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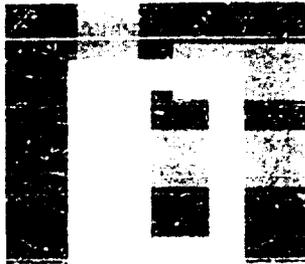
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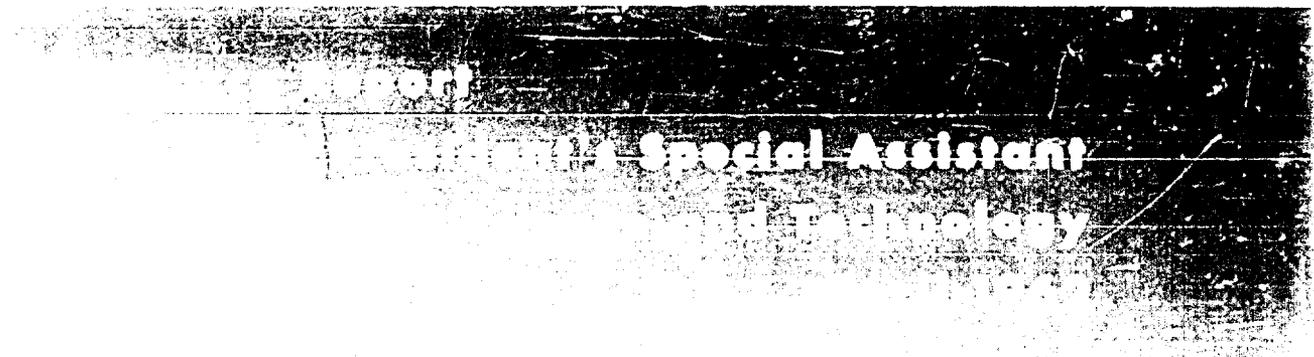
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Scientific and Technological Communication in the Government

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FOREWORD

This report is the result of the activities of a Task Force composed of six individuals who have intensively studied the scientific and technological information (STINFO) activities operating within the Federal Government. The Task Force was established by Dr. J. B. Wiesner, Special Assistant to the President for Science and Technology, for the purpose of making a detailed study of STINFO problems in connection with the conduct of the Government's R&D programs. The mission of the Task Force was set forth in Dr. Wiesner's letter establishing the group:

The proper organization and coordination of the various scientific and technical information activities of the Federal Government so that they best serve the needs of different management levels is of critical importance to the efficient and effective prosecution of the Government's expanding research and development programs. I hope, through this task force, to develop a more comprehensive understanding of the scientific and technical information needs for the conduct of these programs, to assess the strengths and weaknesses of existing and planned scientific and technical information activities, and to determine whether there is a need for improved procedures and organization for the handling of scientific and technical information.

The members of the Task Force have approached these objectives by: (1) studying the existing STINFO services operated by the various Federal agencies, (2) assessing the types of scientific, technological and resource information needed for the management of the Federal R&D effort, (3) identifying those elements of the information flow process which are faulty, weak or absent in the existing information services, and (4) recommending a plan to embody the necessary operating and coordinating functions to fill adequately management's needs.

The first part of this report discusses the urgency of scientific and technological problems the Government is now facing, the nature of the information needed by scientists, technologists and administrators of R&D, and the basic approach

employed by the Task Force in its study. It is followed by an examination of the existing situation, recommended improvement, and suggestions for organizational changes to implement these improvements. Also included is a plan for an orderly transition from the existing situation to the recommended one, based on a suggested organizational structure of the STINFO system. Problems associated with restrictions on the flow of information are also discussed briefly. Reference material and a bibliography are included in appendices.

The Task Force gratefully acknowledges the assistance rendered by the National Science Foundation in providing office space, secretarial assistance and library services. Miss Fern Bartels and Mrs. Betty Portner of NSF deserve specific mention for their efficient secretarial services and assistance.

Members of the Task Force wish to thank their respective organizations for granting the time necessary for the study but must emphasize that the views presented in this report are those of the members and do not necessarily reflect attitudes of their organizations. The interest, stimulation and advice received from Mr. David Z. Beckler, Dr. David Z. Robinson and Dr. Edward Wolk of Dr. Wiesner's staff, and from the President's Science Advisory Committee Panel on Problems of Scientific Information under the Chairmanship of Dr. A. M. Weinberg, are acknowledged with thanks.

The Task Force has made a conscientious effort to consult with responsible individuals in the various Government and quasi-Government agencies connected with STINFO activities. Included were individuals responsible for operating information services as well as representatives of technical management. We would like to acknowledge their contributions to our understanding of the various functions and problems, but hasten to relieve them of responsibility for our conclusions.

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CHAPTER I: THE PROBLEM

In describing the growth of science in his book, Science Since Babylon, de Solla Price⁽¹⁾ points out:

... the growth of science is something very much more active, much vaster in its problems, than any other sort of growth happening in the world today. For one thing, it has been going on for a longer time and more steadily than most other things. More important, it is growing more rapidly than anything else. All other things in population, economics, non-scientific culture, are growing so as to double in roughly every human generation of say thirty to fifty years. Science in America is growing so as to double in only ten years -- it multiplies by eight in each successive doubling of all non-scientific things in our civilization.

As rapid as has been the growth of science and technology, the involvement of the Federal Government in that activity has grown even more rapidly. Prior to 1940, the direct investment of the Federal Government in R&D was modest, the bulk of support deriving from private sources. In 1962, twenty-two years later, Federal expenditures in support of R&D exceed ten percent of the Government budget and account for more than two-thirds of all R&D funds in the United States. This item, budgeted for \$100 million in 1940, has grown to an estimated \$12 billion for fiscal year 1963 -- a hundred-fold increase in a little over twenty years. This growth of Federal support has altered the entire complexion and motivation of scientific and technological pursuits. R&D has become a national enterprise with far-reaching implications for national security, prestige and economic well-being. In addition to continuing defense requirements, the Nation is committed to an expanding program of space exploration and increased efforts in the health sciences. There is no discernible evidence that these programs will decrease in importance in the future.

It is not surprising, in view of this phenomenal growth, that Government R&D is encountering communication problems. Recognizing the key importance of communication to the progress of R&D, both the Legislative and Executive Branches of the Government have given increasing attention to its problems.

(1) Derek de Solla Price, Science Since Babylon (Yale University Press, 1961), Chapter V.

In the Executive Branch, high level attention has been focused by the President's Special Assistant for Science and Technology, the President's Science Advisory Committee and the Federal Council for Science and Technology. Prominent among Congressional studies has been the work of the Senate Committee on Government Operations, under the Chairmanship of Senator McClellan, and of its Subcommittee on Reorganization and International Organizations, under Senator Humphrey; the House Committee on Government Operations, Subcommittee on Government Information, under Congressman Moss; the House Committee on Science and Astronautics under the late Congressman Brooks. The reports of these and other Government studies of the problem have proved valuable to the Task Force.

Two major categories of information are important to the over-all conduct of Federal R&D effort: (1) scientific and technological information (STINFO) and (2) resources information. The first is composed of substantive recorded data, descriptions and results obtained from research and development activities. Advancements in science and technology occur only through building upon past accomplishments, i.e., extending existing frontiers into new and unexplored territory. Therefore, STINFO is a primary resource for R&D and should be treated as such.

Resources information includes data on the means available for R&D aims: funds, trained manpower, schedule estimates, research organizations, industrial potentialities and specialized equipment and facilities. This information should be available in a sufficient depth of detail to allow analysis of specific areas of support and manpower availability in assessing existing investments for comparison with project needs and future goals.

Between these two major categories lies a connecting tissue of information about science and technology, e.g., which research or development group is engaged in what problem or effort, how great is the scope of that effort, who is supporting the work, what additional work is being planned, what is the time schedule, etc. A current-effort index encompassing such information has an important bearing on administrative planning and resource allocation, as well as definite value to the performer in his need to gain ready access to prepublication information through personal contact. For convenience we include current effort information in the major category scientific and technological information.

At the performing level, the major concern is with STINFO. Within the management structure both this category and resources information are vitally important. Intelligent planning and decision-making require that both types of information in the appropriate admixture be available at every level of management. As a rule, the higher the managerial level, the greater is the proportion of resources information required and the more highly digested and evaluated must be the STINFO used. Nonetheless, there are instances in which highly detailed project information is required at the highest administrative levels in agency program evaluations. Therefore, the conclusion is inescapable that an important R&D management function in Government is the maintenance of an adequate information system oriented toward both broad and specific aspects of the agency missions for both their own needs and those of the performing scientists and engineers.

The communication problems of Government are inextricably intertwined with those outside the Government. Both the Government and the non-Government communities are concerned with the same total body of information; the progress made in each contributes vitally to the other. The majority of scientists and engineers participate in R&D programs supported by Federal funds. They have dual responsibility for communication -- as members of the professional community and as participants in Federal programs. Professional societies, industrial organizations, and individual scientists are all concerned about the inadequacies of current communication to fill the information needs of performers and administrators of R&D. This concern is reflected in a growing volume of literature on the "Information Crisis". Hardly a national meeting of a professional society is held without at least a session on STINFO problems. Meetings devoted exclusively to this topic are also becoming numerous. Information on the "Information Crisis" is beginning to create a minor "crisis" of its own.

The urgency of effective communication of STINFO to serve Government-supported R&D arises not only from the size of the programs but even more from the way in which scientific and technological "know-how" is generated and utilized. The applicability and the potential users of the results of R&D cannot be known completely to the generators of those results. The breadth of applicability of specific research results can to some extent be estimated. Such estimates can serve to suggest whether copies of a report should be prepared, and how many, but there can be no effective means for identifying all potential users.

Communication of STINFO across lines of executive responsibility and traditional boundaries between disciplines is vital to the progress of research and development in a number of ways and for a number of reasons. One of the features that characterizes the growth of science and technology is the increasing complexity of interrelations among its elements. It is possible to classify science and technology into hierarchies, but the number of points of view from which this can be done and the resulting number of different hierarchies reflect the large number of elementary interrelations. For example, research on detection of infrared radiation is related to the field of optics since it deals with optical radiation; to the field of solid state physics by virtue of its contribution to understanding of the solid state; to chemistry by virtue of its potential contribution to spectrometric analysis of structure and composition; to instrumentation as a contribution to the transducer art; to communication by means of infrared radiation; to missile guidance; to aircraft safety; to control of space vehicles; to military surveillance; to criminal investigation; to identification of works of art; and to innumerable other areas and in ways not yet conceived. The provincial attitude that a researcher can identify even a major part of the user audience for the information he generates is untenable. To reach its full audience, the information must be made accessible to all.

The Task Force concurs with the widespread opinion that the effective communication of STINFO is an urgent national problem. Because of its large involvement in R&D, the Government has a unique opportunity, as well as a major responsibility, to contribute correspondingly to the solution of this problem. In the framework of national interest, it is essential that STINFO generated with public funds be available not only to the Government community but as widely as possible throughout the nation. This concept of broad national opportunity and responsibility adds to the urgency of achieving and maintaining effective Government communication of STINFO to complement and strengthen privately-supported research, development and communication activities.

Communication is a key element in a number of the positive and negative factors that determine the rate of the exponential growth of science and technology. It is useful to describe some of these factors for concreteness in recognizing the urgency of effective communication:

1. The results of R&D provide the tools for further R&D. The development or improvement of tools not only influences the progress of the research for which they were developed but can exert widespread influence wherever applied. This observation is true whether the new tool is an instrument for more precise measurement, a material with novel properties or a mathematical technique.

2. The results of R&D disclose problems to be solved by further effort. A good piece of research work will, in general, raise numerous questions for every one it answers. The recognition of a problem is a major contribution towards its solution.

3. New information resulting from research can interact in innumerable ways with other information to generate further valuable results. Possibilities for such interactions increase as the body of knowledge increases: To turn these possibilities into achievements, there must be effective communication.

4. As R&D knowledge and manpower increase, the resulting number of possible useful interactions increases even more rapidly. The complexity of communicating the results of R&D to the individual who may benefit from such knowledge increases at a rate far greater than either the amount of information generated or number of individuals to be served.

5. As the body of STINFO grows, it becomes increasingly more difficult to locate the R&D frontiers; new discoveries necessarily take place only at the frontiers. The probability of unwitting duplication of effort increases as the body of knowledge increases.

6. As science and technology grow, they consume a larger share of manpower and other resources. The limitations, both qualitative and quantitative, on the availability of manpower to participate in R&D are so much more critical than the limitations on other resources that the latter are minor in comparison. Limited manpower resources are certainly the major factor in slowing down the rate of growth of science and technology and are likely to be the key factor in bringing to a close the period of exponential growth. Communication profoundly influences the effectiveness of manpower utilization and the productivity of the individual scientist, engineer or administrator. By such influences effective communication can directly increase the potentialities of our limited manpower resources.

Our discussion of the importance of STINFO communication would not be complete if we did not address ourselves to two objections that are frequently raised to proposed improvements of the communication process. These relate to the twin problems of too much information and poor quality of information.

The Problem of Too Much Information

In general, scientists and engineers are finding it difficult to assimilate the information that has already reached their desks. Naturally they question the wisdom of improving the efficiency of the communication system if the only result will be more information that cannot be assimilated. It is true that the ability of the individual or of the project to assimilate new information is limited. This limitation must certainly be considered in planning improved effectiveness or efficiency of communication. Improved communication can ease the user's burden by making the process of search less time-consuming; by decreasing the volume of non-pertinent information delivered in response to inquiry; by providing more derived products of higher quality in lieu of multiple-source documents; by assuring that information is more up to date whether delivered in the formal education process, in the form of derived products, or in professional meetings.

The Problem of Information Quality

The second question usually raised in objection to the increased dissemination of STINFO concerns doubts as to its quality. It is pointed out that bad information may be worse than no information at all. Deterioration in the quality of many STINFO reporting procedures is a consequence of the pace of science and technology that has strained both manpower and schedules. Quality of a report can only be ensured through an adequate review process. In part, this review is the responsibility of the supervisory structure. Very vital additional review is provided by criticism from the scientific community. If the latter is to prove effective, the reports must have adequate dissemination.

The research or technical report, as distinguished from the conventional journal paper, has been both criticized and defended by different elements of the R&D community. Although such reports have been used for many years in industrial

organizations for internal communication they became a major communication tool for general R&D activity during the War when rapid communication between research groups was needed. Informal media of this type which could be subject to close security classification and control were essential to protect sensitive information. It is significant that since the War there has been an increase in the use of these media rather than a decrease. Both classified and unclassified reports continue to be produced and widely circulated. They originate in projects sponsored by both the Government and private industry.

One reason for their continued existence in unclassified areas is their currency. Information can be distributed to both performers and administrators more rapidly in this form than through more formal publications channels. There is an even more significant reason resulting from their value to development efforts; the technical report is a primary recording medium for applied R&D work. It is revealing that most of the criticism of this communication tool comes from the research scientists who are accustomed to the conventional scientific journals; the strongest defense for reports, on the other hand, comes from the technological community for which adequate alternative media are not available. To place the matter further in perspective with respect to the interests of the Federal Government (in connection with which most of the research and technical reports originate), it should be noted that the Federal R&D budget of \$12 billion in 1963 provides for some ten times as much development effort as for basic research.⁽¹⁾ The technical report, whatever its shortcomings, is likely to remain an important element in the technological communication network.

Communication Needs and Responsibilities

For the most part, the STINFO needs of research scientists are better met than those of engineers. The traditional scientific paper has evolved in form to meet the requirements of scientists, who are as interested in how results are reached as in the results themselves. Engineers, on the other hand, need evaluated results, facts or data produced by research effort and prior developments in the state-of-the-art. The engineer must have available the most up-to-date information, whether it be

(1) Federal Funds for Science X, National Science Foundation (NSF 61-82).

found in scientific periodicals, engineering journals, trade literature, handbooks, or informal media such as technical reports or personal consultation.

The traditional division of the body of science into disciplines based on substantive content and the tendency toward specialization have made it easier to satisfy scientists' STINFO needs. This organization of effort and interest has permitted indexing of information in relatively well-defined subject categories. In contrast, engineering efforts cut across traditional scientific disciplines. Engineers are primarily mission oriented; they must be interested in the body of STINFO necessary for the accomplishment of a given task. It should be noted, however, that in recent years research scientists have been losing this advantage of traditional literature organization and retrieval. The interdisciplinary approach is so fruitful in many areas that it has become a very important trend.

This Task Force has not concerned itself with the many factors other than STINFO that enter into the management decision-making process, or with that process itself. We regard STINFO as a valuable tool for R&D management; the more adequate its communication, the greater its value, not only for management but for research scientists and engineers as well.

R&D top management has a responsibility to provide services adequate to satisfy the STINFO needs of all echelons of management and performance. In recent years the need for fulfilling this responsibility has become more urgent. With the great increase of Federal involvement in scientific and technological pursuits and the growing importance of timeliness, traditional media are no longer adequate for the mission-oriented needs of agency programs. Although top management recognizes that STINFO and its communication are necessary to R&D progress, in general they are not aware of the severity of the problem at lower organizational levels.

Science and technology transcend agency mission, responsibilities and organization. Information developed in the programs of one agency is often directly applicable and valuable to progress in programs of other agencies. Progress in Federal programs should not be hampered by difficulties in exchange of STINFO between agencies or separate components of a single agency. Furthermore, to the extent possible, STINFO produced through the

expenditure of public funds should be made available to non-Governmental users. Stimulation of extra-Governmental science and technology through the public availability of this STINFO resource has a beneficial positive feedback to Federal programs.

CHAPTER II: THE APPROACH

The Task Force studied the communication of STINFO within the Federal Government as a system -- a body of rationally connected parts performing mutually interacting and interdependent functions to attain a common purpose. Organizations, people, countries, languages, types of information, types of media, disciplines, processes, elements of time, types of need and use, and numerous other factors are intricately interwoven in the communication system and influence its operation. Dr. Burton W. Adkinson, Head, Office of Science Information Service, National Science Foundation, has emphasized the system approach succinctly:

In the scientific communication system that was good enough for the nineteenth century good enough for the twentieth? We continue to use that system but we haven't reassessed it. ... And this is my plea, to review the total scientific communication system.⁽¹⁾

The term "system" has been widely used in connection with STINFO improvement efforts. Most "systems" thinking in STINFO communication is limited narrowly to a specific communication process, technique or product; e.g., a "system" of indexing, of abstracting, of review publication, of acquisition, and the like. Such connotations are certainly not incorrect, since the total communication system we have in mind is a complex of interrelated component subsystems, functions, activities, operations and processes.

The performance of any one part of a broad system, or a change in its performance, inevitably affects other parts. Improvement of one part of such a system, carried out in isolation, may result in substantive problems, added costs, time losses and similar deficiencies in other parts, which more than offset the immediate, localized gains. Real, as distinct from apparent, improvement of a part of a broad system is attained only if made with reference to the total system.

(1) Better Communication for Better Health. Based on the 1961 National Health Forum; published by the National Health Council, 1962.

The Task Force considers the communication problems in Government R&D programs to be part of the normal phenomena of growth in science and technology. As such, they should not be expected to be temporary and should not be treated by emergency piecemeal measures. In addition to serving its own urgent needs, an effective Federal Government STINFO system will be a major step toward development of effective national and international STINFO communication. The Task Force accordingly concentrated major effort on the functional and organizational aspects of systematic STINFO communication within the Federal Government.

System Elements

Organizational Components

Almost forty Federal Departments and Independent Agencies⁽¹⁾ are involved in STINFO activities. Many thousands of contractors, subcontractors and grantees participate directly in these Federally-supported R&D efforts. In addition to this large number of components which generate and also use STINFO, several Federal and Federally-supported organizations participate as special STINFO processors.

System Purpose

The first essential of system planning is to identify the broad purpose to be served. No statement of purpose has ever been officially promulgated for a proposed or desired communication system for Federally-generated STINFO. Accordingly, the Task Force adopted the following promise of broad purpose as the basis for its further considerations:

In order to advance the programs of the Federal Government, promote the national welfare and foster the progress of mankind, consistent with national requirements for military and economic security, STINFO generated with public funds shall be promptly, economically and systematically made accessible and available to serve the needs of the following:

- (a) the President, the Executive Office of the President, and their affiliates;

(1) See Appendix B for complete listing.

- (b) the Congress, Congressional Committees, and their affiliates;
- (c) the generating agencies, their contractors, subcontractors, grantees and other affiliates;
- (d) other Federal agencies, their contractors, subcontractors, grantees and other affiliates;
- (e) other members of the scientific and technological community, national and international.

The statement of system purpose will need to be amplified by more detailed statements of general objectives and governing principles.

System Functions

As a basis for its assessments of the present situation and recommendations for the future, the Task Force developed the following structure of major operating functions involved in the communication of STINFO. Existing Government STINFO management, organizations, activities, processes, products, services, and the like were related to this structure for analytical and comparative purposes. These analyses revealed deficiencies from a system-wide viewpoint and suggested the course of improvement recommended.

Functional Elements of the STINFO System

A. ORAL COMMUNICATION.

1. Informal Oral Communication (subsystem).

Encompasses normal daily oral communication, on a person-to-person basis, by telephone, etc., concerning any substantive aspects of planned, active and completed research and development work.

2. Communication Related to Formal Meetings (subsystem).

Includes planned group communication, usually in formal technical meetings and scientific symposia,

concerning any substantive aspect of planned, active and completed research and development work.

- a. PRE-MEETING COMMUNICATION: Programming, scheduling, and announcing the planned scope, nature, time(s) and place(s) of the meeting, collecting and distributing abstracts and preprints of meeting papers and facilitating transition from oral to recorded communication.
- b. MEETING COMMUNICATION: Conducting, controlling and, as warranted, recording the communication of information at the meeting.
- c. POST-MEETING COMMUNICATION: Planning, preparing and performing appropriate dissemination of recorded information communicated orally at the meeting.

B. RECORDED COMMUNICATION.

1. Informal Recorded Communication (subsystem).

Encompasses normal, daily, person-to-person exchange and flow of recorded information in personal letters, memoranda, drafts, informal reports, preprints, etc., concerning any substantive aspects of planned, active and completed research and development work.

2. Formal Recorded Communication (subsystem).

Includes planned formal dissemination of information in recorded forms, to facilitate its accessibility and availability to sizeable audiences, concerning any substantive aspects of planned, active and completed research and development work.

a. Production Functions.

- (1) INITIAL RECORDING: Converting knowledge and ideas to a tangible record (e.g., a manuscript, a film, an audio record, a reporting form, etc.) for the production and distribution of multiple copies; and/or for announcement and incorporation into organized, cumulative holdings of research and development information for potential current and future use.

- (2) INITIAL REPRODUCTION: Editing, preparing copy and reproducing, by conventional and non-conventional means, multiple copies of a physical record of information for distribution, for additional system processing and storage, and for retrieval and use.
- (3) INITIAL DISTRIBUTION: Transmitting copies of newly produced records of information:
 - (a) to serve known and anticipated current needs of users;
 - (b) to maintain appropriate stocks and facilitate secondary reproduction of document copies for future needs and requests; and
 - (c) to permit effective announcement, accessibility and availability of information through bibliographic control and services.

b. Bibliographic Control and Service Functions.

- (1) DOCUMENT AND CONTENT IDENTIFICATION: Intellectually analyzing recorded units of information and preparing appropriate title listings, abstracts, indexes, etc., to identify individual documents and their subject content for various purposes, such as current announcement and retrospective search and retrieval.
- (2) IDENTIFICATION STORAGE AND/OR PUBLICATION: Storing units of identification of documents (e.g., titles, numbers, authors, etc.) and of their content (e.g., subject headings, descriptors, etc.) for future centralized search and retrieval in response to ad hoc needs; and/or preparing and publishing compendia of organized units of identification to facilitate decentralized search and retrieval by individual users and using organizations.
- (3) DERIVED AND SPECIAL PRODUCTS: Preparing and issuing:
 - (a) bibliographic summaries of the identified documents accessible and available in selected subject areas;

- (b) compendia of selected, evaluated, identified documents accessible and available in specific subject areas;
- (c) documented reviews and summaries, derived and synthesized from evaluations of selected bodies of information; and
- (d) translations of information and documents accessible and available only in foreign languages.

(4) USER SERVICES: In response to the ad hoc requests of users, providing:

- (a) document copies, including reprints, as required;
- (b) referrals (addresses) to pertinent documents, persons and organizations for the acquisition of needed information; and
- (c) substantive answers to substantive queries.

C. RESEARCH AND DEVELOPMENT.

1. Systems Research and Development (subsystem).

Encompasses systems planning, design and development and systems testing and evaluation, relating to systems of communication.

2. Communication Research and Development (subsystem).

a. Linguistics, semantics, communication theory, etc.

b. Oral Communication:

- (1) user needs, attitudes and behavior, group dynamics; and
- (2) methods and techniques; intellectual, manual and automated.

c. Recorded Communication:

- (1) user needs, attitudes and behavior; and
- (2) methods and techniques, intellectual, manual and automated.

System Management

Effective performance of a complex, multi-component, operating system cannot normally be achieved and maintained without continuing attention and direction. The same is true within the separate organizational components of any such system. For this reason the Task Force appraised carefully the effectiveness with which system functions are being managed, on a Government-wide as well as agency-wide basis.

System Operation

The Task Force found it necessary and advisable to exclude from its assessment of operating functions those involved in informal oral communication and informal recorded communication. While it is recognized that informal communication can be prompt, effective, efficient and vitally important, its informal character precluded any meaningful analyses on a broad basis within the limited time available. Functional operations within the formal communication subsystems were examined separately and collectively, and on a Government-wide and agency-wide basis. Comparisons of functional performance emphasize the importance of operating criteria for promoting optimal compatibility among system components.

System Organization and Development

Finally, and only after determining basic needs for effective STINFO system management and operation, we have considered the organizational aspects of satisfying such needs. It is important to understand that the Task Force has not designed or attempted to design the detailed substantive elements of a Government STINFO communication system. The objectives, governing principles, operating criteria and best solutions of the numerous problems in each identified function of the STINFO system will require collaborative and complementary development effort by all participating agencies in the proposed Government-wide system context. The Task Force has directed its efforts instead toward the creation of a favorable environment and a rational structure of responsibilities and functions, as an essential basis for the many substantive improvements still to be made if Government STINFO communication is to be effective.

Continuing Improvements

The long delay in effecting a concerted attack upon the problems of Government STINFO communication makes it possible

to suggest many ways to achieve better communication without going beyond the current state of the art. It would be folly to permit the accomplishment of such improvements to generate an attitude of complacency that fails to recognize the need for further effort. The situation that has created the problems now confronting us is a dynamic one. The solutions that are suitable today will not long continue to be suitable, nor are they optimum even for meeting current needs. There will continue to be a great opportunity to increase both efficiency and effectiveness of STINFO communication through continuing R&D on the fundamental phenomena of communication, on communication systems, on the needs of management and performers, on the media used to communicate information, on the application of mechanical devices wherever these can assist the processes that make up the communication complex, and on the methods and techniques for carrying on the day-to-day activities of an effective Federal Government STINFO communication system. The large expenditure of resources in the communication process demands appropriate support of R&D efforts to ensure continued effectiveness of that process.

CHAPTER III: STINFO MANAGEMENT

Findings

General Status

Although widely described as both an integral part of and a resource for R&D, STINFO is not commonly managed as such within the Federal Government. Because it is a valuable resource, its communication, accessibility and availability need to be promoted aggressively. Systematic operation of the process cannot be achieved and maintained without systematic management. There are several serious deficiencies in the present situation which simultaneously perpetuate the ambiguous status of communication and preclude its systematic management and operation.

Purpose, Principles, Objectives

If an effective Federal system is to be developed, its elements must be shaped in orderly sequence, with clarity and preciseness. A major void in this respect is the current absence of official statements of purpose, objectives and governing principles to guide the separate and collective efforts of all who participate in the communication of Federally-generated STINFO. Provision must be made at the very beginning of the system development for correcting this serious deficiency. A statement of Government-wide STINFO purpose similar to the Task Force premise stated in Chapter II should be developed and promulgated, and applied in the development of objectives and governing principles of such a system.

Delegations of Government-wide Responsibility and Authority

Title IX of the National Defense Education Act of 1958 directed the National Science Foundation (NSF) to provide or arrange for the provision of helpful information services and to undertake programs to develop new or improved methods. In addition to requiring establishment of an Office of Science Information Service (OSIS) within the Foundation, the Act required establishment of a Science Information Council (SIC) to advise the OSIS. Executive Order 10807, dated March 13, 1959, directed the Foundation to provide "leadership" in the coordination and improvement of Federal Government scientific information activities. The same order directed other Federal agencies "to cooperate" with and assist the Foundation in its Government-wide responsibility.

Of these two mandates, only the Executive Order is directed specifically to the Federal Government communication process. The Legislative Act relates to the national scene. Major emphasis in OSIS has been directed to non-Governmental STINFO activities and organizations. Consistent with its role as a foundation, NSF has concentrated largely on using financial support as the means of stimulating and strengthening non-Government STINFO products, techniques and organizations. Consistent with its primary mission to support basic research, NSF has devoted a large effort to stimulate and support research, study and survey projects relating to STINFO. Consistent with its primary orientation toward science and research, as contrasted with technology and development, the Foundation's efforts have been directed largely toward strengthening the traditional information tools of the research scientists. Numerous benefits relative to improved communication within the general scientific community have accrued from these efforts and the Foundation is to be commended for these contributions.

With respect to Federal STINFO activities, the Foundation has been instructed only to provide "leadership" without any indication of precisely what is meant. As a consequence, a wide variety of interpretations has developed regarding the Foundation's responsibilities in Federal R&D communications. As one of the many Federal agencies supporting R&D, the Foundation cannot reasonably be expected to exercise any forceful direction of other agency STINFO policies and practices. Similarly, the responsibility of other agencies to "cooperate" with NSF's "leadership" is open to diverse interpretations. Generally, other agency executives endorse the theme of cooperation in improving Federal STINFO services so long as cooperation does not require any extensive changes in their own internal, established order, i.e., the organization, policies, practices and support of agency STINFO activities. It is not surprising, in this environment, that many of the middle management officials directly responsible for agency STINFO activities look and hope for a stronger force of pertinent Government-wide responsibility and authority. The Task Force believes that clearer responsibility and authority are imperative to correct the existing situation and to promote aggressively the development of an effective Federal system.

Particular note should be taken of the position of the Bureau of the Budget (BOB) with respect to this communication process. BOB has the same responsibilities and authority regarding adequate organization and resources for R&D communication as it does for other functions and activities of the

Federal Government. In order for the Bureau to carry out its responsibilities, it is necessary that Government-wide guidelines be established for the effective organization of R&D communication in Federal agencies and for its effective identification and financial management. Deficiencies of this type make it difficult for the Bureau, and consequently the President and the Congress, to discharge their normal review and decision responsibilities regarding Federal STINFO activities. It is disturbing, as NSF has discovered, that the actual costs of Federal STINFO activities cannot be determined easily and accurately.⁽¹⁾ We believe that it should be routinely possible to relate STINFO resources to the expanding scope and budgets of the R&D programs to be served.

Delegations of Agency-wide Responsibility and Authority

Three major research and development agencies, the Atomic Energy Commission (AEC), the Department of Agriculture (USDA) and the National Aeronautics and Space Administration (NASA), have been specifically directed by Congressional statutes to disseminate to the public information generated by their respective R&D efforts, as well as related information in their respective fields generated by non-Governmental sources. In each of these agencies there is a relatively high degree of agency-wide direction and control of STINFO activities. We are fully aware that significant differences exist among these agencies in STINFO organization, policies, practices and support. Although we recognize that the communication process in each of these agencies is not perfect, it is significant that where such responsibilities for STINFO dissemination have been assigned, the process enjoys a stronger status among the agencies' missions and activities and a general environment more conducive to its effective performance.

In other agencies, the Department of Defense (DOD) being a notable example, the responsibilities associated with communicating STINFO are matters of internal administrative discretion. The status and scope of activities vary widely among these agencies. In general, however, there is little or no agency-wide planning and direction. Agency top management tends to underestimate the importance, full scope and effective organization of the process. STINFO responsibilities are widely decentralized and serious gaps exist in the operations performed.

(1) Federal Funds for Science X. (Part II. Federal Funds for Scientific and Technical Information) National Science Foundation (NSF 61-82).

Planning and allocation of STINFO resources is generally inadequate, the utilization of such resources is not adequately monitored, and few, if any, agency-wide policies and principles have been established as guides. Agency components develop independently their local operating standards, which bear only a chance relationship to practices in other components and frequently impede progress toward a compatible agency-wide or Government-wide system. The Task Force believes that the chief cause of these undesirable conditions is the absence of specific responsibility, assigned to each agency by higher authority, for effective communication of STINFO.

Recommendations

1. There should be promulgated to the Departments and Independent Agencies of the Federal Government an official statement of the President which gives formal, high-level recognition to the urgent and important character of STINFO communication in relation to Federally-supported R&D programs and which announces the official common purpose of such Federal STINFO activities.
2. There should be established within the structure of the Executive Branch of the Government an organizational focal point of responsibility for the Government-wide direction and review of Federal Government programs and activities for the communication of scientific and technological information:
 - a. To define and announce the major objectives of Federal STINFO activities, as well as the fundamental principles which govern all agencies concerned in the attainment of these common objectives and purpose;
 - b. To plan, develop and guide the implementation of an effective Government-wide STINFO communication system in close collaboration with all participating agencies;
 - c. To plan, develop and guide the application of Government-wide operating criteria which ensure optimal degrees of uniformity and compatibility for the effective functioning of a Federal Government STINFO system;

- d. In close collaboration with the Bureau of the Budget, to plan, develop and guide the implementation of effective organization of STINFO activities in appropriate Federal agencies and of effective financial management of these activities;
 - e. To review continuously the compliance of Federal agencies with official Government-wide purpose, objectives, governing principles, system requirements, operating criteria, organizational requirements and financial management requirements; and,
 - f. To provide for appropriate systems research, engineering and development in order to improve the R&D communication system and maintain it in an optimal state of effectiveness.
3. Each R&D agency of the Federal Government should be directed to establish internally an appropriate, formal organizational focus of responsibility and authority for agency-wide direction and control of STINFO activities:
- a. To plan and implement appropriate internal organization of STINFO activities and related delegations of responsibility and authority;
 - b. To plan and allocate appropriate resources for STINFO activities and monitor their utilization; and,
 - c. To plan and implement, in compliance with the objectives and criteria of a Government-wide operating system, coordinated policies, programs, operations and procedures for STINFO activities.

CHAPTER IV: STINFO OPERATIONS IN R&D AGENCIES

Findings

Communication Related to Formal Meetings

Formal meetings of sizeable audiences are continually being planned and conducted by components of Federal R&D agencies, their contractors and grantees. The annual cost of all such meetings is huge. Participation by individual scientists and engineers is estimated to total several million man-hours each year. The objective of these large expenditures is to communicate information relevant to Federally-supported R&D. With rare exceptions, such meetings are not coordinated with agency information activities or with other meetings. Under the circumstances, undesirable duplication and overlapping of meetings are unavoidable and conflicts in schedules occur which preclude optimal attendance and participation.

Without pertinent guidelines and coordination, effective means are not available for assuring the most profitable attendance. Cost/benefit ratios of many meetings are believed to be unduly high because the responsibility for planning and conducting such meetings is undertaken without appropriate criteria and guidance for attaining optimal communication in a Government-wide system. Because inadequate effort is made to coordinate and systematize communication practices and processes related to such formal meetings, much valuable information is not accessible and available to those who need it within and outside the Government. Few studies of this function and its activities have been carried out.

Initial Recording Function

No uniform requirements, policies or practices for recording information about planned or active units of current R&D or for reporting results of active and completed work exist among agencies. "Recording" does not necessarily imply initial reproduction and distribution of multiple copies. The Task Force believes, however, that information on positive or negative results generated at public expense should at least be documented and stored in organized collections for availability and use, if and when needed.

Criteria are urgently needed regarding value or potential value of information to guide decisions about recording, reproducing, distributing and other processing functions. "Promptness"

needs to be defined in terms of specific time criteria for each and all functions of the communication process, starting with the initial recording function. Uniform criteria must be developed and applied for new and specialized recording media (e.g., audio-visual media) if they are to be systematically accessible and available for utilization by Governmental and non-Governmental users.

Wide variations exist among agencies in the general philosophy, requirements and practices of author abstracting and author indexing as parts of the initial recording function. As a result, one agency's record cannot be easily exchanged and used by another agency without expensive and time-consuming processing or reprocessing. It is gratifying to report the start of efforts to correct this situation. The Air Force now requires authors to assign keywords or descriptors to their recorded documents. The Armed Services Technical Information Agency (ASTIA) is developing an improved thesaurus of descriptors with the close cooperation and assistance of numerous agencies and various non-Governmental organizations. NSF has stimulated creation of an interagency committee to explore the feasibility of compatible interagency indexing, which should facilitate a higher degree of indexing at the source.

Few agencies exercise sustained effort, individually or collectively, in the initial recording function to promote the dissemination of unclassified, unlimited information by preventing the insertion of unnecessary fragments of restricted information. Uniform attention to this aspect of recording would not only speed the dissemination of useful information but would reduce the present costs of subsequent review and deletions required to "sanitize" them.

It is believed that new forms of arranging and presenting recorded information could be developed which would not only enhance reader understanding but would anticipate and facilitate the subsequent identification, storage, retrieval and use of information content.

Initial Reproduction Function

There are no Government-wide criteria and only few instances of agency-wide criteria governing the physical format, graphic quality, promptness, types of documents, coding and numbering of documents reproduced by agencies in multiple copies. Poor graphic quality of initial reproduction frequently precludes secondary

reproduction and distribution, or adds to the difficulty and cost of such reproduction. Slow initial reproduction adds to the ultimate delay in communication and use. Diverse and uncoordinated document formats, types, codes and serial numbers prevent fast and simple identification, location, use and bibliographic processing. Government R&D reports are commonly classed as non-conventional (i.e., unacceptable) scientific publications because of the problems of this type which they raise. NSF is supporting a preliminary study of the particular problems associated with current coding and numbering practices.

The absence of systematic coordination among R&D agencies precludes optimal initial reproduction, distribution and use. Some agencies, such as the AEC, attempt regularly in the production process to anticipate all current needs for documents so that optimal press runs can be made during initial reproduction for users, stockpiles and other purposes. In most agencies, DOD being a specific example, no such coordination of agency-wide or Government-wide needs is attempted regularly. By improved coordination at this stage in the production process, DOD could appreciably speed up initial dissemination of information and significantly reduce the workload at ASTIA for secondary reproduction and distribution of single document copies. Initial reproduction and distribution need to be kept under effective, continuing control to make sure at the same time that excessive quantities are not automatically produced and that scientists and engineers are not automatically burdened with irrelevant materials. NSF is supporting a study which will include an examination of agency economy versus Government-wide economy in this situation and will attempt to determine an optimal balance between initial reproduction and distribution and secondary reproduction and distribution.

Essentially all R&D agencies support and encourage authors to publish in conventional scientific and engineering journals. This is a desirable and commendable policy. A Government-wide policy, sponsored by the NSF, was established in 1961 which authorizes Government agencies to pay journal page costs and abstracting charges. However, the Task Force does not share the frequently expressed view that Federally-generated STINFO which is not published in conventional journals is worthless. Because journals are faced with limitations on their physical capabilities to publish, rejection or acceptance by journal editors is not a wholly reliable measure of information value.

In fact, journal publication is sometimes so delayed as to warrant dissemination by the agency in report form where timeliness of the information is sufficiently important.

The AEC is apparently the only major R&D agency which on an agency-wide basis regularly follows up on each paper submitted for journal publication, cites its journal availability if published, reappraises its substantive merit if rejected or if not published within a reasonable time period, and undertakes appropriate reproduction and distribution. By contrast, the Public Health Service (PHS) of the Department of Health, Education and Welfare (HEW) and NSF rely wholly on conventional publications for the dissemination of information generated in the activities they support. Many chance factors influence the results and effectiveness of such a policy, including the investigator's decisions and actions about preparing and submitting a paper on his work as well as the judgments and limitations of the journals themselves. No supplemental methods are used in these agencies to ensure accessibility and availability if information generated under their sponsorship is not published in conventional journals.

Initial Distribution Function

Initial distribution is centrally controlled in some agencies (e.g., AEC) and highly decentralized in others (e.g., DOD). In general, it is primarily directed to an agency's own components and official affiliates, with differing degrees of attention to the possible current needs of other agencies and non-Governmental users. In the centralized situation, standard distribution lists which consolidate user statements of need are used as the basis for initial distribution by the generating organizations. In others, individual document distribution lists are compiled by the generating organizations on the basis of content and their own knowledge or estimates of users' needs. There can be no prompt and effective dissemination of newly produced information among Government agencies when agency practices are so dissimilar and uncoordinated.

Dissemination to both Governmental and non-Governmental users is also impeded by other variations and deficiencies in agency initial distribution practices. Of particular importance among the users are the discipline-oriented bibliographic services (e.g., Chemical Abstracts, Biological Abstracts, etc.) and the growing number of specialized information services which need prompt accessibility to and availability of pertinent

Government documents in order to provide the scope of services expected of them. No uniform criteria of quantity and time govern the stockpiling of document copies for sale, exchange, loan, secondary distribution and the like. The production, feasibility and compatibility of microforms and other types of document copy are not normally appraised and coordinated on an agency-wide or Government-wide basis. In these respects, promptness and effectiveness of agency-wide and Government-wide communication appear to be unwisely subordinated to local policies.

Several agencies maintain their own networks of regional document depositories, which vary widely in their effectiveness, size and geographical scope. It is largely fortuitous if two or more agencies happen to use the same depository in the same city. Users are thus faced with many different points of access in different locations and need to know which agency's information they are seeking, in order to utilize the depositories economically and effectively. To correct this weakness, NSF is coordinating the development of a network of twelve regional depositories of unclassified, unlimited U. S. Government R&D reports, under the operating direction of the Office of Technical Services (OTS), Department of Commerce. The network will initially receive AEC, DOD and NASA reports but cannot be considered a fully satisfactory solution to the problem of regional accessibility and availability until all R&D agencies are participating.

Inadequate initial distribution significantly delays the communication of scientific and technological information. Further, it adds to the users' burdens and costs in learning of and locating information as well as in requesting and obtaining it. Security and other restrictions on the distribution and flow of information are discussed in Chapter VIII, but a brief statement here is appropriate. Whenever accessibility and availability are limited because criteria for restriction are erroneously interpreted and applied, the adverse impact on R&D progress and the national welfare is certainly serious. Where such restrictions are warranted, it is equally serious if accessibility and availability cannot be systematically assured to those who need and are authorized to receive such information.

Document and Content Identification Function

Agency bibliographic functions often cover a much larger scope of STINFO than that which is generated by the agency's own

R&D programs. For example, AEC, USDA, and NASA cover large amounts of the world's published literature in their respective fields. In effect, each such agency is developing and maintaining a national collection or library in its mission-oriented area.

The National Library of Medicine (NLM) of PHS performs similar bibliographic control and announcement of published literature in its field. However, PHS does not control bibliographically the knowledge generated under its sponsorship which is not published in the recognized periodicals.

ASTIA exercises bibliographic control activities on DOD-generated documents and information. In view of the breadth and nature of DOD subject matter, it is understandable why ASTIA does not similarly place selected published literature under bibliographic control. The problem in DOD is simply that ASTIA receives only limited portions of DOD-generated information, estimated by two commanders of ASTIA to represent between 10-40% of the DOD total. This situation results from deficiencies in agency-wide direction and control of the DOD communication process and in the production functions of that process. Apart from any consideration of the quality of ASTIA service, the ineffectiveness of the DOD communication process precludes an effective system for identifying all DOD documents and their contents.

It is significant from a Government-wide system viewpoint that all Government-generated scientific and technological documents and their content are not uniformly placed under bibliographic control to facilitate their announcement, accessibility and availability. Even more significant is the fact that users, within and outside the Government, cannot know what Government information is or is not under bibliographic control. Under these circumstances the results of search will always be of questionable reliability.

For bibliographic analysis and control purposes, most R&D agencies attempt to collect all of their own internally generated documents and acquire pertinent documents from other agencies and relevant portions of the world literature. Agencies perform their acquisition activities simultaneously and independently, scanning large volumes of the same literature to locate and select relevant items. Specialized information services and centers similarly search independently for their specific document and bibliographic control needs. There is probably no aspect of the communication functions where duplication of effort is so

extensive and susceptible to significant improvement in the environment of a coordinated system.

Adequate information about documents and their content involves a broad spectrum of related analyses for different purposes. If announcement of newly produced documents is the objective, time is a more urgent factor than is normally reflected in agency announcement practices. Announcement of documents reporting the progress or results of active or recently completed work is all too frequently delayed for periods of several months. New meaning must be attached to the significance of time if awareness of new information is in fact to be "current."

As the analysis of information content becomes progressively deeper and more exhaustive, for retrospective search and retrieval, the urgency of the time factor declines proportionately. A single published bibliographic tool and a single level of content analysis cannot adequately serve both the requirements of prompt announcement and those for retrospective search and retrieval. Most of the R&D agencies, however, produce and rely wholly on one major unclassified bibliographic tool to serve a wide range of identification needs and purposes. Examples are ASTIA's Technical Abstract Bulletin, AEC's Nuclear Science Abstracts, Agriculture's Bibliography of Agriculture and NLM's Index Medicus. These tools vary considerably in their content and usefulness. In some, the degree of analysis is more strongly oriented toward announcement as a current awareness service, at the expense of effective deep analysis for retrospective search and retrieval. In others, the opposite situation pertains. From this viewpoint, none of the agency analysis and identification programs is fully effective for either of the broad purposes to be served.

Because centralized agency bibliographic services cannot generally provide adequate depth of content analysis, specialized centers and services which focus on narrowly prescribed subject areas and attempt to cover them exhaustively are growing in number.⁽¹⁾ Federally-supported centers of this type are not normally integrated within the agency's information program and their activities are, therefore, not operationally coordinated and compatible with existing centralized activities. In effect, they exist and function as completely independent operating entities.

(1) Specialized Science Information Services in the United States. National Science Foundation, November 1961. (NSF 61-68)

Some of them have contributed significantly to the communication process by developing effective means for utilization of expert judgments and helpful participation of bench scientists and engineers in acquisition, analysis, identification, storage and service operations. The full potentialities of Federally-supported specialized information services will be realized only when they become full-fledged components of a well designed and operated Federal communication system.

No Government-wide criteria exist regarding the appropriate level of content analysis and identification of units of current R&D effort, planned or active. Compatibility of identification is, of course, essential for development and maintenance of an effective current effort index within each R&D agency. It is also of critical importance to facilitate fast and economical correlation of separate agency input to a Government-wide current effort index, such as the Science Information Exchange (SIE) of the Smithsonian Institution, and to ensure optimal utility of its services to R&D management.

In some agencies, greater emphasis is given in information processing to the allocation of resources for abstracting information (i.e., condensing document content) as contrasted with its indexing (i.e., preparing ordered unit entries to the content). Others do no abstracting but provide varying types and degrees of ordered entry. In view of the differing needs of engineers and scientists, objective reappraisals of the relative importance and appropriate future roles of abstracting and indexing are needed. Generally, abstracts are classed as browsing tools to serve current awareness needs. In retrospective search they are used to scan and screen material to identify items specifically needed in full. Informative abstracts sometimes serve also in lieu of the full-length document to which they relate. Indexes, on the other hand, are tools for either current or retrospective searches for addresses of (i.e., referrals to) information or the information itself. Certain newly developed techniques attempt, with varying degrees of success, to organize the analysis of document content so as to provide simultaneously the ordered entry feature of indexes and the "browseability" feature of abstracts. Abstracting and indexing of documents and their content are not performed with Government-wide uniformity or compatibility of purpose and practice. As a result, users are faced with a confusing variety of analytical and organizing philosophies and of bibliographic products which cannot be used together.

Bibliographic Tools

Most R&D agencies maintain some form of master collection in which are stored organized units of identification of their documents and the document content. However, the breadth and depth of such collections are not widely known nor are the collections coordinated in any planned, over-all scheme. Consequently, the aggregate reference and information service capabilities of the Government agencies cannot be exploited by Governmental and non-Governmental users.

Coordinated planning, control and operation are the primary considerations regarding such collections in the context of developing an effective Government communication system. Also of interest is the entire matter of automated storage and retrieval of Government STINFO. As mechanized techniques are applied, it is essential that these too be compatible so that the individual agency collections can continue to function as component parts of an operating system, once that system has been developed. Mechanized storage and retrieval techniques have already been instituted in DOD's ASTIA collection and are being planned in other R&D agencies. Through an NSF-sponsored interagency group, efforts are under way to coordinate such planning among the agencies in order to foster compatibility of their mechanized techniques. The danger in the current situation is that attention will be so strongly focused on automation that the primary problem of achieving compatibility in the scope and use of agency collections will be neglected.

A multiplicity of announcement publications is issued by Government R&D agencies reporting new documents which they have added to the literature. These publications are not sufficiently prompt. Despite their large number, their coverage is not complete and there is considerable overlap among them. Users cannot turn to a single publication for a current record of newly produced Government scientific and technological reports.

Most agencies publish bibliographic periodicals announcing and describing additions to their master collections, and cumulate them at varying intervals. The basic purpose of such compendia is to permit users to conduct their own searches. These published versions of the master collections reflect the deficiencies of the collections.

Derived and Special Products Function

Some agencies direct continuing attention to the preparation of derived products -- technical reviews, state-of-art summaries, selected bibliographies and similar special publications. In general, these involve the evaluation and condensation of source materials and often result in a synthesis of new information. AEC, for example, prepares a series of quarterly Technical Reviews, each devoted to a currently important specialized subject. DOD's Defense Metals Information Center (DMIC) at the Battelle Memorial Institute (BMI) produces numerous state-of-art summaries in special subjects. These are prepared through the part-time effort of BMI scientists and engineers when warranted by the volume of information generated and accumulated in the subject area or by user needs. NASA has developed plans for a comprehensive program of such derived products.

No agency has yet developed and implemented an adequate program of derived products for the varying and special needs of R&D performers and management. The importance of continuing, high-quality, technical evaluations becomes greater as the volume of information and documents expands and the time between discovery and desired application decreases. A planned and coordinated process of continuing review, evaluation and summarization of mounting volumes of information is essential if significant reductions are to be effected in the numbers of documents which individual users must review and evaluate.

If the present lack of derived products continues, the adverse effect on R&D programs will increase sharply. On the one hand, Federal R&D programs can ill afford the costs and delays associated with countless duplicate reviews and evaluations of the same bodies of literature by individual users, particularly in technological development. On the other hand, more critical evaluations must be prepared and made available, if the quality of individual professional performance and skills is to be maintained.

R&D management in particular will require increasing numbers of evaluations and reviews. Many of these will involve the correlation of a variety of special circumstances, facts and ideas at a particular point in time and in relation to a specific problem. Ad hoc syntheses of this type can be developed promptly and economically for management if they can be based on evaluations completed as part of a regular program of derived products. Otherwise, management decisions will be

seriously impeded because of the constant need to refer to multitudes of source documents for significant information germane to the problem at hand.

Some agencies do not prepare evaluated and derived products. As substitutes, they may prepare on-demand bibliographies of the documents in their collection on a particular subject. If the user needs and is prepared to cope with such unevaluated, comprehensive bibliographies, they obviously serve a purpose. There is reason to believe, however, that the usefulness of such listings is declining as they tend to increase in size.

Brief mention should be made of translations as a form of special information product. More progress has been made in coordinating and improving the accessibility and availability of translations than of evaluated, derived products. Although several major problems remain unsolved with regard to translation policies and procedures, at least a good start has apparently been made in coordinating their announcement, accessibility and availability through the facilities of OIS and the John Crerar Library.

User Services Function

The promptness and effectiveness with which user requests for document copy services are met is wholly dependent on the particular agency involved. All aspects of copy availability on request have evolved without reference to any concept of a Government-wide system. The user, depending on his needs, must deal with many separate organizations of the Government with different capabilities, policies and practices.

Numerous informal arrangements exist among Government libraries and information activities for mutual assistance in providing referral and answering services. There is no Government-wide coordination of these services to ensure prompt, comprehensive and high quality responses to requestors. The Federal Government's many national collections represent a major resource that cannot be fully exploited to serve both Governmental and non-Governmental users. There is no single, simple channel or mechanism by which a user could obtain a coordinated search of any combination of individual collections. Such coordinated searches of mission-oriented collections will become increasingly necessary to assure high quality service for discipline-oriented needs. Only by systematic coordination of search and retrieval services of agency collections can both

mission-oriented and discipline-oriented searches be efficiently accommodated.

Communication Research and STINFO System Development

NSF has encouraged and supported a variety of studies in such fields as mechanical translation, linguistics, semantics, storage and retrieval, and user attitudes and behavior. These have improved understanding of many fundamental aspects of the communication of information. The Foundation has also sponsored studies and surveys of information activities in foreign countries as well as in the United States, covering scientific journals, abstracting and indexing services, specialized information services, and the like. Support has also been provided to scientific societies to undertake communication studies and to plan improvements within their respective disciplines. However, no continuing attention has been directed to the system aspects of STINFO communication, for the Federal Government or nationally.

Recommendations

1. In collaboration with its agency counterparts, the recommended focal point for Government-wide direction and review should develop and announce a logical structure of defined functions which will guide all activities involved in the management and operation of the Federal Government's STINFO system.
2. Government- and agency-wide focal points of responsibility, in close cooperation, should also develop and guide the application of realistic criteria to govern the functional operations of the communication process; included should be criteria for:
 - a. guiding decisions about appropriate STINFO processing consistent with the present and potential value of the information;
 - b. the qualitative and quantitative aspects of information processing, products, techniques and services;
 - c. time schedules required for each function and activity of the communication process;
 - d. the coordination of subject coverage in agency STINFO activities;

- e. the optimal compatibility and coordination of agency processing, techniques, products and services;
- f. the financial aspects of information processing, techniques, products and services; and,
- g. the coordination of communication R&D among agencies.

CHAPTER V: GOVERNMENT-WIDE CLEARINGHOUSE SERVICES

In addition to agency STINFO activities which are directed toward their own mission-oriented needs, several STINFO processing organizations exist which are intended to serve as Government-wide clearinghouses. The Science Information Exchange deals with information on planned and current research effort. The Office of Technical Services of the Department of Commerce, and the Superintendent of Documents of the Government Printing Office announce and distribute STINFO documents. The Science and Technology Division of the Library of Congress, and other agency libraries, provide STINFO reference services. Because of the importance of the clearinghouse function to the Government's STINFO system, our examination of these activities is discussed in detail.

Findings

Indexing Current R&D Efforts

The Science Information Exchange is administered and operated as a special project of the Smithsonian Institution. The present organization is the outgrowth of activities which have been in operation for approximately 20 years in the biomedical field. The Exchange is cooperatively supported by AEC, DOD, NASA, NSF, PHS, Federal Aviation Agency (FAA), and the Veterans Administration (VA) on a voluntary basis. Its primary mission is to collect, correlate and disseminate data and information on current research efforts, as an aid to research management. As a by-product of this service to facilitate personal communication between scientists sharing common or related interests, the Exchange informs research investigators where and by whom specified work is being done.

The Exchange assumed its present scope and name in September 1960 as an enlarged version of the former Bio-Sciences Information Exchange (BSIE). Its subject scope includes the mathematical, physical, engineering and social sciences as well as the biological sciences. Progress toward implementing these expanded responsibilities has been slow and generally discouraging.

SIE enjoys no formal organizational status within the structure of the Federal Government. Its financial support,

provided voluntarily by individual components of the supporting agencies, is in frequent jeopardy, being largely dependent upon the interest of agency representatives and their ability to obtain allocations from their agency funds. SIE policies and long-range goals are set by a Governing Board of agency representatives in which each supporting agency has one vote. Although the Governing Board concept has helped to maintain agency interest and to stimulate the contribution of agency funds, the Task Force believes these advantages are minor compared to the attendant disadvantages. Much of the slow progress of the past year and a half is attributed to the absence of centralized responsibility for SIE policies and programs. The Director of SIE is responsible for its operations, but cannot be expected to expand and improve those operations effectively unless a vigorous and dynamic leadership exists with respect to SIE policies and resources. Such leadership has not been provided by the Governing Board and can hardly be expected where responsibility is so diluted among the supporting agencies and their representatives. The agencies involved have made limited efforts to strengthen SIE, but without notable success.

During the past two years the concept of indexing current R&D work has received increased attention. The Subcommittee on Reorganization and International Organizations of the Senate Committee on Government Operations issued two Committee Prints in 1961 on the subject.⁽¹⁾

Among Government scientists and engineers there is no clear agreement as to the merits of such an information service. Many physical scientists reflect various reservations about their need for such service in the management and performance of their programs. At the same time, they seem to sense potential value in this type of service, if performed effectively, because they are becoming more aware of and concerned with the mounting difficulties of effective management of complex, expanding R&D programs with multiple interagency relationships.

(1) Coordination of Information on Current Scientific Research and Development Supported by the United States Government. Senate Report No. 263, April 17, 1961.
Coordination of Information on Current Federal Research and Development Projects in the Field of Electronics. September 20, 1961.

Biological scientists, on the other hand, have had many years of experience with this type of current effort index through the BSIE and its predecessors. Large numbers of them have been pleased with the past services, despite many limitations in those services.

The Task Force believes that such a service has great potential merit for Federal, as well as national, R&D efforts. The full potentialities of the concept cannot be either appraised or realized until such a facility is organized, administered and operated on a more adequate basis than has been the case to date. All R&D agencies must participate by contributing records of their internal efforts before there can be a fully effective Government-wide clearinghouse on current R&D work.

The scope and nature of SIE operations require extensive revision and improvement. While SIE accepts input on development efforts when voluntarily registered, its present scope is officially limited by its charter to research tasks. This limitation should be removed. The volume of material being received and processed on physical sciences tasks is negligible as compared to the total of such efforts. Coverage of the physical sciences must be expanded at a greatly accelerated rate.

The effort devoted by SIE to recording the frequent changes that are made in proposals is disproportionate to the benefits derived. The objective of SIE service on proposals should be to facilitate contact between inquirers and granting offices. For this purpose specific details are not required.

On the other hand, details concerning approved, active work are much less susceptible to frequent change. As distinguished from the referral service suggested for proposals, SIE should continue to provide an answering service regarding active work. SIE operations would also be simplified and correspondingly more acceptable to agencies if data on support funds reflected orders of magnitude rather than precise budgeted amounts.

SIE does not now maintain records of documents stemming from current R&D efforts. The Task Force believes that coupling these types of information would improve the clearinghouse service.

Published listings covering short periods of time and published promptly would help to reduce the volume of inquiries

for ad hoc search and service. The Exchange should develop a capability for providing such periodic listings as a natural byproduct of its normal activities.

Perhaps the most important capability of SIE is the accumulation and correlation of data and information on other than work tasks and related fund utilization. There are four broad categories of resources of continuing importance to all levels of R&D management. At each such level and to varying degrees, the relationships and changes in relationship of these resources are woven into the fiber of management problems and decisions. These resource categories are: (1) funds; (2) organizations and manpower; (3) facilities and equipment; and, (4) information on the scope, progress and results of R&D work. SIE should cover comprehensively all four categories in connection with current Government-supported R&D.

Finally, there is the matter of correlating Governmental and non-Governmental current efforts. Some of the private health foundations now participate in the SIE and are served by it, with certain limitations on the availability of Government data registered. There have been definite advantages associated with this participation and no serious disadvantages. It seems natural and desirable to the Task Force that a current effort service should, within the framework of voluntary participation, become national in scope rather than merely a Federal Government service.

Current R&D Documents

Public Law 776, 81st Congress, directed the Secretary of Commerce to establish and maintain "a clearinghouse for the collection and dissemination of scientific, technical and engineering information." The declared purpose of the Act was "to make the results of technological research and development more readily available to industry and business, and to the general public..." The scope of assigned responsibility covered all necessary communication processing of information from domestic and foreign sources to make it available to State and local governments and other Federal agencies, as well as American industry, business and the public. It is quite obvious in comparing these responsibilities with those assigned to NSF in Title IX, NDEA 1958, that conflicts of interpretation and understanding might easily and reasonably develop between the two agencies concerned as well as other parties involved or affected. As a matter of fact, such conflicts have arisen and need to be

resolved by appropriate clarification of the relevant legislation.

In contrast to the broad national clearinghouse envisioned in P.L. 776, the Office of Technical Services has developed over a period of twelve years a much narrower and more limited public image. OTS has functioned and is thought of as a sales agency for AEC unclassified reports and that part of DOD's unclassified, unlimited report literature which is available to ASTIA. Not only has the input to OTS from Government R&D agencies been limited largely to DOD and AEC literature, but input apparently visualized in P.L. 776 to come from non-Governmental sources has been practically non-existent, with the notable exception of large volumes of captured German documents acquired by OTS after World War II.

Public Law 776 provides that:

It is the policy of this Act, to the fullest extent feasible and consistent with the objectives of this Act, that each of the services and functions provided herein shall be self-sustaining or self-liquidating and that the general public shall not bear the cost of publications and other services which are for the special use and benefit of private groups and individuals; ...

These provisions of the Act have apparently influenced the limitations of funds allocated to OTS. The resources provided to OTS over the years could not support an effective clearinghouse effort of the type intended by the Congress.

In connection with the recently announced network of regional depositories for Federal Government R&D reports, OTS should develop its publication, U. S. Government Research Reports, into a comprehensive announcement medium of all unclassified and unlimited Government STINFO documents. NSF and OTS are now considering a permuted title index of reports in anticipation of broader OTS announcement services.

P. L. 776 assigns Commerce responsibility for positive action to secure removal of restrictions on the dissemination of STINFO, whenever national security considerations permit the release of such information for the benefit of industry and business. While OTS carries on a limited effort in this

regard, in response to specific requests from its clientele, it has not attempted to stimulate and coordinate declassification review programs among the agencies to anticipate and serve user needs.

The Office of the Superintendent of Documents is a part of the Government Printing Office, an agency of the Legislative Branch. It is responsible for cataloging, announcing, distributing and selling documents of all types which are printed under the aegis of the GPO and bear the Government imprint. Its Monthly Catalog lists those R&D documents that have been printed through GPO channels. These documents are made available through its large network of almost 600 depository libraries. The Superintendent of Documents and the Office of Technical Services have recently worked out a mutually acceptable arrangement which will improve the announcement of Government R&D documents. By this arrangement the Superintendent of Documents will continue to announce and handle Government imprints regardless of subject matter and OTS will concentrate on announcing Government R&D documents regardless of where printed.

Retrospective STINFO Search and Retrieval Services

The Library of Congress is the largest library in the world and is organized basically along functional lines to acquire, process and provide service relating to the millions of items added yearly to its collections. Although the Science and Technology Division is established on a subject basis, relevant accessions are processed according to routine LC policies and procedures. A major part of the input to LC results from the requirements of the Copyright Law (i.e., depositing two copies of each document with the Register of Copyrights), LC's status as a depository of the Superintendent of Documents, and its many foreign exchange agreements.

Within the broad scope of the Library's responsibility and interest, all fields of knowledge -- music, art, history, science, etc. -- are of essentially equivalent importance. If different degrees of importance do exist and affect priorities of processing, these are likely to result from the relative interest and demands of the thousands of libraries which rely on LC for catalog cards and other service. To many of these libraries, a book on Howdy Doody is more important than a document concerning astrophysics, because of the demands of their individual users. Processing within LC must naturally be responsive to such differences in demand.

The Science and Technology Division, because it is a part of LC, has access to the broadest collection of scientific and technological journals, books and related forms of material in the United States. In this particular respect it represents a highly important resource for Federal and national R&D efforts. Because of these unique information resources, the Division performs a large number of special services, surveys, continuing subject bibliographies and other projects for various agencies of the Government as well as private organization. These special tasks are supported by funds from the client agencies and organizations and involve the major part of the Division's work and staff.

No clear and formal delineation of subject coverage and responsibility exists between LC and the National Libraries of Medicine and of Agriculture. Informal understandings have been developed to control duplication of effort and to provide mutual assistance in their services. However, there is no planned, formal relationship by which these three national libraries and the various agencies maintaining national collections in their mission-oriented fields are coordinated in an operating network that ensures optimal compatibility of coverage and processing, full utilization of aggregate information resources and Government-wide service to Federal agencies and the public at large.

Great quantities of R&D knowledge, publicly and privately generated, are under bibliographic control in the separate collections of many Government agencies. No facility exists anywhere which is cognizant in sufficient detail of the scope and retrieval capabilities of each agency and of the aggregate, and is thus in a position to coordinate services and searches involving one or more of these collections.

So long as it remains a component of the Legislative Branch, the Division of Science and Technology of LC cannot be effectively integrated into a Federal STINFO system in the Executive Branch. In our opinion, the wealth of STINFO contained within the LC collection constitutes a unique and natural basis for retrospective clearinghouse service and its exploitation is essential to the Federal STINFO system.

Specialized Information Services and Centers

Closely related to the need for coordinating retrospective search and retrieval services is the need for improved coordination of the growing number of specialized information services

and centers in science and technology. Many of these specialized centers correlate current effort information and provide current document services as well as retrospective search and retrieval service in their highly specialized operations. The NSF has announced its intent to provide a national advisory service in this area but is limited in its capacity to keep current with the proliferation of these centers. NSF is not staffed to coordinate responses to individual requests for specialized STINFO.

Information Related to Formal Meetings

No Government-wide or national clearinghouse service exists to coordinate and disseminate information related to formal scientific and technical meetings concerning R&D matters. Findings related to this aspect of the communication system, as discussed in Chapter IV, suggest that such a service is needed and would be very beneficial.

Recommendations

1. There should be established within the structure of the Executive Branch a Government-wide clearinghouse capability for information regarding currently planned and active research and development efforts.
 - a. All Federal agencies supporting R&D should be directed to: (1) maintain comprehensive, up-to-date indexes of their own current R&D efforts; and (2) provide prompt and appropriate information about those efforts to the clearinghouse for correlation and authorized dissemination.
 - b. The information reported and correlated on each unit of current effort registered should cover supporting funds, organizations and manpower, facilities and equipment, and the scope, progress and results of planned and active work.
 - c. All types and categories of current work should be registered with the clearinghouse. When limitations on dissemination of information pertain, suitable controls should be exercised on the output services.
 - d. The clearinghouse should stimulate widespread and voluntary participation, registration and use of

the service by non-Governmental organizations supporting research and development.

2. There should be established within the structure of the Executive Branch a Government-wide clearinghouse capability for documents reporting the results of research and development work supported by the Federal Government.
 - a. To announce promptly and by appropriate means all such newly produced documents for both Government and non-Government uses.
 - b. To develop, maintain and administer a coordinated network of regional depositories of all such documents, providing optimal accessibility and availability of such information to all interested users, subject to the requirements of national security and other valid restrictions.
 - c. To provide, arrange for the provision of and/or coordinate document copy services related to all titles announced, accessible and available.
3. There should be established in the structure of the Executive Branch a Government-wide clearinghouse capability for retrospective search and retrieval services of Federally-supported, organized collections of scientific and technological information.
 - a. To keep currently informed, in detail, of the scope and retrieval capabilities of individual agency collections, libraries and services, and of the aggregate of these.
 - b. To refer requesters promptly and directly to appropriate individual collections and services.
 - c. To undertake and coordinate, on demand, appropriate simultaneous searches and service of multiple collections.
4. There should be established within the structure of the Executive Branch a Government-wide clearinghouse capability for coordinated access to Federally-supported specialized information centers and services.

To provide accessibility and availability of current effort information, current document services and retrospective search and retrieval services in highly specialized aspects of research and development.

5. There should be established within the structure of the Executive Branch a Government-wide clearinghouse capability for information related to formal scientific and technical meetings supported by the Federal Government.
 - a. To furnish information and render advice concerning the planning, scheduling, announcement and conduct of such meetings.
 - b. To provide coordinated accessibility and availability of pre-meeting and post-meeting records of information communicated or to be communicated orally.

CHAPTER VI: ORGANIZATIONAL CONSIDERATIONS

We have considered the problem of planning an organizational structure to implement our functional recommendations. Rather than present specific recommendations, we prefer to discuss certain important aspects of the organizational problem and to point out what in our opinion is the best solution. All of our organizational suggestions are qualified by our recognition that these problems are complex and that factors not known to us may dictate the choice of alternative solutions.

The functional approach is a technique leading to planned evolution. It envisions an orderly transition in progressing from the present situation toward an effective system in the Federal Government for the communication of STINFO. We realize that this transition will be of several years' duration. Moreover, implicit in the functional approach is the flexibility necessary to keep pace with the dynamic communication needs of scientific research and technological development.

Government-wide Policy Direction and Review

We believe that Government-wide policy direction and review of Federal STINFO activities should not be assigned to any one of the existing Departments or Independent Agencies. There are natural difficulties involved whenever any one agency attempts to direct and review activities of another. These difficulties would be compounded if the function were assigned to any agency which participates in any way in the communication of STINFO, since it would be placed in the awkward position of having to judge objectively its own performance. The dictates of good management alone would discourage any such dual responsibility and involvement.

In our opinion this broad functional responsibility is best located in the Executive Office of the President on a permanent basis. The President's recent Reorganization Plan No. 2, establishing an Office of Science and Technology in the Executive Office of the President, provides a logical placement of the Government-wide policy direction and review function.

In order to carry out this function we estimate that approximately eight manyears of professional effort will be required

annually. It is estimated that about \$150,000 annually will be required for manpower costs and approximately \$350,000 annually for program funds to support systems R&D.

In connection with this plan, NSF's related STINFO role and responsibilities will have to be clarified. As an R&D agency, NSF would be subject, of course, to the recommended direction and review of STINFO activities. The Task Force feels that the NSF role should continue to be that of a foundation, providing financial support for communication research, for publications and other products, for various information services and for developing new and improved techniques of communication or of information processing. Such activities should, of course, be related to and consistent with established system goals and requirements.

The status of information activities and progress toward an effective Government system could be enhanced by certain other organizational changes at the Executive staff level. The Task Force suggests that the President's Science Advisory Committee establish a standing panel (with rotating membership) to give continuing attention to such communication matters. This group would facilitate the future coordination of the Federal system with non-Governmental activities. It would seem essential that the Federal Council for Science and Technology also establish a standing committee to facilitate coordinated development among the R&D agencies of an effective Federal system.

Agency-wide Direction and Control

The STINFO function should be formally recognized and the appropriate direction and control placed at the highest reasonable level in the agency's structure to assure the effective performance of STINFO responsibilities. Staffing for the function should be commensurate with the magnitude of the agency's R&D programs.

It is estimated that effective agency-wide direction and control of STINFO in the R&D agencies will require about 150 additional man-years, at a cost of about \$1,500,000 annually. This increase would in effect double the resources now explicitly devoted to this function throughout the Government.

Functional Operations and Programs of R&D Agencies

It is important that each agency provide for each major functional element in the information system structure. The emphasis on each element need not be the same for all agencies in terms of operating activities, staff and functional program dollars.

It is estimated that the necessary expansion of STINFO operating activities among the R&D agencies will require an increase of about \$30,000,000 yearly above the present annual cost of \$100,000,000. (1) Although we expect the increased level of agency activity to have an impact on contractor information activities, we do not anticipate a proportional increase. We estimate that an additional \$20,000,000 will be required in contractor operations presently estimated to be at least \$150,000,000 annually.

Government-Wide Clearinghouse Services

The most important organizational aspect of the recommended clearinghouse capabilities is that they be operationally integrated. To assure the necessary close relationship among them, the Task Force believes they should be components of a single organization which directs their operation.

Establishment of such an organization would eventually involve:

1. Termination of the present anomalous position of the Science Information Exchange of the Smithsonian Institution and transfer of its resources and activities to the direction and control of the suggested organization for current effort clearinghouse services.
2. Transfer of the resources and responsibilities of the Technical Information Division, Office of Technical Services, Department of Commerce, to the direction and control of the suggested organization, in connection with the recommended clearinghouse capability for announcement and availability of current documents. Legislative action would be required to supersede relevant parts of P.L. 776, 81st Congress.

(1) Federal Funds for Science X, Part II, National Science Foundation (NSF 61-82).

3. Transfer direction and control of the Science and Technology Division of the Library of Congress to the new organization in connection with the recommended clearinghouse capability for retrospective search. This would be necessary to facilitate balanced funding and resources for all clearinghouse activities, to permit coordinated direction and control of the functions to be served, and to promote effective, integrated operation of all aspects of the clearinghouse services. We believe that the Division must remain physically in the Library of Congress so that it may make effective use of the unique STINFO collections and resources of that institution. Since the Library of Congress is an agency of the Legislative Branch, Congressional concurrence will be required for an arrangement of this type. The Executive Branch should urge the Library to emphasize processes related to effective utilization of its STINFO collections and should provide necessary funds. Since the other national collections (National Library of Medicine, National Agricultural Library, etc.) are already maintained by agencies of the Executive Branch, no transfers affecting these activities are contemplated. The clearinghouse would be expected to coordinate utilization of their services.

4. Organization of clearinghouse capabilities for specialized information services and for formal meetings.

How the proposed clearinghouse organization should be internally organized need not be firmly established at this time. Two major functions will characterize its operations -- (a) input, or the collection and organization of appropriate material, and (b) output, or the provision of appropriate services. One internal organizational structure might provide a clearinghouse in each of the recommended areas, with each clearinghouse performing both input and output activities in its area. An alternative structure might provide two major components, one to perform all input activities covering all the areas and the other to perform all required, related services, or output. We believe these organizational decisions can best be made at an appropriate time in the future, in the light of developments and established service needs.

Present basic operations of the Science Information Exchange, the OTS Technical Information Division, and the Science and Technology Division of the Library of Congress involve an annual

aggregate cost of about \$3,000,000. The Task Force estimates that the total annual costs associated with a fully operative clearinghouse organization, encompassing reoriented versions of these three programs as well as the recommended new programs, will approximate \$11,000,000.

The suggested clearinghouse organization will be of immense value to the management and performance of Federally-supported R&D programs. In addition, it will bridge the communication interface between Federal and private research and development communities. The communication channels across this interface are great in number and complexity, connecting thousands of individual points on each side involving sources, users and processors of STINFO. In all of our functional recommendations, we have kept in mind the important problems of communication across this interface. We believe that this organization would have a direct beneficial effect on improving the flow and exchange of information across this boundary. It is expected to be a most important aid toward simplifying and improving such communication.

The Task Force considered several possibilities with regard to the location of the suggested clearinghouse organization and considered none wholly satisfactory. Two of the more obvious possibilities are the OSIS of NSF and the OTS of the Department of Commerce, each of which is enabled by legislation to perform information services for the Federal agencies.

The NSF is a staff-type rather than an operating agency in that it supports operations through contracts, grants and transfers of funds. This mode of procedure has been a very effective one, one which is consistent with the role expected of a foundation. Therefore, we feel that the imposition of the responsibility for operation of the clearinghouse is not consonant with NSF's tradition and could create problems which might endanger the effectiveness of the OSIS service and the Foundation's performance as well.

With regard to OTS, its STINFO mission is quantitatively a minor portion of the over-all activities of the Department of Commerce and has never received emphasis from high administrative levels in that organization. Moreover, the Department of Commerce has its own R&D mission with related STINFO service responsibilities. Past experience has shown that serious problems of interagency cooperation arise when an agency with operating responsibilities is given Government-wide jurisdiction in that same area. Therefore, it is of vital importance that the

clearinghouse service begin life untrammelled by prejudicial influences.

We believe the nature and scope of the collective responsibilities and interrelated activities of this combined clearinghouse network merits independent agency status. To the extent necessary, Title IX, NDEA 1958, should be revised to avoid conflict between the STINFO missions of NSF and the proposed agency.

Summary of Costs

The Task Force estimates of increased annual costs in connection with the implementation of its recommendations are summarized as follows:

	<u>Annual Increases</u>
Government-wide direction and review	\$ 150,000
STINFO systems R&D	350,000
R&D agency-wide direction and control	1,500,000
STINFO operations in R&D agencies	30,000,000
STINFO operations of contractors	20,000,000
Government-wide clearinghouse services	<u>8,000,000</u>
Total Estimated Increase in Level of Annual Support	<u>\$60,000,000</u>

The expanded level of activity as represented by these estimates would be attained gradually, over a period of two to four years.

These increases would place the gross amount of Federal funds for STINFO at about the \$300-350 million level annually. In relation to the \$12 billion Federal expenditures estimated for R&D in FY 1963, this magnitude of information cost would represent about 2.5 - 3.0%. This ratio of STINFO costs to R&D costs is slightly less than that believed to be maintained in industry. While certain industries are known to invest 10 - 30% of their R&D dollar in related information activities, the over-all average is estimated to be about 4% for STINFO purposes. In universities, the ratio is known to be even higher, averaging 4.5 - 5.0% of total costs.

Technical Resources

The Task Force believes it would be remiss in its responsibilities if it did not mention certain matters whose importance

to the R&D management function was progressively appreciated as the study developed. These concern the communication of information relating to the primary resources of R&D. As we have stressed, STINFO is such a resource, and a fundamental deficiency in the current state of affairs stems from the fact that it has not been treated as such. Management attention has conventionally been focused on the more obvious resources: (a) funds, (b) organizations and manpower, and (c) facilities and equipment.

Study of the communication of STINFO to serve R&D management reveals the complex intermingling of these resources in management problems and decisions at all levels throughout the progress of R&D from its conception to its completion. There are continuing problems common to each of these resources, problems which are of major national significance because of their impact on R&D. The demands for each of these resources exceed the available supply and continuing efforts are required to ameliorate this situation, particularly with respect to manpower. Because of these shortages, it is important that R&D resources be utilized effectively and that their utilization be monitored.

The Task Force believes that the same conditions, deficiencies and needs characterize the communication of resources information as were revealed in its assessment of STINFO communication. The proposed Clearinghouse Agency immediately suggests benefits to be derived if the collection and analyses of resources information and STINFO could be closely associated, organizationally and operationally. For example, this close contact would permit effective utilization of the wealth of resources information contained in the current effort index of the Clearinghouse Agency. The availability of analyses of resources information would be of significant value to agency management, to educational and training programs for scientists and engineers, to research grant programs and to executive levels of the Government responsible for long-range national goals and policies. The Task Force therefore suggests that serious consideration be given to the merits of establishing a Bureau of Technical Resources Analysis with Government-wide responsibility for continuing, coordinated analyses of all four categories of R&D resources.

If the scope of the proposed Clearinghouse Agency were expanded to cover information on all these technical resources, as is provided in the current effort part of its mission, it would in effect become a comprehensive activity deserving the designation, Bureau of Technical Resources Clearinghouse Service.

The two proposed Bureaus should be closely related in order to ensure their optimal effectiveness, Government-wide and nationally. For this purpose, it is suggested that establishment of a National Technical Resources Board be considered, as an independent agency of the Executive Branch.

The suggested Board could become a valuable tool to aid the proposed Office of Science and Technology in carrying out its anticipated broad-scale evaluation responsibilities concerning R&D programs. Similarly, it would expedite the work of ad hoc advisory groups and save their members significant amounts of time by making pertinent information promptly available for their use. It would be especially useful for correlating all the resource aspects of an interdisciplinary field or program cutting across agency missions. Such comprehensive assistance has heretofore not been available.

CHAPTER VII: AN IMPLEMENTATION PLAN

How can the Task Force recommendations be implemented? Partial improvements or "sub-optimizations" could be more detrimental than helpful if not developed in a manner aimed to achieve the comprehensive system requirements. To develop the recommended Government-wide system capability, a great complexity of actions involving numerous organizations within the Federal Government is clearly required.

Orderly Transition

Recognizing the futility of any attempt to establish the system by "crash" actions, the Task Force proposes an orderly, step-by-step transition from the existing situation to the Government-wide system it recommends. Figure 1 presents schematically the major actions of the proposed plan, relating to the principal Federal organizations that are involved in the recommended system. The plan is designed to provide for improved operation of the Government's communication process during the transition period. It contains four sequential and evolutionary phases of actions, each of which is prerequisite to succeeding actions and the end objective.

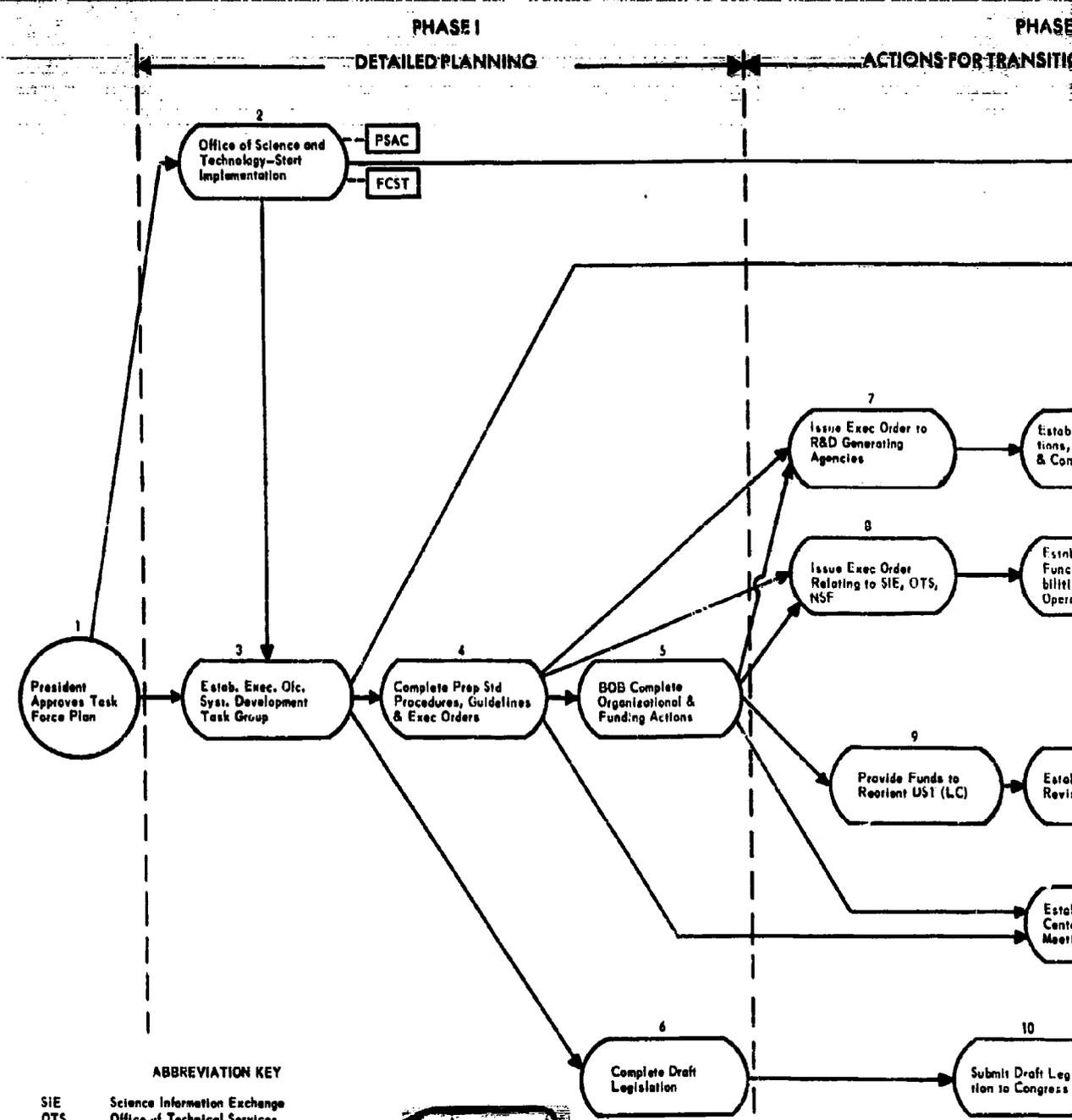
The proposed plan identifies the most important, specific actions and benchmarks to be accomplished, and their necessary sequence and interdependency. It identifies numerous organizations involved but should not be interpreted as an organization chart. It provides a basis for integrating essential effort, for top-level monitoring, review and evaluation, and for modification or adjustment if progress indicates the necessity. It can be time-scaled (PERTed)⁽¹⁾ to indicate periodically the current outlook for meeting the end objective and significant interim objectives. It can also be broken down into more detailed plans of action.

Phases of Effort

The actions and benchmarks of Phases I and II can be accomplished within the existing jurisdiction of the Executive Branch. Those in Phases III and IV can be completed only through new Congressional legislation and coordination.

(1) PERT refers to the management tool, Program Evaluation Review Technique, developed by the U. S. Navy Special Projects Office.

PLAN FOR IMPLEMENTATION



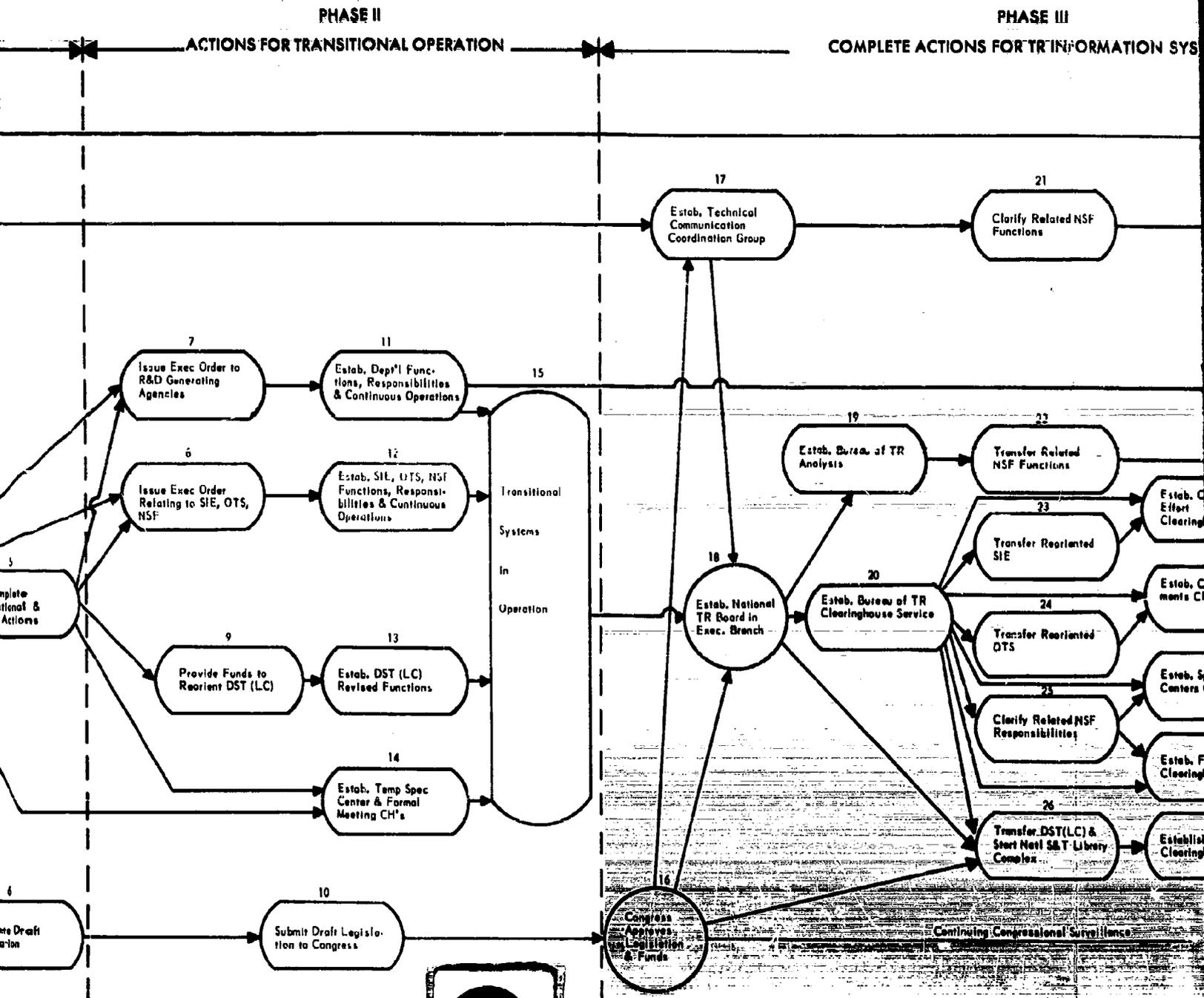
ABBREVIATION KEY

- SIE Science Information Exchange
- OTS Office of Technical Services
- NSF National Science Foundation
- CH Clearinghouse
- DST(LC) Division of Science and Technology (Library of Congress)
- TR Technical Resources

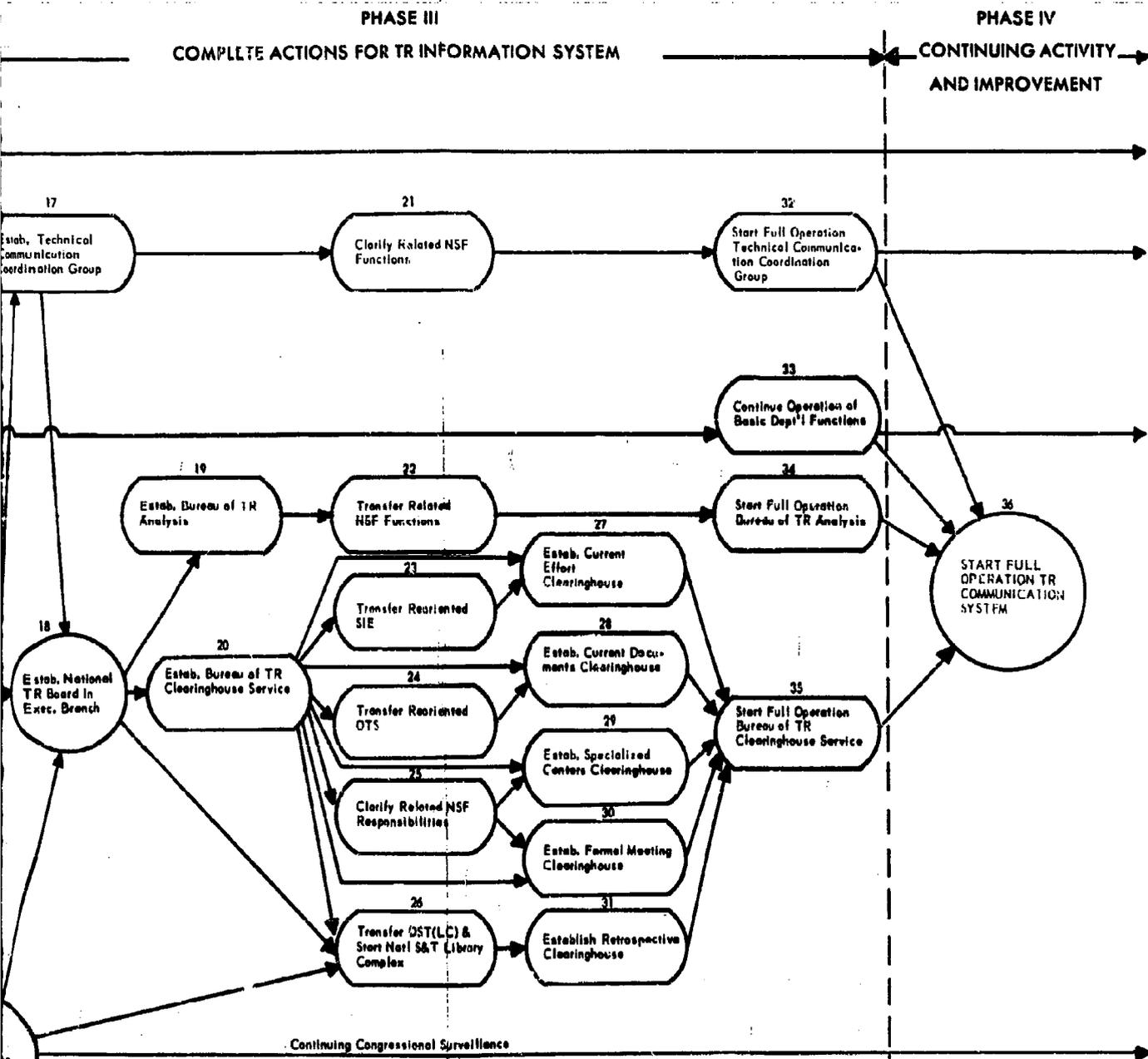


Fig. I

PLAN FOR IMPLEMENTATION OF TASK FORCE RECOMMENDATIONS



FORCE RECOMMENDATIONS



3

Phase I calls for the completion of Executive directives and draft legislation, requiring actions by many Executive Branch agencies to modify their existing STINFO activities. These directives cannot be issued until detailed planning is completed. Phase I contains no actions that would directly alter the existing situation.

Phase II contains the initial transitional actions on the basis of which existing STINFO operations of various agencies would undergo modification. This phase covers principally agency actions that must be completed "to get their houses in order" in compliance with Executive directives.

Phase III outlines the completion of actions and benchmarks to establish operation of the comprehensive system proposed by the Task Force. Initiation of these actions is dependent on the completion of Congressional legislation.

Phase IV begins with operation of the proposed communication system. During this phase, the initial comprehensive system will undergo continuing development and improvement to keep pace with the dynamic situations and requirements of the future.

Explanation of the Plan

Nature of the Plan

Each event in the network of Figure 1 is an unambiguous benchmark of progress that occurs at a point in time. Encircled events represent major objectives of the plan. The arrows depict the interdependency of events and symbolize the passage of time between successive events. Lengths of arrows are not proportional to lengths of time or amounts of effort.

Detailed Description

Events 1 - 6. Once the Task Force plan is approved (Event 1), the first action involves establishment of an Executive Office System Development Group (Event 3), responsible to the Office of Science and Technology (Event 2). This Group will be responsible for preparing detailed plans for subsequent actions, and for monitoring their accomplishment. This Group will prepare standard procedures and guidelines for improved and compatible STINFO communication within and among existing agencies of the Federal Government, including policy statements and Executive directives to carry out those procedures (Event 4). Concurrently, the Group will complete a plan, in coordination with the Bureau

of the Budget, to adjust STINFO funds and to modify existing organizations and STINFO functions (Event 5). The Group will also draft proposed legislation (Event 6) for the approval and funding of Federal Government organizational and functional changes beyond the jurisdiction of the Executive Branch. Detailed planning will also be accomplished for the establishment of specialized center and formal meeting clearinghouse services (Event 14).

During Phase I, the System Development Group will develop similar plans to identify in more detail the activities and events represented by individual arrows. For example, a detailed plan of activities and events essential to complete arrow 7 - 11 might involve a greater number of events than appear in Figure 1.

Events 7 - 15. The first actions to be taken by agencies will be initiated by one or more Executive directives (Events 7 and 8). Prosecution of Phase II of the plan will begin at this point. Implementation of the Executive directives will involve a variety of actions within and among R&D-generating agencies and STINFO processors. Coordination of agency efforts to carry out the Executive directives will be a continuing function of the System Development Group. Another early activity during Phase II requires the provision of funds to reorient the Division of Science and Technology of the Library of Congress (Event 9) to enable that organization to revise and extend its functions (Event 13) as recommended. As early as possible during Phase II, the draft legislation will be submitted to Congress (Event 10) to request authority and funds essential to initiate actions leading to the operation of the proposed system.

As soon as responsible agencies have implemented the Executive directives, the transitional systems will be in operation (Event 15). It is important to note the multiplicity of systems in the description of Event 15. This event is a major interim objective of the plan, but the reader is cautioned not to conclude its achievement satisfies, or nearly satisfies, the Government's need for the comprehensive system proposed by the Task Force. There would at this point be no organization responsible for administering and coordinating Government-wide clearinghouse services.

Events 16 - 35. The completion of actions to establish the desired system (Phase III) begins when the proposed legislation becomes law and the required funds are made available

(Event 16). Shading in Phase III indicates that establishment of the proposed organizations may have to be modified. The System Development Group (Event 1) will be converted into the Technical Communication Coordination Group (Event 17) in the Office of Science and Technology. This Group will continue its system development functions and perform coordinating functions to insure the effective development and operation of the system. It will have staff responsibility to implement the legislation and to establish the National Technical Resources Board (NTRB) in the Executive Branch (Event 18). The Technical Communication Coordination Group will assist the NTRB to establish the Bureau of Technical Resources Analysis (Event 19) and the Bureau of Technical Resources Clearinghouse Service (Event 20). Full operation of this complex (Events 17 - 20) will require the early clarification of responsibilities and the functional transfers shown by Events 21 through 26. The Coordination Group will work closely with the NTRB, the Library of Congress, and the Bureau of TR Clearinghouse Service to establish the Clearinghouse components (Events 27 through 31).

The completion of Events 16 through 31 will permit the several new organizations to begin full operations (Events 32, 34, 35). Throughout and beyond Phase III, the R&D generating agencies will continue their operations of the basic departmental functions (Event 33) in the field of STINFO communications. Full operation of the technical resources information system (Event 36) begins Phase IV. Phase IV will also be characterized by continuing R&D and other improvement efforts to keep pace with the dynamics of science and technology.

Coordinated Scheduling

The network plan is a valuable tool for estimating the time-scale, for realistic scheduling on the basis of time estimates, for monitoring progress in time, and for estimating periodically the current outlook for meeting key objectives and the end objective. To serve these purposes application of the basic PERT timing system would be feasible. This method of time-scaling the plan would motivate responsible individuals and organizations to meet their schedules and provide the Executive Office with continuous knowledge about the outlook for completion.

The End Objective: A Technical Resources Communication System

Figure 2 illustrates the functional and organizational interrelationships that would characterize the end objective. This figure may assist the reader to understand how the technical resources communication system would foster profitable interactions and communication among major Government organizations, and between Government and non-Government communities.

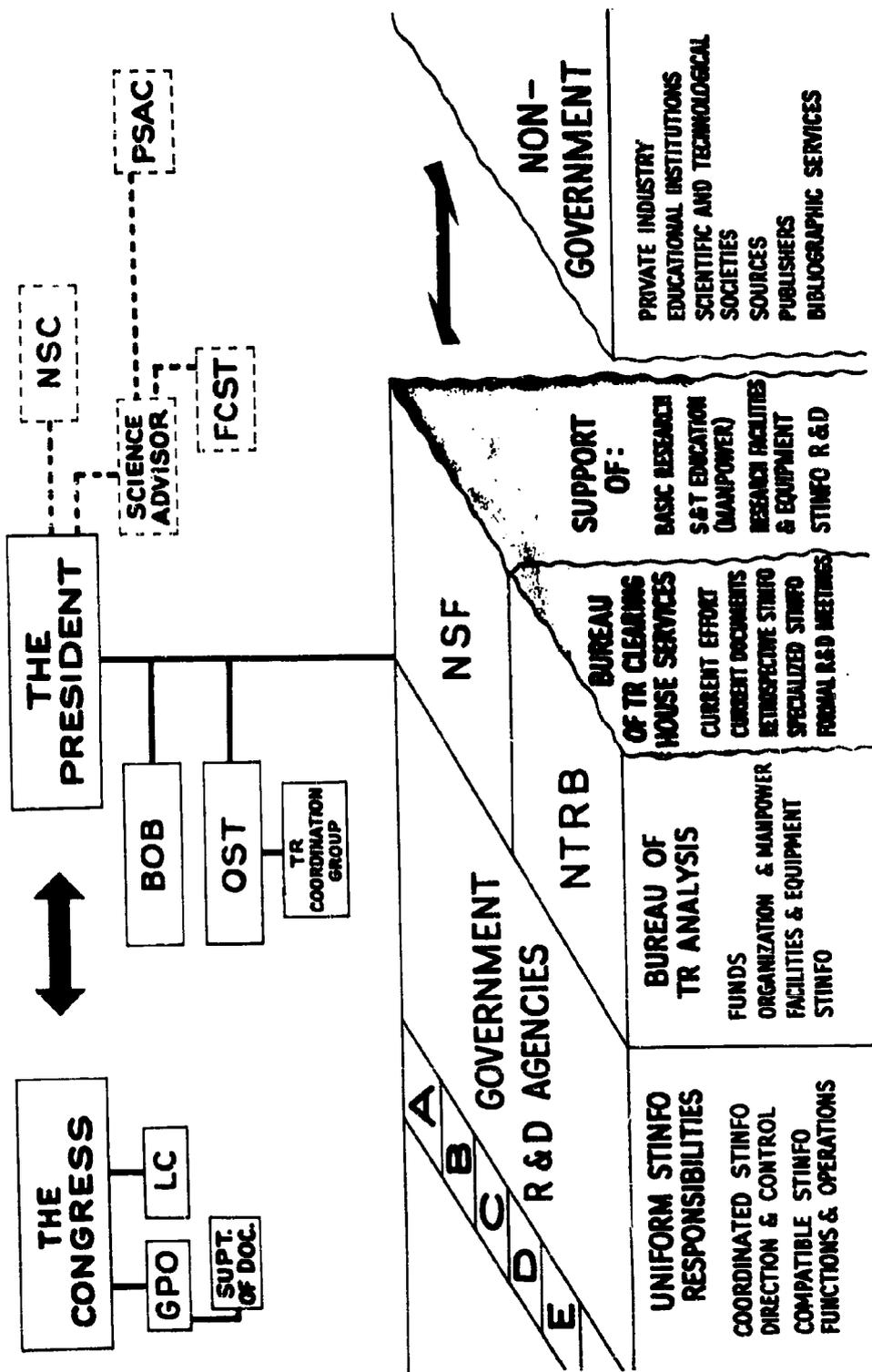


Fig. II

CHAPTER VIII: ADDITIONAL CONSIDERATIONS

Legislative Branch Recommendations

The Senate Committee on Government Operations, and its Subcommittee on Reorganization and International Organizations have issued three reports which make specific recommendations for improvement of STINFO activities in the Federal Government. These are: Documentation, Indexing, and Retrieval of Scientific Information - A Study of Federal and Non-Federal Science Information Processing and Retrieval Programs, (Document No. 113, 86th Congress, 2nd Session); Coordination of Information on Current Scientific Research and Development Supported by the United States Government - Administrative and Scientific Problems and Opportunities of Central Registration of Research Projects in Science and Engineering (Report No. 263, 87th Congress, 1st Session); Coordination of Information on Current Federal Research and Development Projects in the Field of Electronics - An Analysis of Agency Systems for Storage and Retrieval of Data on Ongoing Work and of Views of Private Companies on Indexing and Communication Problems (Committee Print 87th Congress, 1st Session).

The Task Force has attempted to keep those recommendations in mind in the course of its investigations and deliberations. We sincerely believe that most of them will be attended to in connection with the improved Government STINFO system proposed by the Task Force. For the reader's convenience, the various recommendations resulting from these staff studies are listed in Appendix A.

Restrictions to Information Flow

We must mention our concern with the fact that the STINFO communication process is being increasingly impeded by a spectrum of restrictions which serve no essential national purpose. These barriers seriously interfere with scientific and technological progress; they curtail the essential processes of skeptical review and feedback via criticism and discussion, and inhibit the valuable benefits of cross-fertilization of new approaches and ideas among technical specialties.

Proprietary Information

Scientific progress is an evolutionary process in which advancement is dependent upon awareness of previous facts and

accomplishments in an area of specialization and even apparently unrelated fields of inquiry. This is particularly significant in applied R&D where the rapid pace requires that knowledge of the existence of a new device or technique be exploited promptly wherever possible. Consequently, holding back information on advances in R&D seriously retards progress.

This is precisely the situation that prevails in connection with information claimed to be proprietary by many Government R&D contractors. While the Government contract normally stipulates that the information generated in the course of an R&D project be made available for Government uses, a rather narrow interpretation is often applied. Thus, Government-sponsored STINFO of a "proprietary" nature, can be, and often is, excluded from the normal avenues of dissemination, such as primary distribution to contractors with similar projects, and secondary distribution through ASTIA and OTS.

One might observe that the individual Government contract and project officers have the legal right, and should have the desire to spread the technical information, and that they are remiss if they do not do so. However, these Government representatives are primarily concerned with the immediate problems involved in their own programs. In the absence of a Government-wide policy for information exchange and of explicit assigned responsibility for dissemination, they cannot be expected to expend project resources and may not prefer to risk contractor disfavor by such activities. Furthermore, the increased technical complexity of modern R&D has led to Government delegation of a large part of technical management to prime weapons-systems managers or to not-for-profit management-type organizations. Their motives and capabilities for information dissemination are generally not those required to satisfy the needs of the national scientific community. Most major system developments involve very advanced techniques where new knowledge and technology are generated in many phases of the program, including even the testing process. Technical reports from subcontractors, large-system progress reports and testing analyses often contain considerable information pertinent to other national programs. It is therefore very disturbing to learn of the severe restrictions placed on dissemination of such information by the prime contractors and cognizant agencies. As a result, many such reports are unavailable for distribution to technical workers throughout our national complex.

Security Classified Information

A very significant portion of Government-sponsored STINFO is subject to security classification restrictions. We are fully aware that the problems concerning national security policies are very complex; however, we wish to stress the need for improved interpretation and application of these policies so that effective and essential STINFO communication may be achieved, consistent with valid security requirements.

Security classification policies must be interpreted with respect to each research or development program so that specific classification guides may be developed and applied. These are essential to provide necessary consistency and to prevent inadvertent compromise of classified material. Such guides should reflect scientific, technical and military points of view in a balanced perspective. The value and feasibility of such classification guides have been demonstrated in AEC.

Automatic downgrading regulations of DOD now in effect permit much STINFO "born" classified to become unclassified within a maximum of twelve years from its initial reporting. The effectiveness of these regulations needs to be monitored continually. They certainly do not justify a complacent attitude concerning over-classification. The use of up-to-date security classification guides would aid in preventing over-classification, and in identifying and correcting it when it occurs.

We recognize the purpose of the need-to-know principle to limit dissemination to those having a justifiable and recognized information need in connection with their official responsibilities. The basic weakness of this concept is that frequently individuals needing information do not know of its existence and therefore cannot ask for it. We believe that better means are needed and feasible for announcing the existence of classified STINFO without compromising security.

Conclusion

In addition to improving the flow of legitimately-classified STINFO, Government management has opportunities as well as obligations to reduce significantly unjustifiable restrictions on STINFO flow for either proprietary or security reasons. The Task Force is hopeful that its recommendations will provide a more favorable environment for advancing R&D without jeopardizing military or economic security.

APPENDIX A

(Recommendations resulting from Staff Studies of the Senate Subcommittee on Government Reorganization and International Organizations - Chairman, Senator Hubert H. Humphrey.)

The Special Assistant to the President for Science and Technology and the Federal Council for Science and Technology should devote increased attention to coordinated interagency planning and management of scientific research and development, and to the utilization of up-to-the-minute information there-fore.

The policy should be promulgated throughout the Federal Government that:

- a. Decisionmaking on new research and development should be preceded not only by the standard procedure of consulting data on prior results, but by consultation, to the extent feasible and desirable, of pertinent data on work already under way or work completed but not reported or published.
- b. Agencies should be required to cooperate to the fullest extent with the Science Information Exchange.

Strengthen Science Information Exchange

Continue Documentation Center Efforts Toward Coordination.

- a. In the interest of economy and efficiency, the Armed Services Technical Information Agency and the Office of Technical Services should continue in their efforts toward coordination and, as appropriate, integration of activities in the management and dissemination of unclassified information. These centers (like others) should continue to exploit the fullest technological possibilities in the individual and mutual use of electronic data processing and in high-speed reproduction facilities.
- b. All Federal documentation centers should vigorously endeavor to expand their program of cooperation with one another, and with the Science Information Exchange.

Ultimately, it should prove feasible to record within a uniform Government-wide complex a wide variety of pre- and post-publication data. This would permit the tracing of information from the inception of an application for a research or development project to the publication of progress reports, and then, of the final report of the completed research.

The complex should be so organized as to permit an individual located anywhere in the Nation in a Federal Laboratory, in a university, institute, or private company - who has a bona fide need for non-classified information on federally-supported research and development to obtain it promptly and reliably. Minimal effort should be required for searching out the many sources which might have parts of the data.

The Science Information Exchange and Federal agencies maintaining significant internal information systems on current work should strengthen cooperation with professional societies. The societies fullest cooperation should be invited in evaluating systems, making suggestions for strengthening systems, arranging for dissemination and encouraging utilization. International professional organizations should be similarly invited to explore the world-wide phases of the problems and opportunities of information on work in progress.

The National Science Foundation should continue their commendable efforts to determine Federal outlay for scientific communication and information purposes and should receive fullest cooperation from the agencies. To the extent feasible, intensified effort should be made to estimate the indirect costs of information and communication.

More intensive studies should be conducted of scientists' information-gathering patterns, particularly their usage of existing "in-house" and contractual systems, of reports, articles, books and audiovisual materials. The carefully devised scientific studies of information usage should, when completed, be capitalized upon by strengthening existing services or by establishing new pilot systems to test proposed improvements. Professional societies should be encouraged to publicize findings in order that members have an opportunity for self-education so as to avail themselves of benefits that may be foreseen.

- a. The Office of the Secretary of Defense and the respective services should move ahead in resolving policy and operational problems of information systems and activities. This should include determination of which

internal systems among the services should continue to exist and what their relationships should be with the DD 613 system.

- b. The Department should undertake a careful evaluation of its internal project reporting and dissemination procedures. It should seek to make sure that data registered on DD 613 forms include the specific types of information called for, are authentic, up-to-date, and are made readily available to all echelons in DOD having appropriate use for such project information.
- c. The improved DD 613 system should be utilized for intensive study of unintended duplications.
- d. The fullest indexing of current projects should include developmental activities, and should be correlated with reports of results.
- e. The Department is urged to give special attention toward reviewing and using to the maximum extent the results from canceled contracts and subcontracts.
- f. Career incentives for civilian and military manpower, skilled in information problems, should be provided.

It is respectfully submitted that the Senate Committee on Appropriations may wish to consider requiring the funding of the Science Information Exchange to be a budget line item, perhaps as a specific part of a larger item on management of pre- and post-publication scientific information.

- a. At the level of interagency policy, the Federal Council for Science and Technology should devote further attention to the problem of strengthening information on scientific and engineering manpower and action based on analyses of needs, derived from such information.
- b. The NSF should receive a specific mandate to develop with other agencies and with the National Research Council estimates as to long-range, e.g., five and ten year, needs and preparation of scientists and engineers, especially for fields which may prove vital to the national security in the space-nuclear age.
- c. The Science Information Exchange's data on manpower should be utilized to its fullest potentiality and

with minimal duplication of effort in relation to usage of other manpower inventories.

Further recommendations in the field of electronics are as follows:

1. Means should be explored to formalize the information channels associated with existing special information centers in the field of electronics and to extend these channels to cover technical information development in weapons-systems contracts and in the sub-contracting complex.
2. Coordination of information services to avoid overlap of information-collecting activities should be undertaken to avoid placing an increased burden of paper work on those who generate new technical information, and, if possible, to decrease the existing burden.
3. Consideration should be given to establishing information centers for the areas of electronics now served by advisory groups who do not have the benefit of such information services.
4. Any central project index that may be established on an experimental basis should plan to include the field of electronics, both research and development, at the earliest possible moment.
5. The explicit funding of information services should be encouraged as a means for providing more definitive data than is now available for the evaluation of the status of scientific communication.
6. Central indexing of current research should not be permitted to discourage the existence or establishment of special electronics information centers where such centers are needed to provide greater depth of indexing than can be provided by a central activity or where the close association of such information centers with project planning and management activities guarantees their effective utilization.
7. In the course of research on the technical information communication channels used by scientists and engineers, attention should be given to the effectiveness with which indexes could or do support informal communication channels by aiding the organization of symposia, by informing the

seeker for information of the identity of individuals he may usefully contact at such symposia, by guiding correspondence, and in other ways.

8. The contribution of a project index to the indexing of reports emerging from the project should be studied and the possibility considered that close coordination between the two kinds of indexing efforts may effect a large reduction in combined costs.

9. Experiments such as the former CATE program that provide useful information to guide the approach to a more complete solution of the problem of closing the gap between the performance of research and the utilization of the results of research should be encouraged even after more comprehensive information services have been established.

10. The need-to-know as a restriction on the dissemination of non-classified information should be reviewed with the objective of achieving the most widespread dissemination of information consistent with security and of achieving uniform practices and elimination of unnecessary red tape.

11. In the absence of comprehensive and detailed indexing of current electronics research, mechanisms should be set up to insure salvage of advances in electronics technology embodied in canceled programs.

12. A study should be undertaken to provide comprehensive statistical data on reporting requirements and practices in the in-house and contract electronics research and development programs of the Federal Government.

APPENDIX B

Federal STINFO Agencies

The following is an NSF listing of Government Departments and Independent Agencies carrying on STINFO activities:

Department of Agriculture
Department of Commerce
Department of Defense
 Department of Army
 Department of Navy
 Department of Air Force
Department of Health, Education and Welfare
Department of Interior
Department of Justice
Post Office Department
Department of State
Department of Treasury

Atomic Energy Commission
Bureau of the Budget
Civil Service Commission
Council of Economic Advisors, Executive Office of the President
Farm Credit Administration
Federal Aviation Agency
Federal Communications Commission
Federal Power Commission
Federal Trade Commission
Federal Reserve System
General Services Administration
Government Printing Office
Housing and Home Finance Agency
Interstate Commerce Commission
Library of Congress
National Science Foundation
Office of Civil Defense
Securities and Exchange Commission
Small Business Administration
Smithsonian Institution
Tennessee Valley Authority
U. S. Information Agency
Veterans Administration

APPENDIX C

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- No. 5. Tennessee Valley Authority, NSF 60-44, 1960
- No. 6. National Science Foundation, NSF 60-56, 1960
- No. 7. Department of Commerce - Part II: Weather Bureau, Coast and Geodetic Survey, Maritime Administration, Business and Defense Services Administration, Office of Business Economics, NSF 60-58, 1960
- No. 8. Department of Commerce - Part III: National Bureau of Standards, NSF 60-59, 1960
- No. 9. Federal Communications Commission, NSF 61-12, 1961
- No. 10. Veterans Administration, NSF 61-22, 1961
- No. 11. Treasury Department; U. S. Coast Guard, Bureau of Customs, Internal Revenue Service, Bureau of Engraving and Printing, Bureau of the Mint, NSF 61-64, 1961
- No. 12. Department of the Interior - Part I: Bureau of Reclamation, Office of Saline Water, Fish and Wildlife Service, National Park Service, Bonneville Power Administration, Bureau of Indian Affairs, Bureau of Land Management, NSF 61-77, 1961

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