	100.0

profit and nonprofit managers, however, with approximately 18 percent of the profit managers using a library or technical information center one or more times a week and approximately 20 percent of the nonprofit managers using a library or technical information center one or more times a week. Approximately 31 percent of the profit managers and approximately 33 percent of the nonprofit managers use a library

or technical information center one or more times a month. Approximately 39 percent of the profit managers and approximately 45 percent of the nonprofit managers use a library or technical information center less than once a month.

Fewer than one-quarter (24.7 percent) of the profit managers and fewer than one-half (43.1 percent) of the nonprofit managers use on-line (electronic) databases (Table 20).

Table 20. Use of Electronic Databases

Use	Profit Managers		Nonprofit Managers	
	No.	%	No.	%
Yes	23	24.7	22	43.1
No	70	75.3	29	56.9
Total	93	100.0	51	100.0

Of those respondents who use databases, none of the profit managers and none of the nonprofit managers do all of their own searches (Table 21).

Table 21. How Electronic Databases Are Searched

How Searched	Profit Managers		Nonprofit Managers	
	No.	%	No.	%
Do all searches yourself	0	0.0	0	0.0
Do most searches yourself	2	9.1	2	9.5
Do half by yourself and half through an intermediary (e.g. librarian)	2	9.1	3	14.3
Do most searches through an intermediary (e.g. librarian)	9	40.9	8	38.1
Do all searches through an intermediary	9	40.9	8	38.1
Total	22	100.0	21	100.0

Fewer than 10 percent of the profit and nonprofit managers do most of their own database searches. Approximately 9 percent of the profit managers and 14 percent of the nonprofit managers do one-half of their searches and have the other one-half done by an intermediary. Approximately 82 percent of the profit managers use an intermediary to do most or all of their electronic database searches, and about 67 percent of the nonprofit managers 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 88 percent of the profit managers and 92 percent of the nonprofit managers use computer technology for preparing technical communications (Table 22). Profit managers were fairly evenly divided in terms of their degree of use:

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

Frequency	Profit Managers		Nonprofit Managers	
	No.	%	No.	%
Always	22	23.7	21	41.2
Usually	34	36.6	9	17.6
Sometimes	25	26.8	13	25.5
Never	12	12.9	8	15.7
Total	93	100.0	51	100.0

approximately 24 percent "always" use, approximately 37 percent "usually" use, and approximately 27 percent "sometimes" use computer technology for preparing technical communications. Approximately 41 percent of the nonprofit managers "always" use, approximately 18 percent "usually" use, and approximately 26 percent "sometimes" use computer technology.

Approximately 91 percent of the profit managers and 88 percent of the nonprofit managers who use computer technology indicate that this technology has increased their ability to communicate technical information (Table 23). Approximately 49 percent of the profit managers and approximately 68 percent of the nonprofit managers 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	Profit Managers		Nonprofit Managers	
	No.	%	No.	%
A lot	40	49.4	29	67.5
A little	34	42.0	9	20.9
Not at all	7	8.6	5	11.6
Total	81	100.0	43	100.0

Profit and nonprofit managers use a variety of software for preparing written technical communications (Table 24).

Table 24. Use of Software For Preparing Written Technical Communications [n = 80 for profit managers; n = 42 for nonprofit managers]

Type of Software	Profit Managers		Nonprofit Managers	
	No.	%	No.	%
Word processing	72	90.0	41	95.3
Outliners and prompters	8	10.0	3	7.1
Grammar and style checkers	13	16.3	3	7.1
Spelling checkers	45	56.3	28	65.1
Thesaurus	27	33.7	14	33.3
Business graphics	34	42.5	23	54.8
Scientific graphics	46	57.5	22	52.4

The percentage of "yes" responses range from a high of 90.0 percent (word processing) for profit managers and 95.3 percent for nonprofit managers to a low of 10 percent (outliners and prompters) for profit managers and 7.1 percent (outliners and prompters; grammar and style checkers) for nonprofit managers. A list of the five most frequently used

types of software for preparing written technical communications follows:

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

Both profit and nonprofit managers make considerable use of word processing software for preparing written technical communications. There was little variation among the two groups of managers in terms of the types of software used and percentage who use them.

Slightly less than two thirds of the profit managers (62.5 percent) and slightly more than half (54.8 percent) of the nonprofit managers never use an integrated graphics, text, and modeling engineering workstation for preparing written technical communications (Table 25). Of those who do use such a work-

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

Frequency	Profit Managers		Nonprofit Managers	
	No.	%	No.	%
Always	2	2.5	6	14.3
Usually	8	10.0	5	11.9
Sometimes	20	25.0	8	19.0
Never	50	62.5	23	54.8
Total	80	100.0	42	100.0

station, approximately 13 percent of the profit managers and approximately 26 percent of the nonprofit managers "always" or "usually" use it, and 25 percent of the profit managers and 19 percent of the nonprofit managers "sometimes" use it for preparing written technical communications.

Approximately 56 percent of the profit managers and 46 percent of the nonprofit managers use electronic or desk-top publishing systems for preparing written technical communications (Table 26). Of those who do use such systems,

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

	Profit Managers		Nonprofit Managers	
Frequency	No.	%	No.	%
Always	6	7.4	3	7.0
Usually	20	25.0	7	16.3
Sometimes	19	23.8	10	23.2
Never	35	43.8	23	53.5
Total	80	100.0	43	100.0

approximately 32 percent of the profit managers "always" or "usually" use them, and approximately 24 percent "sometimes" use them. Approximately 23 percent of the nonprofit managers "always" or "usually" use electronic or desk-top publishing systems, and approximately 23 percent "sometimes" use them.

Profit and nonprofit managers use a variety of information technologies to communicate technical information (Table 27). The percentages of "I already use it" responses range from a high of 94.4 percent (FAX or TELEX) for profit managers and 82.4 percent (FAX or TELEX) for nonprofit managers to a low of 5.8 percent and 8.7 percent (laser disk/video disk/CD-ROM) for profit and nonprofit managers, respectively.

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

Information Technologies	Profit 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	87	33.3	25.3	41.4
Motion picture film	86	19.8	18.6	61.6
Videotape	91	60.4	34.1	5.5
Desk-top/electronic publishing	89	44.9	44.9	10.2
Floppy disks	90	67.8	25.6	6.7
Computer cassette/cartridge tapes	85	27.0	36.5	36.5
Electronic mail	91	*50.5	44.0	5.5
Electronic bulletin boards	86	*16.3	60.4	23.3
FAX or TELEX	90	94.4	3.3	2.3
Electronic databases	85	55.3	34.1	10.6
Video conferencing	88	19.3	61.4	19.3
Teleconferencing	89	68.5	24.7	6.8
Micrographics and microforms	84	17.9	50.0	32.1
Laser disk/video disk/CD-ROM	85	5.8	67.1	27.1
Electronic networks	87	29.9	56.3	13.8
	Nonprofit Managers			
	No.	%	%	%
Audiotapes and cassettes	47	19.1	29.8	51.1
Motion picture film	47	25.5	23.4	51.1
Videotape	50	48.0	40.0	12.0
Desk-top/electronic publishing	49	42.9	44.9	12.2
Floppy disks	47	70.2	21.3	8.5
Computer cassette/cartridge tapes	46	10.9	52.1	37.0
Electronic mail	50	74.0	20.0	6.0
Electronic bulletin boards	48	58.3	31.3	10.4
FAX or TELEX	51	82.4	13.7	3.9
Electronic databases	48	52.1	41.6	6.3
Video conferencing	49	22.5	57.1	20.4
Teleconferencing	49	65.3	26.5	8.2
Micrographics and microforms	46	19.6	30.4	50.0
Laser disk/video disk/CD-ROM	46	8.7	58.7	32.6
Electronic networks	48	43.8	41.7	14.5

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

A list of the information technologies most frequently used by profit managers and nonprofit managers for communicating technical information follows:

Most Frequently Used By Profit Managers	**Most Frequently Used By Nonprofit Managers**
FAX or TELEX	FAX or TELEX
Teleconferencing	Electronic mail
Floppy disks	Floppy Disks
Video tape	Teleconferencing
Electronic databases	Electronic bulletin boards

Both profit and nonprofit managers make considerable use of FAX or TELEX, floppy disks, and teleconferencing. There are, however, some interesting differences between the two groups. Approximately 60 percent of the profit managers use video tape compared to 48 percent of the nonprofit managers. Approximately 58 percent of the nonprofit managers use electronic bulletin boards compared to approximately 16 percent of the profit managers. Similarly, 74 percent of the nonprofit managers use electronic mail compared to approximately 51 percent of the profit managers.

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 ranges from a high of 61.6 percent (motion

picture film) for profit managers and 51.1 percent (motion picture film and audiotapes/cassettes) for nonprofit managers to a low of 2.3 percent (FAX or TELEX) for profit managers and 3.9 percent (FAX or TELEX) for nonprofit managers. 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 Profit Managers	**Least Frequently Used By Nonprofit Managers**
Motion picture film	Motion picture film
Audiotapes and cassettes	Audiotapes and cassettes
Computer cassette/ cartridge tapes	Micrographics and microforms
Micrographics and microforms	Computer cassettes/ 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 67.1 percent (laser/disc/video disc/CD-ROM) for profit managers and 58.7 percent (laser/disc/video disc/CD-ROM) for nonprofit managers to a low of 3.3 percent (FAX or TELEX) for profit managers and 13.7 percent (FAX or TELEX) for nonprofit managers.

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 Profit Managers	**Most Likely to be Used By Nonprofit Managers**
Laser disc/video disc/ CD-ROM	Laser disc/video disc/ CD-ROM
Video conferencing	Video conferencing
Electronic bulletin boards	Computer cassettes/ cartridge tapes
Electronic networks	Desk-top/electronic publishing
Micrographics and microforms	Electronic networks

Considering the 15 information technologies in the list, profit managers were more likely than nonprofit managers to say that they already use electronic mail and may use electronic bulletin boards 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 Profit and Nonprofit Managers in the Aerospace Community.

The responses of profit managers and nonprofit managers to the five questions associated with this assumption were very similar. The importance of communicating technical information effectively is significant to aerospace profit managers and nonprofit managers 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. Therefore, 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 Profit and Nonprofit Managers in the Aerospace Community.

The responses of profit managers and nonprofit managers to the seven questions associated with this assumption were different. Significant differences were found for 10 of the 14

types of technical information products produced. Significant differences were found for 10 of the 12 types of technical information products used. The magnitudes of difference were greatest for the numbers of memos, letters, and drawings/ specifications produced and used. Significant differences existed among the sources of help used by profit managers and nonprofit managers to write/prepare technical communications.

Significant differences also existed in the types of technical information products produced and used by profit and nonprofit managers in the performance of their duties and in the sources of technical information used to solve technical problems. Profit managers were more likely than nonprofit managers to produce design procedures and methods, product and performance characteristics, technical specifications, and patents, whereas nonprofit managers were more likely than profit managers to produce government rules and regulations. Profit managers were more likely than nonprofit managers to use design procedures and methods and patents.

When solving a technical problem, nonprofit managers were more likely than managers to use personal knowledge. Profit managers turned to experts outside the organization more frequently than did nonprofit managers. 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 Profit and Nonprofit Managers in the Aerospace Community.

The responses of profit mangers and nonprofit managers to the six questions associated with this assumption were very similar. There is little difference in the percentage of profit (24.7 percent) and nonprofit managers (31.4 percent) who had taken technical communications coursework and in the percentages of profit managers (4.3 percent) and nonprofit managers (0.0 percent) who indicated that such coursework had not helped them to better communicate technical information. Further, there were few differences in the types of principles, mechanics, on-the-job communications, and types of technical reports to be included in an under- graduate 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 Databases Differs For Profit and Nonprofit Managers in the Aerospace Community.

The responses of profit managers and nonprofit managers to the three questions associated with this assumption were similar. Approximately 12 percent of the profit managers and 2 percent of the nonprofit managers did not use a library or technical information center. Approximately 75 percent of the profit managers and approximately 57 percent of the nonprofit managers did not use (electronic) databases. Neither group did any of their own searches. Approximately 9 percent of the profit managers and 10 percent of the nonprofit managers did most of their own searches. Therefore, the conclusion of **NO DIFFERENCE** in technical communications practices is reached for **ASSUMPTION 4.**

Assumption 5: The Use and Importance of Computer and Information Technology Differs for Profit and Nonprofit Managers in the Aerospace Community.

The responses of profit managers and nonprofit managers to the six questions associated with this assumption were similar. Approximately 13 percent of the profit managers and approximately 16 percent of the nonprofit managers did not use computer technology for preparing technical communications. Approximately 9 percent of the profit managers and approximately

13 percent of the nonprofit managers indicated that the use of computer technology had not increased their ability to communicate technical information. Profit managers were more likely than nonprofit managers to "already use" electronic mail and use electronic bulletin boards "in the future." Therefore, the conclusion of **NO DIFFERENCE** in technical communications practices is reached for **ASSUMPTION 5.**

CONCLUDING REMARKS

Profit managers and nonprofit managers in the aerospace community display different technical communications practices for only one of the five assumptions tested. Therefore, in response to the study's research question, it is concluded that aerospace profit managers and nonprofit managers **DO NOT** have significantly different technical communications practices.

Although the results of this study provide empirical evidence regarding the technical communications practices of profit and nonprofit managers in the aerospace community, data supporting the conclusion of **NO DIFFERENCE** are neither conclusive nor compelling. The limitations of this exploratory study and the study's research design prohibit reaching that conclusion. A more rigorous research design is needed before such claims can be made. However, it is hard to resist

attributing differences in the use and production of technical information and technical information products (Assumption 2) to fundamental differences between profit and nonprofit aerospace organizations.

There are several speculative explanations for both the similarities and the differences in the findings regarding the technical communications practices of profit and nonprofit managers in the aerospace community. One possible reason for the similarities is that both the profit and nonprofit managers in this study have risen through the ranks and have retained many of the technical communications practices formed while they were nonmanagers. In other words, the technical communications practices "working" engineers and scientists develop transcend profit and nonprofit affiliation. Another possible explanation is that many of the managers included in this study are actually working supervisors and, consequently, utilize common technical communications practices.

The differences may be variously explained. One explanation can be attributed to fundamental differences in profit and nonprofit organizations. For example, it seems logical that nonprofit managers would produce more government rules and regulations than profit managers. Could other factors

or variables (e.g., duties associated with the position) account for the difference in technical communications use and production?

Accessibility or availability of support help may also explain certain technical communications practices among aerospace profit and nonprofit managers. Profit managers seek the help of a secretary to prepare written technical communications more frequently than do nonprofit managers. Likewise, nonprofit managers are more likely than profit managers to use a colleague to help prepare written technical communications. Could accessibility or availability explain why neither profit nor nonprofit managers make extensive use of technical writers and editors? Could familiarity, experience, ease of use, expense, or some combination of these account for this finding?

Profit managers make greater use of experts outside of the organization to solve technical problems. One possible explanation is that profit managers have greater access to outside experts. Another is that the use of outside experts to solve problems is a fairly common practice in the profit sector. On the other hand, the conventional wisdom holds, at least at the federal level, that public organizations make considerable

use of outside consultants. Could recent changes in federal procurement regulations have changed this? 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 profit and nonprofit managers prefer personalized, informal information sources to libraries, technical information centers, and on-line databases. Could this similarity also be attributable to social/professional enculturation? Profit and nonprofit managers make considerable use of computer technology for preparing written technical communications. Could the finding that profit and nonprofit managers use certain information technology be dependent upon access to the technology?

Although the results of this study add to a rather limited empirical knowledge base, more research regarding the technical communications practices of profit and nonprofit managers in the aerospace community is clearly needed. The data reported here offer limited but useful insight into the technical communications practices of aerospace profit and nonprofit managers. 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. 5

   ___ 1 Very Important ___ 2 Somewhat Important ___ 3 Not at all Important

2. How many hours do *YOU* spend each week communicating technical information *TO* others? ___ Hours 6-7

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? 10

   ___ 1 Increased ___ 2 Stayed the Same ___ 3 Decreased

5. As you have advanced professionally, how has the amount of time *YOU* spend working with technical communications received *FROM OTHERS* changed? 11

   ___ 1 Increased ___ 2 Stayed the Same ___ 3 Decreased

6. Approximately how many times in the past *six months* did you write/prepare: 12-53

Letters	___ times in the past **6 months**	Journal articles	___
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? 54-89

Letters	___ # read/used in past **1 month**	Journal articles	___
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: 90-95

	Always	*Usually*	*Sometimes*	*Never*
Other colleagues	___	___	___	___
Secretaries	___	___	___	___
Technical writers or editors	___	___	___	___
A thesaurus/dictionary	___	___	___	___
A style manual	___	___	___	___
A grammar hotline	___ 1	___ 2	___ 3	4

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
		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	1	2	Symbols
		Choosing words (avoiding wordiness, jargon, slang, sexist terms)			
1	2	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	1	2	
		Oral presentations			
		Specifications			
1	2	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	___ 1	___ 2	Scientific graphics	
___ 1	___ 2	Spelling checkers				

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

___ 1 Always ___ 2 Usually ___ 3 Sometimes ___ 4 Never 144

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

___ 1 Always ___ 2 Usually ___ 3 Sometimes ___ 4 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	___ 1	___ 2	___ 3	

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	___ 1	___ 2	___ 3	___ 4	

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

Yes	*No*		
		Scientific and technical information	173-
		Experimental techniques	183
		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	194
		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?

_____

_____

_____

_____

_____

_____

_____

Mail to: Dr. M. Glassman
Dept. of Marketing
Old Dominion University
Norfolk, VA 23529-0218

BIBLIOGRAPHY

Allen, Thomas J. Manging the Flow of Technology: Technology Transfer and the Dissemination of Technological Information Within the R&D Organization. Cambridge, MA: MIT Press, 1977.

Bozeman, Barry and L. Vaughan Blankenship. "Science Information and Government Decision Making: The Case of the National Science Foundation." Public Administration Review 39:1 (January/February 1979): 53-57.

Bozeman, Barry and Elliot Cole. "Scientific and Technical Information in Public Management: The Role of 'Gatekeeping' and Channel Preference." Administration and Society 13:4 (February 1982): 479-493.

Bozeman, Barry and Dong Kim. "Governing the 'Republic of Science': An Analysis of National Science Foundation Officials' Attitudes About Managed Science." The Journal of the Northwestern Political Science Association 14:2 (Winter 1981): 183-204.

Bozeman, Barry; Kenneth Roering; and E. Allen Slusher. "Social Structure and the Flow of Scientific Information in Public Agencies: An Ideal Design." Research Policy 7:4 (October 1978): 384-405.

Lindblom, Charles E. Politics and Markets. New York: Basic Books, 1977.

Pinelli, Thomas E; Myron Glassman; Walter E. Oliu; and Rebecca O. Barclay. Technical Communications in Aeronautics: Results of an Exploratory Study. Washington, DC: National Aeronautics and Space Administration. NASA TM-101534, Part 1, February 1989. 106 p. (Available from NTIS, Springfield, VA.)

Pinelli, Thomas E; Myron Glassman; Walter E. Oliu; and Rebecca O. Barclay. Technical Communications in Aeronautics: Results of an Exploratory Study. Washington, DC: National Aeronautics and Space Administration. NASA TM-101534, Part 2, February 1989. 84 p. (Available from NTIS, Springfield, VA.)

Pinelli, Thomas E.; Myron Glassman; Rebecca O. Barclay; and Walter E. Oliu. Technical Communications in Aeronautics: Results of an Exploratory Study -- An Analysis of Managers' and Nonmanagers' Responses. Washington, DC: National Aeronautics and Space Administration. NASA TM-101625. August 1989. 58 p. (Available from NTIS, Springfield, VA.)

Pinelli, Thomas E.; Myron Glassman; and Virginia M. Cordle. Survey of Reader Preferences Concerning the Format of NASA Technical Reports. Washington, DC: National Aeronautics and Space Administration. NASA TM-84502. August 1982. 84 p. (Available from NTIS, Springfield, VA.)

Pinelli, Thomas E.; Virginia M. Cordle; Myron Glassman; and Raymond F. Vondran. "Report Format Preferences of Technical Managers and Nonmanagers." Technical Communication 31:2 (Second Quarter 1984): 4-8.

Pinelli, Thomas E.; Virginia M. Cordle; Myron Glassman; and Raymond F. Vondran, Jr. "Report-reading Patterns of Technical Managers and Nonmanagers." Technical Communication 31:3 (Third Quarter 1984): 20-24.

Rainey, Hal G.; Robert W. Backoff; and Charles H. Levine. "Comparing Public and Private Organization." Public Administration Review 36:1 (March/April 1976): 233-244.

Ring, Peter Smith and James L. Perry. "Strategic Management in Public Organizations: Implications of Distinctive Contexts and Constraints." Academy of Management Review 10:2 (April 1985): 276-284.

NASA National Aeronautics and Space Administration

Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
NASA TM-101626		

4. Title and Subtitle	5. Report Date
Technical Communications in Aeronautics: Results of an Exploratory Study -- An Analysis of Profit Managers' and Nonprofit Managers' Responses	October 1989
	6. Performing Organization Code

7. Author(s)	8. Performing Organization Report No.
Thomas E. Pinelli, Myron Glassman, Rebecca O. Barclay, and Walter E. Oliu	
	10. Work Unit No. 505-90

9. Performing Organization Name and Address	11. Contract or Grant No.
NASA Langley Research Center Hampton, VA 23665-5225	
	13. Type of Report and Period Covered

12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
National Aeronautics and Space Administration Washington, DC 20546-0001	Technical Memorandum
	14. Sponsoring Agency Code

15. Supplementary Notes

Thomas E. Pinelli: NASA Langley Research Center, Hampton, VA
Myron Glassman: Old Dominion University, Norfolk, VA
Rebecca O. Barclay: Rensselaer Polytechnic Institute, Troy, NY
Walter E. Oliu: U.S. Nuclear Regulatory Commission, Washington, DC

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 profit and nonprofit managers in the aerospace community have different technical communications practices. Five assumptions were established for the analysis. Profit and nonprofit managers in the aerospace community were found to have different technical communications practices for one of the five assumptions tested. It was, therefore, concluded that profit and non profit managers in the aerospace community do not have different technical communications practices.

17. Key Words (Suggested by Author(s))	18. Distribution Statement
Technical communications Managers and nonmanagers Aeronautical engineers and scientists Communications practices	Unclassified - Unlimited Subject Category 82

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of pages	22. Price
Unclassified	Unclassified	71	A04

NASA FORM 1626 OCT 86

For sale by the National Technical Information Service, Springfield, Virginia 22161-2171

NASA-Langley, 1989

National Aeronautics and
Space Administration
Code NTT-4

Washington, D.C.
20546-0001

SPECIAL FOURTH-CLASS RATE
POSTAGE & FEES PAID
NASA
Permit No. G-27

NASA