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Information for a Changing Society

For society's purposes, technical information must be credible, interpreted, and appropriately packaged.

Edward L. Brady and Lewis M. Branscomb

The wise society, like the wise individual, does not act without attempting to determine what the consequences of its actions might be. Surely then, few societies can be called completely wise. On all sides we see concrete evidence of our own society's failure to be wise. Some of those failures are literally embodied in concrete—the concrete of highways that have uprooted populations and changed the character of towns and major cities, the concrete of dams that have now turned into ecological disasters. Others are found in the pollution of our streams, in urban ghettos, in blackouts and brownouts, in ill-fed and poorly-educated children.

Our national administration and our state and local administrations have dedicated themselves to repairing the damage of past imprudence and to ensuring that future decisions are wise ones. This is not a partisan political goal, but a goal of our entire society, one that surely is endorsed by every citizen.

We do not want to appear to line up on the side of those who say that technology has been disastrous and has led to all the evils of our society. Quite the contrary. We believe that technology has been responsible for the material virtues of society, making it possible for much of the world's population to achieve a high standard of living, and pointing the way to peace and material abundance for all. While the misuse of technology has contributed to some of today's problems, the future can be improved only through the better application of new and existing technology.

What is needed to ensure that changing societies make wise decisions?

First, information. Information is needed to tell us what our society is like now, how rapidly and in what ways it is changing, and what scientific and technological alternatives to present practices exist or can be found.

Second, social analysis. Analysis is needed to determine what relations exist between current actions and future effects, to weigh the merits of alternative priority systems, to derive practical, achievable goals for society, and to determine how best to allocate our finite resources to attain those goals.

Third, well-informed decision makers. Society requires mechanisms to ensure that decision makers, including the public, have access to the information they need, have available the results of the analyses carried out, and have alternative courses of action formulated for their consideration.

Fourth, appropriate institutions. Institutions are needed to ensure that decisions can be put into practice. They take many forms—political institutions, financial institutions, legal institutions, and educational institutions.

A report prepared under the auspices of the Organization for Economic Cooperation and Development (OECD) has addressed the first need listed above —that for information. The report, entitled *Information for a Changing Society* (*1*), is an outgrowth of OECD concern with national and international policy relating to information systems in science and technology; its content and its implications are the subject of this article.

In 1969 OECD Secretary General Emile Van Lennep appointed the Ad Hoc Group on Scientific and Technical Information (*2*) to examine the information program of his organization and to advise OECD member states on information policy. The ad hoc group decided in its earliest deliberations that policy for information in science and technology could not be considered separately from policy for science and technology, which in turn could not be separated from policy for economic growth and other social goals. The task of the group thus became an examination of the information needs of the

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changing society that constitutes our global village.

We believe that the guidance provided by the report is useful to governmental and private institutions in the United States, to individual scientists and engineers, and to government officials charged with U.S. participation in OECD. We therefore present a summary of its contents and our interpretation of appropriate implementation of some of its recommendations.

The OECD report examines the uses and needs for scientific and technological information throughout our society, and considers the relations among such information and other kinds of information. Certain themes run throughout the report, binding it into a consistent pattern: (i) various types of information are needed for decision makers at all levels throughout society; (ii) information must be appropriately packaged and interpreted for each specific community of users; and (iii) quality of information—that is, its reliability and credibility—is more important than access to great masses of raw data.

One may argue that there is nothing new or profound in this approach, that it is merely the elaboration of the obvious. Yet it differs enormously from the usual approach to the design and definition of requirements of information systems, where the emphasis is primarily on accessibility to great masses of information and on the technology of manipulating such masses, with little or no thought given to the quality of the input or its evaluation and interpretation for different user communities.

The report states, for example, in the introductory paragraphs (*1*, p. 17): "The information needs of managers and policy makers emerge as critical requirements, and their effective access to information from many disciplines and from many parts of the globe becomes imperative. Thus, we must view scientific and technical information as only part of an immense complex of information including economic, social, legal, and political aspects as well as technical ones."

Continuing this theme, the report later states (*1*, p. 18), "Just as science policy must be an integral part of overall government policy, linked to social and economic affairs, information policy must seek to assure that the world's specialized and professional knowledge is fully and properly used in guiding social evolution."

In effect, the ad hoc group accepted the three basic themes listed above as guiding principles in the preparation of its report, examining their consequences and deriving from them recommendations for action by individual governments and by the OECD. The report first analyzes the needs of various user communities, sets some goals based on those needs, analyzes the implications of those goals for public policy, and then presents a set of specific conclusions and recommendations.

User Communities

Four general communities are recognized to be in need of technical information: (i) the scientific specialist (the researcher), (ii) the industrial engineer (the applier), (iii) the planner, the policy maker, the decision maker, and the manager (the innovators and guiders), and (iv) the public (the consumer, beneficiary, and victim). These users are listed in decreasing order of specialization and increasing order of breadth and generality. Each community needs reliable information that is appropriately interpreted and related to other information, and that is packaged for easy access.

The scientific specialist needs information on which to build the extension of his own work; he needs to find out what is already known, where it has appeared, and how he can get the source material. In areas in which he is not a specialist he needs evaluations and condensations, usually in the form of critical reviews and compilations of data. These are often produced now in "information analysis centers," but the contributions of such centers at present cover only a small fraction of science and technology.

The applied technologist (the engineer) requires basic information also, but in less detailed form. His principal needs are for other types of information—design and product specifications, properties of raw materials, process control techniques, prices, and other forms of commercial data. Formalized systems to serve his needs are in a primitive state of development compared with some of the more elaborate systems for basic science.

More and more in our complex technological society, resolution of a technical issue is a prerequisite for dealing with major social policy. Framing regulations for emissions from chimneys requires knowledge of the nature of the emission—that is, its composition, particle size, amount, and temperature—and its effects on the physical environment and on neighboring populations. Standards for flammable fabrics can be written intelligently only if we know enough about the mechanics of ignition and the processes of flame propagation and their relation to fabric composition, weave, and surface treatment. Systems to provide appropriate information of this type to policy makers exist in some areas, but they are still in an early phase of evolution.

An important development that promises immense consequences for the future is the steadily growing capability of the Congress to gather technical information from various sources, analyze it, and apply it to social problems. The Library of Congress has operated the Legislative Reference Service for this purpose for many years. One of its components is a group of scientists and engineers called the Science Policy Research Division. This group constitutes a true information analysis center, gathering relevant information from many sources and extracting, evaluating, and condensing it to answer specific questions posed by the special community it serves. Congress, recognizing the value of the Legislative Reference Service, has recently decided to expand the service's capabilities manyfold over the next few years and to rename it the Congressional Research Service. This analytical capability, whose nearest counterpart in the executive branch of the federal government is the widely dispersed analytical capabilities of individual agencies, is certain to have a great impact on government operations in the future.

In considering the uses of technical information supplied to the general public, the ad hoc group's report concludes that the principal function of such information is to develop an electorate informed on the social and economic consequences of scientific and technological developments. An informed and sophisticated electorate is essential, first because so much of the material well-being of a society is based upon technological developments, and second because so many modern problems are, in turn, consequences of the use of technology. We cannot help but feel, for example, that much of the fruitless and emotional debate about the siting of power plants, particularly nuclear ones, would vanish if all parties were adequately informed upon

the benefits and costs of alternative technical choices. In this case, as in many similar public debates on technological issues, adequate information upon which to base a rational choice probably does not yet exist. Research, both basic and applied, is needed.

National Goals and Public Policy

Accepting, then, that the needs of the user communities can be satisfied only by blending scientific and technological information with other kinds of information, distilling out the superfluous diluent, and then distributing appropriate fractions to users, the ad hoc group formulated a set of goals for a national policy on information. These goals are (i) to ensure effective utilization of accumulated knowledge, (ii) to promote development of science and technology, (iii) to ensure availability of adequate information for decisions, and (iv) to focus public and private attention on problems of information availability and use. Detailed discussion of these goals seems unnecessary here. As the report points out, despite the protests and clamor of some segments of modern society, "Few people doubt that the further development of industrial society, both to produce more material goods and to improve the quality of everyday life, rests upon the further development and judicious application of science and technology" (*1*, p. 30).

The achievement of these broad goals would imply a governmental responsibility to carry on activities that are themselves directed toward the achievement of certain more specific objectives, which, in turn, imply another set of activities with again more specific objectives. This hierarchy can be extended all the way to the goals and activities of a single individual, becoming more detailed and more specific at each level. The ad hoc group report discusses only the level that follows the four broad social goals mentioned above. This set of eight major governmental objectives is given below.

1) Ensure availability of adequate scientific, technological, economic, and social information.

2) Ensure access to other national and international sources of information.

3) Determine relations between scientific and technological information, and information about social phenomena.

4) Ensure that information is selected, digested, and analyzed for educational, industrial, policy, and other public purposes.

5) Ensure study of habits and needs of information users and new practices in information processing.

6) Ensure availability of resources to establish and operate appropriate information systems.

7) Ensure availability of appropriately trained, broadly competent information system managers and coordinators.

8) Ensure availability of properly trained specialists in the content and technology of information systems.

These are important objectives. Probably most have been advanced by one group or another that has studied the scientific and technological information problem over the past several years; we refer particularly to the Weinberg Panel of the President's science advisory committee and the committee on scientific and technical communication of the National Academy of Sciences–National Academy of Engineering. Most of these objectives are probably accepted by governmental and nongovernmental authorities who have studied information problems. Most may even be considered self-evident by the members of the committee on scientific and technical information of the federal council for science and technology, the body charged with coordinating information policies and practices within the federal government. As yet, however, the evidence does not show that these goals have been accepted universally enough by U.S. policy makers to ensure that the resources needed to achieve them can be mustered. The OECD report has been transmitted to the OECD science ministers council (the U.S. member is Edward E. David, science adviser to the President) for consideration of joint and individual action that might be taken. We recommend that David take appropriate measures to ensure that the report receives careful study in the United States.

Conclusions and Recommendations of the OECD Report

Having accepted the eight governmental objectives listed above as a platform on which to build, the OECD ad hoc group then considered the conclusions to be drawn from the experience and knowledge of its members, and finally drafted a set of recommendations to address to OECD and its member states. A great deal lies behind the conclusions and recommendations; some of the background is presented in the report, but most of it resides in the personal experiences and thinking of the members of the group. The conclusions and recommendations are directed partly to OECD, but far more important are the opportunities suggested for action by the member governments. The ad hoc group considers that the value of the report must be judged by the impact it has on new policy orientations within the member states and on the unifying influence exerted on all aspects of government activity by the approaches advocated for the transfer of information.

The conclusions and the recommendations reached by the group are shown in an abbreviated form in the box on page 965. Each recommendation is associated with the correspondingly numbered conclusion.

We can summarize the conclusions in the following manner. Scientific and technological information has not been used as effectively in the past as it might have been, perhaps partly because it has often been considered an administrative or mechanical matter, treated separately from research and development (R & D) strategy. Full effectiveness of information for public policy demands a proper mixture of scientific and technological information with social, economic, and political information—in a system specifically designed for the purpose, rather than the discipline-oriented information systems designed by specialists for other specialists. More attention should be paid to the development of systems for industrial technology. Greater emphasis on quality control of both input and output is required; since information systems are evolving rapidly now, the need for quality control should be kept in mind constantly during their evolution. National education systems interact with information systems in two ways—by supplying trained workers for the information systems and by relying upon new and adaptable systems to aid the life-long education processes of the future. Finally, no nation, regardless of size or wealth, can afford to be self-sufficient in its generation and use of technical information; smaller nations in particular must pay special attention to careful selection of the information they

need from the great world storehouse, taking into account their own special strengths and opportunities.

What recommendations are derived from these conclusions and what action might the United States take to implement them? The first recommendation is addressed to OECD itself, suggesting that this organization expand the scope and intensity of its information policy activities. Consideration of effective ways of implementing this recommendation is now under way within the OECD information policy group. Plans for reorganizing and strengthening the work of this group are being developed for future action.

Recommendations 2 through 4 relate to the behavior of governmental agencies in developing policy for their operations; they state that policy for generating information must be developed as an integral part of a policy of using information, that information policy must be considered an inseparable part of policy as a whole, and that good management demands integration and availability of appropriate kinds of information. These recommendations can be readily translated into action by government officials. They would require, for example, that the planning of the R & D programs of the Atomic Energy Commission, National Aeronautics and Space Administration, Department of Defense, National Bureau of Standards (NBS), and other agencies include an explicit, detailed treatment of what is to be done with the information produced, as well as what information is sought. Users would be identified within the four broad communities previously discussed, and plans would be made to provide to each the type of information needed. No information would be collected or generated without a definite plan for its use, and great masses of raw observational data would not be saved indefinitely unless a use could be clearly foreseen.

We may well be accused of casting stones without being free from sin ourselves; surely in our present capacities we should have some influence on the practices of the National Bureau of Standards, and we would not dare to assert that NBS follows the advice in recommendations 2 through 4 in all respects. We do claim, however, that the effective use of the information produced at NBS, including its interpretation and repackaging for special audiences, is a matter that engages the attention of the top management. Compared to many other organizations, NBS does not have a bad record, but we are determined to make it even better.

The fifth recommendation of the OECD report has two elements—effective interchange among various disciplines and analysis, consolidation, and repackaging for the needs of each group. In the United States, both aspects are receiving attention, the former much more than the latter. The large information systems operated by professional societies (for example, Chemical Abstracts Service) endeavor to ensure that their material is available to persons in other disciplines. The National Science Foundation, through the program of its Office of Science Information Services, promotes coordination among the services of the private sector, ensuring as much as possible that the interests of various professional disciplines are represented in the planning of the major national systems. These systems, however, concentrate primarily on accessibility, giving little attention to analysis and repackaging. Despite many exhortations from leaders of the scientific community, there has been only a slight response from individual scientists and from funding agencies to increase analytical review. We can again point to the NBS to illustrate the situation. For several years it has managed the National Standard Reference Data System, stimulating, funding, and coordinating projects to evaluate and compile data on physical properties. Despite our best efforts, we have not been able to attract sufficient support from the scientific and engineering community, the executive branch of government, and the Congress to build this program to a really effective level. However, we shall continue to try. In other fields of science and technology, the information centers of NBS also emphasize critical analysis of information. We believe that systematic critical analysis will benefit almost every government program, including our own, and we believe that a well-run information analysis center is a useful mechanism for the purpose.

Recommendation 6 focuses on an area that deserves much greater attention than it has received up to now. Much of the public justification for R & D programs, in the United States as in other countries, has been on possible application to industry. Yet there have been only rudimentary studies of the way industry obtains and uses technical information. Recommendation 6 suggests that this deficiency be rectified. Whose responsibility is it to do something? Clearly, every agency that produces new information used by industry bears a share of the responsibility. But if we accept the principle that the economic development of the nation rests to a large extent on its technological progress, the Department of Commerce should assume the major role. The responsibility might well be shared between the NBS and the National Technical Information Service, which already share a common objective of promoting economic development through the application of technology.

Most agencies of the federal government have opportunities to try the kind of experiment envisioned in recommendation 7—that is, a unified information system in a well-defined area to collect, analyze, interpret, and repackage information to serve the needs of several somewhat disparate communities. We see several possibilities at the National Bureau of Standards—in fire research, in building technology, and in flammable fabrics research. In each of these areas information systems are being developed; they will be designed, insofar as possible, to serve the needs of researchers, those who set government standards, legislators, and the public. Similar experiments could be tried for air pollution, water pollution, and solid waste treatment. We would like to cite as an example a program already initiated by the Department of the Interior—an information center on feed lot waste disposal. Agricultural technology has led to the concept of a feed lot, which may contain tens of thousands of cattle or hundreds of thousands of chickens in pens covering only a few hundred acres. The magnitude of the waste disposal task can be envisioned when one realizes that each cow produces as much waste as 30 human beings do. The wastes from a feed lot cannot just be spread on the nearby fields, as they were in the good old days when a cattle raiser might have a few hundred head. Agricultural scientists have recently expressed great alarm over the potentially permanent damage that such operations can cause to fields and streams. The information center of the Interior Department is intended to provide needed information to cattle raisers, farmers, environmentalists, pollution control authorities, and legislators.

Recommendations 8 and 9 represent two aspects of a general problem—that of assuring a good match between the activities and output of an information system and the needs of the users of the system. The former is addressed to the governmental decision maker, recommending that he take personal initiative to see that his management information system has the needed coverage, consistency, reliability, and utility, while the latter is addressed to the information system operator, recommending that he take measures to ensure that his user community lets him know what it wants and needs. These recommendations emphasize that both parties in an information system—the users and the operators—share the responsibility of making the system effective.

The following two recommendations (10 and 11) deal with relationships between national educational systems and information systems. They point out the need for the educational system to train the people needed to design and operate information systems, and call upon governments to do this, since the educational system is normally the government's responsibility. Further, since the educational system of the future must be a life-long process, information systems must participate in and

Conclusions

1. The scope of OECD's past activity in scientific and technological information has been too narrow.
2. Available scientific and technological information must be used more effectively in the future in making public policy, applying technology, and developing science.
3. Proper handling of information must not be regarded as an administrative or mechanical matter, to be considered apart from R & D strategy.
4. Effective formulation of public policy demands the use of scientific and technological information in conjunction with social, economic, and political information.
5. Information systems designed for research workers for their own requirements are inadequate for users in other disciplines and in technology.
6. Systematic information requirements of industrial technology, in comparison with the requirements of basic science, have been neglected by governments.
7. Traditional, discipline-oriented information systems are not effective in tackling multidisciplinary social problems.
8. Greater emphasis on quality control is needed to ensure that information is not misleading without extensive interpretation.
9. Existing information systems are at an experimental level of development and will remain so for many years.
10. Demands of modern information systems are creating new professions and skills for which organized training is not yet adequate.
11. Information systems of the future must be dynamic, capable of educating, and adaptable to the changing educational systems of the world.
12. National self-sufficiency in scientific and technical information is not a realistic policy alternative for any nation, even the largest.
13. Smaller nations, especially those not using a major world language, have special problems in obtaining access to the world's scientific and technological literature.

Recommendations

1. The OECD should expand its information policy activities.
2. Governments should accord priority attention not only to policies for the generation of scientific and technological information, but also to policies for use in policy making, governmental decisions, and R & D management.
3. Policies and strategies for information should be developed as an integral part of the design of policy as a whole.
4. Management information systems for government should be designed to encompass all forms of relevant information and must be timely, structured, selective, and credible.
5. Governments should give greater support to mechanisms for ensuring effective interchange of information among scientists, paying special attention to analysis, consolidation, evaluation, and repackaging.
6. Governments must determine actual patterns of the use of technical information in industry and examine the utility of government-sponsored systems in light of these patterns.
7. Experimental systems should be developed in a few priority problem areas, to determine the practicality of serving, in a unified system, the needs of researchers, engineers, administrators, and policy makers.
8. Government authorities should examine their needs for information for management decisions and they should take steps to ensure that the information received has appropriate coverage, internal consistency, reliability, and utility.
9. Attention should be given to obtaining feedback from user experience for present and future information systems.
10. Manpower and education programs of governments should consider the need for trained personnel to participate in the design and operation of information systems.
11. Evaluation of educational requirements of modern societies should take account of the need for information transfer systems that are better adapted to the continuing reeducation of adults.
12. International cooperation as a means for using the store of human knowledge more effectively should be increasingly relied upon and strengthened.
13. Nations should design their R & D policies to take account of world knowledge that is available through proper investments in information transfer systems.

adapt to that process. For U.S. policy, especially in scientific and technological education, these recommendations would require the Office of Education and the National Science Foundation to develop joint plans for long-term development. The information systems stimulated by the National Science Foundation have heretofore focused primarily on the needs of research specialists; greater attention should be paid to the life-long educational process of nonspecialists. The network of educational resource information centers sponsored by the Office of Education is an increasingly important mechanism for getting appropriate information collected, digested, interpreted, and placed into the hands of a variety of users. An extension of this concept, as needed, would be consistent with the recommendations and the spirit of the OECD report.

Finally, the last two recommendations of the OECD ad hoc group deal with international cooperation. They urge increased and strengthened international cooperation, pointing out that reliance upon national self-sufficiency has never been a realistic policy. The United States, while still the single largest contributor to the world's new knowledge, is seeing its relative contribution shrink steadily. In most fields of science and technology, the U.S. contribution is now from 20 to 30 percent of the total, down from 25 to 50 percent several years ago. We can no longer assume, as many U.S. scientists and engineers have up to now, that any paper worth reading will appear in the English language. The situation calls for more vigorous development of the information analysis center concept, relying upon such centers to collect relevant literature from the entire world's output, index it, store, evaluate, and condense it into reports on the state of the art, critical reviews, and compilations of data. The smaller nations, especially those whose mother tongue is not a major world language, must take special care to ensure that they have access to that portion of the world's information that they need, taking into account the importance of concentrating their R & D programs on a limited number of technical areas in which they can hope to make a contribution.

We do not claim to have done full justice in this article to the series of conclusions and recommendations produced by the OECD committee. They are worthy of serious consideration by all those governmental and nongovernmental officials concerned with policy decisions on science and technology and with the effective use of the world's greatest natural resource—information.

References and Notes

1. *Information for a Changing Society* (Organization for Economic Cooperation and Development, Paris, France, 1971. Available from OECD Publications Center, 1750 Pennsylvania Avenue NW, Washington, D.C.)
2. Members were Pierre Piganiol (France), S. Balke (Germany), L. M. Branscomb (United States), S. Hamada (Japan), H. T. Hookway (United Kingdom), B. V. Tell (Sweden), and J. R. Whitehead (Canada).

NEWS AND COMMENT

Division of Biologics Standards: Scientific Management Questioned

"The Division of Biologics Standards should be in the forefront of efforts to present the public with the best and most effective and safest vaccines possible. Unfortunately the Division is not in the forefront. Rather it lags so far behind as to be jeopardizing the very concept of vaccine therapy by its scientific mismanagement. The following events suggest a major breakdown in the scientific integrity of the DBS. . . ."

So runs the preamble to a menacing dossier of charges drawn up against the government agency responsible for vaccine regulation by J. Anthony Morris, a DBS research scientist, and James S. Turner, an attorney and former consultant to Ralph Nader's Center for the Study of Responsive Law. The importance of the charges is that they have set in motion thorough investigations of the DBS's affairs by Congress and by the National Institutes of Health, of which the DBS is a part. The precise merit of the Morris-Turner indictment is harder to assess, and the DBS management should be regarded as innocent of the specific charges until and unless the various studies in progress show otherwise.

The charges and the response to them are part of an involved and continuing campaign waged by Morris and Turner against both the DBS and the front office on the NIH campus. The opening round of the campaign was a Civil Service grievance proceeding held early last year, in which Morris, ably represented by Turner, claimed he had been harassed by the DBS management (*Science*, 25 February 1972, page 861). The grievance committee upheld Morris's claim and round one went decisively to Morris and Turner. NIH Director Robert Q. Marston accepted the grievance committee's finding that Morris had been harassed and ordered facilities for scientific work to be restored to him. Marston rejected the committee's recommendation that the DBS management be censured, but he appointed in August last year a group of NIH management consultants to review the administrative affairs of the DBS. (Headed by an NIH management specialist, James W. Schriver, the group's report is still in draft form and has not yet been released by the NIH.)

The second round of the campaign was initiated when Morris and Turner indicted scientific management in the DBS in a document that was delivered simultaneously to Marston and Senator Abraham Ribicoff (D–Conn.) on 27 September last year. When Ribicoff read the document into the *Congressional Record* 3 weeks later, NIH had lost the opportunity of conducting a deliberate in-house review of the charges; instead, Marston appointed a committee of outside academic experts to make an urgent study of the Morris-Turner indictment. Chaired by Abram S. Benenson, professor of medicine at the University of Kentucky, the committee reported on 9 November that, save for a few minor irregularities of no relevance to the public health, it could confirm none of the specific charges raised by Morris and Turner. Round two to the NIH, but by 6 December, within a week of seeing the Benenson report, Morris and Turner had prepared a detailed re-