6. SCIENCE INFORMATION FOR POLICY

SCIENCE POLICY INFORMATION

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1. Access to the Science Policy Information

(1) Functions of Science Policy

Science policy represents the general viewpoints of the central government and the measures it plans to take for the promotion of sciences. The aim of Science policy is to establish research organizations that are best adequate for given research activities, by taking into full account the specific characteristics and the prospects for future direction of development of the subject science areas. Shortly speaking, the functions of science policy is to provide an environment most suitable for the conduct of high level research activities.

It is noted that today the various conditions for scientific research are changing: Universities and colleges that have served for a long time as the center for scientific research, have now become greatly popularized: Scientific research also changes in itself, with the rise of a need for reintegrating the disciplinary branches, and with the recent trend of expanding research scale into so-called "big sciences". The society of today demands more from scientific research. In order to deal with this situation properly, it is obviously necessary for the government to develop a vigorous science policy from a broad comprehensive viewpoint.

In this context, special attention is to be called for to the following points:

a. Achieve optimum combination of the measures for building a broad basis upon which to sprout and grow versatile ideas, and the measures for selecting excellent research programs for special emphasis in providing government support. Such a selective and priolity-based system would assist in making marked progress in the selected important research areas.

b. In providing the selective support, care must be taken to establish a fair and objective evaluation system. This would require the development of reliable methodologies for such evaluation.

c. Basic sciences generally require conbinious support over a long period of time, and their research results are hardly appraisable on a short-range basis. However, there are also times where it is appropriate and necessary to make large investiments rather intensively in certain research areas.

d. Secure researchers of high ability, as the key to success of any programs.

Since science policy is one of the central government's policy complex, framing, scheming, projecting or executing the policy comes to the responsibility of the government ultimately. Science has a cultural value in itself. Thus, science policy constitutes a part of the government's cultural policy in a broad sense. It is also closely integrated in the education policy of the government. Furthermore, in terms of adding "intelectual capital" to a society and in terms of contributing to the welfare of people, the science policy is intimately related to the economic and social policies as well.

Nevertheless, science policy is most directly related to the government's policies for "technological sciences" (or, "science and technology"). The phrase of "technological sciences" refers to the research activities in natural sciences conducted for specific utilization or for certain missions, including resultant technical developments. Thus, the "technological sciences" are different in concept and in approach for promotional steps, from those of the "science policy" which is not, in principle, aimed at a direct application or utilization. Consequently, the policy for the technology-related sciences and the science policy must be disigned to be mutually-complementary in an overall picture of the nation's R & D efforts.

(2) Necessity of the Science Policy Information

In our country, the government has allocated research funds mainly by the request of universities or other research institutes, which has not necessarily been linked with the direction of development of the subject science areas. This has been because the fundamental policy has been that each researcher's free conception should have had the greatest respection in promoting scientific activities, and that, in connection with this policy, main research funds system has been the allocation of general university funds which has not had direct junction with some specific research purpose. We still think this system works good, in our country, but it is also true that recently many people critisize the passiveness and too much indirectness of the system to cope with the radical changing of the research and development, or with the necessity of investing or maintaining of some big scientific projects. To prepare the comprehensive network of research activities through multiple universities and other research institutes, or to plan out arrangement of the big scale equipments, reconsideration of the adequate system for supporting scientific activities has become inevitably necessary, by considering reliability of the schemes, potential of the manpower, inclination of the given science areas, in central government level. Thus, science policy information, which is the sure premise of the prudent consideration, has now closed up as a important device of the policy making.

Science policy information comprises, a) informations necessary to glaspe the present condition and the issues of the research and development activities, and to predict the future tendency of the activities, b) informations necessary to consider the adequate research and development system, including improvement of the relationship between basic research, applied research, and development, reconsideration of the way of participation of each sector (government sector, university sector, industry sector, and so on), and necessary to plan the comprehensive scheme to promote scientific activities, c) informations necessary to maintain the existing research and development activities properly.

(3) Access to the Science Policy Information

As science policy represents the general viewpoints of the central government and the measures it plans to take for the promotion of sciences, when we think about the access to the science policy information, we may think mainly access to the science policy information in a stage of the government.

a. The informations aquiered and stimulated by the ministries and agencies which are concerned with science policy are significant firstly, since the functions of the Cabinet are fundamentally performed by each ministries and agencies. Prime Minister's Office, Science and Technology Agency, and Ministry of Education, Science, and Culture, are the three agencies that are concerned with science policy directly. Under the Prime Minister's Office, such science policy making body as Japan Science Council, Council for Science and Technology, Atomic Energy Commission, and Space Activities Commission are organized. Science and Technology Agency's missions are to promote science and technology, to perform comprehensive scientific and technological administration for the development of national economics. But the science which are concerned merely with humanities or which are performed in universities and colleges are excluded from their duty. Ministry of Education, Science, and Culture's functions are to perform administrations of educational affairs, scientific affairs and cultural affairs comprehensively. They execute surveys and plannings for the promotion of sciences by themselves, but also they have some science policy making body such as Science Council, Geodesy Council, and so on.

   As Science and Technology Agency has many laboratories, and as Ministry of Education, Science, and Culture has national universities and other research institutes, the other agencies such as Japan Police Agency, National Defence Agency, Hokkaido Development Agency, Emvironment Protection Agency, Ministry of Finance, Ministry of Welfare, Ministry of Agriculture and Fishery, Ministry of International Trade and Industry, Ministry of Transportion, Ministry of Telecommunication and Postal Services, Ministry of Labor, Ministry of Construction, Ministry of Domestic Administration, have research institutes or laboratories connected with their missions.

   These agencies have enough informations to perform their duties, as they have collected enormous and intimate informations concerned with their missions. But, the system to utilize these informations comprehensively has not been in effect at present. Examples of the openly published reports are, "Report on the Survey of Research and Devleopment" (annual) by Statistics Bureau of Prime Minister's Office, "White Paper on Science and Technology" (annual) by Science and Technology Agency, Fundamental Educational Statistics (annual), Survey on School Teachers (every 3 years), white papers on education or sciences (on occasion) by Ministry of Education, Science, and Culture. Other agencies also usually publish white papers concerned with their duties.

b. There are two sorts of informations that show the common policy through all agencies. One is a Cabinet decided long or short range plan. Typical one is "New Seven Years Planning for the Economic and Social Development" decided in 1979. Second one is a Budget of the government which is decided by the Cabinet every year. We can read the science policy of the Cabinet expressed in Budget, by analizing Budget Book and its attached papers.

c. Each minister's messages in the Diet are also one of the measures to know science policy expressed officially.

The usual assembly of the Diet opens in December, and they begin their actual sessions in early February, after the Budget of the Cabinet is transmitted to the Diet. They have the Budget Committee at first, which deals with the Budget of the next fiscal year (which begins in comming April 1), and then have committees which deliberate on specific bills. At the beginning of the all sessions, the Prime Minister makes his speach on his Cabinet's general policy, and at the beginning of each committee, ministers make their speaches on the policies they concerns with. These speeches are general ones, and the details can only be cleared through discussions on the committees. But anyway, we can glaspe officially expressed policies through these speeches, and as for the science policy, we have a chance to recognize its general contents and situations connecting with other policies.

2. Issues on International Comparison of the Science Policy Information

(1) Necessity of International Comparison

The nature of science can be said originally international. The development of the sciences in one country precedes the development of sciences in other countries through international exchanges. The results of scientific research are inherited to the next generation as common assets of the humanities. Especially recently, following facts have made the international exchange in scientific affairs more and more important: a) Exchange of the informations and researchers has become remarkably easy as transportation and measures of correspondence has markedly developed, b) Big scale international cooperations in the fields of astronomy, geophysics, etc., in which area researchers need to acquire common data and act cooperately by the nature of the science, have developed rapidly. c) Problems which are concerned with the survival of the human beings, such as those on environment, energy, natural resources, foods, and population, has become urgent issues to be solved globally. d) There has emerged such big cost consuming and numerous manpower requiring science areas as merely one country can not perform; for example, space science, accelerator science, etc. e) The importance of promotion of independent growth of each developing countries in socio-economical or cultural stages has become recognized world-widely. So-called south-north problem is symbolical.

Pursueing these necessities, we have adopted the international exchange in scientific affairs as one of the important science policies, and have endevoured to promote active exchanges. In promoting exchanges, the comparison of the science policy informations or other substructural science policy informations of each country is so significant. Even though each country has its own historical backgrounds or various circumstances, to know the direction of the policy or to learn the wisdom for solving the existing problems is sufficiently useful for the other countries.

Nevertheless, there are so many issues in comparing the informations. Fundamentally, even though scientific activities have international nature, as the science system is undoubtedly one of the social systems of each country, we need comprehensive understanding of the country's historical or social backgrounds to realize the complete meanings of the data available. And even when we do not request such comprehensive or complete comparison, there exist many problems on uncomplex comparison of the informations. Following are some examples of such practical issues, found in the OECD/CSTP papers named "Trends in R & D in the Higher Education Sector in OECD Member Countries since 1965 and their Impact on National Basic Research Efforts" (SPT (79) 20), and "National Method of Measuring Higher Education R & D: Problems of International Comparison" (SPT (79) 21).

(2) Number of Researchers

By STP (79) 20, number of the researchers hired by higher education sector is as shown in Table 1.

Table 1. Numbers of the Researchers Hired by Higher Education Sector (1975)

Country	RSE	Total R & D Manpower	Higher Education RSE / National Total RSE
U.S.A.	82,286	126,191	14 %
France	21,278	41,954	34
Germany	25,617	65,028	40
Japan	141,829	196,003	45
U.K.	15,530	–	17
Others	61,943	120,612	–
Total	348,483	549,788	–

RSE: Research Scientists and Engineers = Researchers

We are astonished by the enomous number of researchers of Japan. The number shares 40% of all OECD countries, and OECD secretariat also notices that this number may be seriously overstimated.

a. To catch the number of "Higher Education" sector precisely, it is important, at first, to make clear what "Higher Education" is. Each country's coverage is reported as follows:

U.S.A.:	Public and private universities (including medical schools) plus 20 or 30 FFRDCs administered by universities.
France:	Public higher education establishments plus the National Center for Scientific Research (CNRS). Excludes private higher education establishments which are included in the Private Non-Profit sector.
Germany:	Universities, technical universities, university clinics, teacher training colleges, combined universities (Gesamthochschulen), music and art colleges, other colleges and post secondary establishments (Fachhochschulen).
Japan:	Universities and colleges (including junior colleges and technical colleges) plus research institutes attached to universities.
U.K.:	45 public universities plus all those non-university post-secondary (further education) establishments thought to perform significant amounts of R & D. It includes the Open University, the private University College Buckingham (not surveyed at all) and Research Council Units at, or associated with, universities (included in the Government sector).

OECD's manual defines "Higher Education" as "All universities, colleges of technology and other institutes of post-secondary education whatever their source of finance or legal status. It also includes all research institutes, experimental stations and clinics operating under the direct control of or administered by or associated with higher education establishments". It seems to be fundamentally clear that they think "Higher Education" as "post-secondary establishments", but definite classification of the university hospital, central research centers such as Research council of the U.K. or CNRS of France, are not completely clearly cut. As for the U.S.A., the treatment of the post-secondary establishments which are not fundamentally engaged in research activities, such as community colleges, seems to be delicate.

b. Second problem is how to count the number of the researchers. As for the Japan's number, Statistics Bureau of Prince Minister's Office defines the numbers, in the "Report on the Survey of Research and Development", as "all persons regularly employed on R & D": This means that they count the number of physical persons. Whereas, in the U.S.A. statistics, it is said that the number is "full-time-equivalent" one, though how to convert physical persons to fulltime equivalent is not clearly shown. European countries use following co-efficients mainly considering the conversion of the numbers of teaching staffs.

Table 2. Co-efficients of Manpower (1975)

	Germany	France	U.K.
Natural Sciences	60	65	35
Engineering	55	65	28
Medical Sciences	50	30	30
Agricultural Sciences	60	30	36
Social Sciences and Humanities	25	10	22

The co-efficients are different not only from country to country, but also they are different from year to year in one country. Besides, the reason why they adopt such co-efficients is not clearly shown. Nevertheless, the adoption of co-efficients is very convenient on comparison. Though it is well understandable that these co-efficients could change by countries or by times, to establish common understanding on co-efficients and improving them seem to be highly recommended.

If we adopt German co-efficients to count the number of the Japan's researchers, it counts 60,426 researchers, and the share of them appears 22.6%.

c. As for graduate school students, both the U.S.A. and Japan have the same policy to count them as researchers. But, speaking them more precisely, in the U.S.A., they counts numbers converted into full-time equivalent, whereas in Japan, they count all numbers of the physical students who are attending doctorate course (which means the latter 3 year period of 5 year graduate school course). On the other hand, in European countries, because graduate school system is not well established, the number of the students seems not to be counted as researchers.

(3) There are Also Problems in the Number of Supporting Staffs.

Table 3. Numbers of Supporting Staffs per Researchers (1975)

	1971	1972	1973	1974	1975
U.S.A.	0.55	0.63	0.60	0.58	–
France	–	–	0.99	–	1.0
Germany	2.5	2.3	2.1	2.1	2.0
Japan	1.6	1.5	1.4	1.4	1.4

The reason why the ratio of the U.S.A. is extraordinarily undercounted is that they only count the numbers of technicians. In Japan, statisticis manual says that supporting staffs include "technicians, assistant research workers, and clergical and other supporting staffs "The difinition in European countries is unclear.

In this issue, we need common understanding on how we classify researchers and supporting staffs, or what is the coverage of supporting staffs.

(4) Amounts of Research Funds

The data on the research funds are shown as follows:

Table 4. University Research Expenditures (1975)

	University Research Expenditure		U R Expenditure/GERD
U.S.A.	5,560.4	$ Million	15 %
France	975.9		16
Germany	1,865.8		20
Japan	2,830.0		28
U.K.	503.0		8

GERD: Gross Intramural Expenditure on R & D

a. The coverage of "Higher Education" should also be the first issue.

b. The next issue is the treatment of educational expenditures. In Japan's statistics, the possibility counting the expeditures of the establishments which are fundamentally educational organizations (the number of such colleges is great.) as the research expenditures seems to be high. Because by the statistics manual, they are requested to cover all the expentitures on R & D such as "wages and salaries, materials, expenditures of tangible fixed assets and other expenditures". But in European countries, they use the same co-efficients on salaries and wages as in the manpower counting, and use another co-efficients on the other current and capital expenditures.

Table 5. Co-efficients on Current Costs and on Capital Expenditures (1975)

	Current Costs		Capital Expenditures		
	Germany	France	Germany	France	U.K.
Natural Sciences	60	20	50	30	20
Engineering	50	20	50	30	20
Medical Sciences	60	20	50	30	20
Agricultural Sciences	75	20	50	30	20
Social Sciences and Humanities	60	20	50	30	20

In case of the U.S.A., they count only separately budgeted expenditures on R & D as current expenditures, and exclude departmental R & D expenditures. OECD secretariat estimates that if added these excluded expenditures, total figure will be up by 12%. And as for capital expenditures, they include expenditures on R & D activities and on instructive activities, but exclude the expenditures on land.

c. One more element that makes comparison complexed is the existance of Generl University Funds. As obvious in Table 6, the share of GUF is big in the U.K. and Japan. In these cases, the total or general running expenditures, including instructive costs, research costs, and other administrative costs, are allocated by, for example, the number of the chairs or staffs, or the number of students, etc. So it is difficult to count clearly the expenditures on research activities.

Table 6. Type of Public Funding of University R & D (1975)

	Direct Funding	Public GUF	Total %
U.S.A.	75	25	100
France	65	35	100
U.K.	23	77	100
Japan	13	87	100

GUF: General University Funds.

d. Next issue is the exchange rates of each countriy's amounts of money. This exchange rate means not merely total conversion rates of each country's current value, but also more intimate changes by the nature of the expenditures, such as labor costs, capital costs, etc. OECD secretarial made some estimates on 1975 data, by using exchange rates shown in Table 7, and made tentative results shown in Table 8. The result seems to suggest that current exchange rates overestimate Higher Education R & D in Germany, are more or less right in France, but underestimate Higher Education R & D in the U.K.

Table 7. Exchange Rates Parities Compared with Current Exchange Rates

	Labor Costs	Other Current	Land & Building	Instrumentations & Equipment	R & D Average
Germany	1.221	1.177	0.999	1.074	1.196
France	0.941	1.040	1.091	1.061	0.975
U.K.	0.726	0.689	1.033	1.025	0.749

Table 8. Adjusted Exchanges Rates (1975)

	Higher Education R & D ($ US Millions)	
	Current Rates	Adjusted Rates
Germany	1,866	1,560
France	976	1,001
U.K.	503	672

(5) Different Treatment Between Research Areas is Also Another Problem

Science policy makers are becoming increasingly interested in detailed analysis by fields of sciences. But unfortunately, there are already problems of comparison for the R & D data for the five major fields of sciences (Natural Sciences, Engineerings, Mecial Sciences, Agricultural Sciences, and Social Sciencies and Humanities). For example, in the 1975 International Survey Year statistics of OECD, Canada and the U.K. reported totals only and the French response grouped the Natural Sciences with Engineering and the Medical Sciences with Agricultural Sciences. In the U.S.A., the Medical and Agricultural Sciences could not be identified separately for certain measures. This failure to break out Agricultural and Medical Sciences generally occurs because they are grouped within a larger Life Sciences category. Even when data exist for all five major fields of sciences, their interpretations are not always evident. Here's another interesting table.

Table 9. Percentage Distribution of Higher Education R & D by Major Fields of Sciences (1975)

	Germany	Japan
Natural Sciences	33.2	7.8
Engineering	16.7	22.0
Medical Sciences	25.4	26.2
Agricultural Sciences	7.5	5.4
Social Sciences and Humanities	17.2	38.5
Total	100	100

In Germany the Natural Sciences rank first for R & D performance but come in second to last in Japan, where top spot goes to the Social Sciences and Humanities. This is because, in Japan, the Social Sciences and Humanities include "domestic economy, nursery science, gymnastics, foreign languages and others", which make up about one-third of university Social Sciences and Humanities R &D (21.4% out of 38.5% is for so-called Social Sciences and Humanities), and which, I suspect, are not counted in SSH in other countries.

(6) Sources of Funds for Higher Education R & D is shown as follows:

Table 10. Sources of Funds for Higher Education R & D (1975)

	Public			Other Sources				
	Total	Direct	GUF	Total	Industry	PNP	HE	Abroad
France	97.9	63.4	34.4	2.1	1.9	0.1	–	0.1
Germany	(90.0)			(10.0)	(2.0)	(8.0)	–	–
U.S.A.	88.5	66.0	22.5	11.5	2.0	4.7	4.8	–
U.K.	80.3	18.5	61.8	19.7	3.4	5.0	9.3	2.0
Japan	56.4	7.4	49.0	43.6	0.7	–	42.9	0.0

PNP: Private Non-Profit
HE: Higher Education

Totally speaking, the Government finances the lion's share of R & D in the Higher Education sector, and Japan appears to be the only country where more than a quarter of total expenditure on university research does not come from Government. This is maijnly because, financial aid for private schools is, same as for national universities, done by allocating GUF funds, and such aid is counted not in Public sector, but in HE category. Public funds for such private school aid count about 12%, which we could count in public funding. Nevertheless, even if we discount these 12% funds, there remain over 30% of funds in HE category. One of the reasons may be that there are many private schools of domestic economy, gymnastics or others which are not counted in any higher educational research category.

INFORMATION FOR SCIENCE POLICY

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The focus of this paper is on the information available to and needed by those who make and implement science and technology policy. Its purview is primarily public policymaking at the level of the national legislature and executive. Thus, it will include, but in less detail, international aspects, relationships with other levels of government, and interactions with private sector, industrial, academic, and not-for-profit institutions. The paper explicitly is not aimed at science and technology information of a substantive nature (often referred to as STINFO) that is both the major input and output of the research and development process.

First it may be helpful to identify key users of science policymaking information – perhaps to be abbreviated SPINFO. In our decentralized multiple-actor, U.S. science policy milieu, the requirements vary greatly as to types of information, timing, and formats. Many of those requiring and using information from some parts of the loose and changing networks are themselves producers of information used by others. Because of greater familiarity, this writer's viewpoint will highlight the role of Congress but this does not imply anything hierarchial or central about the role of Congress. In some areas the Congress is *the* controlling institution. It alone can express national or Federal policy in statutes. It authorizes and appropriates funds and creates and conducts oversight of major Federal science and technology institutions. It is the arbiter and sometimes initiator of national priorities and must bear the pressure when there is insufficient consensus for action. But the President often initiates and almost always implements expressed science policy. Through the executive departments and agencies he carries out authorized programs. Top level administrators for science and technology in executive branch institutions carry great weight in developing, interpreting, executing both the de jure and de facto science policies. Their counterparts in the regulatory, tax, economic, and other agencies also greatly influence science policy, sometimes unconsciously. State and local governments have had greater influence on science policy in recent years but this role waxes and wanes and varies greatly in quality among the States and other governmental units.

There are overlaping and some unique roles in science policymaking by business, labor, the academic and not-for-profit communities, special interest groups and increasingly by highly motivated citizens. The lay-public, in general has a perceptible but diffuse impact on science policy through its expression of values, its life-style patterns, and, of course, through its economic, consumer and political actions. While the "information" generated by these macrobehaviors and beliefs is unspecific, unsystematic and often not explictly perceptible, it is influential along with the specific material to be discussed here under the label SPINFO.

SELECTED DOCUMENTS OF USE IN SCIENCE POLICY DECISIONMAKING

The documents described in this section provide an illustrative cross-section of the variety of documentation available to science policy decision-makers. Although numerous sources of qualitative information exist, the National Science Foundation (NSF) provides the most comprehensive and accurate quantitive information concerning both the Federal Government's and private sector roles in performing science and technology. Congressional documents selected include the familiar recording of hearings and reports on legislation. In addition are variety of informational and analytical reports from the several congressional support agencies – the Congressional Research Service, General Accounting Office, Office of Technology Assessment, and the Congressional Budget Office.

No attempt to be comprehensive has been made in the samples selected. One criteria for selection was to demonstrate the wide range of sources, formats, and frequency of the documentation available to science policy-makers. For these, the subject matter is essentially random. For the more familar periodical and bound literature, the samples were chosen for their relevance to the topic of this paper and thus serve the duplicate role as a bibliography.

National Science Foundation

National Science Foundation. National patterns of science and technology resources 1980. Washington, D.C., National Science Foundation, March 1980. NSF 80-308

A description of "R&D resources as viewed from a national perspective" which includes the following:

historical time series data and estimates for fiscal year 1980 of basic and applied research and development resources; employment opportunities for science and engineering personnel including projections of future conditions in the science/engineering labor market.

National Science Foundation. Federal R&D funding by budget function–fiscal years 1979-81. Washington D.C., National Science Foundation, May 1980.

This self-described "elaboration of the administration position on the R&D portion of the 1981 budget" reviews Federal spending on R&D in 17 functional areas including space, defense, energy and natural science. The report is organized to permit "an immediate comparison (of the) relative emphases given to various areas of Federal responsibility."

National Science Foundation. Projections of Science and engineering doctorate supply and utilization 1982 and 1987. Washington, D.C., National Science Foundation, April 1979. NSF 79-303.

The fourth in a series of projections issued by the National Science Foundation since 1969. The product of a continuously improved model which links the supply and utilization of doctoral level personnel, the projections are "tools to anticipate potential problems and opportunities ... (and to) develop a better understanding of the dynamics of the doctoral labor market."

National Science Foundation. Federal funds for research and development–fiscal years 1977, 1978, and 1979. Washington, D.C., National Science Foundation.

This report surveys Federal agency R&D program requests in the 1979 budget as amended by changes in request levels made by subsequent congressional appropriations. Changes in the nature and distribution of Federal R&D funding over the previous decade (1969-79) are presented as is a 40 year retrospective of Federal research budget outlays and R&D obligations.

National Science Foundation. Women and minorities in science and engineering. Washington, D.C., National Science Foundation, January 1977. NSF 77-304

The report analyzes trends of employment and salary rates for women and minorities in science and engineering. Future prospects and opportunities in these two fields are presented for women and minorities and reviewed.

National Science Board. Science indicators 1978. Washington, D.C., National Science Board, 1979.

The fourth report issued by the National Science Board to assess U.S. science and technology "through the presentation and analysis of quantitative indicators." Subject areas include: R&D, basic research, industrial R&D, and scientific and engineering which are illustrated by statistics, charts, graphs, and projections.

National Science Foundation. Annual report 1979. Washington, D.C., National Science Foundation, 1980. NSF 80-1

The annual description of the activities of the National Science Foundation, the research they have supported and selected research results that were reported in the past year.

National Science Foundation. Science resource studies highlights. Washington, D.C., National Science Foundation, various dates.

Highlights present preliminary data from NSF reports in progress.

National Science Foundation. Five year outlook for science and technology. Washington, D.C., National Science Foundation, 1980.

The National Science Foundation's Outlook, as mandated by the National Science Policy Act of 1976, which reviews and discusses the trends for American science and technology during the next five years is a comprehensive view of U.S. scientific efforts as seen through the eyes of the National Science Foundation.

Congressional Committee Prints

U.S. Congress. Senate Committee on Governmental Affairs. Subcommittee on Energy, Nuclear Proliferation, and Federal Services. United States Senate. Federal Advisory Committee Act (P.L. 94-463) Source book: legislative history, texts, and other documents. Washington, D.C., July 1978.

Includes legislative history of FACA, text of FACA, text of background and preliminary bills, house debates, executive order; senate bills, senate reports, conference actions, and reports and the ensuing executive and judicial action.

U.S. Congress. House. Committee on Science and Technology. National science and technology policy issues: part II implementation of the National Science Policy Act. A review prepared by the Congressional Research Services, 1979.

A status report on the implementation of the National Science Policy Act of 1976. (P.L. 94-282)

Congressional Support Agency Reports

Chartrand, Rober and Jerry Borrell. Scientific and technical information (STI) resources and systems: selected references. Washington, D.C., Library of Congress, Congressional Research Service, 1980.

A bibliography of resources and services that deal with scientific and technical information (STI) issues and problems.

Comptroller General of the United States. Social research and development of limited use to national policymakers. Washington, D.C., General Accounting Office, 1977.

The contributions of social research (both basic and applied) and development to the formulation of social policy are examined.

Office of Technology Assessment. An assessment of oil shale technologies volume II: a history and analysis of the Federal prototype oil shale leasing program. Washington, D.C.; Congress of the United States, Office of Technology Assessment, 1980.

An analysis of the Department of Interior's Prototype Program to stimulate private investment into oil shale as an energy resource.

Schacht, Wendy. The appropriate technology concept in the U.S. government programs for technology transfer and technical assistance to the developing nations. Washington, D.C., Library of Congress, Congressional Research Service, 1980.

In this report, "both the advantages and limitations of appropriate technology (AT) are treated and the integration of the AT concept into various U.S. government programs is reviewed."

Congressional Research Service Issue briefs: short to medium length documents issued by the Congressional Research Service include: issue definition; background and policy analysis; legislation; hearings; reports and congressional documents; chronology of events; and additional reference sources.

Congressional Research Service Mini briefs: short (1-4) page documents also issued by CRS include: issue definition; background and future considerations.

Bortnick, Jane. International data flow issues. Library of Congress, Congressional Research Service. Washington, D.C., 1980.

A discussion of the issues concerning international attempts to regulate the flow of data transmitted through information networks.

Congressional Research Service. Update. Library of Congress, Congressional Research Service. Washington, D.C., 1980.

The CRS Update is issued monthly; it includes a listing of available issue briefs, soon to be released issue briefs and abstracts of new CRS Reports.

Articles from Journals and Periodicals

Ackerly, Robert. The Freedom of Information Act in turmoil. Chemical Times & Trends, July 1980.

The Freedom of Information Act "is often being used as a legal system for industrial espionage. ... The business community has been allowed to demand and receive competitors' confidential data..."

Bozeman, Barry and Ian Mitroff, editors. Symposium on managing national science policy. Public Administration Review, v. 39, no. 2, March/April 1979: p. 111-147.

A "symposium ... composed of essays that deal with various issues pertaining to the comprehensive management of science" in the United States. The authors include Barry Bozeman, Richard Mason, Arthur Levine, Ian Mitroff, Henry Lambright, and Albert Teich.

Brickman, Ronald. National Science policy coordination in the European community. International Organization, v. 31, summer 1977: p. 473-496.

"Multiple obstacles to (science) policy coordination (by members of the European Economic Community) have yet to be overcome" despite the issuance in January 1974 of a "resolution calling for the coordination of the science and technology policies of the member countries."

Brown, James. Disclosure of Business Secrets under FOIA: a business perspective. Food, Drug, Cosmetic Law Journal, v. 34, March 1979: p. 148-152.

Under the Freedom of Information Act "the ... manufacturer ... faces a regulatory climate that may well deprive him of value commercial property unless he is able ... to step in and prevent disclosure of his business

secrets to his competitors."

Kester, Tilo. Exchanging Scientific Knowledge the NATO Approach. NATO Review, v. 25, August 1977: p. 19-22.

A description of the NATO Advanced Study Institutes Program: "Their purpose is to contribute to the dissemination of advanced knowledge and the information of contacts among scientists from different countries."

Mann, Richard. Industrial espionage made legal: the Freedom of Information Act. University of Michigan Business Review, v. 31, Nov. 1979: p. 13-17.

The Freedom of Information Act's "principal impact will be the extreme hazard of lawful industrial espionage it creates."

OECD. Activities of OECD in 1978. Paris: OECD 1979.

The activities of the Industrial Committee, the Committee for Scientific and Technological Policy and the Cooperative Action Programme of the OECD are described.

Young, Anthony. Recent developments under FOIA and FACA directly affecting the pharmaceutical industry. Food, Drug, Cosmetic Law Journal, v. 31, Sept. 1976: p. 507-520.

Legal issues encountered by the pharmaceutical industry due to the enactment of the Federal Advisory Committee Act are analyzed by an attorney who concludes that the FACA and FOIA will facilitate "criticism of the industry ... in a new demonstration of the axiom that knowledge is power.

Congressional Clearinghouse of the Future. What's next? Washington, D.C., monthly. 1976.

The newsletter of the Clearinghouse covers foresight activities in the U.S. Congress and a variety of topics and issues dealing with forecasting and futures research.

Speeches

Nixon, Richard. Special message to the Congress on science and technology. March 16, 1972.

Innovation is the key to increasing economic productivity, therefore the climate for innovation should be favorable. Basic research and a new partnership between government, industry, academia and research centers should be supported.

Nixon, Richard. Message to the Congress transmitting reorganization plan No. 1 of 1973 restructuring the Executive Office of the President. January 26, 1973.

"... it is timely and appropriate to transfer to the Director of the National Science Foundation all functions presently vested in the Office of Science and Technology, and to abolish that office ...."

Ford, Gerald. Message to Congress urging approval of his 1977 budget requests and creation of an Office of Science and Technology Policy, March 22, 1976.

"... we must make sure that we have scientific and technological expertise at the highest levels of government. To do this, I have submitted legislation to establish an Office of Science and Technology Policy in the Executive Office of the President...."

Carter, Jimmy. Science and Technology Message to the Congress. March 27, 1979.

" ... a science and technology policy for the future.... The Federal Government should therefore increase its support both for basic research and, where appropriate, for the application of new technologies...."

Carter, Jimmy. National Academy of Sciences remarks at the Academy's annual meeting. April 23, 1979.

"... reaffirm to you my commitment to basic research ... strengthen basic research in the individual Federal agencies ... need innovation on a broader scale...."

Carter, Jimmy. Economic Renewal Program. August 28, 1980.

"A program ... which will significantly enhance our Nation's industrial innovative capacity and thereby help to revitalize America's industrial base ... a uniform government patent policy ... dissemination in this country of technical information ... two corporations for industrial development, specifically to assist small businesses...."

Carter, Jimmy. Industrial innovation initiatives. August 29, 1980.

"... In addition to tax incentives for investment in the latest technology, I favor substantial real growth in Federal support of basic research, and particularly in the great research centers of our colleges and universities...."

Court Decisions and Executive Agency Reports

Diamond, Commissioner of Patents and Trademarks v. Chakrabarty, 100 S. Ct. 2204 (1980).

In this landmark concerning genetic engineering the Supreme Court of the United States held: "A live, human-made micro-organism is patentable...."

U.S. Department of Transportation. Office of the Secretary. State and Local Technology Sharing. Summary Report. June, 1973. Washington, D.C., 1973.

A survey of the activities of the U.S. Department of Transportation efforts to "develop better means for scientific and technological collaboration between the Federal Government and State and local governments."

Recent Key Books on Science and Technology Policy

Golden, William. ed. Science advice to the President. Technology and Society, v. 2, no. 1&2, 1980.

A double issue of the journal *Technology and Society* which reviews the development of the mechanism for presidential science advice in the post World War II era; it includes articles by former science advisors to the President and other members of the American Science policy establishment.

Katz, James Everett. Presidential politics and science policy. Preger Publishers, New York, 1978.

This book examines the role of the science policy within the overall dynamics of presidential policymaking.

SOME ISSUES

Perceptions, Viewpoints, and Values

C.P. Snow called it "the two cultures."* The differences in values, style, and outlook between politicians and scientists and engineers are well known and much discussed in the literature. They will not be belabored here beyond noting that these two cultures still exist and that completely satisfactory methods for bridging and integrating have yet to be developed. The two cultures problem presents a never ending series of issues in SPINFO. What is "proof" to the technologist may be arcane logic to the legislator. What is a meaningful tradeoff to a policymaker may be political or personal manipulation to the scientist. And so on. Though they may share a common set of SPINO documents, the politicians' and the scientists' perceptions of their meaning and utility may vary widely.

Fortunately, in the United States both groups have had sufficient experience with each other to have come a long way toward mutual understanding. Legislators are no longer in awe of the "Doctors". Scientists and engineers have come to respect their appointed and elected leaders as skilled practioners in a different–but vital to them–arena. The SPINFO literature reflects this growing mutual understanding and respect in its subject matter and formats but more in its candidness and completeness. Scientists no longer over-sell their promises to the degree they used to. Legislators and executive appointees know the tough and right questions to ask and they ask them fairly. But fundamental differences remain and much room for improved understanding and trust exists.

Today in the United States we say that during the sixties "the scientists were riding high"–they got most of what they wanted based on faith that more (and presumably better) science was good for all. In the Seventies the characterization was, in one observer's phrase, that "those scientists should be on tap not on top." The SPINFO documentation of the periods reflect this clearly. As we start the Eighties still another characterization may be emerging that (relatively) reduces the roles of both the politician and the scientists in science policymaking. The emergence of an active "participative" role by citizen, industrial, labor, financial and academic groups will be discussed next.

Participation

The New England face-to-face town meetings of our early American history are nostalgically thought to be the epitome of democratic government in action. But that process became unwieldly long before the United States reached its present population of 223 million served by 80,000 units of local government, fifty States, and a complex tri-partite Federal structure. Elected and appointed representative government has evolved and it works reasonably well to this day. But there is a growing public distrust of government along with all large institutions. This is paralleled by a desire in the citizenry for personal expression and a more direct role as part of "the action".
Two issues are immediately apparent: 1) the lack of sophisticated and comprehensive knowledge of most citizens about scientific and technological matters; and 2) layperson's awareness of the complex policy, resource, institutional and procedural matters of science policymaking. Embryonic efforts have been initiated to deal with the SPINFO aspects of these issues alongside the larger "participation" issues of who has access to what? Who represents whom? Who pays for the information needed and its analysis? And, what are the roles, rights, and responsibilities

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* Snow, Charles Percy. The Two Cultures and the Scientific Revolution. New York, Cambridge University Press, 1959.

of the various parties?

Interdisciplinary Communication

In addition to the problem of creating SPINFO readily understandable by politicians and scientists, and for that pair with the interested public, there is the continuing problem of communication among the ever expanding and narrowing sets of scientific and technological disciplines. The problem goes beyond just the technical jargon to rather fundamentally different patterns of thinking and of experimental approaches among the sciences. In view of the increasing interdisciplinarity of many of the problems and opportunities to which science and technology can contribute, just the further splintering of the science policy information set represents a serious issue.

Cross-Cultural Multi-lingual Issues

Just as public and private domestic activities are becoming less distinguishable, domestic and international issues are increasingly inseparable. If anything, some issues are now irrevocably "global". Major examples are environmental pollution, population, food distribution, energy and key materials, terrorism, monetary stability, allocation of the electromagnetic spectrum, ocean resources management and, essential for human survival, keeping the peace. Science and technology (particularly noting that the soft sciences are always included with the hard) are an ingredient in all of these examples, sometimes as part of the problem and in almost all cases, as part of the solutions.

In these areas, the United States in particular, faces some serious problems as to the adequacy of its science and technology policy information base. This may soon be equally true for its STINFO base as well. While figures vary (a SPINFO deficiency itself) it appears that approximately two-thirds of the world's research and development is now performed outside of the U.S. While earlier figures are also approximate, at the very least this is the reverse of the situation of only a decade or so ago. We have graduated several generations of U.S. scientists and engineers in an aura of, "first, best, largest ..." and the notion "not invented here" was at least tacitly acceptable as a basis to ignore or reject much foreign technology. The situation in science was less smug but then there was (and is) the great imbalance in Nobel awards. Quantitively and qualitively the preeminent position of the U.S. in technology has declined.

This decline has several major implications for SPINFO. Dealing with the balance between self-satisfaction and pride toward our own versus other's technology may be the hardest problem of all. The President recognized this in his October 31, 1979 Industrial Innovation message in calling for improved ways of acquiring knowledge of foreign scientific and technological advances.

But at least three other problems face us. Relatively speaking, few U.S. scientists and engineers are fluent in the range of foreign languages in which the world's scientific and technological literature is now appearing. Added to this are our economic difficulties which make it difficult to mount new and possibly massive efforts at translation and, probably more important, for attendence at S and T meetings and for resident study and research abroad. The three foregoing problems are more relevant to STINFO than SPINFO but not exclusively. Another critical science policy information problem is our weakness in understanding in depth the cultures, values, motivations, and style of many of our foreign competitors and collaborators. We are not always well equipped to understand the hopelessness of today's terrorist, the centuries of deep belief in Islam, or a massive cultural revolution as in China. We are no longer in a position (if we ever were) to enforce our values, standards, and procedures on those who can now do it for themselves, nor is that a desirable goal.

Foresight and Assessment

Program, strategic, long range, and other types of planning have been and are key functions in science policy-making. But in the last decade these types of efforts have taken on new dimensions associated with terms like futures, foresight, outlook, and technology, risk and impact assessments. The two key ideas of what future events and options are likely to occur, and "to look before you leap", dominate these new aspects of SPINFO. The initiatives for most of these foreward looking activities and SPINFO requirements are coming from the legislature.

The Legislative Reorganization Act of 1970 which, among other actions, created the Congressional Research Service, calls for CRS to:

> to advise and assist ... in the analysis, appraisal, and evaluate of legislative proposals ... so as to assist ... in (A) determining the advisability of enacting such proposals; (B) estimating the probable results of such proposals and alternatives thereto; and (C) evaluating alternative

> methods for accomplishing those results...."

As each new Congress convenes every other January, the CRS also is required to prepare for committees of both houses lists of emerging issues that appear to be of potential interest to or may require action by those committees.

The Technology Assessment Act of 1972 had its origins in House Science and Technology Committee discussions starting in 1966. A fully functional Office of Technology Assessment now serves the Congress and the flow of a new class of SPINFO assessment documents is available to decisionmakers.

In 1974 the rules of the House of Representatives were formally changed to incorporate a "Foresight Provision" which requires that "each standing committee other than the Committee on Appropriations and ... Budget ... shall on a continuing basis undertake futures research and forecasting on matters within the jurisdiction of that committee."*

The Budget and Impoundment Control Act of 1974 (P.L. 93-344) which, among other actions, created a Congressional Budget Office, calls for "a projection for the period of five fiscal years ... budget outlays (and) of tax expenditures which will result ..." [See 308 (a)].

With particular reference to science and technology, in the National Science and Technology Policy, Organization, and Priorities Act of 1976 (P.L. 94-282), Congress required the Director of the Office of Science and Technology Policy to prepare annually a Science and Technology Five-Year Outlook to:

> ... identify and describe situations and conditions which warrant special attention within the next five years, involving–(1) current and emerging problems of national significance that are identified through scientific research, or in which scientific or technical considerations are of major significance; and (2) opportunities for, and constraints on, the use of new and existing scientific and technological capabilities which can make a significant contribution to the resolution of problems identified under paragraph (1) of this subsection or to the achievement of Federal program objectives or national goals, including those set fourth in section 101 (b) of this Act. [See 206 (a)]

President Carter, as part of other reorganization moves, delegated this responsibility to the Director of the National Science Foundation and in June 1980 the first Outlook was delivered to the Congress.

SOME TRENDS AND OPPORTUNITIES

That an information revolution is already upon us is no news. In the United States the combination of computers with communications is called "compunications". All about us we see working examples of techniques and processes that just a few years ago would have been labeled impossible–as are many of the claims of planners and marketing people today. A few trends and possibilities seem sufficiently well founded to examine for their impacts on science and technology policymaking information.

One of the closest trends is the one described above–that major qualitative, quantative, and stylistic changes in information technology and handling have started and will increase in the next decade. We will need all the SPINFO and STINFO we can get to cope with it. And will have both the opportunity and pressure to modify SPINFO processes, content and perhaps institutions as changes occur.

The dramatic advances in computer graphics and displays offer all SPINFO producers and users a range of capabilities that are prohibitively expensive and time consuming with manual approaches. Perhaps multiple and alternative displays can help bridge some of the conceptual and communication gaps existent among the many disparate actors in the science policymaking process. Extremely rapid access to memory and almost unlimited storage capacity may similarly help. From common and integrated data bases the several groups can elicit the material desired by them in the form they most accurately perceive it. Individually tailored reports or presentations do not appear to be unreasonable in the foresseable future.

In the interim–which may not be many years–advances in word processing, micro-graphics, and computer "printing" can offer greater flexibility, speed, accuracy, and economy in improving existing systems. Geographic separation of the substantive contributors from each other and from the production and distribution groups (perhaps also separated) is no longer a major problem. Solid wires and microwaves can already handle much of this at reasonable cost, but satellites and optical fibers seem to promise unlimited cheap capacity. The *Wall Street Journal* and *Times'* Hong Kong editions are examples of advanced complex systems currently in operation. The biggest dangers in all this seem to be in two types of overload. Science policymakers can only cope with a fraction of the SPINFO currently available to them. Similarly, increased cheap information gathering capabilities can tempt

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* Rules of the House of Representatives, (cl. 2 (b) (1), Rule X), Jefferson's Manual, Section 692 (a), (95th Congress, p. 397).

higher echelons to require more detailed and extensive reports from lower echelons, further overloading all systems.

Human to human communication will always remain a vital part of any policymaking process. Early video conferencing experiments have been marginally successful, mostly limited by temporary connections, high cost, inexperience, and self-consciousness on the part of the participants. Teleconferences among small groups seems to work reasonably well but large (over 10) meetings have had limited success. Computer conferencing seems to be catching on and several "nets" report success and enthusiasm. Even with the advantages of "timelessness" (the recipeint never has to be "on line" with a sender) and a permanent (but destroyable) record, only elite groups of professionals, usually with considerable computer experience, seem to be taking to it.

The achilles heel of much of what is described above seems to be the software. Already programming and entry/retrieval time and costs are outrunning those for the hardware and other services. Coding and access/storage logic problems loom formidable and have led to increased investments in research in information *science* over information technology. Privacy and criminal invasion of information systems regrettably are a growth area of considerable concern. Problems occur all the way from personal files, credit and bank accounts, to trade information and policy and defense secrets.

All of the foregoing will require considerable innovation in institutional forms and procedures. Who will perform the various functions? Who will make and monitor the rules? Who ajudicates conflicts? And that knotiest of policy (politics?) issues, who pays and who benefits?

This brief review of selected aspects of science policy (making) information has lead full circle–to the need for policies and procedures for information per set, including the sub-set of interest here, SPINFO.