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THE IMPACT OF POLITICAL CONTROL ON TECHNICAL COMMUNICATIONS: A COMPARATIVE STUDY OF RUSSIAN AND U.S. AEROSPACE ENGINEERS AND SCIENTISTS

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ABSTRACT

Until the recent dissolution of the Soviet Union, the Communist Party exerted a strict control of access to and dissemination of scientific and technical information (STI). This article presents models of the Soviet-style information society and the Western-style information society and discusses the effects of centralized governmental control of information on Russian technical communication practices. The effects of political control on technical communication are then used to interpret the results of a survey of Russian and U.S. aerospace engineers and scientists concerning the time devoted to technical communication, their collaborative writing practices and their attitudes toward collaboration, the kinds of technical documents they produce and use, and their use of computer technology, and their use of and the importance to them of libraries and technical information centers. The data are discussed in terms of tentative conclusions drawn from the literature. Finally, we conclude with four questions concerning government policy, collaboration, and the flow of STI between Russian and U.S. aerospace engineers and scientists.

INTRODUCTION

Until the recent dissolution of the Soviet Union, the Communist Party maintained strict control over the intranational and international dissemination of scientific and technical information (STI). Russian engineers and scientists worked within a highly centralized political system characterized by secrecy and distrust. This system actively restricted communication between Russian engineers and scientists and their professional counterparts both at home and abroad.

Although sweeping political changes may free up the flow of STI within the former Soviet Union, it would be a mistake to discount the working environment that has prevailed in Soviet science since 1917 [**1**, 148]. Information flow and the use of products, services, and technologies for acquiring, producing, using, and disseminating STI have traditionally been constrained by government policies formulated to maintain order and control [**2**, 537]. It will take time before the effects of an easing of restrictions on the use of STI are felt by and can influence the communication practices of Russian engineers and scientists.

In addition to a sociopolitical climate that has hampered the flow of STI, infrastructural obstacles to free and open communication exist, such as the poor quality of Russian telecommunications and severe shortages of basic supplies. Reports on the current state of the Russian economy indicate that such problems can only be addressed gradually. Therefore, information on the sociopolitical and economic climate over the last few decades is relevant when assessing the technical communication practices of engineers and scientists whose education and careers have been shaped by the highly centralized character of the Communist Party's rule.

To learn more about international technical communication practices, the *NASA/DoD Aerospace Knowledge Diffusion Research Project* is examining how aerospace engineers and scientists find and use STI. This 4-phase research project is a joint effort of the Indiana University Center for Survey Research and the NASA Langley Research Center. The project is providing information on the flow of scientific and technical information at the individual, organizational, national, and international levels that should prove useful to research and development (R&D) managers, information managers, and others concerned with improving access to and use of STI [**3**]. Studies for Phase 4 have been conducted in the Union of Socialist Republics (the former Soviet Union), Israel, Japan, and several Western European countries to examine the information-seeking behaviors of non-U.S. aerospace engineers and scientists.

The Russian study offers a unique opportunity to examine the influence of the past regime at a time when Russia is opening up to international communication and freer exchange of STI. The former Soviet Union is beginning to play a greater role in the international scientific community, particularly in the area of joint commercial ventures [**4**, 42]. For example, Krunichev Enterprises, the Russian firm that developed the Proton launch vehicle, and Lockheed Missiles and Space, a subsidiary of the Lockheed Corporation, recently announced a joint venture to pursue work in the international commercial satellite market [**5**]. The findings of this study, therefore, may hold particular interest for the American engineers and scientists who will find themselves working on joint projects with their Russian counterparts in the not-so-distant future.

Although considerable research has been done on Soviet science and technology policy and education, few studies have focused on the types of documents used and produced by engineers and scientists or on the level and nature of collaboration involved in the production of scientific and technical documents. A wide range of sources, including reports from emigre scientists, indicates that two key factors have influenced Russian technical communication: (1) severe restrictions on the dissemination of STI and (2) limited computing facilities.

In this paper, we present Soviet and Western-style information models and discuss the characteristics of R&D in the Soviet Union to provide a conceptual framework for understanding the differences between technical communication patterns in Russia and the U.S. We believe that Soviet centralized control of information has played a key role in shaping the communication behaviors of Russian engineers and scientists. Next we examine the results of our survey of Russian and U.S. aerospace engineers and scientists in the light of what we have learned about information control in the former Soviet Union. Finally, we present tentative conclusions and close with four questions concerning government policy, collaboration, and the flow of STI between Russian and U.S. engineers and scientists.

MODELS OF SOVIET AND WESTERN-STYLE COMMUNICATIONS

In examining the national presence of information technologies in the Soviet Union and the West, Goodman presents comparative models of "information societies" [**6**, 15]. Information in general and STI in particular have been viewed in the Soviet Union as a means of achieving centrally formulated goals that include increased industrial productivity, support of military and internal security needs, and improved economic planning and control mechanisms. The driving forces behind Soviet goals have been national level political processes and Western achievements. The systemic conditions underlying information production, transfer, and use include a leadership that distrusts the general population, a strong form of centralized planning and control, government controls on access to and dissemination of information, and powerful national-level controls on social change. Communication and computing capabilities remain modest and narrowly related to specific, government-mandated goals.

In the West in general and in the U.S. in particular, information is regarded as a commodity, and information technologies are viewed as part of a large number of products, services, and processes to be distributed throughout society. Driving forces in the West include push-pull markets, domestic and international competition, and inherent opportunities for innovations in information technologies. Systemic conditions in the West support the broad dissemination of controls for economic efficiency, private activities, and more communications of all kinds. National controls on access to and dissemination of information in general and STI in particular are relatively weak, and there is little, if any, national level control of social change. The West exhibits technological strength and interest in all areas of communication and computing and has a near-universal user community.

CHARACTERISTICS OF RESEARCH AND DEVELOPMENT IN RUSSIA

Centralized Communist Party rule has greatly influenced scientific and technological R&D in the former Soviet Union. Most R&D has been conducted in large, block-funded institutes [**7**, 34] that are characterized by a rigid hierarchy of vertical control and are isolated from outside influences; security departments play a significant role in the hierarchy. Unlike their U.S. counterparts, Russian engineers and scientists infrequently have the opportunity to meet each other and international colleagues at conferences and to use print and electronic media to stay abreast of the latest developments in their fields. American engineers and scientists typically enjoy greater autonomy than do their Russian counterparts who frequently work under the direction of administrators concerned with addressing political rather than scientific issues. The Americans also have much easier and more timely access to professional journals and equipment required for their research than do the Russians.

Despite limitations and restrictions on Russian engineers and scientists, the Communist Party placed a high value on science and technology. Under Communist rule the Soviet Union was a "technotopia" [**8**, 1]; the "Scientific and Technological Revolution" was touted as the solution to all the nation's problems [**9**, 95]. Under the Brezhnev and Gorbachev administrations, Soviet leadership prioritized the improvement and application of computing and communications technologies, allocating resources and creating new programs as well as overtly and covertly transferring technology from abroad [**10**, 537]. An obsessive concern with secrecy and national security, however, has impeded the kind of open personal communication, both intranationally and internationally, that is required if science and technology are to thrive [**11**, 2]. Fierce competition between institutes for funding and recognition has hindered intranational communication. International communication is almost non-existent because of an unwillingness to reveal information to foreigners and a fear of foreign sources corrupting Soviet scientists.

Restricted Participation in International Science

Soviet scientists seeking to attend conferences abroad were frequently denied permission to do so by an artificially lengthy application process to leave the country. Frequently administrators delayed a decision until after the conference date. As Popovsky points out, the loss is not just to Soviet science, but to the entire international scientific community that could benefit from collegial exchanges of ideas [**12**, 104–107]. The Communist Party's restrictions on travel actually prevented the exchange of information that is necessary if government-mandated scientific and technological developments are to succeed. Furthermore, red-tape and censorship have limited possibilities for the publication of Soviet work in Western journals. Recently, however, the Soviet government has begun to admit the harmful effects of restricted communication on science and technology [**13**].

Another disadvantage hampering Russian engineers and scientists is the extreme difficulty they have obtaining foreign journals. A shortage of hard currency has led to a limited number of foreign journals being available to Russian engineers and scientists; the authorities who allocate funds believe that foreign goods and physical technology are more important than foreign technical and scientific publications. Although the former Soviet Union has the largest R&D community in the world, they purchase only about one half of the scientific books and journals sold abroad each year [**14**, 24–25].

An even greater problem than the limited acquisition of foreign journals is inefficient distribution. All journals made available to Russian engineers and scientists must first pass through the hands of censors, a process which typically adds another six months to distribution time. Prior to 1974 when the Soviet Union began adhering to the International Copyright Convention which prohibits cover-to-cover copying, foreign journals were actually cut apart by secret police officials who then pasted up and photocopied them in an expurgated form [**15**, 26].

Restricted Dissemination of Information Within Soviet Science

In addition to the limited availability of foreign STI, inadequate serial publication of Soviet research affects the intranational dissemination of STI. Russian engineers and scientists frequently encounter problems getting their research published. The number of journals is insufficient to support the large number of researchers working in the Soviet Union. From the early 1960s to the late 1970s, the number of scientific workers grew to approximately 1,300,000. During that same period, 82 new academic journals were created and 400 irregular serials were shut down. Then, in 1979 the Central Committee adopted a resolution "On the Rationalization of the Edition Sizes and Reduction of the Number of Periodical Publications" which caused 300 journals to be reduced in size [**16**, 16–19].

The reduction was made because of paper shortages and the low priority given to the allocation of resources for scientific and technical publications. For this reason, when articles do find their way into print, they are markedly affected by the limited space available in existing journals. The *Journal of Experimental and Theoretical Physics* limits submissions to 15 typed pages [**17**, 242]. Calculations and details are often omitted in the interest of saving space, and many Soviet journal articles are so abbreviated as to appear to be written in code. The lack of modern facilities for producing graphs and other visual supports for articles has also detracted from the impact of the work of Soviet researchers abroad [**18**, 171–173].

Soviet journals typically have limited press-runs because of restrictions on paper; reprints are very difficult to obtain and preprints are virtually unknown [**19**, 37]. Since preprints and conference presentations are two primary means for the early dissemination of scientific and technical information, Soviet scientists have faced considerable difficulty staying abreast of developments in their fields. Writing as recently as October 1992, Travica and Hogan point out that "it may seem remarkable to us how little individual Soviet scholars and scientists know about each other and their work" [**20**, 130].

Limited Photocopying Facilities

Inadequate photocopying facilities and strict control on access to photocopying have also limited the acquisition, use, and dissemination of STI. The problem is so serious that a special commission of the State Committee on Science and Technology was charged with studying the question of raising the quality and output of copying machines [**21**, 62]. Better quality photocopying facilities have been introduced more recently, but they are available only to the elite. When reproductions are available at all, there is frequently a long delay before they are produced. This problem, compounded by a reluctance, now based on economic hardship, to purchase a significant number of foreign journals and the delays and inadequacies of publication in Soviet journals, renders a large amount of STI, both foreign and domestic, inaccessible to engineers and scientists.

Limited Computer Technology

Despite serious obstacles to the dissemination of information through printed media, computing and the electronic transfer of information is the area where the former Soviet Union has lagged farthest behind Western nations [**22**, 116]. In 1985 the Soviet Politburo approved a plan to create, develop, and use computer technology and automated manufacturing systems throughout the country by the year 2000; however, specific details about this plan and other Five-Year-Plan targets indicate that successful implementation of these goals would not raise computing to late 1980s Western standards [**23**, 537–538]. Harley Balzer has correctly identified computing as "the Achilles' heel of Soviet science" [**24**, 159].

Several factors have retarded the growth of computing in the Soviet Union: an inability to establish serial production of personal computers, the poor quality of telecommunications, and an electrical supply system subject to frequent blackouts. Soviet computing has also been plagued by an inadequate supply of peripheral devices, lagging software development, and the incompatibility of existing models. Tape cassettes and disks are expensive, and paper, ribbons, and disks are in limited supply [**25**, 231–232].

Access to computing has been limited to the elite of the scientific community. However, even where computing facilities are available, their use has been circumscribed by tight political control. Permission to print a program or document, for example, would require several levels of clearance. At most research institutes a scientific worker would have to obtain written approval from as many as five individuals before printing a document [**26**, 155].

Soviet leaders faced the contradiction that the very scientific and technical progress that they strove for would threaten the sociopolitical status quo. The Party feared that widespread computing would facilitate the free flow of information and thereby undermine national security and state control. The role played by computer networks in the failed 1991 Soviet coup demonstrates the validity of this fear. "During the coup, the computer network became a broadcasting operation. Networkers acting as unofficial correspondents posted information and political commentary.... Telecommunications network systems and information technology became a distributed publishing service — a freedom press" [**27**, 129].

Balzer predicted the need for a cultural change before computing could be fully integrated into Soviet science [**28**, 201–202]. With the recent political changes we are, in fact, seeing an increase in the free flow of information. Rapid growth in the on-line information market is expected in the 1990s. Telecommunications are also expected to grow at an unprecedented rate. Robert Noel, discussing the potential for scientific communication and technology transfer with Central Asia, stresses the new opportunities for scientists and technical communicators in a climate of free information flow [**29**, 552].

However, despite the increased potential for scientific and technological growth in the countries of the former Soviet Union, we will examine the results of our survey bearing in mind the climate of secrecy, strict centralized control, and limited flow of scientific and technical information which have prevailed for most of the working lives of our respondents, and which have undoubtedly shaped and influenced both their technical communication practices and their attitudes toward technical communication.

RESEARCH DESIGN AND METHODOLOGY

The research was conducted at comparable aeronautical research facilities, the Central Aero-Hydrodynamics Institute (TsAGI), the NASA Ames Research Center and the NASA Langley Research Center, using self-administered (self-reported) mail surveys. The instrument used to collect the data had been used previously in several Western European countries and Japan and was adapted for use in Russia. Russian language questionnaires were distributed to 325 researchers at TsAGI, and 209 were received by the established cut-off date for a completion rate of 64 percent. English language questionnaires were distributed to 558 researchers at the two NASA installations, and 340 were received by the established cut-off date for a completion rate of 61 percent. The survey at TsAGI was conducted during April and May of 1992, and the surveys at the NASA centers were conducted during July and August of 1992 [**30**].

PRESENTATION OF THE DATA

This paper presents selected results from the Russian and U.S. studies. Demographic data are presented first, followed by data about the time devoted to technical communication, collaborative writing practices and attitudes toward collaboration, the kinds of technical documents the survey respondents produce and use, their use of computer/information technology, and their use of and the importance to them of libraries and technical information centers.

Demographic Information About the Survey Respondents

Survey respondents were asked to provide information regarding their professional duties, years of professional work experience, educational preparation, current professional duties, and gender. The two groups differ significantly in terms of education, current duties, and professional/technical society membership; they are similar in years of professional work experience, organizational affiliation, educational preparation, and gender. The following "composite" participant profiles were based on the demographic data. The Russian survey participant works as a researcher (77%), has a bachelor's degree (53%), was trained as an engineer (79%) but currently works as a scientist (68%), and has an average of 20 years professional work experience. The U.S. survey participant works as a researcher (82%), has a graduate degree (73%), was trained as an engineer (80%), currently works as an engineer (69%), has an average of 17 years of professional work experience, and belongs to a professional/ technical society (78%).

Time Spent Communicating Technical Information

In Russia scientific and technical information has been closely guarded from outsiders [**31**, 102]. Information transfer has been given a low priority and many of the means that are used in the United States to disseminate information, such as electronic networks and teleconferencing, are not widely available. Therefore, it is not surprising to find that American engineers and engineers spend more time than do their Russian counterparts in both oral and written communication of technical information (table 1). When subjects were asked how many hours per week they spend communicating technical information, the median for Russian respondents was 7 hours, compared to 15 hours for American respondents.

Collaborative Writing Practices

Questions about collaboration on the production of written technical communications elicited interesting differences between U.S. and Russian respondents. The differences were related both to collaborative writing practices and to the respondents' perceptions regarding the productivity of writing as part of a group. These differences may be understood in light of the highly collective nature of Russian life generally and of work in research institutes specifically. Most Soviet scientists are part of research collectives and work in small groups that have fewer than ten members [**32**, 131]. The individual has been subjugated in Russia; it is not unheard of for junior colleagues to be assigned to write a senior administrator's dissertation [**33**, 48–49].

When asked what percentage (median) of their written technical communications involved writing alone, the Russian respondents reported 20 percent as opposed to 70 percent for American respondents. Both groups reported that 20 percent of written technical communications were prepared in collaboration with one other person. Both groups reported that only 10 percent of written technical communications involved writing in a group of five or more persons.

Table 1. Mean (Median) Number of Hours Spent Each Week by Russian and U.S. Aerospace Engineers and Scientists Communicating Technical Information

Communications	Russia	U.S.
Communication with Others	8.75 (7.00) hours/week	16.95 (15.0) hours/week
Working with Communications Received from Others	7.64 (6.00) hours/week	13.97 (12.0) hours/week

Forty-four percent of the Russian respondents reported that writing as part of a group is more productive than writing alone, while only 33 percent of the U.S. respondents found writing in a group more productive than writing alone (table 2). Further, approximately eight percent of the Russians reported that writing as part of a group is **less** productive than writing alone as compared to 20 percent of the Americans. Clearly the Russian and American respondents have different perceptions of the productivity of writing as part of a group.

Documents Prepared Most Frequently

There is little difference in the types of documents produced most frequently by Russian and U.S. respondents (table 3). When writing alone and when writing as part of a group, the documents that the Russian respondents prepared most frequently were drawings/specifications, letters, and memoranda. They infrequently prepared journal articles, audio/visual materials, technical manuals, and technical talks/presentations. As expected, they prepared no trade or promotional literature. When preparing these documents in a groups, the median number of people in the group was either two or three (table 3).

When writing alone and when writing as part of a group, the American respondents frequently prepared memoranda, letters, audio/visual materials, and drawings and specifications. They infrequently prepared journal articles (table 4).

Given the very different emphasis placed on the communication of technical information in Russia, it is surprising to find that the two groups produce the same types of documents. This finding contradicts our expectation that a different perception of the importance of information dissemination would lead to different types of documents being produced. This contradiction may be explained, in part, by the fact that the documents most frequently produced by both groups were letters and memoranda which are likely to be the documents most frequently produced in any society.

Another contradiction in these findings is that both Russians and Americans reported that they infrequently prepared journal articles. We may surmise that issues of security and a limited number of journals publishing scientific and technical information explain the infrequent production of journal articles by the Russians. But that assumption does not explain why the Americans infrequently prepare journal articles. One reason for this finding may be the proprietary nature of work in the aerospace industry even in America.

Table 2. Influence of Group Participation on Writing Productivity
For Russian and U.S. Aerospace Engineers and Scientists

Productivity	Russia		U.S.	
	%	(n)	%	(n)
A Group Is More Productive Than Writing Alone	44	(92)	33	(110)
A Group Is About As Productive As Writing Alone	41	(86)	32	(107)
A Group Is Less Productive Than Writing Alone	8	(17)	20	(68)
I Only Write Alone	7	(14)	15	(50)

Table 3. Mean (Median) Number of Technical Information Products
Produced in the Past Six Months by
Russian Aerospace Engineers and Scientists

Information Products	Alone		In a Group		Average Number of Persons Per Group	
	Mean	Median	Mean	Median	Mean	Median
Abstracts	6.13	(2.00)	1.82	(1.50)	2.61	(2.00)
Journal Articles	1.43	(1.00)	1.48	(1.00)	2.55	(2.00)
Conference/Meeting Papers	2.00	(1.00)	1.53	(1.00)	2.96	(2.00)
Trade/Promotional Literature	0.00	(0.00)	3.00	(1.00)	3.00	(3.00)
Drawings/Specifications	8.29	(5.00)	12.40	(2.00)	3.10	(2.00)
Audio/Visual Material	1.50	(1.50)	4.43	(1.00)	2.71	(2.00)
Letters	6.24	(5.00)	3.82	(2.00)	2.86	(2.00)
Memoranda	6.46	(3.00)	2.40	(2.50)	2.20	(2.00)
Technical Proposals	3.03	(2.00)	2.02	(2.00)	3.81	(3.00)
Technical Manuals	1.67	(1.00)	1.60	(1.00)	2.67	(2.00)
Computer Program Documentation	5.73	(2.00)	2.83	(1.50)	2.50	(2.00)
In-house Technical Reports	2.76	(2.00)	2.71	(2.00)	3.65	(3.00)
Technical Talks/Presentations	1.70	(1.00)	1.54	(1.00)	2.52	(2.00)

When examining the production of technical communication, we need to study other factors besides frequency of production. In order to gain a fuller understanding of the production of technical communication in Russia, it would be helpful to study other aspects of document production, such as the amount of time spent on different types of documents, the document review process, and the role of collaboration.

Documents Used Most Frequently

We asked respondents to indicate the types of technical documents they used most frequently in performing their work. The Russian respondents most frequently used journal articles, abstracts, letters, memoranda, and computer program documentation. They least frequently use audio/visual materials, technical proposals, and trade/promotional literature (table 5).

In light of the difficulty Russian engineers and scientists have obtaining journal articles, it is interesting to note their frequent use of them as information sources. We can only speculate on the effect of this difficulty on R&D in Russia. Since Russians are relying on an incomplete, and probably censored, body of journal articles, it is reasonable to suppose their research is impeded to some extent and that they spend time unnecessarily replicating experiments and studies. Their reliance on in-house reports is consistent with a pervasive control of external information as it is certain the holdings of in-house libraries are restricted by administrators and security departments. In fact, the in-house libraries at Russian R&D organizations are not as well stocked as the libraries at most major American universities [**34**, 125].

Table 4. Mean (Median) Number of Technical Information Products Produced in the Past Six Months by U.S. Aerospace Engineers and Scientists

Information Products	Alone		In a Group		Average Number of Persons Per Group	
	Mean	Median	Mean	Median	Mean	Median
Abstracts	1.67	(1.00)	1.81	(1.00)	2.67	(2.00)
Journal Articles	1.33	(1.00)	1.75	(1.00)	2.74	(2.00)
Conference/Meeting Papers	1.90	(1.00)	1.54	(1.00)	2.79	(3.00)
Trade/Promotional Literature	2.00	(1.00)	1.00	(1.00)	2.50	(2.50)
Drawings/Specifications	7.21	(3.00)	3.83	(3.00)	3.02	(2.00)
Audio/Visual Material	5.73	(4.00)	5.82	(2.00)	2.95	(2.00)
Letters	9.96	(6.00)	5.95	(3.00)	2.32	(2.00)
Memoranda	16.06	(9.00)	5.14	(3.50)	2.55	(2.00)
Technical Proposals	2.17	(2.00)	2.64	(1.50)	2.61	(2.00)
Technical Manuals	2.11	(1.00)	2.11	(1.00)	3.11	(3.00)
Computer Program Documentation	3.43	(2.00)	2.20	(1.50)	2.35	(2.00)
In-house Technical Reports	2.34	(2.00)	1.80	(1.00)	2.87	(2.00)
Technical Talks/Presentations	3.54	(2.00)	3.07	(2.00)	3.46	(3.00)

Table 5. Mean (Median) Number of Technical Information Products Used in the Past Six Months by Russian and U.S. Aerospace Engineers and Scientists

Information Products	Russia		U.S.	
	Mean	Median	Mean	Median
Abstracts	16.48	(6.00)	16.45	(10.00)
Journal Articles	18.33	(7.50)	16.54	(10.00)
Conference/Meeting Papers	6.71	(3.00)	12.00	(10.00)
Trade/Promotional Literature	4.97	(2.00)	11.77	(6.00)
Drawings/Specifications	6.63	(5.00)	15.48	(5.00)
Audio/Visual Material	2.66	(2.00)	14.59	(5.00)
Letters	13.11	(8.00)	17.28	(9.00)
Memoranda	10.12	(5.50)	25.44	(10.00)
Technical Proposals	4.41	(3.00)	5.89	(2.00)
Technical Manuals	5.26	(3.00)	7.65	(5.00)
Computer Program Documentation	9.61	(5.00)	14.57	(5.00)
In-house Technical Reports	8.61	(5.00)	6.93	(5.00)
Technical Talks/Presentations	5.08	(3.00)	10.25	(6.00)

In contrast to the Russians, the U.S. respondents most frequently use memoranda, letters, journal articles, abstracts, and drawings/specifications. They least frequently use technical proposals, technical manuals, and in-house technical reports. Their reported frequent use of journal articles and abstracts, suggests that these materials are readily available to users who are aware of their existence and how to access them.

Use Of Computer Technology

The easing of restrictions on STI now occurring are likely to be aided by dramatic changes in computing in Russia during this decade. At the time of this survey, Russia lagged far behind the U.S. in computing. U.S. respondents reported much greater use of computer technology than their Russian counterparts reported. While approximately 72 percent of Russian respondents do use word processing software, they reported little use of other types of software; less than 5 percent of Russian aerospace engineers and scientists used desktop publishing compared to 48 percent of the U.S. respondents (table 6).

A small percentage of the Russians reported using any information technologies in communicating technical information. Less than 3 percent of the Russians indicated that they used electronic mail, electronic bulletin boards, video conferencing, teleconferencing, laser disk/video disk/CD-ROM, or electronic networks (table 7). The lack of use of these information technologies is probably related to the strict control of information. It is probably also related to problems with the telecommunications system, electrical supply, serial production of personal computers, and software development.

Table 6. Use of Computer Software by Russian and U.S. Aerospace Engineers and Scientists to Prepare Written Technical Communication

	Russia		U.S.	
Software	%	(n)	%	(n)
Word Processing	72	(150)	96	(327)
Outliners and Prompters	34	(72)	14	(46)
Grammar and Style Checkers	11	(22)	30	(103)
Spelling Checkers	17	(35)	88	(299)
Thesaurus	12	(26)	37	(127)
Business Graphics	24	(50)	15	(52)
Scientific Graphics	53	(110)	91	(308)
Desktop Publishing	4	(9)	48	(162)

Table 7. Use, Nonuse, and Potential Use of Information Technologies by Russian and U.S. Aerospace Engineers and Scientists

	Already Use It		Don't Use It, But May in Future		Don't Use It, and Doubt If Will	
Information Technologies	Russia %	U.S. %	Russia %	U.S. %	Russia %	U.S. %
Audio Tapes and Cassettes	12	13	22	30	34	57
Motion Picture Film	20	17	19	29	28	55
Videotape	15	63	37	31	19	7
Desktop/Electronic Publishing	5	60	41	32	14	8
Computer Cassettes/Cartridge Tapes	58	44	20	32	3	24
Electronic Mail	2	83	48	15	11	2
Electronic Bulletin Boards/Cartridge Tapes	2	36	43	48	10	17
FAX or TELEX	21	91	37	8	9	1
Electronic Data Bases	25	56	46	40	6	4
Video Conferencing	2	37	31	54	33	10
Teleconferencing	2	53	28	40	32	7
Micrographics and Microforms	54	23	12	42	9	34
Laser Disk/Video Disk/CD-ROM	1	19	44	68	17	14
Electronic Networks	3	76	51	19	12	5

A large percentage of Russian respondents not currently using electronic media do expect to use them in the future. This finding is consistent with the fact that both telecommunications and the on-line information market are expected to grow at a rapid rate in the 1990s. In fact, information technology is one area where information control could only be practiced at the expense of scientific and technological progress [**37**, 551].

Use of Libraries and Technical Information Centers

Almost all of the respondents indicated that their organization has a library or technical information center. Unlike the U.S. respondents (9%), about 45 percent of the Russian respondents indicated that the library or technical information center was located in the building where they worked. About 53 percent of the Russian and 88 percent of the U.S. respondents indicated that the library or technical information center was outside the building in which they worked and that it was located nearby where they worked. For about 49 percent of the Russians, the library or technical information center was located 1.4 kilometers or less from where they worked. For about 81 percent of the U.S. respondents, the library or technical information center was located 1.0 mile or less from where they worked.

Respondents were asked to indicate the number of times they had visited their organization's library or technical information center in the past 6 months (table 8). Overall, the Russian respondents used their organization's library or technical information center more than the U.S. respondents used theirs. The average use rate for Russian aerospace engineers and scientists was $\bar{X} = 12.5$ during the past 6 months compared to $\bar{X} = 9.2$ for the U.S. aerospace engineers and scientists. The median 6-month use rates for the two groups were 10.0 and 4.0, respectively.

Respondents were also asked to rate the importance of their organization's library or technical information center (table 9). Importance was measured on a 5-point scale with 1 = not at all important and 5 = very important. A majority of both groups indicated that their organization's library or technical information center was important to performing their present professional duties. About 83 percent of the Russian aerospace engineers and scientists indicated that their organization's library or technical information center was very important to performing their present professional duties. About 68 percent of the U.S. aerospace engineers and scientists indicated that their organization's library or technical information center was very important to performing their present professional duties. About 2 percent of the Russian respondents and about 13 percent of the U.S. respondents indicated that their organization's library or technical information center was very unimportant to performing their present professional duties.

Table 8. Use of the Organization's Library in Past 6 Months
by Russian and U.S. Aerospace Engineers and Scientists

	Russian		U.S.	
Visits	%	(n)	%	(n)
0 times	4	(9)	11	(37)
1 - 5 times	31	(65)	43	(145)
6 - 10 times	34	(71)	21	(73)
11 - 25 times	19	(40)	14	(49)
26 - 50 times	6	(13)	7	(22)
51 or more times	2	(5)	1	(4)
Does not have a library	3	(6)	3	(11)
Mean	12.5		9.2	
Median	10.0		4.0	

Table 9. Importance of the Organization's Library
to Russian and U.S. Aerospace Engineers and Scientists

	Russian		U.S.	
Importance	%	(n)	%	(n)
Very Important	82.8	(173)	68.3	(232)
Neither Important nor Unimportant	12.4	(26)	15.6	(53)
Very Unimportnant	2.0	(4)	12.9	(44)
Does not have a library	2.8	(6)	3.2	(11)

DISCUSSION OF THE DATA

Prior to the dissolution of the Soviet Union, the dissemination of STI within it was strictly controlled, and communication between Russian engineers and scientists and their foreign counterparts was highly restricted. Although sweeping political changes in the former Soviet Union have led to a relatively free flow of international STI, the lasting effects of the former working environment and of the corresponding Soviet information model that has prevailed since 1917 cannot be discounted. Our analysis of the performance and operation of science and technology in this environment leads to the following tentative conclusions.

1. Because of a tradition of strict control exerted by the Communist Party over STI, Russian aerospace engineers and scientists can be expected to spend less time communicating STI than their U.S. counterparts spend.

Data contained in table 2 support this conclusion. The Russian aerospace engineers and scientists in this study spend about half the time that their U.S. counterparts spend communicating with others and working with communications they receive from others. They devote only 41 percent of a 40-hour work week to technical communication, compared to 77 percent for their U.S. counterparts. Only 30 percent of the Russian respondents indicated that they had increased the amount of time they spend communicating STI over the past five years, whereas 70 percent of the U.S. respondents reported spending more time communicating STI during the same time. In fact, 29 percent of the Russian respondents noted a decrease in the amount of time they spent communicating technical information, compared to 6 percent of the U.S. respondents.

2. Given a cultural tradition of valuing collective efforts over individual efforts, Russian aerospace engineers and scientists might be expected to emphasize the importance of collaboratively produced technical communication to a greater degree than do their U.S. counterparts. We found no evidence of this.

Writing appears to be a collaborative process for both groups of respondents. Although no statistical tests were performed, there appears to be little difference between Russian and U.S. aerospace engineers and scientists and either their collaborative writing practices or their production of written technical communication as a function of the number of groups and group size. However, this lack of a real difference between the two groups in their collaborative writing practices and their production of technical communication may well be attributable to the nature of engineering work itself. Engineering work requires engineers to function as teams and to share their knowledge and the results of their work with others in order to create products. It is interesting to note, however, that only 8 percent of the Russian respondents (compared to 33% of the U.S. respondents) indicated that group writing is more productive than writing alone; 44 percent of the Russian respondents (and 20% of the U.S. respondents) actually found group writing less productive than writing alone.

3. Given a fundamental difference between Russian and U.S. approaches to the conduct of science and technology (i.e., centralized vs. decentralized), shortages of paper, and limited access to information resources, differences in the production and use of technical information products can be expected between Russian and U.S. aerospace engineers and scientists.

Data contained in tables 3 and 4 (production) and table 5 (use) support this tentative conclusion. Shortages of hard currency and paper, limited availability of printing and reproduction equipment, and censorship would limit the ability of Russian aerospace engineers and scientists to produce documents and scientists to produce documents and make presentations. The effects of information control, the low priority given to funding the acquisition of print and nonprint STI, and Western nations' restrictions on the transfer of STI to the former Soviet-bloc countries combine to limit the access to acquisition and use of STI by Russian aerospace engineers and scientists.

4. Given that the former Soviet Union lagged behind the West in computer and information technology, the patterns of computer and information technology use among Russian aerospace engineers and scientists can be expected to demonstrate a similar lag.

Data contained in table 7 support this assumption. As a framework for discussion, the computer and information technologies contained in table 7 may be placed in into three categories: mature, maturing, and nascent. Russian aerospace engineers and scientists make greater use of the mature computer and information technologies (e.g., computer cassettes and cartridge tapes) than they do of the maturing (e.g., desktop publishing) and nascent (e.g., electronic networks) ones.

The growth of computing in the former Soviet Union has been hampered by insufficient production and support capabilities for hardware, inadequate software and peripherals development, and limited computer supplies. In addition, the poor quality of Soviet telecommunications and the inconsistency of the electrical supply system exacerbate the situation.

CONCLUDING REMARKS

Despite the limitations of this investigation, these findings contribute to our knowledge and understanding of the technical communication practices among aerospace engineers and scientists at the national and international levels. The primary data elicited by this kind of questionnaire-based research speak to a number of current areas of scholarly and professional interest, both within the field of technical communication, and within a number of related fields—information science, engineering education, public policy, rhetoric, and composition, to name just a few. Here are five of the interesting questions our research invites practicing engineers, scientists, scholars, teachers, and R&D managers to ask:

1. How does government policy toward the flow of STI shape the technical communication practices of scientists and engineers? There is evidence in this Russian study to suggest that the tightly controlled communication practices of the former USSR had a profound effect, one that has outlasted the government that created it. While other countries may not have policies as transparently different from that of the U.S. as the Soviet Union's, there are still undoubtedly differences. As this Russian study suggests, the effects of those differences are expressed in ways an uninformed outsider might not anticipate. Knowing more about each government's policy towards the flow of STI can thus help anyone involved in international work in two ways: (1) to better anticipate possible areas of misunderstanding due to such differences, and (2) to take advantage of differences that produce vigor.

2. How do cultural differences shape the flow of STI? Beyond a government's official policies, there are the broader cultures—the language itself, the workplace, the profession, the role of the worker in society, and so on—that change from country to country. The ways in which they shape the flow of STI in the U.S. are becoming better and better known, but little is known in the U.S. about how other countries' cultural differences shape the flow of STI there.

3. What implications do these findings hold for those who may one day find themselves teaching people from countries such as Russia to create their own technical documents in English? Not only does the flood of non-U.S. graduate students into U.S. universities continue to grow, but today an increasing number of U.S. teachers are going to foreign countries to teach writing. Along with many elements of second-language teaching that are already known, the differences spotlighted in this and similar studies need to be taken into account in such teaching.

4. What implications do these findings and those of similar studies have for those who find themselves working collaboratively on projects with scientists and engineers from such countries? Witness, for example, Germany's, Spain's, Italy's, and Great Britain's $34 billion joint production of a fighter aircraft, Japan's participation in the production of Boeing's 767, and the International Aero Engines (IAE) Consortium led by Rolls-Royce and Pratt and Whitney. Boeing has recently proposed a "joint venture" with the Russian Central Hydro-dynamics Institute (TsAGI) that could result in U.S. aerospace engineers' and scientists' working directly with their Russian counterparts. The success of the Boeing/TsAGI effort will depend, to some extent, on how effectively Russian and U.S. aerospace engineers and scientists acquire, process, and communicate STI within a collaborative framework, given a number of presumed cultural and institutional differences in their communication practices.

Finally, we close by posing three more questions that address problems inherent in international communication. How do country-by-country differences impact on the production, transfer, and use of STI and the various classes of data flowing across national boundaries? What steps can be taken to facilitate communication at the individual, organizational, national, and international levels and ensure its effective management? What safeguards will countries impose on information dissemination to protect national sovereignty, and what role will information standards play in the international dissemination of information?

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