The foreign-language problems encountered in indexing are considerably less than the foreign-language problems met with in the overall assembling of *Chemical Abstracts*. Nevertheless, production of the semiannual author and patent indexes requires well-devised and accurately executed techniques. This is especially true in the handling of names of foreign authors.

In the subject indexes of *Chemical Abstracts*, subjects, not merely words, make up the entries. The entire abstract is indexed, and many additional index entries are prepared from the original patent or paper. The abstract is used as an outline for these entries. The availability of good English-language abstracts enables the indexer to locate information of specific interest in the primary documents even when these documents are in languages with which he is not fully familiar. New compounds are generally characterized by their physical properties, given in numerical values, and by their chemical structures. Reactions may be illustrated, through intermediate steps, by presentation of structures—a universal language. This often enables the indexer to follow the technical and theoretical presentation of the paper even though his familiarity with the language of publication is minimal. As in the editorial department, difficult problems are referred to chemists with facility in the language in question.

From acquisition to indexing, production of an abstracting journal that covers foreign literature is a complex and a costly endeavor. Over $4 million will be spent during 1963 in the production of *Chemical Abstracts* and its indexes.

On the basis of the coverage of *Chemical Abstracts*, it can be concluded that some 60 percent of the world's scientific literature is printed in languages other than English (*2*). The practicing scientist normally has neither the time, the language ability, nor the access to vast library resources that he would need to keep informed, from primary sources, of advancements in his field. As long as this situation exists, the abstracting journal, as an assimilator of foreign scientific literature, will remain invaluable.


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# Primary Scientific Publication and the Federal Government

## The nation's principal supporter of research has a major responsibility toward publication of results.


Burton W. Adkinson


Two basic facts underlie the federal government's extensive, long-time participation in the original dissemination in published form of research results, that is, in primary scientific publication. First, the government supports a vast amount of scientific experimentation both in its own laboratories and through contracts and grants in nongovernment organizations. That current federal funding of scientific research approaches two-thirds of total U.S. expenditures in this field has been noted and commented upon frequently (*1*). Sometimes forgotten, perhaps, is the fact that government support of scientific research has been substantial for a great many years. Such agencies as the Department of Agriculture through its Agricultural Research Service, the Bureau of Standards and the Weather Bureau of the Department of Commerce, the Bureau of Mines and the Geological Survey of the Department of the Interior, and others, long have played important roles in the nation's overall scientific research program. The second basic fact is simply that publication, in various forms, has for decades been the principal method by which the results of scientific research have been made widely available to the scientific community. Thus, it would have been almost impossible for the federal government to avoid becoming a major publisher and supporter of publication in science and technology, even if it had wanted to.

With the immense and extremely rapid expansion in recent years of federal conduct and support of scientific research, the government's overall role in primary scientific publication has become highly complex and has posed a variety of increasingly serious problems. My intent in this article is (i) to outline the various forms that federal participation in primary scientific publication now takes, and (ii) to mention several principal problem areas and comment briefly on certain remedial steps being taken or planned.


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### The Government as a Publisher

Federal participation in primary scientific publication is of two general kinds. Government agencies themselves are, in effect, both the originators and publishers of scientific monographs, journals, and other documents. Government agencies support, by one means or another, the initial publication of scientific information by privately owned media.

Government agencies publish a wide range of primary scientific documents in support of, and associated with, their respective missions. These are mostly printed by the Government Printing Office. Established in 1860 to correct inefficiencies in the then decentralized government printing procedure, GPO has grown into a $127 million annual operation (fiscal year 1962) and is one of the world's largest printing establishments. Its output of scientific and technical material includes books,

monographs, journals, reports, and translations. Government scientific journals printed and issued through the GPO include *Agricultural Research, Journal of Research of the National Bureau of Standards, Journal of the National Cancer Institute, Monthly Weather Review, Naval Research Reviews, Power Reactor Technology, Technical Translations,* and many others. Among the significant monographic publications are the Department of Agriculture yearbook, each volume of which is a comprehensive treatise of one subject in agricultural science; Bureau of Mines documents, such as the encyclopedic reference work "Mineral Facts and Problems"; such Bureau of Standards publications as the nine-volume "Standard X-ray Diffraction Powder Patterns"; numerous important professional papers issued by the Geological Survey; and many others.

GPO's principal announcement medium is the *Monthly Catalog* of U.S. government publications, each issue of which lists from 1000 to 2000 items. A sharp delineation between what is or is not scientific or technical is, of course, difficult to establish. A check of the January and February 1963 issues of the *Catalog,* however, indicates that of the approximately 3400 items listed in these two numbers, about 20 percent are scientific or technical and come from 18 to 20 different agencies and bureaus. Topics in the biological, physical, and social science areas are represented (*2*).

The Atomic Energy Commission is a prime example of an agency with an extensive publication program, much of which is handled through commercial publishing companies. It is one of the few agencies whose mission requires it, within the limitations of national security, to disseminate information in its field to the scientific community and to the nation as a whole. In view of this responsibility and the vast magnitude of its research program, the AEC has developed a technical information policy that fosters very wide publication and dissemination of information in the atomic and nuclear fields. Outstanding among the commercially published books which it has produced (and for which, in effect, it stands in the position of author) are the *National Nuclear Energy Series* (*3*) of approximately 50 unclassified volumes, the *Source Book on Atomic Energy* (*4*), *Elements of Nuclear Reactor Theory* (*5*), and *Principles of Reactor Engineering* (*6*). The government's relation to this mode of effecting primary publication of scientific material differs from that discussed in the next section of this paper in that here a federal agency is completely responsible for and controls the content of the documents, although the actual publication is handled by a commercial publisher.

The so-called "technical report" cannot be ignored in this consideration of the government as a publisher of original research results, even though this type of document may not usually be thought of as part of the primary scientific literature. The 100,000 or more such reports that emanate annually from government laboratories and contractors (principally those of the Atomic Energy Commission, the National Aeronautics and Space Administration, and the Department of Defense) have in common the basic mission of reporting promptly on federally supported research and development to those individuals and organizations that require the information quickly and have a right to demand it. These include contracting agencies, laboratory and company heads, research directors, and the like. In almost every other respect, such as size, scope and significance of content, quality of writing, effectiveness of presentation, and so forth, they are an extremely heterogeneous lot.

Initial distribution of technical reports is handled by the various issuing organizations and contracting agencies, with systems for such dissemination varying from a haphazard document-by-document approach of "Let's see now, who ought to get this one?" to well-planned and integrated distribution patterns. There has, however, been little or no interagency or inter-laboratory coordination of this initial transmission of technical reports.

Some technical-report material, of course, appears subsequently in conventional primary journals. Quantitative data on this point are meager, although one limited investigation of Department of Defense reports indicated the following for the approximately 1100 reports whose "case histories" were studied: (i) that 60 to 65 percent of these documents contained publishable information, as judged by their authors; (ii) that for about half of the reports that contained publishable data, all such information was published, but some of it with a 2- to 3-year time lag; and (iii) that the publishable data in about one-fifth of the reports probably never appeared in conventionally printed form (*7*). Some of the problems posed by the superposition of this decentralized technical-report literature upon the conventional publication system are discussed in this article, along with certain remedial measures that are being taken.

## Government Support of Non-Government Publication

If one accepts the principle that dissemination of the results of scientific experimentation is, or should be, an integral element in the research sequence, then to the extent that federally financed research findings are made available through private publication, the government should assist in the support of such publishing efforts. On this basis, the problem becomes one of mechanism, not of principle. Two general approaches have been made to this problem. One is to link publication support as directly as possible to research support; the other is to provide separate, direct subsidy for publication.

The principal mechanism of the former kind that is being employed is the "page charge," pioneered some 30 years ago in U.S. physics journals (*8*), and now a part of the support structure of more than 45 professional scientific journals in a variety of subject fields. Among the societies that have adopted a page-charge policy recently is the American Chemical Society which initiated such charges in January 1963 for eight of its periodicals (*9*).

In amount, the page charge is set equal to, or less than, the so-called fixed cost of publication—the portion of the total cost not dependent upon the number of copies printed and distributed. Payment of the charge is requested, not of the author, but of the laboratory or other organization that supported the research reported in his paper. However, such payment is never made a condition of publication.

The page-charge approach finds its greatest application within government in the departments that have extensive programs of basic research. Agencies such as the Office of Naval Research and the National Science Foundation long have permitted research grant funds to be used to pay such charges for papers published on research that they support. In government as a whole, however, there was considerable lack of uniformity of policy re-

garding page charges. Consequently, in October 1961 the Federal Council for Science and Technology approved the use of federal research funds to pay page charges levied by nonprofit scientific journals, provided such charges are standard for all papers published by the journal and payment is not a condition of manuscript acceptance (see *10*).

The major argument for the page-charge policy is that it channels an appropriate portion of the research dollar into primary publication of research data. In other words, it promotes the basic principle that dissemination of the results of experimentation is an integral element in the research process. It has been suggested that a government agency with an extensive research support program might prefer to make annual lump sum payments to journals to cover page-charge costs for the papers published during the year on research the agency supported. I believe very firmly that this practice would be highly inadvisable since, far from supporting the principle mentioned above, it would tend to negate it by helping to preserve the unfortunate notion that making research results available for use should be separate from, rather than linked with, the experimentation that produced the data.

The National Science Foundation has been the principal agency granting direct subsidy for the support of primary publication. This role stems both from NSF's enabling legislation and from certain directives the Foundation received in 1958 and 1959 to provide for, or arrange for the provision of, an adequate national scientific information system (*11*). These charges place particular emphasis upon coordinating and supplementing, not supplanting, the various elements of the existing private and government system concerned with the bibliographic control and the dissemination of scientific information.

Any scientific publication, primary or otherwise, that receives NSF grant support must satisfy two basic criteria: It must be making, or show promise of making, a significant contribution to the scientific research literature, and the proposed mechanics of publication must be judged sound. Decisions on requests for publication support are made in the light of recommendations from reviewing groups that include experts on both points. Within this framework, grants are made to help establish needed new periodicals, to assist significant existing journals in financial emergencies, and to enable them to accomplish specific publication tasks related to their main missions (for example, to eliminate backlogs of accepted manuscripts, to prepare cumulative indexes, or to expand coverage). Under no circumstances is a primary journal's normal day-to-day operation supported indefinitely by grants. Here, the Foundation applies the basic principle emphasized previously; the cost of disseminating research data is a legitimate charge against research and the appropriations for the latter should cover the former. Thus, NSF's support of the ordinary, "bread-and-butter" functioning of primary journals is accomplished by approving use of its research grant funds to pay page charges on papers that report results of the research.

In the case of single items (books, monographs, conference proceedings, and the like), the Foundation subsidizes publication only when a scientifically significant manuscript cannot be made readily accessible (that is, available for purchase at going rates) in any other way. In other words, it is assumed that any scientific manuscript that can be published through conventional commercial channels should be so handled. Except under very special circumstances, grants are not made for scientific publications that are largely to be distributed free of charge.

Conference proceedings require a special word or two, perhaps mostly because of a seemingly widespread belief that some sacred law of nature requires every conference to be followed by a physically impressive proceedings volume. In its publication support program, NSF rejects this idea. It believes instead that a proceedings manuscript should be held to the same criterion of solid scientific merit that any other manuscript must meet and, that frequently, perhaps usually, separate publication of worthwhile papers in appropriate journals is greatly preferable to issuance of proceedings of any kind.

I have gone into some detail on the NSF publication support program in order to emphasize certain of the principles involved and because, as already mentioned, the Foundation is the only government activity officially concerned with the support of scientific publication per se. Other federal agencies that provide funding directly to privately managed primary publications do so as part of the agencies' own basic research and development missions. Thus, for example, various units of the Department of Health, Education, and Welfare make grants to assist with the publication of primary journals and monographs in subject areas of HEW research interest. Similarly, NASA provides some such support in the space field, AEC in certain aspects of atomic and nuclear energy, the Navy and the Weather Bureau in meteorology, and so forth. Support criteria related to scientific quality and production efficiency are much the same in all of these cases as the ones outlined for NSF. Their viewpoint is likely to be somewhat different, however, and understandably so, on the questions of free distribution and whether to support monograph publication that might have commercial possibilities. Their basic concern has to be maximum effectiveness in support of the agencies' respective research and development programs; that of NSF must be promotion of the best possible total national scientific information system.

## Problems and Remedial Measures

Problems pertinent to the topic of this article have two characteristics common to problems in most areas of human activity; they are plentiful and they can be classified in many different ways. I limit my discussion to two general categories. One concerns questions related to intra-government coordination of existing publication policies and practices. The other, which perhaps is the more fundamental, involves the need to explore possible new approaches to the primary dissemination of scientific information.

The inevitability of the government's involvement in primary scientific publication has already been noted. Perhaps almost as unavoidable has been the uncoordinated manner in which programs in this field have evolved in the various federal agencies concerned with scientific research. At least, one can easily understand how this situation came to pass since each agency had its own peculiar research mission to fulfill and naturally established its particular publication practices accordingly; there was little overlap among the research interests of the different government agencies; and, in today's terms, the total scientific research and publication programs remained relatively small for many years. Now, when federally supported research and

development have become "big business," and when almost every scientific discipline has significant implications for numerous other fields, effective coordination has become imperative.

While the present support policies of the various federal agencies probably are reasonably consistent in the case of conventional primary publications (that is, monographs and journals, not reports), a study in this area is under way. A statement of NSF policies has been circulated to all government agencies that support research and development, with the request that each one indicate wherein its policies are similar, are different, or have not been formulated. The replies will provide information on the basis of which, it is hoped, an overall federal policy on support of publication can be devised, one that will promote the national scientific welfare in an effective manner without jeopardizing the responsibility each individual information activity has toward its own agency's research and development program.

Because of the enormous heterogeneity in almost all aspects of the federal technical-report literature, coordination and effective overall dissemination of scientific material have been particularly difficult. Initial distribution of technical reports also lacks coordination. Coverage of them by conventional announcing, abstracting, and indexing services has been very meager because of the documents' wide variation in scientific stature and the inability of the secondary services to insure their availability to readers. Until fairly recently, there was no centralized government report announcement or abstracting service that consistently covered a large percentage of the reports on federally sponsored research. And there has been no "last resort" type of office to which a frustrated scientist or engineer could turn for information about report sources in particular subject fields. In line with its scientific information coordinating responsibility, the National Science Foundation has worked on these problems with a number of other federal agencies. Some of the results to date are:

1) *Initial distribution.* A comprehensive study has been made of existing practices for the initial dissemination of technical reports. Work is under way toward the development of an effective government-wide pattern that will meet both the overall problem and the individual needs of the various agencies that support research and development.

2) *Prompt announcement.* For some years the Office of Technical Services (OTS) of the Department of Commerce has published the monthly abstracting journal, *U.S. Government Research Reports*, which has listed various categories of these documents. Improved cooperation of the report-producing agencies has enabled OTS greatly to expand its coverage, making it now substantially complete for the unrestricted reports of AEC, NASA, and the Armed Services Technical Information Agency, the three agencies whose production and holdings constitute the bulk of all technical reports on government-supported research and development. The journal's coverage of the reports of other agencies also is increasing.

3) *Availability of copies.* All reports abstracted in *U.S. Government Research Reports* always have been available for purchase in one form or another; thus, the expansion of this journal's coverage automatically has increased substantially the number of reports available. In addition, 12 regional depositories have been established to receive and provide bibliographic service on all reports in the OTS system (*12*).

4) *Referral service.* Not always met by the steps described above is the problem of the individual who wants to know whether technical reports have been issued on a given subject and, if so, by whom. The National Referral Center for Science and Technology, recently established in the Library of Congress, performs this function for scientific and technical inquiries in general, including those involving the technical-report literature. This Center does not itself provide substantive technical data; its mission is to know where reliable and authoritative answers can be found to technical questions and to make this information available upon request.

Not directly a part of the primary publication complex, but having important implications for it, is the Science Information Exchange in the Smithsonian Institution. The Exchange maintains, and makes available, data on current, federally sponsored research, that is, on who is conducting what research where, in the life, physical, and social sciences. This organization represents an expansion of the Bio-Sciences Information Exchange which was established some years ago.

Problems concerned with new approaches to scientific publication affect all technical publishing, not just that which is government supported. Various developments of recent years have created a scientific information climate radically different from that which existed a decade or two ago. Probably chief among these are the vast and rapid expansion of research and development with its accompanying deluge-like growth of resulting information to be disseminated, the breakdown of boundaries between conventional disciplines, the increased significance of research data published in languages other than English, and the ever accelerating emphasis on the rapid reporting of research results. The combined effect of these factors has been to raise serious questions regarding several aspects of our traditional techniques for making today's research findings available for use in furthering tomorrow's research and development, that is, for maintaining unbroken the blood line of research results that is essential for continued, effective scientific progress.

For example, whereas formerly a scientist or engineer could follow perhaps two or three publications and feel reasonably certain he was keeping up with material pertinent to his interests, he now finds useful research results turning up in many different disciplines. He cannot possibly read all of the journals in all of these fields. Simply to reduce the scope of coverage of individual journals and define their respective bailiwicks more sharply would not be a solution. This procedure would simply aggravate the journal population explosion; further, no two individuals would want the total "cake" sliced in the same way. Information services that, by one means or another, can tailor their products to fit specialized needs seem to offer promise. A number of approaches of this kind are being tried, with the mode of tailoring varying from strict request answering to automatic specialized dissemination according to individually established information "profiles."

Or, consider the matter of promptness of availability of research findings. As pressures grow greater to reduce the time lag between "discovery" and "application," conventional journals seem to be increasingly unable to meet the total dissemination problem. Here experiments are being conducted along a number of lines, with some already proving quite successful. One is the relatively new periodical, *Physical Review Letters* (*13*), which is reproduced

by photo-offset from typed copy. It publishes contributions within 1 to 2 months of receipt and editorial review is limited largely to acceptance or rejection of manuscripts. This publication is intended for quick announcement in summarized form of significant results and supplements the parent journal, *The Physical Review*, which continues conventional publication of full papers. Similarly successful has been the new chemistry publication *Chemical Titles* (*14*). Although not itself a primary publication, it provides rapid announcement of papers published in primary chemistry journals. This semimonthly periodical, which is a permuted-title index, is photo-offset from mechanically composed copy; papers are listed in it less than four weeks after journal publication.

Another serious problem, of course, is the rapidly mounting cost of all phases of publication. Here, new techniques, such as photocomposition and mechanization of various steps in the total process, are attractive avenues for exploration. Indeed, some of the approaches being tried have remedial possibilities along several lines. One "family" of experiments, for example, combines new kinds of composition with computer techniques for mechanized, high-speed print-out. Such a system might accomplish appreciable reduction in both cost and time lag. Another dual-benefit approach that has been suggested in a variety of forms, but as yet not tried with a major scientific publication, would limit the conventionally distributed journal to abstracts or digests of papers with the complete papers being kept on deposit and photocopies of them sold on request. An interesting periodical that represents a kind of "cousin" of this approach is *Wildlife Disease* (*15*), now in its fifth year of publication. It is the only scientific "journal" published exclusively in microform; each issue consists of a conventionally printed pamphlet of abstracts plus microcards of the full papers.

## Summary

The federal government, as the nation's largest supporter of scientific research, is also its greatest producer and user of scientific information. That this properly and necessarily involves it deeply in the publication of the results of research, government and nongovernment, is underlined in the following pair of paragraphs from a recently issued report of the President's Science Advisory Commitee (*16*).

> Since strong science and technology is a national necessity, and adequate communication is a prerequisite for a strong science and technology, the health of the technical communication system must be a concern of Government. Moreover, since the internal agency information systems overlap with the non-Government systems, the Government must pay attention to the latter as well as to the former.
>
> The Government must be concerned with our non-Government communication systems. . . . The technical literature with its long tradition of self-criticism helps, by its very existence, to maintain the standards, and hence the validity, of science, particularly of basic science. The Government, as the largest supporter of basic science, has a strong interest in keeping viable this mechanism of critical review.

Federal agencies that conduct and support scientific research and development increasingly are recognizing their responsibilities in this regard and are taking steps to improve their scientific information activities in ways that will both provide greater support to their own research and development missions and contribute to the development of a more effective national scientific publication program.

### References and Notes


1. Data from the National Science Foundation indicate a total U.S. research and development expenditure in fiscal year 1962 of almost $15 billion of which approximately 65 percent is estimated to have come from federal sources. Latest estimates indicate that the total for fiscal year 1963 will probably be of the order of $17 billion.
2. For a summary on the Government Printing Office, see the National Science Foundation series, "Scientific Information Activities of Federal Agencies," Bulletin No. 4, U.S. Government Printing Office (NSF 60-9), March 1960.
3. U.S. Atomic Energy Commission (McGraw-Hill, New York, 1947 through 1963).
4. S. Glasstone (Van Nostrand, Princeton, N. J., 1950).
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9. *Chem. Eng. News* **40**, 92 (1962).
10. *Scientific Information Notes* **3**, 1 (1961).
11. Public Law 507, 81st Congress, Sec. 3a(5); Title IX, National Defense Education Act of 1958; and March 1959 amendment to Executive Order 10521.
12. *Scientific Information Notes* **4**, 1 (1962).
13. Published semimonthly by the American Physical Society at Columbia University, New York, N. Y.
14. A product of Chemical Abstracts Service, published by American Chemical Society, Washington 6.
15. Published by the Wildlife Disease Association, c/o American Institute of Biological Sciences, 2000 P Street, NW, Washington 6.
16. "Science, government, and information," a report of the President's Science Advisory Committee (U.S. Superintendent of Documents, 10 Jan. 1963), p. 1.