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Communication in the Physical and the Social Sciences

The processes of disseminating and assimilating information differ in these two groups of sciences.

William D. Garvey, Nan Lin, Carnot E. Nelson

In the last quarter of a century the scientific community has concerned itself increasingly with the flood of scientific information, initially emphasizing the need for improving the distribution, storage, and retrieval of scientific literature. About a decade ago, however, a number of scientists challenged this emphasis. One such scientist, Bentley Glass, called for a more eclectic approach to improving scientific communication (*1*): "In light of the very large sums of money—to say nothing of the time and the skilled labor—expended annually on the indexing and abstracting of the scientific literature and on the development of new methods of recording and retrieving information, it seemed desirable to examine the actual ways in which representative scientists in practice find out about the existence of scientific work that is crucial to the development of their own research."

Since Glass's remark, much research (*2*) has been done to explore scientific communication activities in several disciplines, and it is now generally recognized that the scientific literature, while a crucial medium, is only one facet of the overall process of disseminating and assimilating scientific information. Active researchers rely heavily upon informal media for information crucial to their continuing research.

These findings, greatly generalized in recent years, have left the impression that, regardless of the discipline, all scientists exhibit identical patterns of communication behavior and therefore have similar problems. The research conducted at Johns Hopkins and reported here provides, we believe, evidence on which to reevaluate that impression. This article focuses on differences between the physical and the social sciences regarding three major factors associated with the dissemination and assimilation of scientific information: (i) lags in the process of information flow; (ii) the organization and effectiveness of informal networks; and (iii) the transfer of information from the informal to the formal domain (*3*).

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Lags in Information Flow

Time intervals associated with production of journal articles. Figure 1, part *A*, shows the average times at which critical stages associated with the production of articles eventually published in "core" journals (*4*) occurred. The graphs of Fig. 1, part *A*, illustrate the times when authors (*A-1*) began the work reported in the articles; (*A-2*) completed the work; (*A-3*) began first drafts of the manuscripts; and (*A-4*) submitted the manuscripts to the journals that published them. Each stage of this process—from the inception of work to its publication—occurred closer to the time of publication for the physical sciences than for the social sciences.

The graphs of Fig. 1, part *B*, illustrate the points where lags in the process occurred. The major lag (*B-1*) relates to the actual conduct of the work, each group requiring a year, on the average, to complete it. Graph *B-2* shows that little time is wasted between completion of the work and the initiation of first drafts of the manuscripts; the lag (2 months) is identical for the two groups. Graph *B-3* shows the interval between the time the authors started their manuscripts and the time they submitted them to the journals that published them; these intervals were longer for social science articles (7 months) than for physical science articles (4 months). Graph *B-4* shows that the lags between time of submission of the manuscript and time of publication are generally the second longest lags in the process. The physical scientists reported publication lags 4 months shorter than those reported by the social scientists.

Owing to these longer lags associated with publication of social science articles, the social scientists, it was found, started disseminating oral or written

prepublication reports of the main content of their articles earlier (28 months before journal publication) than the physical scientists did (16 months before publication). Typically, the social scientist also continued his prepublication reporting over a longer period (13 months, as compared to 7 months for the physical scientist).

While most authors disseminated their work in the form of informal reports at least once before publication in a journal, 83 percent of the physical science authors did so, as compared to 72 percent of the social science authors. Therefore, the physical scientists produced more prepublication reports than the social scientists did, and in a shorter period.

Once a scientist starts writing his journal-article manuscript, he usually makes no more prepublication reports. This delay (9 months for the physical scientists and 15 months for the social scientists) impresses us as one of the more important consequences of information lags, since the scientific public has no access to the information during the interval between the time of the last prepublication report and the time of journal publication.

Interval between presentation of material at meetings and journal publication. Another series of studies concerning lags in the system traced the journal-publication fate of material presented at national meetings. Graph *A-1* of Fig. 2, which gives the percentages of authors who submitted presentation-based manuscripts to journals within a year after the meetings, shows that over half the physical science and social science authors did so.

Graph *A-2* of Fig. 2 shows the percentages of meeting presentations *published* within a year after the meetings. More than a third of the physical science meeting presentations had been published, as compared to only one-sixth to one-fifth of the social science presentations.

Graph *A-3* shows the percentages of *submitted* manuscripts that had been published, and here one sees clearly the effect of the longer publication lag in the social sciences.

Delay in publication resulting from manuscript rejection. Rejection of submitted manuscripts produced considerable lags in the information-flow process. Graph *B-1* of Fig. 2 shows the percentages of presentation-based manuscripts which were submitted to, but rejected by, one or more journals during the first year after the meeting. Much of the time lag associated with the publication of material presented at social science meetings resulted from the high rate of manuscript rejection.

Another study, concerned with manuscripts initially rejected by other journals and later published in the "core" journals of a particular discipline, provided additional data on the effect of manuscript rejection upon time lag.

Social science "core" journals published a disproportionately large number of manuscripts previously rejected by other journals (see Fig. 2, graph *B-2*). Social science "core" journals published previously rejected manuscripts almost six times as often as physical science "core" journals did. The fact that many of the previously rejected manuscripts in the social sciences had been rejected by several journals before being accepted for publication resulted in an average delay of 8

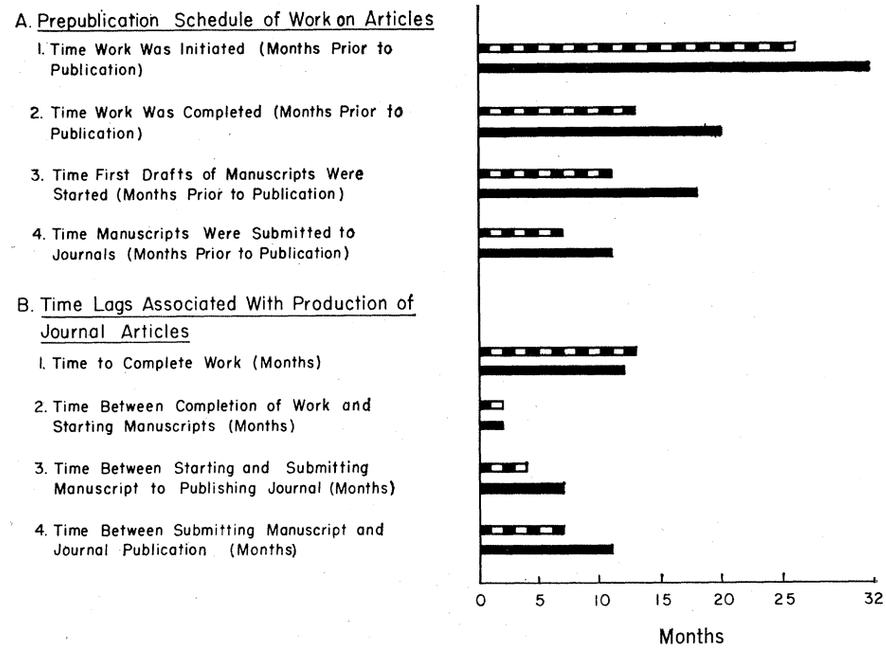

Fig. 1. Prepublication schedule of work and time lags associated with production of journal articles. (Broken bar) Physical sciences; (solid bar) social sciences.

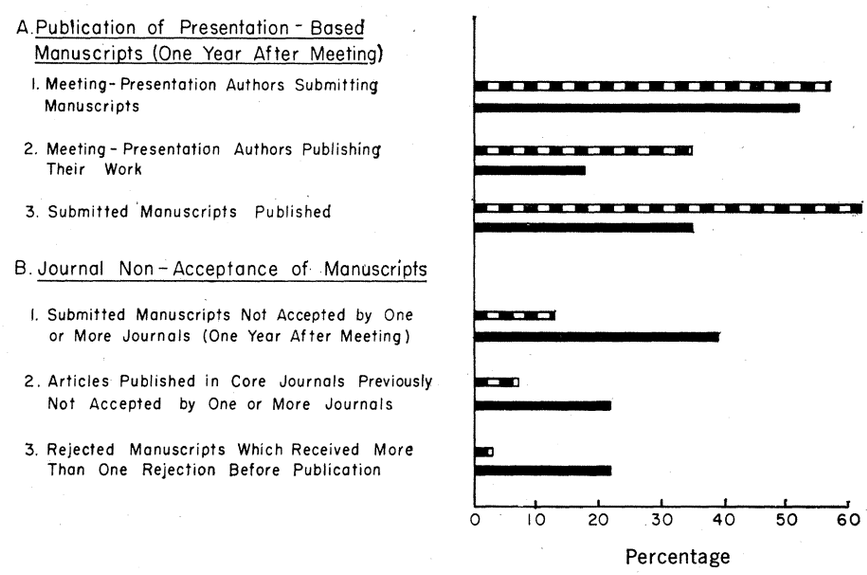

Fig. 2. Publication status of manuscripts based on presentations at a national meeting 1 year after the meeting, and data on rejection of such manuscripts. (Broken bar), Physical sciences; (solid bar) social sciences.

months before publication for social science manuscripts as compared to 4 months for previously rejected physical science manuscripts (Fig. 2, graph *B-3*).

Overall lags in the dissemination process. In Fig. 3 we summarize these findings. The diagram shows the sequence of events associated with the publication of articles in "core" journals and the times (in average number of months after initiation of the work reported) at which they occurred. In analyzing the lags associated with the published articles for each group of sciences (physical and social), we separated manuscripts rejected at least once before publication from manuscripts that had never been rejected.

First, let us consider the articles that had never been rejected. While the intervals between completion of the work and initiation of the writing of the manuscript and between initiation of the writing and submission of the manuscript for publication appear identical for the social and the physical sciences, the total interval between submission of a manuscript and publication is considerably greater for the social sciences.

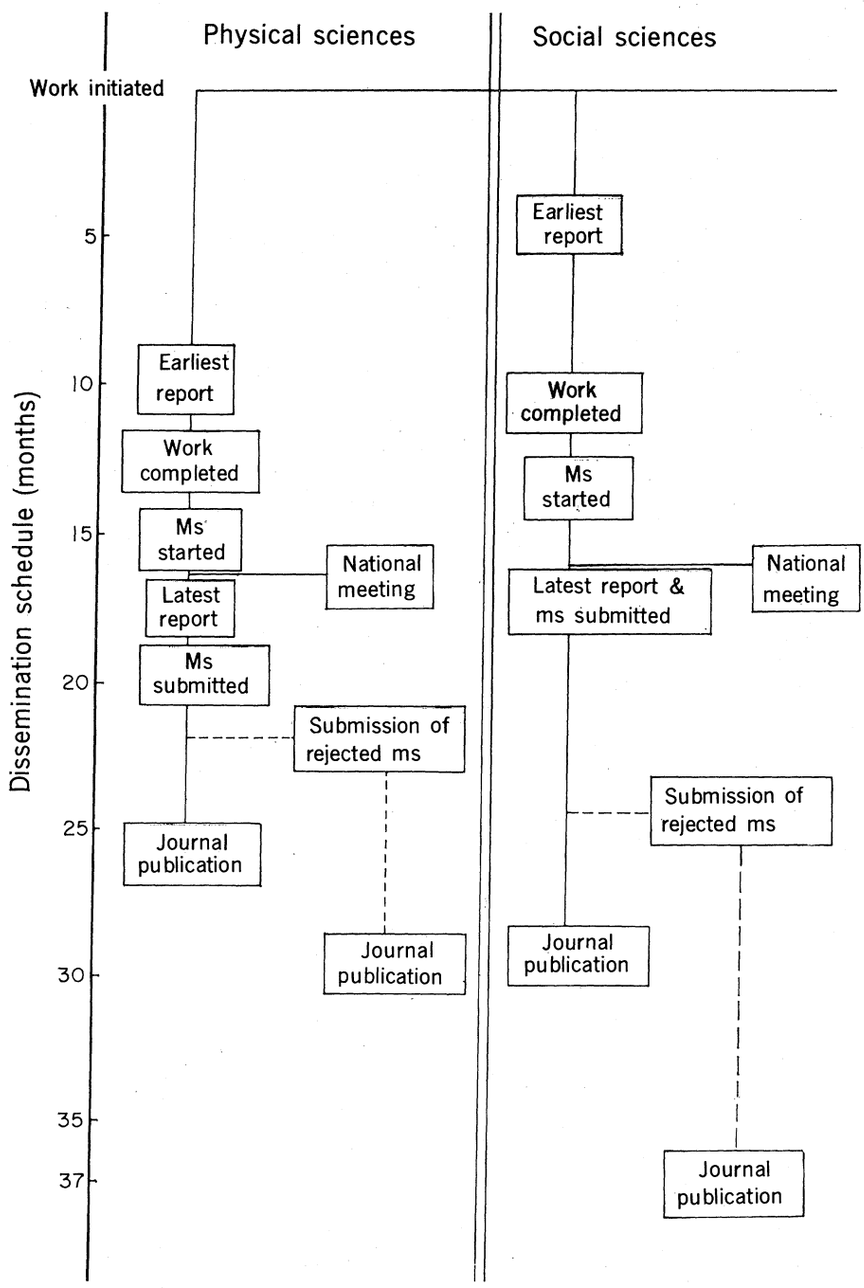

Fig. 3. Dissemination schedule for work reported in journal articles for the physical and social sciences.

Next, let us examine the lags associated with publication of manuscripts that had been rejected by one or more journals prior to acceptance by another journal. The interval between first (unsuccessful) and final (successful) submission is 7 months for the social sciences and 3 months for the physical sciences.

Moreover, the period between submission of previously rejected manuscripts to the publishing journals and publication is longer for manuscripts in the social sciences. (For both the physical and the social sciences, this period was, on the average, 1 month longer than the corresponding period for manuscripts with no history of rejection. The previously rejected manuscripts apparently required more editorial processing.)

In summary, it is the systemic structure of the current process of disseminating material in the social sciences (not an individual's lethargy or inefficiency) that mainly accounts for the longer lags in the social sciences.

Organization and Effectiveness of Informal Networks

Prepublication dissemination of the main content of published articles. During a period that begins 26 months before journal publication for social scientists and 16 months before journal publication for physical scientists, most authors disseminate the main content of their articles in various informal ways. Our studies revealed that the social scientists are less active than the physical scientists in this regard.

In reporting their work, the two groups used the various informal media differently. Both groups reported their work more frequently at national meetings than at any other kind of widely attended meeting; a third of the physical scientists and a sixth of the social scientists used this medium. Social scientists used meetings of local, state, or regional societies almost as often as they used national meetings, and twice as often as physical scientists did. Physical scientists reported their work at international meetings four times as often as social scientists did, and also reported it more often before small, select groups (such as colloquia and invitational conferences). When the informal medium chosen was the prepublication written report, the form chosen by physical scientists was usually the technical report, whereas that chosen by

social scientists was generally the thesis or dissertation.

Authors who distributed prepublication reports before submitting a manuscript to a journal often received feedback leading to modification of the manuscript. More social scientists than physical scientists modified their manuscripts as a result of feedback from prepublication reports, but the modifications made by the social scientists were more often changes of style and organization than substantive changes such as reanalysis of data, redefinition of concepts, or revision of interpretation. In both groups one author in five made substantive changes because of feedback from prepublication reports.

Over half of the authors in each group distributed preprints (prepublication drafts of their manuscripts), primarily to colleagues working in the areas treated in their articles. The second major group of recipients of such drafts was comprised of people acquainted with the author's earlier work who had requested copies of future manuscripts as soon as they were available. The size of this group reflects the effectiveness of previous prepublication networks; over one-fourth of the authors who distributed preliminary drafts did so because of such requests. "Formally" organized preprint-exchange groups constitute only a minor medium for the exchange of preprints; fewer than one author in 12 routinely distributes preprints through such groups.

Social science authors modified their manuscripts because of feedback from distribution of preprints more often than physical scientists did. The likelihood of receiving worthwhile suggestions for modifying their manuscripts before submitting them to the rugged editorial process in the social sciences may well account for the social scientists' reliance on this informal network.

Structure of the prepublication dissemination process. The informal networks for the flow of information in the physical sciences appear to have a tighter structure and a more sequential orderliness than do the corresponding networks in the social sciences. When we studied the sequence in which the various prepublication media are typically used in the dissemination process, we found that this process is shorter for the physical than for the social sciences, and that, for the physical sciences, the pattern of information dissemination is almost perfectly logical, beginning with the most specific and ending with the most general audience. The sequence associated with the physical sciences is as follows: thesis committee meeting; written thesis; reports to contracting agencies; in-house oral reports; colloquia within the author's institution; in-house written reports; colloquia outside the author's institution; scientific or technical committee meetings; local, state, or regional meetings; published proceedings; technical reports; invitational conferences; national meetings; and international meetings. For the social sciences this dissemination process required more time (80 percent more), and the sequence of events seemed much less systematic than it did for the physical sciences—the flow of information in the informal domain seemed far less organized.

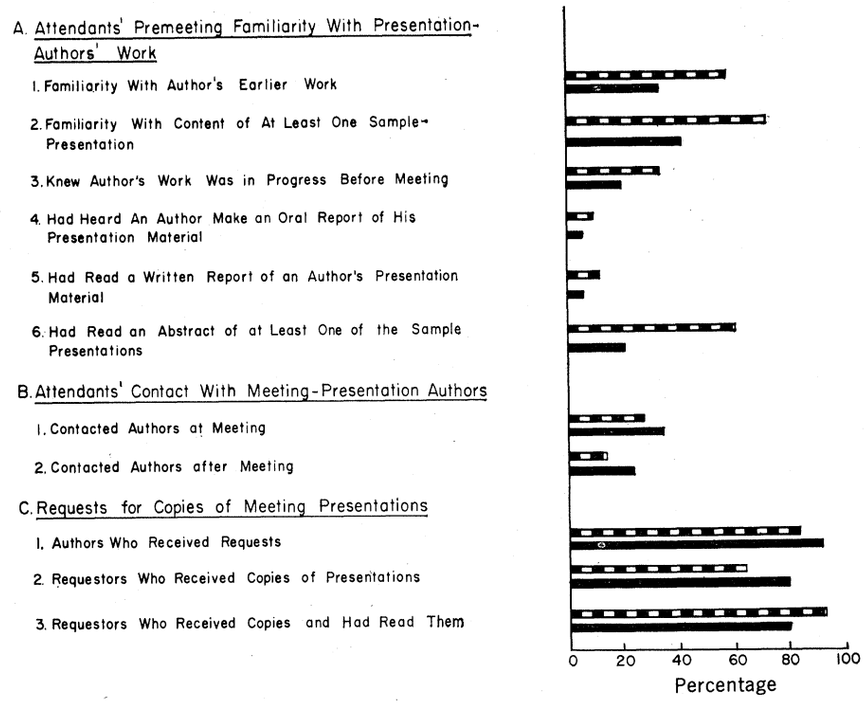

Fig. 4. Data on the attendants' familiarity, prior to a meeting, with the earlier work of authors making presentations, on the degree of meeting-associated contact with authors, and on requests for copies of meeting presentations. (Broken bar) Physical sciences; (solid bar) social sciences.

Prepublication assimilation of the main content of journal articles. Up to this point we have been discussing the effects of prepublication dissemination of information on *authors*. We also investigated the effects on others working in the same field (*5*). We found that most scientists working in the author's area had some familiarity with the work described before the article appeared in a journal. However, prepublication dissemination of information appeared less effective in the social sciences than in the physical sciences. Only 70 percent of the social scientists, as compared to 84 percent of the physical scientists, were acquainted with the main content of the articles before they were published in journals.

Premeeting dissemination of material presented at national meetings. The national meeting is the major occasion on which scientists report their work to large audiences before publishing it. We turn now to the authors' dissemination of their presentation material prior to the national meeting. We found that more physical scientists than social scientists (75 percent as compared with 66 percent) reported their work on such occasions. Half the authors in both groups had made premeeting written reports of the work presented at the meeting, but physical scientists had more often reported their work orally. The premeeting written reports of physical scientists were more often technical reports, whereas those of the social scientists were more often theses or dissertations. Premeeting oral reports were mainly in the form of colloquia for both groups, but physical scientists used this medium more frequently.

The outstanding difference between the two groups was the fact that the physical scientists made more premeeting reports than the social scien-

tists did, and made them on a greater variety of occasions, notwithstanding the fact that the interval between completion of the work presented and the time of the meeting was much shorter in the case of the physical scientists.

Premeeting assimilation of information presented at national meetings. Figure 4 presents data relating to the effectiveness of the premeeting informal dissemination of information for people who attended the actual presentation at the meeting (*6*).

Graph *A-1* of Fig. 4 shows the percentage of individuals who attended the presentation ("attendants") who were familiar with the author's earlier work—work done prior to that reported at the meeting. More physical scientists than social scientists were acquainted with the author's earlier work. These attendants may have learned of it through such formal channels as journal articles.

The remaining graphs in Fig. 4, part *A*, present data on the attendants' familiarity, acquired before the meeting through informal channels, with the material presented there. Graph *A-2* shows the percentage of attendants familiar before the meeting with the content of at least one of the sample presentations (*6*). More physical scientists than social scientists reported such familiarity.

The next three graphs of Fig. 4 present information on the various types of such acquaintance. Graph *A-3* shows the percentage of attendants who, before hearing the presentations at the meeting, knew of the authors and knew that their work was in progress. Such "personal" acquaintance with authors apparently was the main source of premeeting familiarity with the presentation material. The physical scientists reported such premeeting familiarity more often than the social scientists did.

Graph *A-4* shows the percentages of attendants who had heard authors make oral reports of their work prior to the meeting, and graph *A-5* shows the percentages of attendants who had read written reports of the work prior to the meeting. Few attendants in either group assimilated much information from premeeting reports, and this is hardly surprisingly, since such reports usually had been disseminated to small audiences, often as much as 5 months before the meeting.

Graph *A-6* of Fig. 4 shows the percentages of attendants who had read abstracts of at least one of the sample presentations before attending the sample session. Curiously enough, the social scientists, who were less familiar with the presentation material before the meeting than the physical scientists were, had read fewer abstracts.

These findings about prior acquaintance with presentation material suggest important differences in the informal networks associated with the disciplines under study. Of the two groups, the physical scientists disseminate information more intensively, in a shorter period of time and more effectively.

Information-exchange activities at, and resulting from, the meetings. Thus, as one would expect, the information-exchange activities associated with meetings of the physical scientists and of the social scientists differ. The social scientists generally seek information at meetings more arduously. The graphs of Fig. 4, part *B*, show the percentages of attendants who established contact with authors at the meeting and who corresponded with authors afterward. The social scientists showed greater activity on both counts than the physical scientists did.

The remaining graphs of Fig. 4 present data pertaining to requests authors received for copies of the text of their presentation. Graph *C-1* shows that more social science than physical science authors received such requests. Distribution of copies of presentation texts evidently was a major dissemination activity associated with meetings; authors received on the average five requests, and some authors received more than 200.

Graph *C-2* shows that the social science authors were more likely to fulfill such requests. Graph *C-3*, however, shows that the social scientist recipients of copies read them less thoroughly than the physical scientist recipients did. Two months after the meeting, only 80 percent of the social science recipients, as compared to 93 percent of the physical science recipients, had read the copies they had requested.

Comparison of the dissemination process before the meetings with the information-exchange activities at, and resulting from, the meetings suggests that, for the social scientists, the national meeting served as an occasion on which they devoted considerable time and energy to establishing lasting informal contacts to compensate for the ineffectiveness of their informal channels of communication prior to the meeting.

Transfer of Information from the Informal to the Formal Domain

In the scientific communication systems we have studied, information first flows through the informal domain and then, following some development, to the formal domain, where it becomes genuinely public and archival. We turn now to the process of transferring information from the informal to the formal domain.

Postmeeting dissemination of material presented at national meetings. At the time of the national meeting, over 90 percent of the authors of presentations in the two groups planned to disseminate their presentation material in written form, and most—79 percent of the physical science and 74 percent of the social science authors—planned to disseminate the material through journal publication. Many authors had started writing their presentation-based articles at the time of the meeting, and some submitted them to journals within a few weeks after the meeting.

We have already touched on the extent to which these plans for journal publication had been fulfilled 1 year after the meeting (see Fig. 2, part *A*). Over half of both the physical science and the social science authors submitted their presentation-based manuscripts to journals during the first year after the meeting; this amounted to 70 percent of those in each group who, at the time of the meeting, had planned dissemination through journal publication.

The data also show the difficulty social scientists encountered in transferring information from the informal to the formal domain. Within 1 year after the meeting, only about a third of the social science manuscripts submitted (as compared to over 60 percent of the physical science manuscripts submitted) had been published.

The high rates of rejection and the fact that their journals do not use a system of "page charges" (discussed below) seem to account for much of the laggardness in the journal publication process for social science authors. Graph *A* of Fig. 5 shows the percentages of authors who had made presentations at the meeting whose manuscripts had been submitted to, but not accepted by, one or more journals during the first year after the meeting. Only about one physical scientist in eight, as compared to more than one social scientist in three, had had a manuscript rejected.

Graph *B* of Fig. 5 shows the per-

centages of presentation-based manuscripts accepted during the first year by journals levying page charges—that is, requiring that publication costs be shared by the authors or their institutions. While physical scientists use this system, so that the number of pages their journals can publish is not strictly limited by annual publication budgets, social scientists do not. As a result, more articles per year are published in a physical science journal than in a social science journal. For the manuscripts submitted to social science journals this means accumulated lags and delayed publication.

The diffuseness of their dissemination process further complicates the social scientists' transfer of information into the formal domain. Graph *C* of Fig. 5 shows the percentages of presentation-based manuscripts accepted by "core" journals during the first year after the meeting. Note that, while most of the physical science manuscripts accepted were accepted by "core" journals, only a little over a quarter of the accepted social science manuscripts were accepted by "core" journals.

The number of journals that accept presentation-based manuscripts within a year after a meeting indicates further the diffuseness of this transfer process for the social sciences: 108 journals accepted 488 presentation-based physical science manuscripts; 107 journals accepted 193 social science manuscripts. In other words, with the same number of journals and in the same length of time, 2½ times as many presentation-based physical science manuscripts as social science manuscripts were published. Thus, in the physical sciences relatively few journals disseminate the bulk of the literature and the "core" journals annually publish large numbers of articles, whereas in the social sciences many journals disseminate the literature and the "core" journals publish relatively few articles. (The "core" journals in each physical science discipline generally publish two to four times as many articles per year, relative to membership, as do the "core" journals in any of the social science disciplines.)

Although the typical social scientist may have use for the information contained in the various journals, the diffuseness of the publication process makes it difficult for him to learn of its availability. After material presented at a meeting had been published in journals, we contacted people who had requested copies of presentation texts at the time of the meeting, to determine whether or not they knew of the later publication. This study is continuing for some disciplines, but evidence already gathered suggests that far more physical scientists than social scientists knew of the later publication. For example, 86 percent of the main group of physical scientists of the study knew of such publication, as compared to 46 percent of the main group of social scientists.

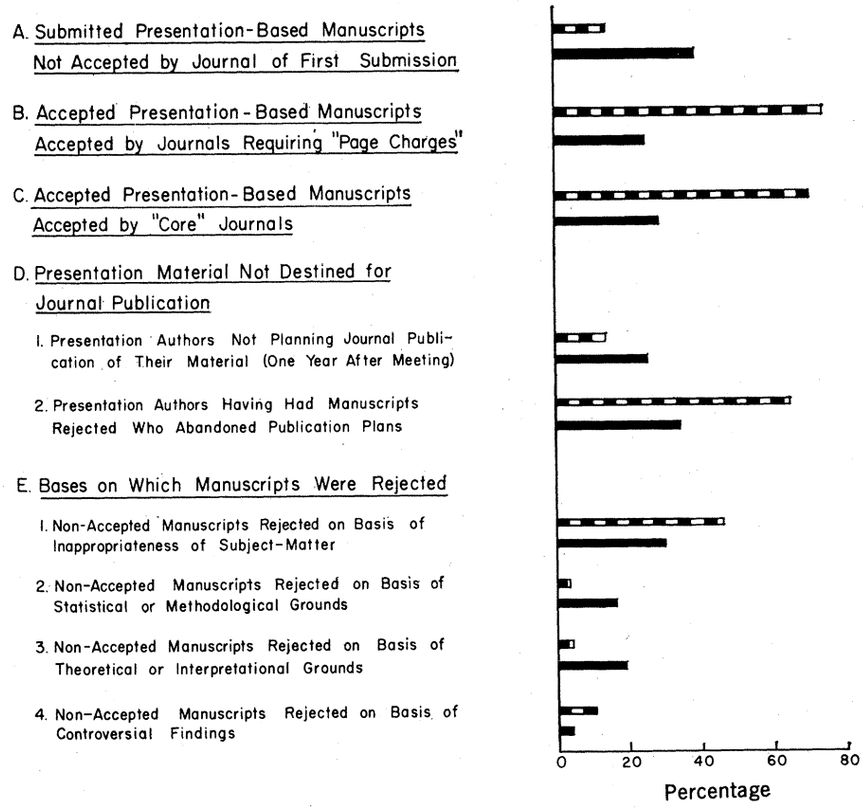

Fig. 5. Publication fate, 1 year after the meeting, of material presented at the meeting. (Broken bar) Physical sciences; (solid bar) social sciences.

Formal dissemination of material presented at a meeting does not stop with initial journal publication. Over 50 percent of the social science and 40 percent of the physical science authors whose work had been published in a journal within a year after the meeting planned further formal dissemination. One-fourth of the social science authors chose books or collections of papers as the medium for further dissemination, while about one-sixth of the physical scientists reported plans for writing additional articles based to some degree on material they had already published in journals. Very few authors in either group planned further *informal* dissemination—for example, fewer than 2 percent planned further dissemination by way of technical reports.

In Fig. 5, graph *D-1* shows the percentage of all presentation authors who had no plans to publish their work 1 year after the meeting at which they had presented their work; more social scientists than physical scientists tended not to plan journal publication at that time. Since so many social scientists' manuscripts were rejected during the first year after the meeting, one might expect to find that the authors had abandoned publication plans by the end of a year. Graph *D-2* of Fig. 5 shows the percentages of presentation authors who submitted their work for publication, had it rejected, and thereafter abandoned publication plans. The graph indicates that social scientists are not so easily discouraged from publishing their work in journals as one would expect. They seem, instead, to understand how their system works and to appreciate the value of persistence when submitting work for publication.

Both physical and social scientists appear strongly motivated to disseminate information about their work. Most authors of meeting presentations (over 60 percent) who were not planning journal publication cited the availability of their work in another form as their reason. However, physical scientists and

social scientists differ with respect to the media they choose as alternatives to journals. The physical scientists choose the technical report; the social scientists choose the book.

Publication of articles in "core" journals. In discussing transfer of information from the informal to the formal domain we have been dealing with data concerning postmeeting publication of material presented at a meeting. We gathered further data on this process in studying the production of articles in "core" journals. First, let us consider how the scientists selected the journals to which they submitted their work.

Most authors reported having selected a particular journal because it reached an audience that seemed suitable for their articles. Speed of publication appeared to rank next in importance as a selection criterion, constituting the basis for selection of a given journal by one physical scientist in six but by only one social scientist in 15. Since their publication process involves long publication lags, one might expect the social scientists to make a point of selecting journals with a view to overcoming this delay. But publication lag apparently permeates the social science journal system so thoroughly that social scientists do not even attempt to overcome it.

Editorial policy is also a concern of authors, particularly of social scientists, of whom one in six selects a journal on this basis. It is not surprising, given their experience with rejection of manuscripts, that social science authors pay particular attention to a journal's editorial policy.

Despite such caution, almost one-fourth of the social science authors (as compared to only one-twelfth of the physical science authors) whose articles were published in "core" journals experienced rejection of the manuscripts at least once before submitting them to the journals that published them. Some of the authors of not-yet-accepted manuscripts (one social science author of such a manuscript in six, as compared to one physical science author in ten) withdrew manuscripts after submitting them for publication, usually because they considered the revisions required by editors inappropriate. Delay in editorial action was not given as a major reason for withdrawing manuscripts; the physical scientists appeared more sensitive to such delay than the social scientists did.

Editorial rejection accounted for most authors' failure to publish in the journal of their first choice. Graph *E-1* of Fig. 5 shows that inappropriateness of subject matter for the journal in question was the main reason given for rejection. Emphasis on applied work in a manuscript submitted to a basic-research journal was typical of what physical science journals considered "inappropriate." In the case of social science journals the statement that subject matter was "inappropriate" was often an editorial euphemism, almost always accompanied by additional reasons for rejection. The remaining graphs of Fig. 5, part *E*, show examples of these reasons.

Graph *E-2* shows the percentages of manuscripts rejected for statistical or methodological reasons. This is a reason for rejection rarely given in the case of physical science manuscripts but given one time in eight in the case of social science manuscripts.

Although the theoretical framework of social science is not as well delineated as that of physical science, the social scientists had manuscripts rejected on theoretical or interpretational grounds more often then the physical scientists did. Graph *E-3* shows the percentages of manuscripts rejected on such grounds.

Graph *E-4* shows the main reason given (other than inappropriateness of subject matter) for the rejection of physical science manuscripts. One rejected physical science manuscript in ten was rejected because its findings were controversial. This was the reason editors gave least frequently for rejecting social science manuscripts.

Summary

Although composed of similar elements and structured similarly, the communications systems associated with the physical sciences and the social sciences differ markedly with respect to the operation and use of these elements. For both groups of disciplines, as information flows through the system it encounters lags and filtering, and much of a scientist's communication behavior is an effort to compensate for these factors. Because the lags and filtering within each system differ in loci and extent, the members of different disciplines adjust to them differently, and the overall information flow patterns in the physical and in the social sciences differ.

The results of our studies suggest that scientific communication in the social sciences is in an early stage of development relative to that in the physical sciences: the elements of the social sciences' communication structure are relatively noncohesive; the flow of scientific information through the communication system follows less predictable sequences; and the processing of information for the archives appears less efficient (more time-consuming, more haphazard, and more diffuse). Because of this state of affairs in the social sciences, social scientists appear to communicate more randomly than do physical scientists, whose communication system is more highly developed.

The eclectic ("soft") nature of the social scientists' subject matter probably contributes to this situation. For example, social science authors and editors disagree more often than physical science authors and editors do on the appropriateness of required revisions; the editorial process in the social sciences focuses more on the mechanics of the work, such as statistical procedures and methodology, than on the controversiality of research findings; and whereas "core" journals in the physical sciences receive few manuscripts previously rejected elsewhere, social science authors repeatedly recycle manuscripts rejected by "core" journals and resubmit them to other "core" journals.

In conclusion, the findings reported here strongly suggest that planners of innovation in scientific communication, especially planners who contemplate patterning the communication system of one discipline after that of another, may be misled by the gross similarities of the scientific communication process for most disciplines. These similarities can mask some important differences between disciplines, and communication innovations designed for one discipline may prove inappropriate and even damaging for another.

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3. The nine scientific and engineering disciplines considered in the study are represented by the following societies. *Physical sciences*: American Geophysical Union; American Meteorological Society; Optical Society of America; American Institute of Mining, Metallurgy, and Petroleum Engineers. *Social sciences*: American Sociological Association; American Educational Research Association; Association of American Geographers. *Engineering sciences*: American Society of Heating, Refrigerating and Air-Conditioning Engineers; American Institute of

Aeronautics and Astronautics. The findings reported here were selected from a series of studies in which data were collected on over 30,000 scientists, and the statistics presented are averages (medians) of data collected in the study of the social and physical sciences. Data for the engineering sciences are not given, as those studies are continuing. The American Psychological Association (APA) has made similar studies in the area of psychology. When appropriate, we compared the APA data with our data. Apparently the dissemination process for psychology is similar to that for the social sciences we studied.

4. In a study of authors of presentations at national meetings, the Center obtained data on the journals to which these authors planned to submit manuscripts based on their presentations. The Center made citation analyses based on the journals mentioned most often and on journals published by the societies sponsoring the meetings. The Center analyzed references found in the issues of these journals that had been published during the previous 2 years, and included analyses of references from the journals most often cited in the first group of cited references. This process was continued for meetings of each of the nine societies of the study until a point of diminishing returns had been reached—that is, until the journals that remained could not be considered to be in the mainstream of the discipline's journal literature. Such analyses, for the various disciplines in the Center's program, indicated that (i) a small number of journals have a central, or "core," position in the discipline's literature; (ii) a slightly larger number of journals relate peripherally to this "core" literature; and (iii) a large group of journals are loosely associated with this "core" literature.
5. These were people reported by the authors to be conducting work in the areas discussed in their articles—that is, work deriving from the authors' findings, stemming from the same conceptual or theoretical framework as their work, attacking the same problems from different points of view, stimulating their work, and so on.
6. In its study of meeting attendants the Center obtained a random sample of persons attending sessions at the meetings. In the questionnaire used to study this sample each attendant was asked about four sample presentations that had occurred during the session in question.
7. The Research and Studies Section of the Office of Science Information Service of the National Science Foundation (NSF-GN514) supported the work reported here. Kazuo Tomita, Gayle Rummel, and Barbara Pajak contributed significantly to the work reported, and Cheryl Barnett helped to prepare the manuscript. Details of the work may be obtained from the series of reports produced by the Johns Hopkins Center for Research in Scientific Communication.

The Mao Ethic and Environmental Quality

Leo A. Orleans and Richard P. Suttmeier

It is only recently that apprehension over the rapidly intensifying problems of environmental quality in the industrialized world has reached a point where it has become obvious that solutions will require much more money, effort, and desire on the part of both government and people. It may come as something of a surprise, therefore, to find that as early as the 1st century B.C. the Chinese *Record of Rites of the Elder Tai* (*1*) warned against man's polluting his environment, and that Communist China, at best only a partially industrialized nation, has shown some concern regarding questions of environmental quality for almost all of the 20 years of its existence. Taking great satisfaction in their professed accomplishments in this field, the Chinese news sources have been quick to report and comment on U.S. problems of pollution, citing them as among the more serious weaknesses of the capitalist system. They even referred to President Nixon's State of the Union Message, commenting that he "helplessly wailed that [in 10 years] the so-called 'pollution' problem in the United States would 'become insoluble'" (*2*). They have also pointed to reports in the *Wall Street Journal* that the production of antipollution devices has become the new "glamor industry," stating that American antipollution programs are a guise for further exploitation of the American people by "monopoly capitalists" (*3*).

Setting for Chinese Environmental Concerns

The fight against environmental contamination in Communist China, which has taken various forms over the years, was recently manifested in the ideological struggles of the now waning Cultural Revolution—the struggle between the all-powerful thoughts of Mao Tse-tung and the black deeds of Liu Shao-chi, the former President of the People's Republic of China, who took the "capitalist road." Liu, as politician and development strategist, has often been identified by the Maoists with China's "bourgeois experts"—those managers, engineers, and scientists whose positions in the technically oriented bureaucracy implied the emergence of a technocratic elite. Thus it was not only Liu but also the "experts" and all they represented in terms of economic growth and social modernization that became subjects for attack during the Cultural Revolution. According to Maoist news sources, the approach of Liu Shao-chi and the technical experts toward industrial wastes was to treat these as "industrial 'garbage,' . . . [maintaining that] because they could not be reused to produce large quantities of valuable products, it would not pay to utilize them. They [Liu followers] not only threw away these valuable materials, but let them pollute the air and rivers" (*4*). Thus "Liuism" has come to represent a position of opposing the comprehensive utilization of resources, of relying on the opinions of experts, and of being insensitive to environmental pollution.

Maoism, on the other hand, is first and foremost an ethic of frugality, of "doing more with less." It is an ethic of self-reliance, but of self-reliance tempered with the cooperation that theoretically results from the mobilization of all sectors of the society for given tasks. Maoism is an ethic of progress, but of progress that relies more on the transformation of the Chinese masses than on the directions and recommendations of a scientific and technological elite. Hence, progress and the resulting changes in the means of production—the development of new technologies—are to remain under human control. It is therefore an ethic that appears to make technological development dependent on social development, instead of letting social development slip completely out of phase with technological progress. As an environmental ethic, then, Maoism may seem very attractive indeed to many of the citizens of the complex industrial societies of the West, who are increasingly disturbed about the secondary and tertiary ecological effects of their technologies.

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