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The Technical Communication Practices of Aerospace Engineering Students: Results of the Phase 3 AIAA National Student Survey

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INTRODUCTION

The growing national debate over U.S. competitiveness appears to have produced a consensus of opinion on the following points: (1) the production, transfer, and use of knowledge is of paramount importance to the process of technological innovation; (2) current "supply-side" U.S technology policy, which emphasizes the creation of knowledge, should be modified to include the transfer, absorption, and utilize of that same knowledge; (3) a mechanism that contains a "proactive" scientific and technical information (STI) component is needed for the diffusion of knowledge from government research facilities to industry; (4) engineers and scientists should be proficient in the acquisition, communication, and use of STI; and (5) engineering and science students should be trained in the acquisition, communication, and use of STI as part of their educational preparation.

Studies such as those conducted by Mailloux (1989) demonstrate that communicating information takes up as much as 80% of an engineer's time and is considered essential to successful engineering practice. Surveys of industrial firms that employ engineers and scientists indicate that employers place a high priority on engineers' ability to acquire, to communicate orally and in writing, and to use STI. These same studies show that industry respondents rate the importance of communications skills as high as or higher than their technical skills. Many industry respondents hold the opinion that newly graduated engineers and scientists lack proficiency in communications skills (Black, 1994; Morrow, 1994; Evans, et al., 1993; Katz, 1993; Strother, 1992; Garry, 1986; Devon, 1985; and Sylvester, 1980).

Because the effective communication of information is fundamental to engineering, questions arise of what communications skills should be taught to engineering students and when, how much communications instruction is necessary, and how effective that instruction is. What is missing from any discussion of communications skills instruction for engineering student is (1) a clear explanation from the professional engineering community about what constitutes "acceptable and desirable communications norms" within that community; (2) adequate and generalizable data from engineering students about the communications skills instruction they receive; (3) adequate and generalizable data from entry-level engineers about the adequacy and usefulness of the instruction they received as students; and (4) a mechanism, probably focused within academia, that solicits feedback from the workplace and a system that utilizes the feedback for answering the questions of what and how much should be taught and when, and for determining the effectiveness of instruction.

To address the second question and help provide a student perspective, we undertook a survey of engineering students who were student members of the American Institute of Aeronautics and Astronautics (AIAA)[1] in the spring of 1993. The questions were assembled according to the following topics: (1) the students' selection of a career in engineering; (2) the importance

[1]Similar surveys were conducted among engineering and science students attending the University of Illinois, aerospace engineering students at Texas A&M, and technology students at Bowling Green State University. Aerospace engineering students in India, Japan, Russia, and the United Kingdom were also surveyed.

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of selected communications skills to professional success, the instruction received in these skills, and the helpfulness (usefulness) of that instruction; (3) the use and importance of libraries and other information sources and products; and (4) the use of computers, selected information technologies, and electronic networks. This study contributes to our understanding of the production, transfer, and use of information by aerospace engineering and provides feedback that may be helpful in shaping the communications components of engineering curricula in higher education.

BACKGROUND

The diffusion of knowledge, including its production, transfer, and use, is an essential part of aerospace R&D and is of paramount importance to the process of innovation within the U.S. aerospace industry. To learn more about this process, researchers at the NASA Langley Research Center, the Indiana University Center for Survey Research, Rensselaer Polytechnic Institute, and institutions in selected counties organized a research project to study knowledge diffusion in aerospace. Sponsored by NASA and the DoD, endorsed by aerospace professional societies, and sanctioned by several groups and panels, the *NASA/DoD Aerospace Knowledge Diffusion Research Project* was begun in 1989 as a five-year project "to provide descriptive and analytical data regarding the flow of scientific and technical information (STI) at the individual, organizational, national, and international levels and to examine both the channels used to communicate STI and the social system of the aerospace knowledge diffusion process" (Pinelli, Kennedy, and Barclay, 1991). The Project, in four phases, focuses on technology rather than science and on engineers rather than scientists and takes the position that STI resulting from federally funded aerospace R&D is an economic asset or resource rather than a component of national security. The Project Fact Sheet is Appendix A.

The research results of the Project could be used to understand the information environment in which U.S. aerospace engineers and scientists work (that is, the academic, government, and industrial sectors), the information-seeking behaviors of U.S. aerospace engineers and scientists, and the factors that influence their use of STI. Such an understanding could (1) lead to the development of practical theory, (2) contribute to the design and development of systems for diffusing aerospace information, and (3) have practical implications for transferring the results of federally funded R&D to the U.S. aerospace community.

METHODS AND SAMPLE DEMOGRAPHICS

Self-administered (self-reported) questionnaires were sent to a sample of 4,300 aerospace engineering students who were members of the AIAA. A group of engineering faculty members, librarians, and technical communicators worked with the Project team to compile the list of survey questions. The questions were pretested before distribution. The student survey is Appendix B. The questionnaire and cover letter on NASA stationery were mailed from the NASA Langley Research Center in spring 1993. Altogether, 1,673 AIAA student members returned the questionnaire by the completion date of September 1, 1993. Due to the summer break, only one mailing was possible. After reducing the sample size for incorrect addresses and other mailing problems, the response rate for the survey was 42%. This rate is very acceptable for a student survey with one mailing.

The presentation of survey results compares undergraduate students with graduate students. Chi-square tests (for categorical variables) and student *t*-tests (for interval data) are used to estimate if observed differences between undergraduates and graduate students are statistically significant. A significant test result ($p \leq .05$) indicates that there is only a 5% probability that the observed differences between undergraduate and graduate students' distribution of responses can be attributed to chance. A significant result is therefore interpreted as evidence that students' responses on the factors or variables in question are influenced by (vary systematically with) a student's academic (undergraduate or graduate) status. A code book containing the aggregate responses from the AIAA national student survey is Appendix C.

PRESENTATION OF THE DATA

Demographic characteristics of the AIAA student survey respondents are summarized in table 1. The final sample included 948 undergraduate students (57.3%) and 707 graduate students (42.7%). The majority of respondents are male. About 82% of the undergraduates and 87% of the graduate students were male. Most respondents report that they are studying to become engineers. Among undergraduates, about 95% are preparing to become engineers; about 2% reported that they are preparing to become scientists. About 90% of the graduate students are preparing for careers in engineering; a slightly higher percentage of graduate students, about 7% reported that they were preparing to become scientists.

Most AIAA student members are U.S. citizens; about 92% of the undergraduate students and about 81% of the graduate students indicated they were U.S. citizens. English is the first (native) language for most of the student participants. About 87% of the undergraduate students reported that English is their first (native) language and about 77% of the graduate students indicated that English is their first (native) language. The U.S. was the native country of most survey participants. About 84% of the undergraduates and about 73% of the graduate students indicated that the U.S. was their native country.

We also asked respondents to compare their families's incomes with the incomes of most families in their native countries. Most students report that their family's incomes were either the same as or higher than the incomes of other families. About 30% of undergraduates and about 34% of the graduate students reported that their family's incomes were higher than the incomes of other families in their native countries. About 16% of the undergraduate and graduate students reported that their family's had lower incomes that other families in their native countries. About half of the student respondents (52.1% undergraduate and 47.9% graduate) reported that their families's incomes were about the same as other families in their native country.

Table 1. Survey Demographics
[N = 1655]

Demographics	Undergraduate (n = 948)		Graduate (n = 707)	
	%	(n)	%	(n)
Gender				
Female	18.2	172	13.0	92
Male	81.8	775	87.0	614
Educational Status	57.3	948	42.7	707
Educational Preparation As				
An Engineer	95.4	904	89.7	634
A Scientist	1.8	17	6.9	49
Other	2.8	27	3.4	24
Native Country				
China	0.1	1	2.1	15
Japan	0.2	2	1.0	7
Korea	0.8	8	1.4	10
Taiwan	1.1	10	2.4	17
U.S.	84.1	796	73.4	518
Other	13.7	130	19.7	139
Native (First) Language				
English	86.9	824	76.9	544
Chinese	2.7	26	5.1	36
Japanese	0.2	2	1.0	7
Korean	0.6	6	1.1	8
Spanish	2.4	23	1.7	12
Other	7.4	67	14.1	100
U.S. Citizen				
Yes	92.1	871	80.9	572
No	7.9	75	19.1	135
Relative Family Income				
Higher than Other Families	29.4	276	33.7	236
About the Same as Other Families	52.1	490	47.9	335
Lower than Other Families	16.3	153	16.3	114
Can't Compare to Other Families	2.2	21	2.1	15

Aerospace Engineering as a Career Choice

Most students made their decision to study engineering prior to beginning college (see table 2). Nearly two-thirds of undergraduates made their decisions to pursue a career in engineering while in high school, and about 16% made their decisions while in elementary school. About 55% of graduate student reported that they made their decisions in high school and about 11% while in elementary school. A higher percentage of graduate than undergraduate students made their decisions to pursue a career as an engineer either when they started or after they had started college.

Table 2. Career Choice/Selection Decision Point of U.S. Aerospace Engineering Students

Decision Points	Undergraduate		Graduate	
	%	(n)	%	(n)
While Still In Elementary School	15.8	150	10.5	74
While In High School	64.0	607	54.5	385
When Starting College	9.0	85	14.7	104
After Starting College	7.4	70	15.3	108
Other	3.3	31	4.5	32

Factors Influencing Career Choice

Students were asked to rate the importance of six factors that may have influenced their choice of careers (table 3). Three of the factors deal with the influence of people (i.e., parents, other family members, and teachers) in helping students to make their career choices; one factor focused on the influence of information about the career. The remaining two factors related to the career itself and include such elements as financial security. Mean ratings for each factor are listed in table 3. For both undergraduate and graduate students, the most important factors were those related to the job itself. The perception that engineering is a career with rewarding activities received the highest mean ratings from both undergraduates ($\bar{X} = 6.3$) and graduate students ($\bar{X} = 6.1$) followed by the perception that a career in engineering will lead to financial security ($\bar{X} = 4.6$ and $\bar{X} = 4.3$). The undergraduate importance ratings for these two factors were significantly higher than the rating assigned to these factors by the graduate students.

The availability of information on career opportunities also appears to have an important influence on the career decision. The importance of this factor was also rated significantly higher by undergraduate ($\bar{X} = 4.5$) than graduate ($\bar{X} = 4.2$) students. Importance ratings of the influence of other people -- parents, teachers, and other family members -- were lower than the importance rating of job-related factors. There were no significant differences in the importance ratings

Table 3. Influence (Importance) of Selected Factors on Career Choice of U.S. Aerospace Engineering Students

Factors	Undergraduate Mean[a]	Undergraduate (n)	Graduate Mean[a]	Graduate (n)
Your Parents Encouraged Your Area Of Study/Major	3.4	879	3.6	666
Other Family Members Encouraged Your Area Of Study/Major	2.9	853	2.8	636
Teachers Encouraged Your Area Of Study/Major	3.7	884	3.7	664
You Feel That A Career In Your Major/Area Of Study Will Lead To Financial Security	4.6	932	4.3*	690
You Feel That A Career In Your Major/Area Of Study Will Provide A Career With Rewarding Activities	6.3	940	6.1*	700
Information On The Career Opportunities Available In Your Major/Area Of Study	4.5	918	4.2*	671

[a]Students used a 7-point scale to rate the importance of each factor, where 7 indicates the highest rating.
*$p \leq 0.05$.

undergraduate and graduate students assigned to the influence of others on career choice. Of the three factors concerned with the influence of people (i.e., parents, other family members, and teachers) in helping students to make their career choices, the encouragement of teachers ($\bar{X}$ = 3.7 for undergraduate and graduate students) appears to have exerted greater influence on career choice than did encouragement from parents and other family members.

Satisfaction with Career Choice

Students were asked to rate their current level of satisfaction with their career choice (table 4). About 28% of undergraduate and 28% of the graduate students reported that they are happier about their career decisions now compared to when the decisions were first made. About 47% of undergraduates and about 42% of graduate students surveyed reported that they feel about the same now as when they first made their career decision. However, a higher percentage of graduate students reported they were less happy with their career choice now (30.6%) compared to undergraduate students (24.2%).

Table 4. Career Choice/Selection Satisfaction
of U.S. Aerospace Engineering Students

Satisfaction Level	Undergraduate		Graduate	
	%	(n)	%	(n)
I Am Happier About My Career Choice Now Than When I First Made It	28.6	268	27.6*	194
I Feel About The Same Now As When I First Made It	47.2	443	41.7	293
I Am Less Happy About My Career Choice Now Than When I First Made It	24.2	227	30.6	215

* $p \leq 0.05$.

Career Expectations and Goals

This section explores the expectations of AIAA student respondents concerning several aspects of their future careers. Students were asked to indicate the type of organization in which they hope to work after graduation. They were also given a list of 15 specific career goals and aspirations and asked to rate the importance of each to a successful career.

Type of Organization. Students were asked to identify the type of organization in which they hope to work after graduation. Table 5 shows their organizational preferences. Most students report that they plan to work in industry. Graduate students (25.6%) were significantly more likely than undergraduates (7.3%) to aspire to work in academia. Undergraduate students were significantly more likely to select industry as the type of organization were they plan to work. About 75% of the undergraduates plan to work in either national (44.1%) or multi-national (30.8%) industrial organizations. Less than 60% of the graduate students plan to work in either national (35.6%) or multi-national (23.5%) industrial organizations. About 34% of the undergraduate and 30% of the graduates reported that they planned to work for a government organization. Less than 2% of graduate students and less than 1% of undergraduates reported that they planned to work for a non-profit organization.

Professional Aspirations. Students were asked to rate the importance of 15 goals to a successful career. The list includes aspirations that are classified as either engineering, science, or management goals. Table 6 shows the mean importance ratings for each goal. Both undergraduate and graduate students gave high ratings to the engineering-related goals and aspirations. The ordering of mean importance ratings for these factors, from highest to lowest, is similar for both undergraduates and graduate student members. The opportunity to explore new ideas about

Table 5. Type of Organization Where U.S. Aerospace Engineering Students Plan to Work

Type Of Organization	Undergraduate		Graduate	
	%[a]	(n)	%[a]	(n)
Academic	7.3	69	25.6*	181
Government	34.1	323	30.0	212
Industry (National)	44.1	418	35.6*	252
Industry (Multi-national)	30.8	292	23.5*	166
Not for Profit	0.8	8	1.8	13
Other	6.7	63	4.7	33

[a]Percentages do not total 100 because students could select more than one response.
* $p \leq 0.05$.

technology or systems ranked highest ($\bar{X}$ = 6.3 for both undergraduates and graduate students). The opportunity to work on projects that require learning new technical knowledge ranked second $\bar{X}$ = 5.9 for both undergraduates and graduate students). Having the opportunity to work on complex technical problems ranked third ($\bar{X}$ = 5.7 for undergraduates and $\bar{X}$ = 5.9 for graduate students). Graduate students assigned significantly higher importance ratings than did undergraduate students to the goals of having the opportunity to work on complex technical problems and to working on projects that utilize the latest theoretical results in their specialty.

Developing a professional reputation outside of the organization was significantly more important to graduate than to undergraduate students. Establishing a reputation outside your organization as an authority in your field ($\bar{X}$ = 5.3 for undergraduates and $\bar{X}$ = 5.4 for graduate students) and being evaluated on the basis of your technical contributions ($\bar{X}$ = 5.3 for undergraduates and $\bar{X}$ = 5.5 for graduate students) were the goals rated highest in this category. Presenting papers at professional society meetings ($\bar{X}$ = 4.8 for undergraduates and $\bar{X}$ = 5.2 for graduate students) and publishing articles in technical journals ($\bar{X}$ = 4.5 for undergraduates and $\bar{X}$ = 5.2 for graduate students) were the goals in this category rated least important.

Attaining a leadership or management position was a significantly more career goal (aspiration) for undergraduate than for graduate students. Advancing to a high level staff or technical position ($\bar{X}$ = 5.4 for both undergraduate and graduate students) and planning projects and making decisions affecting the organization ($\bar{X}$ = 5.4 for undergraduates and $\bar{X}$ = 5.2 for graduate students) were the goals rated highest in this category. Becoming a manager or director in the organization ($\bar{X}$ = 5.1 for undergraduate and $\bar{X}$ = 4.7 graduate students) and advancing to a policy-making position in management ($\bar{X}$ = 4.7 for undergraduates and $\bar{X}$ = 4.4 for graduate students) were the goals in this category rated least important by survey participants.

Table 6. Career Goals and Aspirations of U.S. Aerospace Engineering Students

Goals	Undergraduate		Graduate	
	Mean[a]	(n)	Mean[a]	(n)
Engineering				
Have The Opportunity To Explore New Ideas About Technology Or Systems	6.3	942	6.3	700
Adance to High Level Staff Technical Position	5.4	928	5.4	695
Have The Opportunity To Work On Complex Technical Problems	5.7	946	5.9*	702
Work On Projects That Utilize The Latest Theoretical Results In Your Specialty	5.6	943	5.5*	699
Work On Projects That Require Learning New Technical Knowledge	5.9	946	5.9	703
Science				
Establish A Reputation Outside Your Organization As An Authority In Your Field	5.3	938	5.4	697
Receive Patents for Your Ideas	4.5	923	4.1*	686
Publish Articles In Technical Journals	4.5	937	5.2*	697
Communicate Your Ideas To Others In Your Profession by Presenting Papers At Professional Meetings	4.8	941	5.2*	704
Be Evaluated On The Basis Of Your Technical Contributions	5.3	930	5.5*	700
Leadership (Management)				
Become A Manager Or Director	5.1	928	4.7*	690
Plan And Coordinate The Work Of Others	5.1	932	4.8*	688
Advance To A Policy-making Position In Management	4.7	924	4.5*	688
Plan Projects And Make Decisions Affecting The Organization	5.4	937	5.2*	693
Be The Technical Leader Of A Group Of Less Experienced Professionals	5.3	936	5.1*	692

[a]Students used a 7-point scale to rate the importance of each goal, where 7 indicates the highest rating.

* $p \leq 0.05$.

Communications Skills

The literature on engineering education establishes the importance of effective communications skills to professional success (Black, 1994; Morrow, 1994; Evans, et. al., 1993; Katz, 1993; Garry, 1986; Devon, 1985). AIAA student members were asked to assess the importance of selected communications skills to professional success, to indicate if they had received instruction in these skills, and to rate the helpfulness (usefulness) of that instruction.

Importance of Communications Skills Training

Students were asked to rate the importance of six communications skills to professional career success (table 7). Students assigned the highest importance ratings to the ability to use computer, communication and information technology ($\bar{X}$ = 6.6 for undergraduates and $\bar{X}$ = 6.5 for graduate students). Oral and written technical communications skills received the next highest importance ratings. The mean ratings for these two communication skills were $\bar{X}$ = 6.3,6.3 for undergraduate and $\bar{X}$ = 6.3,6.4 for graduate students. Significant differences in the means exist between undergraduate and graduate students for five of the six communications skills.

Table 7. Importance of Selected Communications Skills to U.S. Aerospace Engineering Students

	Undergraduate		Graduate	
Competencies	Mean[a]	(n)	Mean[a]	(n)
Effectively Communicate Technical Information In Writing	6.3	942	6.4*	702
Effectively Communicate Technical Information Orally	6.3	942	6.3	701
Have A Knowledge And Understanding Of Engineering/Science Information Resources And Materials	6.3	936	6.1*	702
Ability To Search Electronic (Bibliographic) Data Bases	5.6	919	5.3*	697
Ability To Use A Library That Contains Engineering/Science Information Resources And Materials	5.8	938	5.7*	701
Effectively Use Computer, Communication And Information Technology	6.6	943	6.5*	701

[a]Students used a 7-point scale to rate the importance of each competency, where 7 indicates the highest rating.
*$p \leq 0.05$.

Receipt and Helpfulness of Communications Skills Instruction

Table 8 shows the percentage of students who have received communications skills instruction. About 87% of the undergraduates and 78% of the graduate students have received instruction in the use of computer, communication, and information technology. Approximately 73% of the undergraduates and 71% of the graduates have had technical writing instruction. About 65% of the undergraduates 58% of the graduate students have received instruction in speech/oral communication. About two-thirds of the undergraduates and slightly more than half of the graduate students had received instruction in (1) using engineering/science information resources and materials and (2) using a library that contains engineering/science information resources and materials. About 55% of the undergraduates and 43% of the graduate students had received instruction in searching electronic (bibliographic) data bases.

Table 8. Communications Skills Instruction Received by U.S. Aerospace Engineering Students

Instruction	Undergraduate		Graduate	
	%	(n)	%	(n)
Technical Writing/Communication	73.4	692	71.1	500
Speech/Oral Communication	64.8	611	58.0	408
Using A Library That Contains Engineering/Science Information Resources And Materials	64.5	608	53.8	378
Using Engineering/Science Information Resources And Materials	68.7	648	55.8	392
Searching Electronic (Bibliographic) Data Bases	55.2	521	43.0	302
Using Computer, Communication, And Information Technology	87.1	821	77.9	547

Students receiving communications skills instruction were asked to rate the helpfulness (usefulness) of that instruction (table 9). For the most part, students reported that the instruction they received was helpful. Furthermore, undergraduate and graduates students assigned similar importance ratings to the helpfulness of the skill instruction they had received. They assigned the highest ratings ($\bar{X}$ = 6.0 for undergraduates and $\bar{X}$ = 5.8 for graduate students) to instruction in using computer, communication, and information technology. Importance ratings for the five remaining skills ranged from a high of $\bar{X}$ = 5.6 to a low of $\bar{X}$ = 5.0 for undergraduates and a high of $\bar{X}$ = 5.4 to a low of $\bar{X}$ = 4.9 for graduate students. Statistical differences between the scores reported by undergraduate and graduate students for helpfulness of instruction received in technical writing/communication and in using computer, communication, and information technology.

Table 9. Helpfulness of Communications Skills Instruction Received by U.S. Aerospace Engineering Students

Instruction	Undergraduate		Graduate	
	Mean[a]	(n)	Mean[a]	(n)
Technical Writing/Communication	5.6	680	5.3 *	509
Speech/Oral Communication	5.5	606	5.4	427
Using A Library That Contains Engineering/Science Information Resources And Materials	5.2	604	5.0	381
Using Engineering/Science Information Resources And Materials	5.3	648	5.2	395
Searching Electronic (Bibliographic) Data Bases	5.0	533	4.9	318
Using Computer, Communication, And Information Technology	6.0	808	5.8 *	543

[a]Students used a 7-point scale to rate the helpfulness of each competency, where 7 indicates the highest rating.
*$p \leq 0.05$.

Impediments to Preparing Written Technical Communications

We asked students the extent to which a lack of knowledge/skill about certain communications principles impedes their ability to write (table 10). Overall, students did not report serious problems with their writing skills, at least to the point that any deficiencies might impede the technical writing process. The lowest "impedance" scores (i.e., mean scores clustering around 3.0) were recorded for writing grammatically correct sentences, notetaking and quoting, editing and revising, and developing paragraphs. In terms of their ability to prepare written technical communication, both undergraduate and graduate students appear to have the greatest difficulty with preparing/presenting information in an organized manner, defining the purpose of the communication, and assessing the needs of the reader.

Collaborative Writing

Most of the students in this study have experience in collaborative writing. About 80% of both undergraduate and graduate students report that they have produced written technical communication as part of a group. On average, undergraduate students report that they collaborate on about 33% of their written technical communication. A slightly higher percentage, on average about 35%, of graduate students' report that their written technical communication is collaborative. However the difference is not significant.

Table 10. Factors Impeding the Ability of U.S. Aerospace Engineering Students to Produce Written Technical Communication

Principles	Undergraduate		Graduate	
	Mean[a]	(n)	Mean[a]	(n)
Defining The Purpose Of The Communication	3.7	840	3.6	640
Assessing The Needs Of The Reader	4.0	864	3.9	643
Preparing/Presenting Information In An Organized Manner	3.6	870	3.6	647
Developing Paragraphs (Introductions, Transitions, Conclusions)	3.3	874	3.5*	648
Writing Grammatically Correct Sentences	3.1	873	3.2	653
Notetaking And Quoting	3.1	856	3.1	627
Editing And Revising	3.3	855	3.3	622

[a]Students used a 7-point scale to measure the extent to which each principle impedes their ability to produce written technical communications, where 7 indicates greatly impedes.
*$p \leq 0.05$.

Table 11 also reports the percentage of students' written technical communication that is required to be collaborative. A significantly greater percentage of undergraduate students' written technical communication is required to be collaborative. On average, undergraduate students report that they are required to collaborate on about 48% of their written technical communication compared to about 43% of written technical communication prepared by graduate students.

We also asked students who write collaboratively to compare the productivity of group writing to the productivity of writing alone (table 12). A high percentage of students (47.1% undergraduate students; 39.2% graduate students) feels that group writing is more productive than writing alone. About 27% of the undergraduates and about 30% of graduate students reported that group writing is less productive. About 26% of undergraduate students and about 30% of graduate students reported that group writing was as productive as writing alone.

Use and Importance of Libraries and Selected Information Sources and Products

This section examines the use and importance of libraries and STI sources and products to engineering and science students. First, we examine the type of library use instruction that

Table 11. Production of Written Technical Communication By U.S. Aerospace Engineering Students

Factor	Undergraduate		Graduate	
	%	(n)	%	(n)
Percentage Of Written Technical Communication Involving Collaborative Writing				
0%	19.4	158	18.8	124
1 - 24%	29.2	239	25.7	168
25 - 49%	14.7	119	14.5	95
50 - 74%	19.7	161	24.6	162
75 - 99%	15.2	124	11.9	78
100%	1.6	13	4.9	32
Mean	33.3		35.3	
Percentage Of Written Technical Communication Required To Be Collaborative?				
0%	4.5	27	9.6	46
1 - 24%	21.5	128	21.8	114
25 - 49%	18.4	111	18.3	88
50 - 74%	30.4	184	28.0	134
75 - 99%	14.7	89	10.6	51
100%	11.1	67	11.7	56
Mean	47.6		43.3*	

*$p \leq 0.05$.

Table 12. Productivity of Collaborative Writing of U.S. Aerospace Engineering Students

How Productive	Undergraduate		Graduate	
	%[a]	(n)	%[a]	(n)
Less Productive Than Writing Alone	26.8	179	30.4	162
About As Productive As writing Alone	26.2	175	30.4	162
More Productive Than Writing Alone	47.1	315	39.2	209

[a]Percentages exclude students who report that they never collaborate on academic writing projects.

student respondents received, the effectiveness of the information obtained from the library in meeting students' engineering/science information needs, and their use (search) of electronic (bibliographic) data bases. Finally, we explore the use and importance of selected information sources and products.

Library Use Instruction

We asked students to indicate whether they had received instruction in six areas related to library use. These data are summarized in table 13. About half of undergraduate respondents and about 40% of the graduate students reported that they had received a tour of their library; about 41% and 31% of the undergraduate and graduate students, respectively, had received a library presentation as part of their academic orientation.

A higher percentage of undergraduates compared to graduate students received instruction in six of the seven types of instruction. Less than one-fourth of students surveyed had taken a library skill/use course in engineering/science information resources and materials instruction as part of their engineering curriculum. Nearly 30% of both student groups had received library instruction for end-user searching of electronic (bibliographic) data bases. Less than 20% of both groups of students had received library skill/use instruction in engineering/science information resources and materials.

Table 13. Library Training Received
by U.S. Aerospace Engineering Students

Type Of Instruction	Undergraduate		Graduate	
	%	(n)	%	(n)
Library Tour	50.2	464	39.9	275
Library Presentation As Part Of Academic Orientation	41.1	377	30.8	212
Library Orientation As Part Of An Engineering/Science Course	23.3	215	20.8	142
Library Skill/Use Course (Bibliographic Instruction)	32.5	295	21.7	147
Library Skill/Use Course In Engineering/Science Information Resources And Materials	18.1	165	19.6	133
Library Instruction For End-user Searching Of Electronic (Bibliographic) Data Bases	30.4	272	28.6	195

Library Use

We also asked students respondents to indicate the number of times that they had used a library during the current school term (see table 14). Undergraduates appear to use a library significantly less often than do graduate students. About 15% of the undergraduates indicated that they had not used the library at all, compared to about 5% of graduate students. Overall, undergraduates averaged 8.8 "uses of the library" during the current school term compared with 11.0 "uses" for graduate students.

Table 14. Use of A Library This School Term by U.S. Aerospace Engineering Students

Visits		Undergraduate		Graduate	
		%	(n)	%	(n)
0	Times	15.1	139	5.2	35
1 - 5	Times	42.5	391	36.2	243
6 - 10	Times	18.7	172	28.9	194
11 - 25	Times	16.4	151	20.0	134
26 - 50	Times	6.0	55	6.6	44
51 Or More	Times	1.3	12	3.3	22
	Mean	8.8		11.0*	
	Median	5.0		10.0	

*$p \leq 0.05$.

Effectiveness of Information Obtained From the Library

Those students who had used a library during the current term were asked to rate the effectiveness of the information obtained from the library in meeting their engineering/science information needs (see table 15). The overall rating of the "effectiveness of the information received" given by graduate students ($\bar{X}$ = 5.1) was significantly higher than undergraduates' overall rating ($\bar{X}$ = 4.8). About 42% of graduate students indicated that the information they received was very effective in meeting their information needs, compared to about 33% of the undergraduates. Less than 7% of both student groups indicated that the information they obtained from the library was very ineffective in meeting their engineering/science information needs. About 51% of the undergraduate students reported that the information they received from the library was neither effective nor ineffective, compared to about 51% of the graduate students who reported that the information they received from the library was neither effective nor ineffective in meeting their engineering/science information needs.

Table 15. Effectiveness of Information Obtained From the Library in Meeting Information Needs

Effectiveness	Undergraduate		Graduate	
	%	(n)	%	(n)
Very Effective	32.5	259	42.2	278
Neither Effective Nor Ineffective	60.7	484	51.4	339
Very Ineffective	6.9	55	6.4	42
Mean	4.8		5.1*	

*$p \leq 0.05$.

Reasons for Nonuse of a Library

We also asked the 139 undergraduate students and 35 graduate students who had not used a library during the current term to indicate their reasons for non-use. The percentages of undergraduate and graduate non-users by the reason for non use of a library appear in table 16. About 75% of undergraduate non-users and about 47% of graduate students reported that they had no information needs. About 68% of undergraduate non-users and 88% of graduate non-users indicated that their information needs were more easily met by sources other than the library. About 22% of the undergraduate and about 32% of graduate students reported that they had tried the library before but could not find the information they needed.

Searching of Electronic (Bibliographic) Data Bases

We were also interested in finding out how students search electronic (bibliographic) data bases (table 17). About 40% of undergraduates and about 44% of the graduate students do all of their own searching. About 37% of undergraduate students and about 36% of graduate students reported that they did most of their own searching. Less than 10% of the undergraduate searching and about 12% of graduate student searches involve a librarian. About 11% of undergraduates and about 8% of graduate students do not use electronic data bases; about 5% of the undergraduates and about 2% of the graduate students do not have access to electronic (bibliographic) data bases.

Student Information-Seeking Behavior

To learn students' preferences for using particular information sources, we asked students to indicate the sequence in which they consulted a range of information resources (table 18). The first step for most undergraduate and graduate students was to consult their personal stores of technical information. (About 48% of undergraduates and 51% of graduate students consulted their personal stores of technical information first.) The second step for most undergraduates was

Table 16. Reasons U.S. Aerospace Engineering Students Did Not Use A Library During This Current School Term

Reasons	Undergraduate		Graduate	
	%	(n)	%	(n)
I Had No Information Needs	74.8	101	46.7	14
My Information Needs Were More Easily Met Some Other Way	68.3	86	87.9	29
Tried The Library Once Or Twice Before But I Couldn't Find The Information I Needed	22.6	28	32.1	9
The Library Is Physically Too Far Away	4.1	5	17.9	5
The Library Staff Is Not Cooperative Or Helpful	3.3	4	7.7	2
The Library Staff Does Not Understand My Information Needs	8.2	10	7.4	2
The Library Did Not Have The Information I Need	16.5	20	14.8	4
I Have My Own Personal Library And Do Not Need Another Library	11.6	14	18.5	5
The Library Is Too Slow In Getting The Information I Need	7.5	9	12.0	3
We Have To Pay To Use The Library	0.8	1	0.0	0
We Are Discouraged From Using The Library	0.0	0	0.0	0

Table 17. How U.S. Aerospace Engineering Students Search Electronic (Bibliographic) Data Bases

Approach	Undergraduate		Graduate	
	%	(n)	%	(n)
I Do **All** Searches Myself	40.3	378	43.5	304
I Do **Most** Searches Myself	36.9	346	35.8	250
I Do **Half** By Myself And **Half** Through A Librarian	5.5	52	6.6	46
I Do **Most** Searches Through A Librarian	1.3	12	3.7	26
I Do **All** Searches Through A Librarian	0.4	4	1.3	9
I Do **Not Use** Electronic Data Bases	10.9	102	7.6	53
I Do Not Have Access To Electronic Data Bases	4.6	43	1.6	11

Table 18. Information Sources Used by U.S. Aerospace Engineering Students in Problem Solving

Information Source	Used 1st %	Used 2nd %	Used 3rd %	Used 4th %	Used 5th %	Used 6th %	Used 7th %	Did Not Use %
Undergraduate								
Used Personal Store Of Technical Information	48.2	14.1	14.9	6.7	4.6	2.6	0.9	8.0
Spoke With Students	14.5	34.3	17.6	9.7	8.6	5.6	1.3	8.5
Spoke With Faculty Members	19.3	20.0	26.1	11.5	7.3	5.0	1.7	9.0
Used Literature Resources (e.g., Conference Papers, Journal Articles, Technical Reports)	6.4	10.5	14.6	26.0	12.7	5.9	1.6	22.2
Spoke With A Librarian	0.6	1.9	3.5	5.7	5.7	4.9	3.9	73.9
Used Literature Resources Found In A Library	4.6	9.7	12.5	18.9	19.3	7.3	2.1	25.7
Searched (Or Had Someone Search For Me) An Electronic (Bibliographic) Data Base In The Library	5.9	10.2	8.3	7.4	7.8	8.3	2.5	49.7
Used None Of The Above Steps	0.2	---	---	---	---	---	---	---
Graduate								
Used Personal Store Of Technical Information	51.4	15.4	11.3	6.2	6.1	4.3	1.2	4.1
Spoke With Students	4.9	21.9	16.9	13.5	12.5	10.5	4.9	14.8
Spoke With Faculty Members	23.3	21.8	20.3	12.2	10.2	6.1	1.0	5.0
Used Literature Resources (e.g., Conference Papers, Journal Articles, Technical Reports)	10.4	22.5	21.0	22.9	10.4	4.5	0.4	7.8
Spoke With A Librarian	1.1	1.8	2.7	4.4	6.9	8.7	7.9	66.7
Used Literature Resources Found In A Library	3.8	7.9	19.4	23.7	21.3	6.3	2.2	15.4
Searched (Or Had Someone Search For Me) An Electronic Bibliographic) Data Base In The Library	5.9	10.4	9.6	11.7	9.0	8.3	4.0	41.2
Used None Of The Above Steps	0.3	---	---	---	---	---	---	---

to speak with other students; about 34% for undergraduate students. For graduate students, the pattern of the most frequently chosen source used second in the search process is mixed. The search strategy of graduate students tended to be divided between using literature resources (22.5%), speaking with other students (21.9%), and speaking with faculty members (21.8%). About 26% of undergraduates spoke with faculty members as the third step in searching for information. Graduate students most frequently used literature resources (21.0%) and spoke to faculty members (20.3%) during the third step. Undergraduate students do not begin to use formal resources such as literature sources and libraries until the fourth step in the search process. Graduate students used literature sources found in a library (23.7%) and used literature sources (22.9%) during the fourth step. Undergraduates and graduate students relied on literature sources found in a library (19.3%;21.3%) during the fifth step. About 74% of the undergraduate students did not consult a librarian during the search process and about 50% did not search (or have searched) an electronic (bibliographic) data base in the library during the search process. A higher percentage of graduate students (66.7%) did not consult a librarian during the search process and a lower percentage (41.2%) did not search (or have searched) an electronic (bibliographic) data base in the library during the search process.

Use and Importance of Selected Information Sources

Student participants were also asked to indicate the frequency of their use of selected information sources and the importance of these sources (table 19) in meeting the in- formation needs of U.S. aerospace engineer students. Students used their personal collections of information more than any other information source ($\bar{X}$ = 3.9 for undergraduate students and $\bar{X}$ = 4.1 for graduates). For undergraduates, the second most frequently used source of information was

Table 19. Frequency of Use and Importance of Information Sources Used to Meet Information Needs During the Most Recent School Term

Information Source	Use				Importance			
	Undergraduate		Graduate		Undergraduate		Graduate	
	Mean[a]	(n)	Mean[a]	(n)	Mean[a]	(n)	Mean[a]	(n)
Your Personal Collection Of Information	3.9	935	4.1*	699	5.8	938	6.1*	697
Other Students	3.4	936	3.2*	697	4.8	936	4.4*	697
Faculty Members	3.2	935	3.4*	697	5.2	938	5.2	698
Library	2.9	932	3.4*	697	4.5	935	5.2*	697
Librarian	1.8	928	2.0*	685	2.6	933	3.0*	695
Your Personal Contacts Within Industry	2.6	937	2.6	696	4.4	937	4.1*	695
Your Personal Contacts At Government Laboratories	2.8	937	2.6	696	4.6	936	4.3	696

[a]Frequency of use was measured using a 5-point scale, where 1 = never and 5 = always. Importance was measured using a 7-point scale, where 1 = very unimportant and 7 = very important.

*$p \leq 0.05$.

other students. In contrast, the second most frequently used source of information for graduate students were faculty members and a library ($\bar{X}$ = 3.4). The third most frequently used source of information for undergraduates was faculty members. The third most frequently used source of information for graduate students was other students. Both undergraduates and graduates used their personal contacts in industry and in government laboratories more often than they consulted a librarian. Graduate students were significantly more likely than undergraduates to use their personal collection of information ($\bar{X}$ = 4.1 and $\bar{X}$ = 3.9), ask faculty members ($\bar{X}$ = 3.2 and $\bar{X}$ = 3.4), use a library ($\bar{X}$ = 3.4 and $\bar{X}$ = 2.9), and consult a librarian ($\bar{X}$ = 2.0 and $\bar{X}$ = 1.8). Undergraduate students were significantly more likely than graduate students to ask other students ($\bar{X}$ = 3.4 and $\bar{X}$ = 3.1).

Use and Importance of Selected Information Products

Students were also asked about the frequency of their use of a variety of information products during the most recent school term and to rate the importance of these products in satisfying their information needs (table 20). There were significant differences between undergraduate and graduate students both in the extent of their usage and the importance of the information products listed. Undergraduate students reported the highest frequencies of use for the following products: textbooks ($\bar{X}$ = 4.4), computer programs/documentation (X = 3.2), handbooks ($\bar{X}$ = 2.9), journal articles ($\bar{X}$ = 2.7), and technical reports ($\bar{X}$ = 2.4). There are statistical differences between undergraduate and graduate students and their use of 11 information products. Undergraduate students used significantly more textbooks, handbooks, audio/visual materials, and drawing/specifications than did graduate students. Graduate students used significantly more journal articles, computer programs/documentation, conference/meeting papers, theses/dissertations, U.S. government and industry technical reports, and technical translations than did graduate students.

Undergraduate students recorded the highest importance rating for the following products: textbooks ($\bar{X}$ = 6.3), computer programs/documentation ($\bar{X}$ = 5.0), handbooks ($\bar{X}$ = 4.6), journal articles ($\bar{X}$ =4.2), and technical reports ($\bar{X}$ = 3.8). Graduate students recorded the highest importance rating for the following products: textbooks ($\bar{X}$ = 6.0), journal articles ($\bar{X}$ =5.6), conference/meeting papers ($\bar{X}$ = 5.1), computer programs/documentation ($\bar{X}$ = 4.9), and technical reports ($\bar{X}$ = 4.8). There are statistical differences between undergraduate and graduate students and their importance ratings for 10 information products. Undergraduate students assigned a significantly higher important rating to textbooks, computer programs/documentation, handbooks, drawings/specifications, audio/visual materials, and patents than did graduate students. Graduate students assigned a significantly higher importance rating to journal articles, conference/meeting papers, U.S. government technical reports, abstracts, and thesis/dissertations than did undergraduate students.

Use of Foreign and Domestically Produced Technical Reports

Students were asked if they use technical reports produced in the U.S. and foreign countries (table 21). Overall, use of foreign produced technical reports by undergraduate and

Table 20. Frequency of Use and Importance of Information Products Used to Meet Information Needs During the Most Recent School Term

	Use				Importance			
	Under-graduate		Graduate		Under-graduate		Graduate	
Information Product	Mean	(n)	Mean	(n)	Mean	(n)	Mean	(n)
Abstracts	2.1	936	2.8*	696	3.2	922	4.2*	693
Conference/Meeting Papers	2.1	935	3.3*	699	3.3	924	5.1*	695
Journal Articles	2.7	935	3.6*	698	4.2	924	5.6*	695
Handbooks	2.9	936	2.8	693	4.6	925	4.4*	689
Textbooks	4.4	937	4.0*	697	6.3	926	6.0*	694
Computer Programs/Documentation	3.2	938	3.4*	698	5.0	924	4.9	692
Bibliographic, Numeric, Factual Data Bases	2.2	936	2.3	691	3.6	922	3.6	692
Theses/Dissertations	1.6	934	2.5*	699	2.8	922	4.0*	693
Technical Reports	2.4	933	3.1*	695	3.8	922	4.8*	693
Audio/Visual Materials	1.8	932	1.7*	695	2.9	923	2.6*	690
Foreign Language Technical Reports	1.3	933	1.4	693	2.1	922	2.1	691
Technical Translations	1.4	932	1.5*	696	2.3	922	2.3	694
Patents	1.3	934	1.2	698	2.3	922	2.0*	691
Industry Technical Reports	1.9	933	2.0*	695	3.3	922	3.4	689
Drawings/Specifications	2.2	930	1.9*	692	3.5	923	2.8*	687
Preprints Or Deposited Manuscripts	1.5	923	1.6	693	2.6	913	2.5	682
Informal Information Products (e.g., Vendor/Supply Catalogs, Company Literature, Trade Journals/Magazines)	2.4	931	2.4	695	3.6	924	3.4*	693

[a]Frequency of use was measured using a 5-point scale, where 1 = never and 5 = always. Importance was measured using a 7-point scale, where 1 = very unimportant and 7 = very important.

*$p \leq 0.05$.

graduate students was low. A higher percentage of graduate students than undergraduates reported using technical reports from all nine countries/organizations. Both groups report the highest use of U.S. (NASA) technical reports (64.8% of undergraduates and 89.1% of graduate students). Undergraduate students made the greatest use of AGARD technical reports followed by ESA technical reports, and British ARC and RAE technical reports. Graduate students made the greatest use of AGARD technical reports followed by British ARC and RAE technical reports, ESA technical reports, technical reports produced in Germany, and French ONERA tech-

Table 21. Use of Foreign and Domestically Produced Technical Reports by U.S. Aerospace Engineering Students

Country/Organization	Undergraduate		Graduate	
	%	(n)	%	(n)
AGARD Reports	10.2	94	35.1*	243
British ARC and RAE Reports	5.7	52	15.4*	106
Dutch NLR Reports	1.2	11	3.3*	23
ESA Reports (European Space Agency)	8.5	78	14.6*	101
Indian NAL Reports	0.2	2	2.3*	16
French ONERA Reports	1.5	14	10.7*	74
German DFVLR, DLR, and MBB Reports	3.1	28	11.3*	78
Japanese NAL Reports	1.7	16	4.2*	29
Russian TsAGI Reports	1.6	15	3.2	22
U.S. NASA Reports	64.8	604	89.1*	624

* $p \leq 0.05$.

nical reports. Graduate students used a statistically significantly higher number of technical reports than did undergraduate students.

Bilingual and Foreign Language Fluency

About 83% of the student respondents indicated that English was their first (native) language. (About 80% of the survey participants indicated that the U.S. was their native country. Furthermore, about 88% indicated that they are a citizen of the country where they are attending college.) About 20% student participants indicated that they are bilingual. Table 22 reports students opinions concerning the importance of being bilingual relative to achieving career success. A significantly greater percentage of undergraduate students believe that, in terms of achieving their career goals and aspirations, being bilingual is important. About 38% of undergraduates report that it is very important to be bilingual, compared to 33% of graduate students. Only about 19% of the undergraduate students indicated that knowing a second language is very unimportant to career success, compared to 25% of the graduate students.

Survey respondents were asked to provide information about their reading and speaking competencies in six languages (table 23). About 99% of the respondents read and speak English fluently. Few students reported skill in reading or speaking languages other than English. Undergraduate reading and speaking abilities were recorded for the following languages: French (26.8%/24.4%), German (20.8%/19.2%), and Spanish (17.8%/16.3%) (languages for which instruction is offered at most U.S. high schools and colleges). Less than 6% reported that they read or speak Japanese or Russian. Undergraduate reading and speaking abilities were recorded

Table 22. Importance of Being Bilingual in Achieving Career Goals and Aspirations

Importance	Undergraduate		Graduate	
	%[a]	(n)	%[a]	(n)
Very Important	37.9	254	33.1*	164
Of Average Importance	43.0	288	41.7	207
Very Unimportant	19.1	128	25.2	125

[a]Percentages exclude students who reported that they are not bilingual.
* $p \leq 0.05$.

Table 23. Language Fluency of U.S. Aerospace Engineering Students

Language	Undergraduate				Graduate			
	Reading		Speaking		Reading		Speaking	
	% Read	Mean Ability[a]	% Speak	Mean Ability[a]	% Read	Mean Ability[a]	% Speak	Mean Ability[a]
English	98.5	5.0	98.2	5.0	99.2	5.0	99.0	4.9
French	26.8	2.0	24.4	1.8	24.9	2.1	22.7	1.9
German	20.8	2.0	19.2	2.0	20.9	1.9	18.9	2.0
Japanese	3.8	1.7	4.3	1.6	4.3	2.4	3.7	2.4
Russian	5.2	2.0	5.4	1.9	5.4	1.9	4.9	1.8
Spanish	17.8	2.8	16.3	2.6	9.4	2.5	7.7	2.5
Other	6.4	3.5	6.9	3.7	5.6	3.6	5.9	3.8

[a]A 5-point scale was used to measure fluency with "1" being passably and "5" being fluently; hence, the higher the average (mean), the greater the ability (fluency) of the student to read/speak the language.

for the following languages: French (24.9%/22.7%), German (20.9%/18.9%), and Spanish (5.4%/4.9%) (languages for which instruction is offered at most U.S. high schools and colleges). Less than 6% reported that they read or speak Japanese or Russian.

Use of Computer and Information Technology and Electronic Networks

The use of computer technology to prepare written technical communications was investigated. Students were asked about their current and anticipated use of selected information technologies. Specifically, students were asked about their use of electronic networks, their use of electronic networks for specific purposes, and their use of electronic networks to exchange messages and files.

Computer Ownership and Use of Computers to Prepare Written Technical Communications

Almost two-thirds of the survey respondents own a personal computer (see table 24). Nearly all the students we surveyed use computers when they prepare written technical communications (97.5% of undergraduates and 99.9% of graduate students). Undergraduate students who do not use computer technology to prepare written technical communications gave the following reasons for "non-use": lack of knowledge/skill using a computer (39.1%), no/lack of access to computer technology (34.8%), and prefer not to use a computer (17.4%).

Table 24. Computer Use/Nonuse by
U.S. Aerospace Engineering Students

Factor	Undergraduate		Graduate	
	%	(n)	%	(n)
Do you own a Personal Computer?				
Yes	67.9	642	66.9	471
No	32.1	303	33.1	233
Do You Use A Computer To Prepare Written Technical Communication?				
No	**2.5**	**23**	**0.1**	**1**
Yes	**97.5**	**898**	**99.9**	**700**
Sometimes	4.9	45	3.0	21
Frequently	15.3	141	8.3	58
Always	77.3	712	88.6	621
Your Reason(s) For Not Using A Computer?				
No/Limited Computer Access	34.8	8	100.0	1
Lack Of Knowledge/Skill Using A Computer	39.1	9	0.0	0
Prefer Not To Use A Computer	17.4	4	0.0	0
Other	21.7	5	0.0	0

Use of Electronic (Computer) Networks

Most students also use electronic networks. Table 25 shows that about 82% of the undergraduates and about 90% of graduate students report that they use electronic (computer) networks. About 66% of the undergraduates and about 80% of the graduate students reported that they personally use them. About 12% of undergraduates and about 7% of the graduate students use electronic (computer) networks through intermediaries.

Table 25. Use of Electronic (Computer) Networks by U.S. Aerospace Engineers Students

Factor	Undergraduate		Graduate	
	%	(n)	%	(n)
Do You Use Electronic (Computer) Networks?				
Yes	**82.2**	**720**	**89.6**	**608**
Yes, I Personally Use Them	66.1	622	79.5	558
Yes, I Use Them But Through An Intermediary	11.5	108	7.1	50
No	**17.8**	**166**	**10.4**	**73**
No, Because I Do Not Have Access To Electronic Networks	6.0	56	3.7	26
No, But I May Use Them In The Future	11.8	111	6.7	47

Table 26 lists the percentages of undergraduate and graduate students who use electronic (computer) networks for 11 different functions. Nearly all students use networks for exchanging electronic mail (87.6% of undergraduates and 93.7% of graduate students). Students also make extensive use of networks for searching library catalogs (74.7% of undergraduate and 83.7% of graduate students) and for transferring files electronically (72.8% of undergraduates and 87.7 % of graduate students. Other network functions utilized by high percentages of students include connecting to geographically distant sites, using networks for computational analysis and access to design tools, searching electronic (bibliographic) data bases, and for information search and retrieval. The functions used least included using network computers to control laboratory instruments and design tools, ordering documents from the library, and preparing STI with colleagues at geographically distant sites. Less than 20% of students reported that they use networks for these purposes.

Although high percentages of undergraduates use electronic (computer) networks for most of the functions described in table 26, significantly greater percentages of graduate students use networks for nearly all functions. There were only two network functions that undergraduate and graduate students used in similar proportions. These include the use of electronic bulletin boards or conferences (51.1% of undergraduates and 53.2% of graduate students) and using networks to control instruments and tools (15.5% of undergraduates and 17.6% of graduate students.

Students who use electronic (computer) networks to exchange messages or files do so with others at a wide array of locations (table 27). Over 80% of both undergraduate and graduate students

Table 26. Uses of Electronic Networks by U.S. Aerospace Engineering Students

Purpose	Undergraduate		Graduate	
	Mean	(n)	Mean	(n)
Connect To Geographically Distant Sites	56.3	407	71.5*	429
Electronic Mail	87.6	635	93.7*	565
Electronic Bulletin Boards Or Conferences	51.1	369	53.2	317
Electronic File Transfer	72.8	526	87.7*	522
Log Into Computers For Computational Analysis Or To Use Design Tools	67.5	489	77.4*	466
Control Equipment Such As Laboratory Instruments Or Machine Tools	15.5	112	17.6	104
Access/Search The Library's Catalog	74.7	541	83.7*	503
Order Documents From The Library	17.2	124	21.7*	129
Search Electronic (Bibliographic) Data Bases	54.8	395	60.9*	363
Information Search And Data Retrieval	58.0	418	57.4*	342
Prepare Scientific And Technical Papers With Colleagues At Geographically Distant Sites	8.2	59	22.3*	133

*$p \leq 0.05$.

reported that they use electronic networks to exchange messages with members of their academic classes (see table 27). Graduate students are significantly more likely to exchange messages with others outside of their academic classes both at the same geographic site (68.8%) and at different geographic sites (63.3%) compared to undergraduate students (58.5% and 39.7%, respectively). A significantly higher percentage of graduate students also uses networks to contact people outside of their academic community (67.2%) compared to undergraduates (52.1%).

Use of Selected Information Technologies

Students were asked about their use and nonuse of a wide range of information technologies (table 28). Specifically, they were asked to indicate if they "already use it," "don't use it but may in the future," and "don't use it and doubt if I will." Undergraduate and graduate students reported the greatest use of computer-based information technologies such as electronic publishing, electronic mail, desk top publishing, and electronic bulletin boards and data bases. Graduate students also make extensive use of FAX/TELEX technologies. Students do not yet participate

Table 27. Use of Electronic Networks by U.S. Aerospace Engineering Students to Exchange Messages or Files

Exchange With --	Undergraduate		Graduate	
	%	(n)	%	(n)
Members Of Your Academic Classes	84.0	609	81.5	492
Other People In Your Academic Community At The **SAME** Geographic Site Who Are Not In Your Academic Classes	58.5	421	68.8*	414
Other People In Your Academic Community At A **DIFFERENT** Geographic Site Who Are Not In Your Academic Classes	39.7	284	63.3*	380
People Outside Of Your Academic Community	52.1	374	67.2*	403

* $p \leq 0.05$.

in video or computer conferencing, but a majority of students expect to use these technologies in the future. Most students do not expect to use audio tapes or motion picture tapes in the future. Most students do not yet participate in video or computer conferencing, but between 80% and 90% of students expect to use these technologies in the future. Less than 15 percent of undergraduates and less than 10% of graduate students report that they use audio tapes or motion picture tapes. About 40% of undergraduates and between 50 and 60% of graduates do not expect to use audio- or videotapes during their future careers.

FINDINGS

1. The average AIAA student member in our sample is male, a U.S. citizen, and is preparing for a career as an aerospace engineer, and made the career decision prior to entering college.

2. Graduate student members are more likely than undergraduates to aspire to work in academia upon graduation, while undergraduate student members prefer to work in industry.

3. In defining career success, graduate student members feel that it is important to develop a professional reputation outside of the organization by communicating their ideas to others in the discipline by publishing articles and presenting papers at professional meetings. Undergraduates feel that it is important to advance within the organization by taking on management and leadership roles.

Table 28. Use, Nonuse, and Potential Use of Information Technologies by U.S. Aerospace Engineering Students

Information Technologies	Already Use It		Don't Use It, But May In Future		Don't Use It, And Doubt If Will	
	%	(n)	%	(n)	%	(n)
Undergraduate						
Audio Tapes And Cassettes	14.8	139	43.8	411	41.4	389
Motion Picture Film	12.9	121	47.6	447	39.5	371
Videotape	35.0	330	59.1	557	5.9	56
Desktop/Electronic Publishing	64.4	608	33.3	314	2.3	22
Computer Cassettes/Cartridge Tapes	24.0	225	51.0	477	25.0	234
Electronic Mail	58.9	557	38.0	359	3.1	29
Electronic Bulletin Boards	35.0	330	59.7	562	5.3	50
FAX Or TELEX	37.7	356	61.5	581	0.7	7
Electronic Data Bases	45.6	430	52.1	491	2.2	21
Video Conferencing	2.7	25	88.7	832	8.6	81
Computer Conferencing	10.2	96	84.2	793	5.6	53
Micrographics And Microforms	29.2	273	60.3	563	10.5	98
Graduate						
Audio Tapes And Cassettes	9.7	68	29.5	207	60.8	426
Motion Picture Film	8.7	61	39.5	277	51.9	364
Videotape	34.3	240	55.9	391	9.9	69
Desktop/Electronic Publishing	76.6	530	20.4	141	3.0	21
Computer Cassettes/Cartridge Tapes	36.1	251	39.1	272	24.7	172
Electronic Mail	78.3	549	21.0	147	0.7	5
Electronic Bulletin Boards	38.9	272	55.0	385	6.1	43
FAX Or TELEX	66.3	463	33.0	230	0.7	5
Electronic Data Bases	55.9	388	41.4	287	2.7	19
Video Conferencing	6.0	42	81.1	567	12.9	90
Computer Conferencing	8.9	62	80.2	559	10.9	76
Micrographics And Microforms	37.6	259	44.6	307	17.9	123

4. Both undergraduate and graduate student members feel that mastering information skills is important to career success. Most students receive training in skills in locating and communicating STI.

5. Most students have experience in producing written STI as a member of a group, and feel that group writing is as productive or more productive than writing alone.

6. Less than half of undergraduate and graduate student members received training directed solely at library skills.

7. Both undergraduate and graduate students use (or expect to use) electronic media (computers and networks) at higher rates than other media in locating and communicating STI.

8. Undergraduate students are more likely than graduate students to indicate that they had no information needs that must be satisfied by using a library.

9. Graduate student AIAA members use formal information resources and products more often and value them more highly than undergraduate students do. Consider the following:

- graduate students use the library more often than undergraduate students;

- with the exception of personal collections of information, undergraduates students consult faculty and other students more often, and value them more highly as information resources, than graduate student do. Graduate students use libraries (and librarians) more often, and value them more highly, than undergraduate student do;

- undergraduate students use information products related to classroom use (textbooks, computer programs, and handbooks) more frequently and value them more highly than graduate students. In additions to textbooks, the information products that graduate students use most frequently (and value most highly) include journal articles and conference and meeting papers;

- greater percentages of graduate students use technical reports, produced both in the U.S. and in other countries, compared to undergraduate students.

10. Undergraduate student members are more likely than graduate students to feel that knowing a second language is important to achieving career success, although there are only minor differences between undergraduate and graduate students in both the percentages which read or speak a foreign language and their ratings of their abilities in reading and speaking a second language.

CONCLUDING REMARKS

We interpret the survey data to indicate that there are two major differences between undergraduate and graduate AIAA student members. The first difference is rooted in the types of organizations that they plan to join upon graduation. The second is the structure of the academic experience which defines students' information needs and the strategies employed for meeting them.

Undergraduate students expect to work in industry, at both the national and multi-national levels. The high importance values that undergraduate students placed on goals which define career success through advancement within the organization are consistent with these expectations. Undergraduate students also value knowledge of a second language more highly than graduate students do; this may result from the greater proportion of undergraduate students who aspire to work in multi-national industry. Graduate students are more likely than undergraduates to aspire to work in academia. The high importance ratings that graduate students assigned to developing a professional reputation through written and oral communication of their ideas is consistent with this goal.

There were also clear differences in the information seeking habits of undergraduate and graduate students. Although undergraduates are at least as well trained in information seeking skills as graduate students are, undergraduate students apply these skills less often. Industry recommendations for improvement of engineering education curricula consistently point to the need for better training in skills related to locating, using, and communicating STI. This survey of AIAA student members indicates that students are reasonably well trained in information skills, and that they appreciate the importance of these skills for future career success. Nevertheless, it appears that undergraduate students -- those students destined to work in industrial setting -- lack the opportunity to hone these skills by applying them routinely during the course of their education. As long as undergraduate students are able satisfy their STI needs through informal channels and by mainly using textbooks and other classroom materials, they will continue to be unprepared to meet the expectations of their future employers. When they begin their careers, these students will be expected to show competence in locating, using and communicating STI on an ongoing basis; classroom-type materials are not adequate sources for these information needs.

At the undergraduate level, students would therefore benefit from curricular changes that require them to use and communicate STI that they must locate on their own. Students indicate that they already make intensive use of computers and computer networks for a wide variety of functions, and the majority have received training in using computer networks for searching bibliographic databases. Course requirements should take advantage of students' willingness to use computers in ways that provide students with the opportunity to use their computer skills, while at the same time helping them to hone their skills in locating and communicating STI.

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APPENDIX A

NASA/DoD AEROSPACE KNOWLEDGE DIFFUSION RESEARCH PROJECT

Fact Sheet

The process of producing, transferring, and using scientific and technical information (STI), which is an essential part of aerospace research and development (R&D), can be defined as *Aerospace Knowledge Diffusion.* Studies tell us that timely access to STI can increase productivity and innovation and help aerospace engineers and scientists maintain and improve their professional skills. These same studies indicate, however, that we know little about aerospace knowledge diffusion or about how aerospace engineers and scientists find and use STI. To learn more about this process, we have organized a research project to study knowledge diffusion. Sponsored by NASA and the Department of Defense (DoD), the *NASA/DoD Aerospace Knowledge Diffusion Research Project* is being conducted by researchers at the NASA Langley Research Center, the Indiana University Center for Survey Research, and Rensselaer Polytechnic Institute. This research is endorsed by several aerospace professional societies including the AIAA, RAeS, and DGLR and has been sanctioned by the AGARD and AIAA Technical Information Panels.

This 4-phase project is providing descriptive and analytical data about the flow of STI at the individual, organizational, national, and international levels. It is examining both the channels used to communicate STI and the social system of the aerospace knowledge diffusion process. Phase 1 investigates the information-seeking habits and practices of U.S. aerospace engineers and scientists, in particular their use of government-funded aerospace STI. Phase 2 examines the industry-government interface and emphasizes the role of the information intermediary in the knowledge diffusion process. Phase 3 concerns the academic-government interface and emphasizes the information intermediary-faculty-student interface. Phase 4 explores the information-seeking behaviors of non-U.S. aerospace engineers and scientists from Western European nations, India, Israel, Japan, and the former Soviet Union.

The results of this research project will help us to understand the flow of STI at the individual, organizational, national, and international levels. The findings can be used to identify and correct deficiencies; to improve access and use; to plan new aerospace STI systems; and should provide useful information to R&D managers, information managers, and others concerned with improving access to and utilization of STI. These results will contribute to increasing productivity and to improving and maintaining the professional competence of aerospace engineers and scientists. The results of our research are being shared freely with those who participate in the study.

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APPENDIX B

Technical Communications in Aerospace: The AIAA National Student Membership Study

These questions ask about your career goals and aspirations.

1. To have a successful career, how important will it be for you to: (Circle number)

		Very Unimportant						Very Important	Don't Know
1	Have the opportunity to explore new ideas about technology or systems	1	2	3	4	5	6	7	8
2	Advance to a high-level staff technical position	1	2	3	4	5	6	7	8
3	Have the opportunity to work on complex technical problems	1	2	3	4	5	6	7	8
4	Work on projects that utilize the latest theoretical results in your specialty	1	2	3	4	5	6	7	8
5	Work on projects that require learning new technical knowledge	1	2	3	4	5	6	7	8
6	Establish a reputation outside your organization as an authority in your field	1	2	3	4	5	6	7	8
7	Receive patents for your ideas	1	2	3	4	5	6	7	8
8	Publish articles in technical journals	1	2	3	4	5	6	7	8
9	Communicate your ideas to others in your profession through papers delivered at professional society meetings	1	2	3	4	5	6	7	8
10	Be evaluated on the basis of your technical contributions	1	2	3	4	5	6	7	8
11	Become a manager or director in your line of work	1	2	3	4	5	6	7	8
12	Plan and coordinate the work of others	1	2	3	4	5	6	7	8
13	Advance to a policy-making position in management	1	2	3	4	5	6	7	8
14	Plan projects and make decisions affecting the organization	1	2	3	4	5	6	7	8
15	Be the technical leader of a group of less experienced professionals	1	2	3	4	5	6	7	8

These questions ask about your decision to choose a career in engineering or science.

2. How important were each of the following in making your career choice? (Circle number)

	Very Unimportant						Very Important	Not Applicable
1 Your parents encouraged your area of study/major	1	2	3	4	5	6	7	9
2 Other family members encouraged your area of study/major	1	2	3	4	5	6	7	9
3 Teachers encouraged your area of study/major	1	2	3	4	5	6	7	9
4 You feel that a career in your major/area of study will lead to financial security	1	2	3	4	5	6	7	9
5 You feel that a career in your major/area of study will provide a career with many rewarding activities	1	2	3	4	5	6	7	9
6 Information on the career opportunities available in your major/area of study	1	2	3	4	5	6	7	9

7 Other important factors (Please specify) ______________________

3. When did you first decide on your area of study/major? (Circle number)

1 While still in elementary school
2 While in high school (or equivalent)
3 When you started college (or equivalent)
4 After starting college (or equivalent)
5 Other (Please specify) ______________

4. How well do your current feelings about the career opportunities in your major/area of study match with those you had when you first decided on your career path? Would you say: (Circle ONLY one)

1 I am more happy about my career choice now than when I first made it
2 I feel about the same now as when I first made it
3 I am less happy about my career choice now than when I first made it

These questions ask about the importance of certain skills for your professional success.

5. How important do you think it will it be for you to: (Circle number)

	Very Unimportant						Very Important	Don't Know
1 Effectively communicate technical information in writing	1	2	3	4	5	6	7	8
2 Effectively communicate technical information orally	1	2	3	4	5	6	7	8
3 Have a knowledge and understanding of engineering/science information resources and materials	1	2	3	4	5	6	7	8
4 Be able to search electronic (bibliographic) data bases	1	2	3	4	5	6	7	8
5 Know how to use a library that contains engineering/science information resources and materials	1	2	3	4	5	6	7	8
6 Effectively use computer, communication, and information technology	1	2	3	4	5	6	7	8

The next group of questions asks about course work or instruction you might have received as part of your education or academic preparation.

6. Have you received training or course work in: (Circle number)

	Yes	No	No Instruction Available
1 Technical writing/communication	1	2	8
2 Speech/oral communication	1	2	8
3 Using a library that contains engineering/science information resources and materials	1	2	8
4 Using engineering/science information resources and materials	1	2	8
5 Searching electronic (bibliographic) data bases	1	2	8
6 Using computer, communication, and information technology	1	2	8

7. **If you received training or instruction in any of the following, was it helpful? (Circle number)**

	Not Helpful						Very Helpful	Don't Know	Did Not Receive Training
1 Technical writing/communication . .	1	2	3	4	5	6	7	8	10
2 Speech/oral communication	1	2	3	4	5	6	7	8	10
3 Using a library that contains engineering /science information resources and materials	1	2	3	4	5	6	7	8	10
4 Using engineering/science information resources and materials	1	2	3	4	5	6	7	8	10
5 Searching electronic (bibliographic) data bases	1	2	3	4	5	6	7	8	10
6 Using computer, communication, and information technology	1	2	3	4	5	6	7	8	10

These next questions ask about your preparation of written technical communication as part of your education or academic preparation.

8. **What percentage of your written technical communication involves collaborative writing (i.e., writing as a member of a group)?**

   ______ % **(If 100% of your writing is done alone, go to Question 11.)**

9. **If you do write as a member of a group, what percentage of your written technical communication is required to be collaborative?**

   ______ %

10. **In general, do you find writing as part of a group more or less productive (i.e. quantity/ quality) than writing alone? (Circle number)**

    1 Less productive than writing alone
    2 About as productive as writing alone
    3 More productive than writing alone

11. **Do you use a computer to prepare written technical communication? (Circle number)**

    1 Never
    2 Sometimes }
    3 Frequently } Go to Question 13.
    4 Always }

12. **If NEVER, which one of the following best explains your reasons for non-use? (Circle numbers)**

1 No or limited computer access
2 Lack of knowledge/skill using a computer
3 Prefer not to use a computer
4 Other (Please specify) ____________________

13. **To what extent does lack of knowledge/skill about each of the following communication principles impede your ability to produce (i.e., quality/quantity) written technical communication? (Circle all that apply.)**

	Does not Impede						Greatly Impedes	Don't Know
1 Defining the purpose of the communication	1	2	3	4	5	6	7	8
2 Assessing the needs of the reader	1	2	3	4	5	6	7	8
3 Preparing/presenting information in an organized manner	1	2	3	4	5	6	7	8
4 Developing paragraphs (introductions, transitions, and conclusions)	1	2	3	4	5	6	7	8
5 Writing grammatically correct sentences	1	2	3	4	5	6	7	8
6 Notetaking and quoting	1	2	3	4	5	6	7	8
7 Editing and revising	1	2	3	4	5	6	7	8
8 Other (Please specify) ____________								

These questions ask about your use of electronic/information technologies.

14. **Describe your use of the following electronic/information technologies for communicating technical information. (Circle number)**

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
1 Audio tapes and cassettes	1	2	3
2 Motion picture film	1	2	3
3 Video tape	1	2	3
4 Desktop /electronic publishing	1	2	3
5 Computer cassette/cartridge tapes	1	2	3
6 Electronic mail	1	2	3
7 Electronic bulletin boards	1	2	3
8 FAX or TELEX	1	2	3
9 Electronic data bases	1	2	3
10 Video conferencing	1	2	3
11 Computer conferencing	1	2	3
12 Micrographics & microforms	1	2	3

15. **Do you ever use electronic (computer) networks? (Circle number)**

1 Yes, I personally use them
2 Yes, I use them but through an intermediary
3 No
4 No because I do not have access to electronic networks
5 No but may use them in the future

$\left.\begin{array}{l}3\\4\\5\end{array}\right\}$ Go to Question 18.

If you answered "no" to Question 15, please go to Question 18. If you answered "yes" to Question 15, please continue to Question 16.

16. **Do you use electronic networks for the following purposes? (Circle number)**

		Yes	No
1	To connect to geographically distant sites	1	2
2	For electronic mail	1	2
3	For electronic bulletin boards or conferences	1	2
4	For electronic file transfer	1	2
5	To log into computers for such things as computational analysis or to use design tools	1	2
6	To control equipment such as laboratory instruments or machine tools	1	2
7	To access/search the library's catalogue	1	2
8	To order documents from the library	1	2
9	To search electronic (bibliographic) data bases	1	2
10	For information search and data retrieval	1	2
11	To prepare scientific and technical papers with colleagues at geographically distant sites	1	2

17. **Do you exchange electronic messages or files with: (Circle number)**

		Yes	No
1	Members of your academic classes	1	2
2	Other people in your academic community at the **SAME** geographic site who are not in your academic classes	1	2
3	Other people in your academic community at a **DIFFERENT** geographic site who are not in your academic classes	1	2
4	People outside of your academic community	1	2

These questions ask about your use of libraries and library services as part of your education.

18. **During this current school term, about how many times have you used a library to meet your engineering/science information needs?**

_______ number of times

If you answered "0" times to Question 18, please go to Question 20. If you answered "1 or more" times to Question 18, please continue to Question 19.

19. During the current school term, how effective was the information obtained from the library for meeting your engineering/science information needs? (Circle number) } Go to Question 21.

Very Ineffective						Very Effective	Don't Know
1	2	3	4	5	6	7	8

20. Which of the following statements best describes your reasons for not using a library during this current school term? (Circle ALL that apply)

		Yes	No
1	I had no information needs	1	2
2	My information needs were more easily met some other way	1	2
3	Tried the library once or twice before but I couldn't find the information I needed	1	2
4	The library is physically too far away	1	2
5	The library staff is not cooperative or helpful	1	2
6	The library staff does not understand my information needs	1	2
7	The library did not have the information I need	1	2
8	I have my own personal library and do not need another library	1	2
9	The library is too slow in getting the information I need	1	2
10	We have to pay to use the library	1	2
11	We are discouraged from using the library	1	2

21. As part of your academic preparation, have you received or participated in the following library activities? (Circle ALL that apply)

		Yes	No	Not Available	Don't Know
1	Library tour	1	2	6	8
2	Library presentation as part of academic orientation	1	2	6	8
3	Library orientation as part of an engineering/ science course	1	2	6	8
4	Library skill/use course (bibliographic instruction)	1	2	6	8
5	Library skill/use course in engineering/science information resources and materials	1	2	6	8
6	Library instruction for end-user searching of electronic (bibliographic) data bases	1	2	6	8

22. Which ONE of the following BEST characterizes your use of electronic (bibliographic) data bases? (Circle ONLY ONE number)

1 I do **all** searches myself
2 I do **most** searches myself
3 I do **half** by myself and **half** through a librarian
4 I do **most** searches through a librarian
5 I do **all** searches through a librarian
6 I do **not use** electronic data bases
7 I do not have access to electronic data bases

These questions ask about the use and importance of information to engineering/science students.

23. How OFTEN during this current school term have you used the following information sources to meet your engineering/science information needs? (Circle numbers)

		Never	Seldom	Sometimes	Frequently	Always	Not Available
1	Your personal collection of information	1	2	3	4	5	6
2	Other students	1	2	3	4	5	6
3	Faculty members	1	2	3	4	5	6
4	Library	1	2	3	4	5	6
5	Librarian	1	2	3	4	5	6
6	Your personal contacts within industry	1	2	3	4	5	6
7	Your personal contacts at government laboratories . . .	1	2	3	4	5	6

24. How OFTEN during this current school term have you used the following information products to meet your engineering/science information needs? (Circle numbers)

		Never	Seldom	Sometimes	Frequently	Always	Not Available
1	Abstracts	1	2	3	4	5	6
2	Conference/meeting papers	1	2	3	4	5	6
3	Journal articles	1	2	3	4	5	6
4	Handbooks	1	2	3	4	5	6
5	Textbooks	1	2	3	4	5	6
6	Computer programs and documentation	1	2	3	4	5	6
7	Bibliographic, numeric, factual data bases	1	2	3	4	5	6
8	Theses/dissertations	1	2	3	4	5	6
9	Technical reports	1	2	3	4	5	6
10	Audio/visual materials . . .	1	2	3	4	5	6
11	Foreign language technical reports	1	2	3	4	5	6
12	Technical translations . . .	1	2	3	4	5	6
13	Patents	1	2	3	4	5	6
14	Industry technical reports .	1	2	3	4	5	6
15	Drawings/specifications . .	1	2	3	4	5	6
16	Preprints or deposited manuscripts	1	2	3	4	5	6
17	Informal information products e.g., vendor/supply catalogs, company literature, trade journals/magazines)	1	2	3	4	5	6

25. How IMPORTANT are the following information sources in meeting your engineering/ science information needs? (Circle numbers)

		Very Unimportant						Very Important	Not Available
1	Your personal collection of information	1	2	3	4	5	6	7	8
2	Other students	1	2	3	4	5	6	7	8
3	Faculty members	1	2	3	4	5	6	7	8
4	Library	1	2	3	4	5	6	7	8
5	Librarian	1	2	3	4	5	6	7	8
6	Your personal contacts within industry	1	2	3	4	5	6	7	8
7	Your personal contacts at government laboratories	1	2	3	4	5	6	7	8

26. How IMPORTANT are the following information products in meeting your engineering/ science information needs? (Circle numbers)

		Very Unimportant						Very Important	Not Available
1	Abstracts	1	2	3	4	5	6	7	8
2	Conference/meeting papers	1	2	3	4	5	6	7	8
3	Journal articles	1	2	3	4	5	6	7	8
4	Handbooks	1	2	3	4	5	6	7	8
5	Textbooks	1	2	3	4	5	6	7	8
6	Computer programs and documentation	1	2	3	4	5	6	7	8
7	Bibliographic, numeric, factual data bases	1	2	3	4	5	6	7	8
8	Theses/dissertations	1	2	3	4	5	6	7	8
9	Technical reports	1	2	3	4	5	6	7	8
10	Audio/visual materials	1	2	3	4	5	6	7	8
11	Foreign language technical reports	1	2	3	4	5	6	7	8
12	Technical translations	1	2	3	4	5	6	7	8
13	Patents	1	2	3	4	5	6	7	8
14	Industry technical reports	1	2	3	4	5	6	7	8
15	Drawings/specifications	1	2	3	4	5	6	7	8
16	Preprints or deposited manuscripts	1	2	3	4	5	6	7	8
17	Informal information products (e.g., vendor/supply catalogs, company literature, trade journals/magazines)	1	2	3	4	5	6	7	8

27. Do you use the following technical reports in meeting your engineering/science information needs? (Circle numbers)

		Yes	No	Don't Have Access
1	AGARD reports	1	2	6
2	British ARC and RAE reports	1	2	6
3	Dutch NLR reports	1	2	6
4	ESA reports	1	2	6
5	Indian NAL reports	1	2	6
6	French ONERA reports	1	2	6
7	German DFVLR, DLR, and MBB reports	1	2	6
8	Japanese NAL reports	1	2	6
9	Russian TsAGI reports	1	2	6
10	U.S. NASA reports	1	2	6

28. Think of the most technically challenging assignment you have worked on this current school term. What steps did you follow to obtain the information you needed to complete this assignment? Please sequence these items (e.g., #1, #2, #3, #4, #5) and mark an X beside the step(s) you DID NOT USE.

Sequence

____ Used my personal store of technical information
____ Spoke with other students
____ Spoke with faculty members
____ Used literature resources (e.g., conference papers, journal articles, technical reports)
____ Spoke with a librarian
____ Used literature resources found in a library
____ Used none of the above steps
____ Searched (or had someone search for me) an electronic (bibliographic) database in the library.

These questions will be used to determine whether students with different backgrounds and from different countries have different technical communication practices.

29. What is your gender? (Circle number)

1 Female
2 Male

30. What is your educational status? (Circle number)

1 Freshman
2 Sophomore
3 Junior
4 Senior
5 Graduate
6 Other (Please specify) ____________________

31. Is your education primarily as:

1 An engineer
2 A scientist
3 Something else
(Please specify) ____________________

32. What is your native language?

Please specify ____________________

33. What is your native country?

Please specify ____________________

34. Are you a citizen of the country where you are attending school? (Circle number)

1 Yes

2 No

35. How well do you read the following languages? (Circle numbers)

	Passably				Fluently	Do not Read This Language
1 English	1	2	3	4	5	6
2 French	1	2	3	4	5	6
3 German	1	2	3	4	5	6
4 Japanese	1	2	3	4	5	6
5 Russian	1	2	3	4	5	6
6 Other (please specify) ____________________						

36. How well do you speak the following languages? (Circle numbers)

	Passably				Fluently	Do not Speak This Language
1 English	1	2	3	4	5	6
2 French	1	2	3	4	5	6
3 German	1	2	3	4	5	6
4 Japanese	1	2	3	4	5	6
5 Russian	1	2	3	4	5	6
6 Other (please specify) ____________________						

over ➡

37. In terms of your career goals and aspirations, how important will it be for you to be bilingual (i.e., read and speak more than one language)? (Circle number)

Very Unimportant						Very Important	Am Not Bilingual	Don't Know
1	2	3	4	5	6	7	8	9

38. In what type of organization do you hope to work after graduation? (Circle number)

1 Academic
2 Government
3 Industry (national)
4 Industry (multi-national)
5 NOT for profit
6 Other (please specify) ______________________________

39. When you were growing up, do you think your family's income was: (Circle number)

1 Much higher than that of most families in your native country
2 Higher than that of most families in your native country
3 About equal to the average family income in your native country
4 Lower than that of most families in your native country
5 Much lower than that of most families in your native country
6 I cannot compare my family's income with incomes of other families

40. Do you own a personal computer? (Circle number)

1 Yes

2 No

41. As a high school student, how often did you use your: (Circle number)

	Never	Seldom	Sometimes	Frequently	Always	Not Available
2 High school library	1	2	3	4	5	6
3 Public library	1	2	3	4	5	6

42. As a technology major, about how many hours a week (exclusive of classroom and course assignments) do you spend reading (keeping current with) the professional literature associated with your discipline?

________ hours each week

43. Are you a member of a professional student (national) engineering, scientific, or technical society? (Circle number)

1 Yes

2 No

APPENDIX C

AIAA NATIONAL STUDENT MEMBERSHIP

These questions ask about your career goals and aspirations.

1. To have a successful career, how important will it be for you to:

	Very Unimportant 1 %	2 %	3 %	4 %	5 %	6 %	Very Important 7 %
Have the opportunity to explore new ideas about technology or systems	1.0	0.5	0.8	2.2	11.1	28.7	55.7
Advance to a high-level staff technical position	1.6	2.3	4.9	14.4	27.1	25.6	24.3
Have the opportunity to work on complex technical problems	0.9	1.3	2.0	8.5	20.9	32.7	33.7
Work on projects that utilize the latest theoretical results in your specialty	1.1	1.9	4.5	12.2	22.9	26.7	30.7
Work on projects that require learning new technical knowledge	0.6	0.6	1.8	7.2	19.9	34.4	35.4
Establish a reputation outside your organization as an authority in your field	2.6	3.1	6.5	15.2	21.6	22.7	28.3
Receive patents for your ideas	5.7	9.8	14.6	23.8	21.0	11.6	13.5
Publish articles in technical journals	3.8	5.2	10.2	21.0	22.5	19.7	17.6
Communicate your ideas to others in your profession through papers delivered at professional society meetings	2.5	4.9	8.7	18.1	24.9	24.5	16.4
Be evaluated on the basis of your technical contributions	1.6	2.3	4.4	12.3	26.4	30.6	22.4
Become a manager or director in your line of work	3.8	4.8	8.6	18.3	23.5	21.6	19.4
Plan and coordinate the work of others	2.9	3.0	10.1	18.8	25.1	22.2	17.9
Advance to a policy-making position in management	5.6	7.3	11.4	19.9	20.8	18.3	16.7
Plan projects and make decisions affecting the organization	2.3	3.2	5.3	13.7	26.1	27.0	22.4
Be the technical leader of a group of less experienced professionals	1.2	3.2	5.8	15.1	27.7	29.2	17.8

These questions ask about your decision to choose a career in engineering or science.

2. How important were each of the following in making your career choice?

	Very Unimportant 1 %	2 %	3 %	4 %	5 %	6 %	Very Important 7 %	NA 9 %
Your parents encouraged your area of study/major	20.1	14.5	12.1	17.7	15.1	7.2	7.2	6.1
Other family members encouraged your area of study/major	27.5	16.2	13.3	17.9	8.2	3.9	3.4	9.6
Teachers encouraged your area of study/major	14.9	12.3	13.1	21.6	16.9	9.9	5.4	5.9
You feel that a career in your major/area of study will lead to financial security	6.5	7.2	11.8	21.5	24.7	16.8	10.3	1.2
You feel that a career in your major/area of study will provide a career with many rewarding activities	0.8	0.9	1.2	4.2	11.2	30.2	51.2	0.3
Information on the career opportunities available in your major/area of study	7.8	7.3	11.8	22.9	22.5	14.5	10.3	3.0

3. When did you first decide on your area of study/major?

While still in elementary school	13.4%
While in high school (or equivalent)	60.1%
When you started college (or equivalent)	11.5%
After starting college (or equivalent)	10.9%
Other	4.1%

4. How well do your current feelings about the career opportunities in your major/area of study match with those you had when you first decided on your career path?

I am more happy about my career choice now than when I first made it	28.8%
I feel about the same now as when I first made it	44.4%
I am less happy about my career choice now than when I first made it	26.8%

AIAA National Student Membership

These questions ask about the importance of certain skills for your professional success.

5. How important do you think it will be for you to:

	Very Unimportant 1 %	2 %	3 %	4 %	5 %	6 %	Very Important 7 %
Effectively communicate technical information in writing	0.9	0.3	0.9	2.8	11.2	25.5	58.3
Effectively communicate technical information orally	0.7	0.5	0.6	2.9	11.6	26.1	57.6
Have a knowledge and understanding of engineering/science information resources and materials	0.7	0.5	0.5	2.6	15.4	30.3	50.0
Be able to search electronic (bibliographic) data bases	0.8	1.7	4.4	13.7	28.0	27.2	24.2
Know how to use a library that contains engineering/science information resources and materials	0.7	1.5	2.3	8.3	23.3	31.8	32.1
Effectively use computer, communication, and information technology	1.0	0.2	0.4	1.2	6.1	21.7	69.2

The next group of questions asks about course work or instruction you might have received as part of your education or academic preparation.

6. Have you received training or course work in:

	Yes 1 %	No 2 %	No Instruction Available 8 %
Technical writing/communication	72.2	25.2	2.6
Speech/oral communication	62.2	35.0	2.9
Using a library that contains engineering/science information resources and materials	59.9	32.6	7.5
Using engineering/science information resources and materials	63.6	29.4	7.0
Searching electronic (bibliographic) data bases	50.2	40.9	8.9
Using computer, communication, and information technology	82.9	14.5	2.7

7. If you received training or instruction in any of the following, was it helpful?

	Not Helpful 1 %	2 %	3 %	4 %	5 %	6 %	Very Helpful 7 %	No Training 10 %
Technical writing/communication	1.0	1.5	3.7	8.7	19.0	19.1	20.1	27.0
Speech/oral communication	0.7	1.2	3.2	7.5	17.0	16.2	18.3	35.8
Using a library that contains engineering/science information resources and materials	0.6	1.7	4.5	12.2	18.1	12.8	11.4	38.6
Using engineering/science information resources and materials	0.5	1.4	4.2	10.8	19.0	16.1	12.9	35.0
Searching electronic (bibliographic) data bases	1.1	2.2	5.4	9.4	13.1	12.7	9.3	46.7
Using computer, communication, and information technology	0.5	1.2	2.5	8.1	14.2	20.0	36.9	16.7

These next questions ask about your preparation of written technical communication as part of your education or academic preparation.

8. What percentage of your written technical communication involves collaborative writing?

0 percent	18.9%
1 through 25 percent	32.9%
26 through 50 percent	24.3%
51 through 75 percent	10.9%
76 through 99 percent	9.9%
100 percent	3.2%

9. If you do write as a member of a group, what percentage of your written technical communication is required to be collaborative?

0 percent	6.7%
1 through 25 percent	28.7%
26 through 50 percent	34.8%
51 through 75 percent	9.3%
76 through 99 percent	9.2%
100 percent	11.4%

10. In general, do you find writing as part of a group more or less productive than writing alone?

Less productive than writing alone	28.0%
About as productive as writing alone	28.3%
More productive than writing alone	43.7%

11. Do you use a computer to prepare written technical communication?

Never	1.4%
Sometimes	4.0%
Frequently	12.3%
Always	82.3%

12. Which of the following best explains your reasons for non-use?

No or limited computer access	37.5%
Lack of knowledge/skill using a computer	37.5%
Prefer not to use a computer	16.7%
Other	20.8%

13. To what extent does lack of knowledge/skill about each of the following communication principles impede your ability to produce written technical communication?

	Does not Impede 1 %	2 %	3 %	4 %	5 %	6 %	Greatly Impedes 7 %
Defining the purpose of the communication	22.4	17.3	11.1	10.0	13.8	10.4	15.0
Assessing the needs of the reader	10.3	13.2	16.9	19.2	19.7	13.5	7.1
Preparing/presenting information in an organized manner	22.6	17.4	12.5	12.0	10.6	12.7	12.2
Developing paragraphs (introductions, transitions, and conclusions)	25.3	16.7	12.4	13.3	14.9	10.3	7.1
Writing grammatically correct sentences	33.7	15.6	9.6	11.8	10.7	10.5	8.0
Notetaking and quoting	24.3	17.8	17.6	17.6	13.5	5.3	3.9
Editing and revising	24.3	18.5	13.4	14.3	12.2	10.2	7.1

These questions ask about your use of electronic/information technologies.

14. Describe your use of the following electronic/information technologies for communicating technical information.

	I already use it 1 %	I don't use it, but may in the future 2 %	I don't use it and doubt if I will 3 %
Audio tapes and cassettes	12.5	38.0	49.5
Motion picture film	11.0	44.4	44.6
Video tape	34.7	57.6	7.6
Desktop/electronic publishing	69.6	27.9	2.5
Computer cassette/cartridge tapes	29.6	45.8	24.6
Electronic mail	67.1	30.7	2.1
Electronic bulletin boards	36.7	57.7	5.6
FAX or TELEX	50.6	48.6	0.8
Electronic data bases	50.2	47.4	2.4
Video conferencing	4.1	85.5	10.4
Computer conferencing	9.8	82.4	7.8
Micrographics & microforms	32.9	53.8	13.3

15. Do you ever use electronic networks?

Yes, I personally use them	71.7%
Yes, I use them but through an intermediary	9.4%
No	4.1%
No, because I do not have access	5.2%
No, but I may use them in the future	9.7%

16. Do you use electronic networks for the following purposes?

	Yes 1 %	No 2 %
To connect to geographically distant sites	63.6	36.4
For electronic mail	90.1	9.9
For electronic bulletin boards or conferences	52.0	48.0
For electronic file transfer	79.4	20.6
To log into computers for such things as computational analysis or to use design tools	71.9	28.1
To control equipment such as laboratory instruments or machine tools	16.7	83.3
To access/search the library's catalogue	78.9	21.1
To order documents from the library	19.4	80.6
To search electronic (bibliographic) data bases	57.7	42.3
For information search and data retrieval	58.1	41.9
To prepare scientific and technical papers with colleagues at geographically distant sites	14.9	85.1

17. Do you exchange electronic messages or files with:

	Yes 1 %	No 2 %
Members of your academic classes	82.7	17.3
Other people in your academic community at the same geographic site who are not in your academic classes	62.8	37.2
Other people in your academic community at a different geographic site who are not in your academic classes	50.3	49.7
People outside your academic community	59.2	40.8

These questions ask about your use of libraries and library services as part of your education.

18. During this current school term, about how many times have you used a library to meet your engineering/science information needs?

0 times	10.9%
1 through 25 times	80.8%
26 through 50 times	6.2%
51 through 75 times	0.4%
More than 75 times	1.8%

19. During the current school term, how effective was the information obtained from the library for meeting your engineering/science information needs?

Very Ineffective 1	2	3	4	5	6	Very Effective 7
%	%	%	%	%	%	%
2.0	4.6	8.7	15.5	31.9	22.5	14.8

20. Which of the following statements best describes your reasons for not using a library during this current school term?

	Yes 1 %	No 2 %
I had no information needs	70.9	29.1
My information needs were more easily met some other way	72.0	28.0
Tried the library once or twice before but I couldn't find the information I needed	24.2	75.8
The library is physically too far away	7.1	92.9
The library staff is not cooperative or helpful	4.5	95.5
The library staff does not understand my information needs	7.8	92.2
The library did not have the information I need	16.3	83.7
I have my own personal library and do not need another library	12.4	87.6
The library is too slow in getting the information I need	8.7	91.3
We have to pay to use the library	0.6	99.4
We are discouraged from using the library	0.0	100.0

21. As part of your academic preparation, have you received or participated in the following library activities?

	Yes 1 %	No 2 %	Not Available 6 %
Library tour	46.1	47.8	6.1
Library presentation as part of academic orientation	36.6	55.2	8.2
Library orientation as part of an engineering/science course	22.4	61.6	16.0
Library skill/use course (bibliographic instruction)	28.0	61.3	10.7
Library skill/use course in engineering/science information resources and materials	18.9	64.8	16.3
Library instruction for end-user searching of electronic (bibliographic) data bases	30.0	58.5	11.5

22. Which one of the following best characterizes your use of electronic data bases?

I do all searches myself	41.9%
I do most searches myself	36.5%
I do half by myself and half through a librarian	6.0%
I do most searches through a librarian	2.3%
I do all searches through a librarian	0.8%
I do not use electronic data bases	9.1%
I do not have access to electronic data bases	3.3%

These questions ask about the use and importance of information to engineering/science students.

23. How often during this current school term have you used the following information sources to meet your engineering/science information needs?

	Never 1 %	Seldom 2 %	Sometimes 3 %	Frequently 4 %	Always 5 %	Not Available 6 %
Your personal collection of information	1.2	4.1	17.3	49.2	27.4	0.8
Other students	4.1	15.6	35.4	37.2	7.3	0.5
Faculty members	3.5	17.3	37.9	34.4	6.4	0.5
Library	6.5	22.3	30.6	30.9	9.3	0.3
Librarian	37.4	39.6	18.2	3.7	0.5	0.6
Your personal contacts within industry	35.7	22.8	17.9	7.2	1.8	14.7
Your personal contacts at government laboratories	44.9	14.1	12.4	4.8	1.4	22.4

24. How often during this current school term have you used the following information products to meet your engineering/science information needs?

	Never 1 %	Seldom 2 %	Sometimes 3 %	Frequently 4 %	Always 5 %	Not Available 6 %
Abstracts	32.7	21.1	26.8	15.6	2.3	1.6
Conference/meeting papers	30.6	15.6	24.8	22.5	4.8	1.7
Journal articles	14.5	14.1	29.0	34.5	7.9	0.2
Handbooks	17.1	20.8	31.3	23.0	7.1	0.8
Textbooks	1.1	2.0	12.7	43.3	40.7	0.1
Computer programs and documentation	11.1	13.7	25.2	35.6	13.3	1.0
Bibliographic, numeric, factual data bases	31.0	29.3	26.3	10.1	2.2	1.2
Theses/dissertations	47.0	22.4	19.9	8.5	1.3	0.9
Technical reports	20.3	22.1	30.1	22.5	4.4	0.6
Audio/visual materials	55.4	23.7	12.9	5.7	0.9	1.3
Foreign language technical reports	82.5	9.8	3.7	0.9	0.6	2.3
Technical translations	74.0	15.5	7.0	0.9	0.3	2.3
Patents	85.8	8.1	2.8	0.6	0.0	2.7
Industry technical reports	47.2	24.0	19.9	6.1	0.8	2.0
Drawings/specifications	45.1	21.0	21.2	9.0	2.1	1.6
Preprints or deposited manuscripts	70.4	16.3	8.0	1.9	0.4	3.1
Informal information products (e.g., vendor/supply catalogs, company literature, trade journals/magazines)	29.2	23.2	26.6	16.7	3.3	1.1

25. How important are the following information sources in meeting your engineering/science information needs?

	Very Unimportant 1 %	2 %	3 %	4 %	5 %	6 %	Very Important 7 %	Not Available 8 %
Your personal collection of information	1.6	2.3	4.7	7.3	13.5	19.1	51.2	0.3
Other students	4.2	9.3	11.6	17.7	22.4	19.5	15.0	0.2
Faculty members	1.3	4.1	9.8	15.7	21.9	24.8	22.0	0.4
Library	4.0	9.1	10.6	17.4	18.7	18.7	21.3	0.2
Librarian	28.3	23.2	17.7	14.6	8.8	4.0	2.8	0.7
Your personal contacts within industry	18.0	13.8	11.5	13.1	11.0	6.4	6.2	19.9
Your personal contacts at government laboratories	24.0	11.4	7.3	9.1	8.1	5.2	5.6	29.3

26. How important are the following information products in meeting your engineering/science information needs?

	Very Unimportant 1 %	2 %	3 %	4 %	5 %	6 %	Very Important 7 %	Not Available 8 %
Abstracts	20.5	13.1	13.8	17.8	14.2	8.7	9.0	2.8
Conference/meeting papers	17.9	10.2	12.5	14.1	14.6	13.3	14.7	2.6
Journal articles	8.7	6.1	9.2	14.3	19.6	18.1	23.4	0.6
Handbooks	9.3	9.2	10.5	18.8	18.3	16.6	16.2	1.2
Textbooks	0.6	0.5	2.0	6.9	13.4	24.1	52.1	0.3
Computer programs and documentation	6.1	5.6	9.1	14.5	19.0	20.1	24.4	1.2
Bibliographic, numeric, factual data bases	18.2	14.4	15.8	20.0	13.8	8.8	7.0	2.0
Theses/dissertations	24.3	17.0	14.8	15.9	12.0	9.2	5.2	1.7
Technical reports	12.7	9.0	10.5	18.1	19.7	16.7	12.1	1.3
Audio/visual materials	35.9	19.4	13.6	13.0	7.4	4.8	3.5	2.4
Foreign language technical reports	59.2	16.3	7.0	6.7	2.9	1.9	1.5	4.4
Technical translations	51.7	17.8	9.1	8.7	4.5	1.8	2.4	4.0
Patents	57.5	15.0	8.3	7.6	3.1	1.5	1.7	5.4
Industry technical reports	27.6	12.9	14.3	15.9	11.9	8.2	5.8	3.4
Drawings/specifications	31.7	12.4	11.9	15.6	11.9	7.6	6.0	2.8
Preprints or deposited manuscripts	46.2	16.9	9.5	11.9	4.8	3.0	2.1	5.5
Informal information products (e.g., vendor/supply catalogs, company literature, trade journals/magazines)	23.9	13.5	13.5	15.3	14.0	9.9	7.9	1.9

27. Do you use the following technical reports in meeting your engineering/science information needs?

	Yes 1 %	No 2 %	Don't Have Access 6 %
AGARD reports	21.4	54.5	24.0
British ARC and RAE reports	10.1	62.6	27.3
Dutch NLR reports	2.1	67.7	30.2
ESA reports	11.1	62.1	26.8
Indian NAL reports	1.1	68.4	30.5
French ONERA reports	5.6	65.0	29.4
German DFVLR, DLR, and MBB reports	6.7	63.7	29.6
Japanese NAL reports	2.8	67.0	30.2
Russian TsAGI reports	2.4	67.0	30.5
U.S. NASA reports	75.4	17.2	7.4

28. Think of the most technically challenging assignment you have worked on this current school term. What steps did you follow to obtain the information you needed to complete this assignment?

	Step 1 %	2 %	3 %	4 %	Steps 5 through 7 %	Did Not Use 0 %
Used my personal store of technical information	49.3	14.7	13.3	6.6	9.5	6.5
Spoke with other students	10.6	28.7	17.2	11.2	20.7	11.7
Spoke with faculty members	21.1	20.8	23.3	12.0	15.2	7.6
Used literature resources	8.1	15.7	17.6	24.8	18.0	15.8
Spoke with a librarian	0.8	1.9	3.1	5.0	18.3	70.8
Used literature resources found in a library	4.3	8.9	15.6	20.8	29.3	21.2
Searched an electronic data base in the library	5.8	10.2	8.8	9.3	19.7	46.1
Used none of the above steps	1.0	-----	-----	-----	-----	-----

These questions will be used to determine whether students with different backgrounds and from different countries have different technical communication practices.

29. What is your gender?

Female	16.0%
Male	84.0%

30. What is your educational status?

Undergraduate	55.0%
Graduate	41.0%
Other	4.1%

31. Is your education primarily as:

An engineer	92.8%
A scientist	4.1%
Something else	3.1%

32. What is your native language?

Chinese	3.6%	Romanian	0.2%
English	82.8%	Russian	0.3%
Farsi	0.5%	Spanish	2.2%
French	0.6%	Tagalog	0.2%
German	0.8%	Tamil	0.9%
Greek	0.6%	Telugu	0.3%
Hindi	0.5%	Turkish	0.3%
Japanese	0.5%	Vietnamese	0.6%
Korean	1.0%	Arabic	0.5%
Malayalam	0.3%	Italian	0.1%
Portuguese	0.5%	Other	2.7%

33. What is your native country?

Brazil	0.6%	Philippines	0.5%
Canada	1.3%	Romania	0.2%
China	0.9%	Russia	0.2%
France	0.2%	Singapore	0.4%
Germany	0.7%	Taiwan	1.6%
Hong Kong	0.6%	USA	79.8%
India	2.4%	Vietnam	0.8%
Iran	0.5%	Spain	0.3%
Japan	0.5%	Italy	0.1%
Korea	1.2%	Greece	0.4%
Malaysia	0.5%	Portugal	0.2%
Mexico	0.5%	Other	5.6%

34. Are you a citizen of the country where you are attending school?

Yes	87.5%
No	12.5%

35. How well do you read the following languages?

	Passably 1 %	2 %	3 %	4 %	Fluently 5 %	Do not read this language 6 %
English	0.1	0.0	0.4	2.1	96.2	1.2
French	12.6	5.0	4.9	2.4	1.2	73.9
German	10.5	4.3	3.3	1.5	1.1	79.3
Japanese	2.1	0.9	0.5	0.1	0.5	95.9
Russian	3.0	1.2	0.4	0.5	0.4	94.5
Spanish	31.3	19.3	17.6	12.9	18.9	0.0
Other	17.9	7.4	18.9	12.6	43.2	0.0

36. How well do you speak the following languages?

	Passably 1 %	2 %	3 %	4 %	Fluently 5 %	Do not speak this language 6 %
English	0.0	0.2	0.9	3.6	93.8	1.5
French	12.7	5.2	3.5	1.5	1.0	76.1
German	9.9	2.7	3.8	1.3	1.3	81.1
Japanese	2.5	0.8	0.1	0.1	0.6	95.9
Russian	3.2	0.7	0.6	0.4	0.4	94.7
Spanish	35.9	17.2	19.1	8.1	19.6	0.0
Other	19.4	6.8	11.7	6.8	55.3	0.0

37. In terms of your career goals and aspirations, how important will it be for you to be bilingual?

Very Unimportant 1 %	2 %	3 %	4 %	5 %	6 %	Very Important 7 %	Am Not Bilingual 8 %	Don't Know 9 %
6.7	8.8	7.6	10.0	12.8	8.8	16.4	19.6	9.2

38. In what type of organization do you hope to work after graduation?

Academic	14.7%
Government	31.9%
Industry (national)	40.3.%
Industry (multi-national)	27.7%
Not for profit	1.3%
Other	6.0%

39. When you were growing up, do you think your family's income was:

Much higher than that of most families in your native country	2.6%
Higher than that of most families in your native country	28.5%
About equal to the average family income in your native country	50.4%
Lower than that of most families in your native country	13.5%
Much lower than that of most families in your native country	2.8%
I cannot compare my family's income with incomes of other families	2.2%

40. Do you own a personal computer?

Yes	67.7%
No	32.3%

41. As a high school student, how often did you use your:

	Never 1 %	Seldom 2 %	Sometimes 3 %	Frequently 4 %	Always 5 %	Not Available 6 %
High school library	8.0	26.3	31.8	26.3	6.4	1.3
Public library	9.5	26.7	30.6	24.9	7.2	1.2

42. As a technology major, about how many hours a week (exclusive of classroom and course assignments) do you spend reading the professional literature associated with your discipline?

0 hours	4.5%
1 through 5 hours	78.1%
6 through 10 hours	11.5%
11 through 25 hours	5.0%
More than 25 hours	1.0%

43. Are you a member of a professional student (national) engineering, scientific, or technical society?

Yes	96.0%
No	4.0%

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13. ABSTRACT *(Maximum 200 words)*
This report describes similarities and differences between undergraduate and graduate engineering students in the context of two general aspects of the educational experience. First, we explore the extent to which students differ regarding the factors that lead to the choice of becoming an engineer, current satisfaction with that choice, and career-related goals and objectives. Second, we look at the technical communication practices, habits, and training of aerospace engineering students. The reported data were obtained from a survey of student members of the American Institute of Aeronautics and Astronautics (AIAA). The survey was undertaken as a phase 3 activity of the *NASA/DoD Aerospace Knowledge Diffusion Research Project.* Data are reported for the following categories: student demographics; skill importance, skill training, and skill helpfulness; collaborative writing; computer and information technology use and importance, use of electronic networks; use and importance of libraries and library services; use and importance of information sources and products; use of foreign language technical reports; and foreign language (reading and speaking) skills.

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