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Symposium on International Models of Budget Coordination and Priority Setting for S&T

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This Final Report on a Symposium on "International Models of Budget Coordination and Priority Setting for S&T," held for the National Science Board in November 1999, consists of two volumes. The first consists primarily of an Executive Summary of important themes and issues raised during the two-day Symposium, a brief review of relevant literature, and other background materials on S&T policy-making in the countries represented at the time of the Symposium, prepared by SRI International. (A number of changes have occurred in several countries since that time.) The second volume consists of materials derived from individual presentations representing seven individual countries plus a speaker from the European Commissions Directorate-General for Research. The views expressed in this Report are the responsibility of SRI International and the individual speakers at the Symposium and do not necessarily reflect the views of the National Science Foundation/National Science Board nor of the governments of the individual speakers.

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EXECUTIVE SUMMARY

SYMPOSIUM ON INTERNATIONAL MODELS FOR S&T BUDGET COORDINATION AND PRIORITY SETTING

SUMMARY OF THEMES

INTRODUCTION

This Executive Summary takes the form of a summary of important themes raised during Symposium discussion in the course of presentations by representatives of seven countries, as well as the European Union, on the ways in which their governments and national systems dealt with establishing R&D budget priorities. There were, as organized here, a number of common themes, although not always shared by all of the countries. Given the range of methods and variety of ways in which they have been applied, it is difficult to identify "best practices" at this point in time.

One of the purposes of the Symposium was to identify unique models, methodologies, or other approaches that had been both successful in a particular country and had potential for being applied in the United States. Again, what is unique is hard to identify, and it is even harder at this point to determine what the few identifiably unique features do for the country involved. The budget making processes described had more in common than they did any strikingly individual characteristics – there seemed to be a spread of overlapping approaches. The two most interesting features that suggest possible emergence of unique efforts are both under development. They are:

1) South Korea's first iteration of a budget process that places great emphasis on broad evaluations of both programs and research fields that is expected to alter the content of research activity in various fields, if not the funding distribution of fields broadly described;

2) The remarkable number of major reorganizations taking place as countries grapple with the questions posed by the Symposium and focus on the centrality of a country's S&T infrastructure to its competitiveness in the global economy.

Methods and Techniques Employed

Consensus, if something of an abstraction, was the strongest theme in terms of the method employed to reach a set of priorities and budget figures. The countries participating were generally pluralistic in the number of government agencies involved in the process, although there were varying degrees of centralization. Korea and Brazil have central "Science Ministries," although they share S&T policy responsibilities with other ministries such as education. Germany, France, and Sweden have combined education and science into a single ministry – although France recently reversed the combination. Britain and Japan currently have several ministries involved and rely more on coordinating councils or other mechanisms to bridge departmental differences. However, S&T policy is concentrated in the Department of Trade and Industry (DTI) in Britain, and an ongoing reorganization in Japan will result in greater concentration in a new Ministry of Education and Science (MEXT).[1] All have sought to develop a ***process*** that brings together the stake-holders in S&T policy to build a consensus that can be implemented in the concrete terms of budget allocations. One participant summarized it as "more process than strong methods."

A target percentage of GDP (Gross Expenditure on R&D [GERD] divided by GDP) invested in R&D is often a goal and probably the strongest theme in terms of a concrete objective. This goes as high as Korea's recently set target of 5% by 2003, but is more commonly in the vicinity of the roughly 2-3% spent in the United States, Sweden, Germany and Britain, although the impact of defense R&D on GERD varies considerably among these countries. Developing countries, such as Brazil, are far from attaining such numbers due to a significant extent to the lack of industry support for R&D.

"Foresight" techniques, typically involving multiple panels engaged in "Delphi" approaches to identify promising areas of research are prominent as a method, but limited in their influence. Britain, Germany and Japan have formal iterative processes that use this approach as an input for science policy, but all emphasize that it is part of the dialogue and process, not an algorithm to set policy. Brazil is embarking on a first round.

Increased productivity and "quality" are earnestly sought through a variety of monitoring and evaluation techniques, commonly including publication and citation counts as part of the assessment of outputs. There is widespread concern that a high quality research base is not adequately contributing to innovation and competitiveness (especially, Britain, Brazil, and the EU as a whole). Much of this concern is based on patent indicators, but patents enjoy a mixed reputation as indicators of productivity and commercialization, particularly given the small proportion of those granted that are actually exploited.

[1] Although Japan is joining the countries that have joined higher education and science in ministries, France recently reversed its earlier joining of the two to split the ministry back into the education and research components. What seemed to be a secular trend now seems to have become a fragmented one.

While “benchmarking” can play a role, few countries specifically use comparisons with other countries as yardsticks for setting their own priorities. Germany’s comparison efforts involve carefully constructed “missions” to examine how a field is being handled in other countries and may lead to contrasting approaches to the field at home. A trend toward involving foreign scientists (Sweden for some time, France, Korea, and Japan moving in this direction) in evaluation exercises or advisory committees implies more foreign benchmark inputs, but these are diffuse, not direct priority influences.

Benchmarking and indicators play a role, but there is strong resistance on the part of the research community to the application of the types of rigorous analysis that typify the rigor of their own tools-of-the-trade to the process of evaluation, monitoring, and priority setting.

“Strategic plans” are required at a variety of levels. These may be individual fields within an organizing bridge institution (e.g., France’s plans within the CNRS), particular laboratories or university units, or departments at the ministerial level. Combined with iterative review at higher levels, these tend to serve as further input to the dialogue, not deterministic road maps.

Social Goals

Social goals guide S&T policy. They represent higher level priorities that set parameters for most other policies, including S&T priorities. They can be highly generic, such as “quality of life” (e.g., France) or may derive from specific national circumstances (e.g., the need to address problems of aging populations, especially in Japan and Britain). The EU deliberately poses priority questions in social rather than scientific terms in an effort to force articulation of choices in terms more clearly understood by the political process and politicians involved. Indeed, a shift toward social goals for R&D is now a major emphasis within the Commission (Caracostas and Muldur, 1998). OECD data are being classified, among other categories, into social goals.

Social aspects of the S&T enterprise itself are important factors in shaping priorities and policies. Some countries face an aging population of researchers that must be renewed with younger people, while most industrialized nations, including the United States, Japan, and most European countries, face systemic problems of aging populations that impinge on R&D priorities. This poses recruitment and mobility problems that must be addressed with both policies and funding – for recruitment, education, training, career startups, and the like.

Human Resources

Countries face imbalances in human resources for S&T. France produces more Ph.D.s than it can absorb, but most countries are having trouble attracting enough students to science, math, and engineering to meet their needs. France tends to lose Ph.D. graduates to overseas post-doctoral opportunities, which do not exist at home, and has trouble attracting them back. Koreans and Brazilians who train abroad, however, generally return home. Korea, in particular, has made significant efforts to develop attractive professional opportunities to bring scientists and engineers back.

Nearly all countries face problems in providing for industry's needs. The education system often produces the wrong kind of product, products at the wrong time in terms of career choice, products that cannot be absorbed, or have only limited potential career trajectories in industry.

Specific Fields

The countries show considerable unanimity in terms of specific fields that show up in their listings of priorities. These include:

- Genomic and post-genome bioscience;
- Other bioscience and biotechnologies;
- Information technology and telecommunications;
- Advanced materials science.

The emergence of nanotechnology, one of NSF's specific priority areas, was cited as a priority by several other countries. On the other hand, there was a sense that countries are ill-served if priorities squeeze certain fields, such as nuclear energy, down to the point where there is no capacity to gear up the country's capabilities if there are changes that require rebuilding.

Involving Industry

Non-industrial research institutions are commonly being encouraged to interact with industry through the use of various mechanisms, including tax credits for industrial research, cost-sharing arrangements for contract arrangements with universities and other laboratories, and forced budget targets for funding from external contracts.

Industry is provided with a "place at the table" in important councils influencing overall budgets and processes behind these (Britain's involvement of industry in the Research Councils and the Research Assessment Exercise, a variety of German initiatives for regional development efforts, as well as its more traditional involvement through the Fraunhofer Gesselschaft).

The importance of "relevance," "exploitability," and "spin-off companies" are frequent factors that influence budget priorities. However, clear, functional and fundable mechanisms to effect these desirable ends are not well understood.

There are some promising experiments ongoing, but countries emulate each other in funding various mechanisms to encourage interaction of industry with the non-industrial R&D community. These include centers patterned after NSF's ERC program and establishment of technology parks. The degree to which such initiatives affect budgets for particular fields is not clear. For example, a regional initiative in Germany is said to have stimulated substantial amounts of basic research as well as the desired regional biotechnology focus, but no data were available concerning on its impact on *bund* [federal] and *laender* ["state"] funding. It was noted that the very common theme of the need to assist "small and medium enterprises" (SMEs) seemed less visible at the Symposium than it typically is in many forums on S&T funding and innovation.

Role of the Research Community

Although the community is ultimately the recipient of the funding allocated through the R&D budget process, the community is also intimately involved in the setting of priorities through a variety of mechanisms in which it participates. These include:

- consultative roles in the overall budget process (e.g., Korea and Japan);
- competitive peer review allocation of funds provided to research councils (Britain, Sweden, Brazil's PADCT program, the EU's Framework), or independent funding institutions (Germany's DfG or France's CNRS and INSERM) once an overall budget is set;
- a high degree of autonomy in peer reviewed funding allocations within programmatic parameters;
- international peer review as part of the monitoring and evaluation process (France and Sweden, with Japan and Korea implementing such a process).

International Cooperation

International cooperation is on the increase by all empirical measures available. This is partially a function of the information revolution, in which virtual laboratories come into existence via the internet (and are encouraged both intra- and internationally by governments). It is also related to various megaprojects that cannot be sustained by a single country. Finally, the tradition of PI cooperation across national boundaries, in addition to being facilitated by the internet, continues to be supported by various nationally funded programs.

EU cooperation in S&T, especially its five-year Framework programs, is the third largest category of expenditure for the EU (although a quite distant third at 4-5% of the budget). The Framework program is worked out in extensive democratic consultation among the members, and is intended to complement, not substitute for national R&D. It does not conduct basic research (a national function), nor does it do applied research that addresses specific national problems.

Several countries (Sweden, France, Korea, and the EU) have programs intended to support S&T in developing countries. They include training grants, fellowships, exchanges, and some research funding, but are not major investments.

For industrialized countries, mega-projects and selected fields that are not viable on a national basis are the primary motivation for formal cooperation. Mega-projects include the international space station and some large-scale astronomical instruments, as well as cooperation on the human genome effort. The latter, however, is now seen as a prologue to an important new priority area that, itself, has nearly attained completion under ongoing national or industrial efforts. Meanwhile, Germany has, effectively, ceded all of its fusion energy research to the program administered by the EU.

I. Background and Objective of the Symposium

In its Working paper on *Government Funding of Scientific Research* (NSB-97-186), the National Science Board identified a national interest in "some form of 'comprehensive' and 'coherent' coordination of Federally-financed research," which would first require the development of "guidelines to provide clear direction on setting priorities within the Federal research budget." The Strategic Plan of the National Science Board states that: "...the development of an intellectually well founded and broadly accepted methodology for setting priorities across fields of science and engineering is a prerequisite for a coherent and comprehensive Federal allocation process for research." In recent years, stakeholders in both the Administration and the Congress have urged better coordination for the Federal budget for research, and the development of a methodology for priority setting across fields of science and agencies to further that objective.

As a consequence, the *Ad Hoc* Committee on Strategic Science and Engineering Policy Issues, acting in concert with the NSB Task Force on International Issues in Science and Engineering, undertook the arrangement of a "Symposium on International Models for S&T Budget Coordination and Priority Setting. The objective of the Symposium and its background preparations was to provide a review of the relevant literature, as well as hearing the views of a number of active R&D policy makers across a variety of internationally representative countries. The Symposium was held on November 19-20, 1999, in the NSF Board Room, where Committee and Task Force members heard presentations and engaged in dialogue with representatives of seven countries and one international entity, the European Union, on the topic.

The participating countries were selected on the basis of the following criteria:

- Does the country have sufficient experience to serve as a model?
- Does the methodology or aspects of it have potential for application to the U.S.?
- Is the methodology sufficiently different from others to offer special lessons?
- Does inclusion of the country need to be considered for political or representational reasons?
- Are excellent presenters/spokespersons for the country's system likely to be available?
- Does the system for government support of research appear to contribute positively to the scientific and engineering strength of the country?

The countries selected for participation included three large European nations – France, Germany, and the United Kingdom, as well as the European Union, which is a major sponsor of research. Two other industrialized nations, Japan, a major Asian industrial nation, and Sweden, a smaller but scientifically highly advanced country were included. One "Newly Industrialized Economy," the Republic of Korea, and Brazil, the largest scientific presence in Latin America, filled out the roster of participants.

SRI International, a contractor, was asked to identify as potential speakers individuals with roles like that of the U.S. science advisor: in government; intimately knowledgeable about how the process works; and at a high level. Normally that would not be the minister of science or equivalent, who are often in office very briefly and who cannot speak from extensive experience about their government's funding for R&D. Countries vary, but the individuals invited were all at a high level in government and very knowledgeable about how the research budget is actually developed.

The following framework for presentations was provided to the invited guests of the National Science Board:

Guidelines for Speakers

Your presentation should be limited to approximately 25 minutes, followed by a question and answer period with members of the Committee and the Task Force.

Board members will have received a briefing document on your country's R&D budget process prior to the Symposium, outlining the general structure and procedures for your national system as they are described in the published literature. We will be supplying you with a copy of that background document. We ask, therefore, that you assume that Board members are familiar with the background material and address your presentation to the following questions, as appropriate to your national system.

Questions to Address on R&D Budget Coordination and Priority Setting

Q1: What needs are targeted in your country's R&D budget—government, in dustry, society as a whole? International cooperative R&D for activities such as megascience projects, major instrumentation, databases, or human resource capacity building?

Q2: In planning for your government's budget for R&D, how are appropriate levels of support determined for the budget as a whole and for programs and activities funded through the R&D budget?

Q3: Are the research activities of other countries a significant factor in developing your R&D budget? How do you evaluate research supported by other countries? Which other countries? How is this information used in your budgeting activities?

Q4: Please describe the priority setting process in detail.

- What are the key organizations or individuals involved in the priority setting process for the R&D budget? What measures or indicators, models or methodologies are employed in weighing alternative prospects for government investments in R&D?
- How is the priority setting process applied to government support for ***fundamental*** research?

Q5: How do you determine that an area is worth pursuing as a national priority, or whether it should be left to other countries? How do you decide which areas should be pursued collaboratively?

- Do multinational themes, e.g. in the environment, enter into the process for determining national priorities for R&D?
- How are international collaborations supported: direct funding, in-kind contributions, other means?
- Does your government make any specific or special provisions for scientific cooperation with developing countries? If so, are these handled out of your science ministry or equivalent or some other part of the government?

Q6: What mechanisms and tools do you use to assess the benefits of scientific research and development and its contributions to your society?

- What units of analysis are used in measuring the return on government investment? e.g., government agencies and their programs; nongovernmental organizations or sectors that receive government support, such as universities or research institutes; scientific fields of study/disciplines; industrial research and technologies; occupational groups; geographic/political units?

Q7: What data are available for measuring R&D investments and returns on your country's investments? Are these sources available in published or electronic form?

II. Overview of International Practices on Priority Setting and Budget Coordination for S&T

A. Introduction

There is worldwide interest, from highly industrialized nations to the least developed countries and international institutions, such as the World Bank and the European Community, in setting priorities for investment in science and technology. Competitiveness in the emerging global economy, the importance of "knowledge-based societies" and their ability to engage in "created comparative advantage," as well as the desire to address a variety of social problems and values drives this interest.

Despite this, there is very little literature that deals with general models or methodologies for priority setting and budget coordination processes in science and technology (S&T) policy. Most of what can be gleaned from the literature relates to the experiments, some of which are quite similar or represent imitation, by individual countries in their efforts to improve the efficiency of their public S&T investments, as well as the conversion of new knowledge into innovation.[1] The bibliography and review in this report are therefore primarily organized by country.

Perhaps one of the most telling aspects of the Symposium was the eagerness of the invited representatives of other countries to learn from the United States. Representatives of systems that would generally be perceived as more centralized seemed to believe that the U.S. system, long perceived to be decentralized, rich, and in no need of setting priorities, had something to teach other countries.

[1] Although it, too, is based on a series of seven country case studies, SRI International's Science and Public Policy Program is currently working on the final stages of a cross-national comparison project entitled "Strategic Plans and Priorities for Science and Technology: Indicators for a Comparative International Assessment" funded by an NSF grant from the Division of Science Resources Studies. The results should be available some time during the first half of 2001.

B. General Literature

To refer to them as "models" or "methodologies" overstates the amount of rigor involved, but four approaches to priority setting and budget coordination stand out as being widely tried and/or accepted across a number of countries. These are:

- GDP targets
- "Foresight" models or techniques;
- Links to industry;
- Monitoring and evaluation; and
- High level coordination.

Briefly on each of these topics, the United States is roughly at the norm for industrialized countries of 3% of Gross Domestic Product (GDP) as Gross Expenditure on Research and Development (GERD, in terms of OECD Frascati Manual terminology), and on an upward trend. With respect to "Foresight" techniques, the United States has engaged in "Critical Technology" exercises, but Foresight has smacked of "picking winners," anathema to Republicans, not an objective for Democrats. Monitoring and evaluation has not been strongly supported in the United States until the Government Performance and Results Act began to put pressures on agencies for metrics on their performance and outputs. The U.S. science policy apparatus has never had nor been hospitable to a centralized or highly coordinated approach.

The U.S. GERD figure has generally been high, although it has not been a specific target, and, until the end of the Cold War, was strongly affected by the high proportion of defense spending involved. This is now declining, but remains high with respect to international comparisons. The GERD figure has been rising in recent years despite the fact that R&D spending (aside from defense, which is now under pressure) is part of the discretionary budget. Although a limited proportion of the federal budget falls into this category, there has been bipartisan support for R&D spending. Both the Reagan and Clinton administrations have been kind to the research community in their budgets, and Congress has followed their lead – indeed, seized the reins in providing increases in funding for health research. At 2.9% in 1999, the GERD percentage is expected to continue rising given the Administration's boost in R&D budgets for FY2001 and an expected continuing increase in industry's investment in R&D, which accounts for about 70% of GERD in the United States[1].

Internationally, while the U.S. figure has run close to that of Japan and somewhat above the figures for the aggregate of OECD and European Union countries (see the graph in the Swedish presentation, Volume II of this report), Sweden is higher – currently about 4%. The figure for developing countries is generally

[1] Payson, Steven. "R&D as a Percentage of GDP Continues Upward Climb." Division of Science Resources Studies Data Brief. National Science Foundation, 1999.

less than 1%, often despite higher goals. However, India has recently increased its emphasis on science and technology and announced a goal of 2% by 200**, while South Korea, a Newly Industrializing[ed] Economy (NIE) has announced goals of 3% by 2001 and a very high 5% by 2003 (see South Korean presentation, Vol. II).

In terms of policy, GERD is a composite figure over which most governments have only partial control. Governments invest in both civilian and defense research, but the level at which industry chooses to invest in R&D is an independent decision. Government policies, such as the U.S. R&D tax credit and similar programs in other countries, can seek to influence private decision-making. The degree to which such policies actually increase private R&D spending, or even end up paying for R&D investment that would have been done without the incentive is not clear. While private firms typically account for a high percentage of GERD in industrial countries, there is not a tradition in many developing countries of industryial spending on R&D, and many have great difficulty in stimulating such investment. The public R&D budget in Brazil, for example, cannot be greatly expanded at this point and the country's desire to get GERD over 1% is largely dependent on stimulating investment by industry (Brazilian Symposium presentation).

Finally, GERD figures say little about the distribution of funds among fields. Aside from the need to judge the impact of defense spending, the figures primarily suggest the overall emphasis given to R&D by the country as a whole. Breakdown figures by field provided by the OECD are quite broad, and do not provide numbers within the category of "natural and biological sciences" (OECD – Basic Indicators). The greatest current significance of GERD in terms of policy is the broad consensus that the figure should be at least 3% of GDP and that most countries are struggling with ways of increasing their current figure.

Foresight is the approach that can most accurately be referred to as a "model," although its practice varies sufficiently from one country to another that the term "model" is compromised. Both countries and corporations have long attempted to assess prospective developments in science and technology through efforts such as the identification of "critical technologies" and technology forecasting. Distinctions came to be made between "forecasting" (assigning some probability to a specific anticipated outcome), and "Foresight":

"... the ***process*** [emphasis added] involved in systematically attempting to look into the longer-term future of science, technology, the economy and society with the aim of identifying the areas of strategic research and the emerging generic technologies likely to yield the greatest economic and social benefits." *—(Martin, 1995, p.140).*

"Process" is emphasized because Foresight exercises are increasingly treated as part of a national dialogue on national priorities, whereas they initially were viewed, optimistically, as producing clearer road maps to priorities than most countries are willing treat them now. This was reinforced by presentations at the Symposium.

However, what have come to be referred to as “Research Foresight” techniques in a formal sense began to be developed toward the “notional” internationally utilized methods during the 1980s, initially in Canada and the United Kingdom, then in the Netherlands (Elzinga, 1983; Irvine and Martin, 1989; Martin, 1995). The most significant dynamic behind this was the influence of the Thatcher Government in Britain, with its budget cutting and “value for money” outlook. Indeed, the impact of the Thatcher approach to S&T policy and the generally stringent budgetary circumstances of many countries during the 1980s had an impact across many countries (Cozzens *et. al.*, 1990).

The U.K. policy process includes what is probably the most formal incorporation of Foresight in a national policy process (Georghiou, 1996, add). Aspects of the approach are widespread, and there have been an number of cooperative efforts among nations, (Martin, 1995; and German presentation, Vol. II).

Monitoring and evaluation of research programs has long been a factor in S&T policy. Monitoring in the sense of periodic reports and audits is a fact of government support, but site visits to large projects, especially, raise this process to new levels of intensity. Moreover, most U.S. evaluation efforts have been embodied in the *ex ante* process of peer/merit review prior to an award. Although *post hoc* evaluations have been sanctioned, even with funding guidelines of about 2%, by Congress, such guidelines have been more honored in the breach than the observance. The passage of GPRA has concentrated minds mightly on the construction of metrics or the development of alternative, usually qualitative, methods to meet the need for evaluating outputs of government programs, including research.

The evaluation of research programs is a difficult and complex process – and it is generally quite costly. A multidimensional approach is usually called for, one that may include literature review, bibliometrics, expert panels, surveys and focus groups, and site visits. Smaller countries, with Sweden a pioneer (e.g., NFR, September 1997), and larger countries, now increasingly, are bringing foreign scientists into evaluation processes (e.g., Ciba Foundation, 1989; Anderson and Fears, 1996). Thus, this practice is becoming more widespread and is often a formalized part of national priority and budget setting practices (see the Symposium presentations from the United Kingdom and the Republic of Korea, as well as Sweden in Volume II of this report).

General Bibliography

Caracostas, Paraskevas, and U. Muldur. *Society, The Endless Frontier.* (European Commission, Brussels, Belgium, 1998).

Commission of the European Communities. *Research and Technological Development Activities of the European Union: 1999 Annual Report.* (Commission of the European Communities, Brussels, Belgium, 1999).

Cozzens, Susan E., P. Healey, A. Rip, and J. Ziman, (ed.) *The Research System in Transition.* (Kluwer Academic Publishers, Dordrecht, The Netherlands, 1990).

De Marchi, M. et al. *Changing Structure, Organisation and Nature of PSR Systems*. (CNR, Rome, 1998).

Ergas, Henry. "Does Technology Policy Matter?" *Technology and Global Industry: Companies and Nations in the World Economy.* B. Guile and H. Brooks, (ed.) (National Academy Press, Washington DC, 1987, pp. 191-245).

European Union Research Organisations Heads of Research Councils. *(report). Reports on the Strengths and Weaknesses of European Science.* (European Union Research Organisations Heads of Research Councils, 1997).

Evered, David and S. Harnett (ed.) *The Evaluation of Scientific Research.* Ciba Foundation Conference. (John Wiley & Sons, Chichester, UK, 1989).

Future National Research Policies Within the Industrialized Nations, (Report of a Symposium). Government-University-Industry Research Roundtable. (National Academy Press, Washington DC, 1992).

Indicators and Data for European Analysis (IDEA). (further information available at: http://www.step.no/Projectarea/IDEA/papers.htm)

Intangible Assets (publication list) available at: http://www.oecd.org/dsti/sti/industry/indcomp/prod/intang.htm

Koenig, Robert. "E.U. Grabs Food Safety by the Horns". *Science*. (Vol. 287, Jan. 21, 2000, pp. 403-405).

Koenig, Robert. "Research Chief Wants to Make Science Matter". *Science*. (Vol. 286, Dec. 10, 1999, pp. 2065-2067).

Koenig, Robert. "Tough Questions Greet New Research Chief". *Science*. (Vol. 285, Sep. 17, 1999, pp. 1829-1830).

Martin, Ben R. "Foresight in Science and Technology". *Technology Analysis & Strategic Management.* (Vol. 7, No. 2, 1995, pp. 139-168).

Martin, Ben R., and J. Irvine. *Research Foresight: Priority Setting in Science.* (Pinter Publishers, London, 1989).

Martin, Ben R., and J. Irvine. *Research Foresight: Creating the Future.* (Netherlands Ministry of Education and Science, The Hague, 1989).

McLoughlin, Glenn J. *International Science and Technology: A Comparative Study.* (report, prepared at the request of the Committee on Science, House of Representatives). 1997.

Measuring and Reporting Intellectual Capital: Experience, Issues and Prospects. (meeting symposium). (further information available at: http://www.oecd.org/dsti/sti/industry/indcomp/act/Ams-conf/symposium.htm).

Munoz, E., M.J. Santesmases, and J. Espinosa de los Monteros. *European Comparison of Public Research Systems. The Dynamics of PSR in Spain and Portugal.* (IESA, CSIC, Madrid, 1999).

Nelson, Richard R. (ed.) *National Innovation Systems: A Comparative Analysis.* (Oxford University Press, New York, NY, 1993).

Policy Evaluation in Innovation and Technology. (further information available at: http://www.oecd.org/dsti/sti/stat-ana/prod/evaluation.htm).

Research and Technological Development policy (RTD), (further information available at http://europa.eu.int/pol/rd/index_en.htm)

Rothwell, Roy and W. Zegveld. *Industrial Innovation and Public Policy: Preparing for the 1980s and the 1990s.* (Greenwood Press, Westport, Connecticut, 1981).

Senker, J. *Changing Structure, Organisation and Nature of European PSR Systems. Synthesis Report.* (SPRU, University of Sussex, Brighton, 1999).

Senker, J. et al. *European Comparison of Public Research Systems.* (SPRU, University of Sussex, Brighton, 1999).

Schimank, U., and M. Winnes. *Public Sector Research in Europe: Comparative Case Studies on the Organisation of Human Genetics Research.* (Max Planck Institute for the Study of Societies, Koln, March 1999)

Science, Technology and Innovation (working papers) available at: http://www.oecd.org/dsti/sti/s_t/inte/prod/online.htm.

Skoie, H. *The Scandinavian Countries and their Systems of Public Research.* (NIFU, Oslo, 1998).

Vig, Norman J., and H. Paschen, (ed.) *Parliaments and Technology: The Development of Technology Assessment in Europe.* (State University Press, Ithaca, NY, 1999).

Ziegler, J. Nicholas. *Governing Ideas: Strategies for Innovation in France and Germany.* (Cornell University Press, Ithaca, NY, 1997).

III. National Case Studies

A. Introduction

This section represents individual case studies based on selections from the current literature available on each of the countries (and the European Union) represented at the Symposium. For each country a short narrative brief was developed, intended to distill the S&T policy-making process – summarizing where it has been, methodologies or models that have influenced its practices, and the importance that each country ascribes to efforts to set priorities, especially among scientific fields. In each case, the narrative piece describes the stakeholders, government policy-making and funding organization, and the research performing infrastructure of the country.

Wherever possible, a summary organization chart was either taken from the available literature or compiled based on available descriptions of circumstances in late 1999. The objective was to provide an overall chart showing institutional stakeholders in the S&T policy and budget process for each country. Efforts were made to present the organization charts in a particular manner, showing:

1) S&T policy-making and budget setting organizations at the top;
2) Research funding organizations in the middle; and
3) Research performing organizations at the bottom.

Preparations for the Symposium made it clear that many countries share an interest in priority-setting models and that there are changes afoot in many countries in an effort to improve the process of priority setting and budget coordination. The NSB's interest in the topic is most timely, with the invited foreign participants as interested in learning from the United States as in imparting their own countries' experiences.

Many countries are in the process of making major changes in their S&T system, and presentations at the Symposium often displayed changed organizations or contemplated changes to their institutions that already have or will make the charts shown here obsolete.

The most difficult task in considering the ways in which countries set priorities is to discern the balance between "top-down" efforts of governmental agencies to establish priority fields and allocate funding accordingly, and the more traditional "bottom-up" way in which individual fields develop their own priorities and seek the funding that has increasingly come from national governments, especially for basic science. Each of the countries participating in the Symposium has developed ways in which the government and funding agencies seek to influence priorities in order to develop what are perceived as desirable areas of scientific strengths that will typically contribute to competitiveness in the global economy and other social goals, including health and defense. For mission agencies, in fact, the relationship of their research portfolio to such goals, particularly competitiveness, has become an important new dimension of funding criteria. Even the most proactive national efforts, however, have been limited in the degree to which they have attempted to divert their national scientific research effort from a strong reliance on the evolving interests and ideas of their scientific community.

B. Federal Republic of Germany

The system for the conduct of scientific research in Germany is pluralistic and decentralized, with a diversity of performer organizations, each of which has a relatively large degree of autonomy in selecting, managing and directing its own research activities. German public R&D financing has a strong regional dimension. The central government (*Bund*) and the states (*Laender)* accounted for a ratio of 53% - 47% of public R&D expenditures in 1995. Laender funding is concentrated on university research, whereas Bund financial support focuses more on non-university, industrial, and international research. However, with both the Bund and Laender providing funds for R&D, the system of funding is a dual one. It operates quite differently, however, from the dual system in place in the United Kingdom. Rather than two channels of funding from the central government flowing downward toward research institutions, the German system provides two lateral flows of funding – one through Bund and one through Laender mechanisms, a reflection of its more pluralistic character. The system has been complicated in recent years by the effort to assimilate the research infrastructure of the former East Germany, generally patterned on the Soviet Academy model.

The Science Council is a science policy advisory body set up in 1957 to advise the German federal and state governments on all matters of higher education and research policy. Its main function is to prepare reports and recommendations on the structural development of higher educational institutions and research institutes, taking into account the cultural and socio-economic needs of the country. Although the Science Council can only give non-binding statements and recommendations, it has had a decisive influence on the development of the research system, since its resolutions are based on voluntary agreed compromises among the central actors in the system.

The Federal Ministry of Education and Research (BMBF or BMB+F) was established in 1994 by a fusion of the former Ministry for Education and Science and the Ministry for Research and Technology. The Ministry has the overall responsibility for higher education and S&T policy of the central government. BMBF accounts for about 65% of federal expenditures on R&D. BMBF also administers most of the federal priority programs in selected areas of research and technology. Other Ministries that have a significant role in R&D financing are the Ministry of Defense and the Ministry of Economics. (See the flow chart in Vol. II, Ch. II, p.8.)

The German Research Association (Deutsche Forschungsgemeinschaft – DFG) provides most of the outside support for basic research in the universities. The DFG is a non-governmental organization, even though its funds are received almost entirely from the federal and state governments. There are in addition some 900 foundations offering private sources of support for higher education and research. Among the largest of these are the Robert Bosch Foundation, the Humboldt Foundation, and the Volkswagen Foundation.

R&D performer organizations in Germany include higher educational establishments, government research laboratories and institutes, and industry. Included within the higher educational sector are a variety of forms of institutions, including comprehensive universities, technical colleges/universities, colleges of education, art colleges, and polytechnics. As in the United States, the universities in Germany are the major performers of basic research, both in volume of effort and number of research personnel. Also as in the United States, research is closely coupled with teaching in the universities (the "Humboldt principle"). Essentially all higher educational institutions are state institutions financed by the Laender governments, with some additional federal support. However, higher educational institutions in Germany are *by law* independent bodies that are free from any government domination.

Government research organizations include research institutes subordinate to independent coordinating organizations, such as the Max Planck Society and the Fraunhofer Society, which receive all or a substantial portion of their funding from the federal and state governments; "big science" national laboratories supported by the BMBF; and research establishments subordinate the federal or Lnder ministries or both (federal-state research institutes, usually referred to as the "Blue List"). Blue List institutions are independent research institutions whose functions are of national importance and in the interest of national science policy. The Hermann von Helmholtz Association of National Research Centers (HGF) employs multidisciplinary research and development capacities for the solution of long-terms problems entailing economic risk. The national research centers are legally independent bodies, and have a fair amount of autonomy to determine their research priorities. However, the federal government (mainly BMBF) provides guidelines, and BMBF's priority programs influence the process of priority setting with each of the centers. Delphi approaches to Foresight techniques have been practiced, but their results have largely been handed over to the scientific community, which is left to respond as it will. An effort to broaden and democratize the Foresight exercises known as "Futur" is now underway (see the materials in Vol. II, Ch. II).

BIBLIOGRAPHY: GERMANY

Abramson, H.N., J. Encarnacao, P. P. Reid, and U. Schmoch (ed.) *Technology Transfer Systems in the United States and Germany*. (National Academy Press, Washington, DC, 1997).

Balzs, Katalin. *Strategic Priority-Setting in Science: Germany*. (draft). Report for SRI International (Arlington, VA, January 1999).

Federal Ministry of Education and Research (BMBF*). Basic and Structural Data 1998/99*. (part of a series). (BMBF, Bonn, 1998).

Federal Ministry of Education and Research (BMBF*). Facts and Figures 1998* (abridged). (part of a series). (BMBF, Bonn, 1998).

Federal Ministry of Education and Research (BMBF*). Faktenbericht 1998*. (part of a series). (BMBF, Bonn, 1998).

Federal Ministry of Education and Research (BMBF*). Numerical Barometer 1998/ 99*. (part of a series). (BMBF, Bonn, 1998).

Federal Ministry of Education and Research (BMBF*). Report of the Federal Government on Research* (abridged). (part of a series). (BMBF, Bonn, 1996).

Germany's Technological Performance: updated and expanded report. (Summary). (BMBF, 1996).

Koenig, Robert. "10 Years After the Wall, Science Revives in Eastern Germany." *Science*. (**Vol. 286**, Oct. 15, 1999, pp. 392-395).

Krull, W., and F. Meyer-Krahmer, (ed.) *Science and Technology in Germany.* (Cartermill, London, 1996).

Lundvall, Bengt-Ake. (ed.) *National Systems of Innovation.* (Pinter Publishers, London, 1992).

Martin, Ben R. and J. Irvine. "Research Foresight in Germany" in: *Research Foresight Priority-Setting in Science.* (1989).

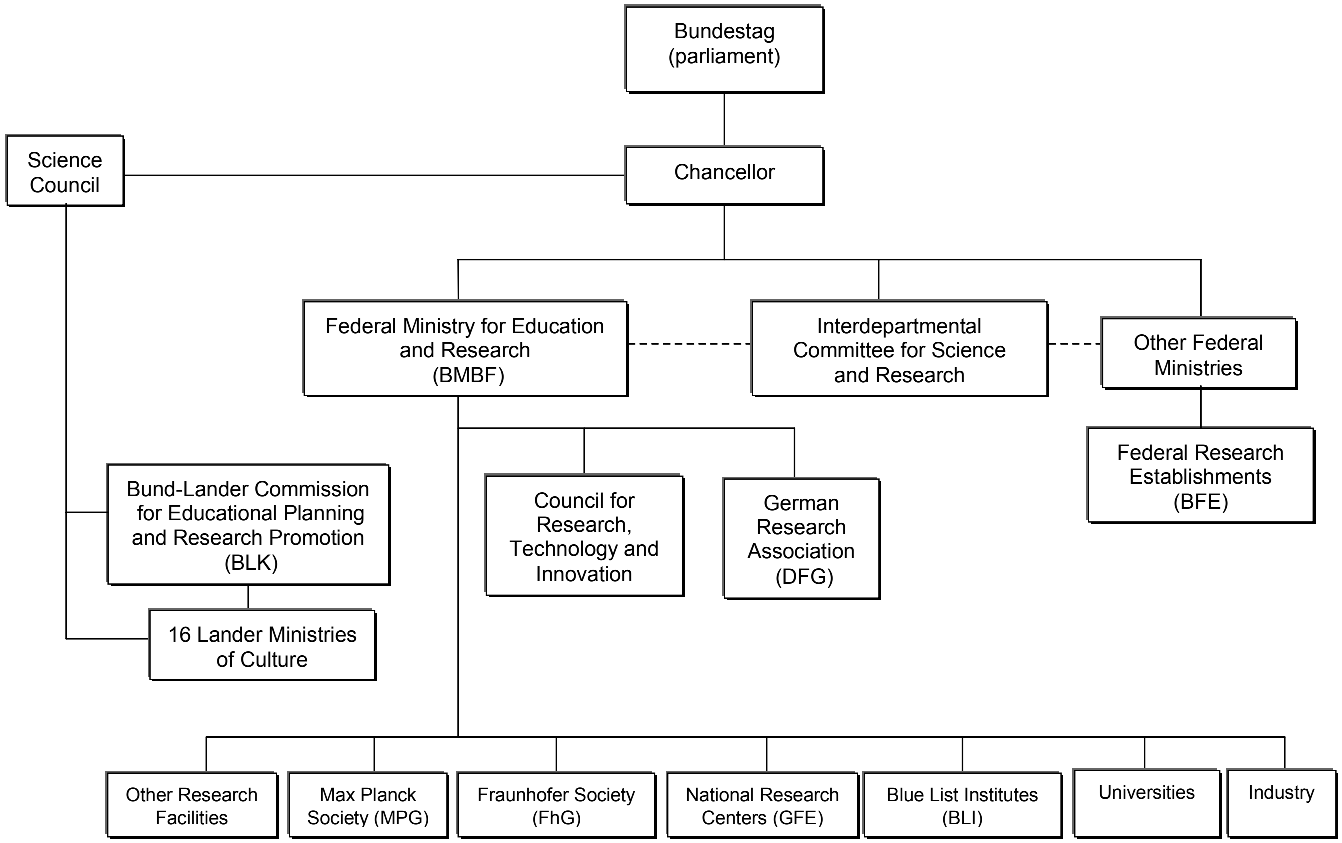
Parthier, Benno. *Transformation of Science After the Reunification of Germany*. (Web site). (http://biology.anu.edu.au/rsbsweb/conferences/NatConf/Natpap11.html)

Reger, G., and S. Kuhlman. *European Technology Policy in Germany.* Physica Verlag 1995.

Schimank, U. and M. Winnes. *National Report. Federal Republic of Germany*. (Max-Planck-Institut fur Gesellschaft, Koln, 1999).

www.aif.de
www.bmbf.de
www.fhg.de
www.mpg.de

GERMANY


Bundestag (parliament)
Chancellor
Science Council
Federal Ministry for Education and Research (BMBF)
Interdepartmental Committee for Science and Research
Other Federal Ministries
Federal Research Establishments (BFE)
Bund-Lander Commission for Educational Planning and Research Promotion (BLK)
16 Lander Ministries of Culture
Council for Research, Technology and Innovation
German Research Association (DFG)
Other Research Facilities
Max Planck Society (MPG)
Fraunhofer Society (FhG)
National Research Centers (GFE)
Blue List Institutes (BLI)
Universities
Industry

C. FRANCE

Advance background materials from the literature concerning the process of budgeting and priority setting in France are limited and largely in French. This section relies heavily on a report by Laredo and de Laat (1998), part of a European Commission funded cross-national study. It also draws upon the official annual publication on French S&T policy, the so-called "*Jaune"* (because of its yellow covers: *Projet de loi de finances pour 2000: Etat de la recherche et du developpement technologique*). See Vol. II, Ch. III for further materials in the Symposium presentation on France).

The S&T system is unusual in that there are no research councils on the model of most European countries, but the system of R&D funding bears some resemblance to the duality of the British system. Research is partially funded through the university system, which has enjoyed a growing research capability in recent years, and partially through government research institutions, in particular, the Centre National de Recherche Scientific (CNRS) and a set of "Organismes Public de Recherche" (OPRs). The CNRS has had both independent labs and ones collocated with universities, with which it is now strengthening its ties. The CNRS focuses on fundamental research, while the OPRs are sectorally oriented and more focused on applied research in areas such as atomic energy (CEA), health and medical research (INSERM), agriculture (INRA), etc.

The system has been undergoing a series of important changes. Some are strategic and long term in terms of efforts to join the academic to other research sectors and focus public research on innovation-oriented activities. At the same time, until very recently, the Ministry of National Education and Research and Technology, formed by merging two ministries in 1995, was the major policy maker for S&T, as well as higher education. However, in March of 2000, a ministerial shakeup dismissed the Minister and restored the separation between Research and Higher Education as separate Ministries. A number of the previous minister's aggressive efforts at reforming the system were successfully implemented, some held in abeyance, and some stand to be reversed by the new Minister (Balter, *Science,* January 28, 2000 *).*

Laredo and de Laat (1998) note that there have been four characteristics of French research policy historically:

1) until recently, the military represented about 30% of publicly funded research, now declining;

2) deriving from the 1960s, a series of "Grands Programmes," designed to support "national champion" corporations' competitiveness in advanced technological areas, which have in recent years declined in public funding to the point of no longer being major factors due to privatization and other factors;

3) the large share of research conducted by the mission-oriented OPRs; and

4) a separation of fundamental research conducted by the CNRS from that combined with education in the universities.

The declining support of military and industrial-oriented research, has been accompanied by increases in the staffing of both the CNRS and INSERM, as well as in the universities. Recent policies have sought to develop closer ties and a convergence of research strategies between the universities and the OPRs, including the CNRS and INSERM, as well an increased ties to industry.

The public research sector in France is quite large. There are nearly 70,000 FTE research scientists and engineers in a total of about 135,000 FTE research staff, third after Germany and the UK. The annual expenditure on GERD in 1998 was about 188 billion French francs, representing about 2.2% of GDP – a decline from nearly 2.5% in 1993. Just over half comes from industry, which has been increasing its investment in R&D. The military's share of research funding has dropped from about 30% to 20% and now ranks behind public funding of basic research.

The Grands Programmes represented public expenditures on research in several industrial sectors aimed at assisting French corporations like GS Thomson, Alcatel, Airbus, or Aerospatiale to attain global competitiveness. Historically five in number (space, electronuclear, civil aeronautics, computer and electronics, and telecommunications), they initially represented costs in the billions of French francs, but movement away from public support in these areas and the substitution of internal industry funds for research in these sectors has reduced most of them to a shadow of their former selves. Privatization of France Telecom and the rise of Alcatel has placed most telecommunications research in the private sector, and most of the others are much reduced in funding. Only the Space Programme has remained "grand" with some increases in its budget.

The OPRs – mission-oriented agencies with laboratories active in specific fields – have remained stable over the past two decades. As noted, these dominate publicly funded research, and their mission-orientation means that their funds are devoted to problem areas more than fields of research. However, a number of them have been considered since a 1982 law, "public establishments of a scientific and technological character," and are required to conduct a core of scientific research. The CNRS and INSERM are generally considered separately and are more oriented toward funding basic research. Like the CNRS, the OPRs are subject to peer-review evaluation procedures, and there has been a rapid increase in their collaboration with industry in the form of contract research. In this sense, they have shifted from their original links with various professions to the development of close ties to industrial sectors.

The CNRS was established after World War II as the functional equivalent of the OPRs for the conduct of basic research. One effect of this was that, despite the fact that research was part of the mission of the universities, very little was carried on in that sector until recently. From the mid-sixties, "associated," or "mixed" research units developed in which personnel worked in joint units where CNRS, INSERM, and university personnel collaborated in laboratories, frequently co-located with the involved universities. More recently, Ministerial policy has been to reinforce these ties with four-year contracts, certification of the joint institutes by the CNRS, and quadrennial evaluations by the CNRS. In 1997, university FTE research personnel outnumbered those of the CNRS and INSERM combined by about three-to-one. The Grand Ecoles, too, have been drawn into the web of research partners being forged in France.

Priority setting and budget coordination are also affected by the institution of several new instruments for managing the public research sector, which are referred to under the rubric of "managing at a distance". These include:

1) broader contractualization arrangements between the government and research organizations than have been thus far mentioned;
2) "forward looks" by the executive and parliament;
3) institualization of evaluation; and
4) the influence of upcoming social issues on research policy.

Contractualization is a relatively recently phenomenon that began in 1994 and includes the OPRs, as well as the universities. With the OPRs, the contracts focus on ensuring that government objectives are taken into account in planning the research program of the organization. The contracts are monitored on an annual basis. For universities, where nearly 90% of research funding falls under contracts, the objective is the unification of education and research, as well as relating efforts to strategic aspects of national R&D policy. The contracts often involve the CNRS as well as the Ministry and university. The research institutions commit to the support of policy goals such quality control, evaluation, and doctoral training changes, while the government provides new permanent positions and the organization's budgetary allotment.

France, with its tradition of "plannification" and "La prospective," was a major source of the development of future studies and "Foresight" techniques. Under Minister Chevenement in the 1980s a national process of dialogue, first regional, a *Colloque National Recherche et Technologie"* in early 1982 was held to develop a national strategy for S&T. Similar exercises, although not so prominent nor influential, have been held in the 1990s. Delphi techniques and cooperative efforts with Germany and Japan have been included in Foresight exercises. A considerable portion of these national consultations focused on harnessing the nation's R&D efforts to industrial innovation, especially in support of small and medium enterprises (SMEs). Efforts to support SMEs and others have also taken the form of establishing "Technopoles" (technology park-like campuses). The French Parliament established an office roughly comparable to the now defunct U.S. Congress' Office of Technology Assessment. Under this, the Parliament refused to accept a scientific consensus concerning nuclear waste disposal and insisted on research on three alternatives.

Three approaches have been taken to evaluation. A National Committee for evaluation (CNE) supervises the evaluation of university research. It reports directly to the President (i.e., is independent of the Ministry) and currently evaluates more than twenty universities per year, and plays a role in the renewal of contractualization agreements. The National Committee for Evaluation of Research (CNER) is similarly independent and evaluates the OPRs, national programs, and such R&D related policies as research tax credits. Its approach has emphasized the use of evaluative techniques individually adapted to the program under consideration.

Both the CNE and the CNER have been the subject of criticism in national dialogues, while their existence has seemed to lead to a parallel proactive effort by the OPRs to establish their own evaluation techniques. These tend to focus on long term strategies, rather the *post hoc* evaluation of previous efforts. The evolution of such efforts has increasingly focused on the contractualization agreements.

Both for evaluation, policy studies, and the production of science and engineering indicators, France has established an "Observatoire des Sciences et des Techniques," which publishes the French equivalent of the U.S. *Science and Engineering Indicators* report (L'Observatoire…, 2000) in addition to a variety of individual studies not unlike NSF/SRS, but as an independent institution and with a larger original research component. The "Observatory" concept is generating interest in other countries and several imitative institutions have been set up in Latin America.

The poor handling of new major social problems such as AIDS and the accompanying scandal over the problem of contaminated blood supplies has recently led to greater emphasis and the establishment of mechanisms to grapple with the public interest on emerging areas of research. The mechanisms are not yet well established, but it is intended that once such issues have been examined in this venue, they be handed back to the traditional research organizations with appropriate recommendations concerning the nation's research agenda. Special efforts are being made to support the humanities and social sciences.

Two other factors influence priority setting are the emergence of emphasis on deconcentration and devolution of efforts and powers to regions away from the Paris area, and the influence of the European Community as a source of funding under the Framework program. A general policy of empowering regional areas in France through the redistribution of important national institutions has had its impact on the S&T infrastructure, with many research positions having been transferred to more peripheral institutions. Efforts are also being made to provide for greater institutional mobility among French researchers and support for young researchers (see French presentation, Vol. II, Ch. III).

Bibliography: France

Balter, Michael. "Street Protests Keep the Pressure on Allegre". *Science*. (**Vol. 287**, Feb. 4, 2000, p. 781).

Balter, Michael. "New Chief Promises Renewal and Openness". *Science*. (**Vol. 287**, Jan. 28, 2000, p. 567).

Commasariat General du Plan, *Recherche et innovation: la France dans la competition mondiale* (Paris: La Documentation Francaise, October 1999).

Laredo, P. and B. de Laat. *Changing Structures, Organisation and Nature of PSR* [Public Sector Research] *Systems: FRANCE*, Synthesis Report (Paris: Centre de Sociologie de l'Innovation, Ecole Nationale Superieure des Mines de Paris, June 1998)

OST, *Science & Technologie – Indicateurs Edition 2000* Rapport de l'Observatoire de Science et des Techniques (Paris: Editions ECONOMICA, 2000).

Projet de Loi de Finances Pour 2000: Etat de la Recherche et du Developpement Technologique. (annual report of the Government of France to Parliament). (Paris Imprimerie Nationale, Paris, 1999).

D. Japan

The Japanese S&T policy structure and process is undergoing significant change. The system has been divided in responsibility among the two primary Ministries, the Ministry for Education ("Monbusho"), and the Ministry for Trade and Industry ("MITI") with a coordinating agency, the Office of Science and Technology (OST), as well as a Science and Technology Agency (STA) within the Prime Minister's Office. NISTEP, the National Institute for Science and Technology Policy, is a research organization affiliated with the STA. The system will become more centralized in 2001.

Recent policy has been based on a White Paper published in 1996, "Science and Technology Basic Plan," due to be updated in 2001. The Basic Plan concluded that greater concentration on basic research capabilities and expanded visibility of Japanese research in the international research community was a major priority. The plan pledged significant support for the development of university research infrastructure, including instrumentation, as well as human resource support for researchers. In terms of priority fields, however, the Basic Plan largely anticipated that the agenda would be set by individual researchers, who were to be afforded a variety of funding sources, primarily aimed at "diversifying" the research base. More recent reports have examined the Japanese R&D system in terms of a number of international indicators, and generally concluded that Japan still needs to pursue the goals of increasing its basic research base and visibility, but needs also to relate its S&T efforts to social and economic goals.

More recently, S&T have come to be viewed as one of the potentially important contributions to efforts to stimulate and modernize the faltering Japanese economy. In addition to providing added funding to the overall S&T budget, special "Millennial Projects" in information technology, genetics, and environmental studies will be injected into the system. How these funds will be distributed in terms of specific institutions and projects is not yet clear, but they will tilt priorities in the direction of the indicated fields, especially since the R&D budget is not expected to rise much further otherwise (see Vol. II, Ch. IV).

In terms of the S&T policy organization, important changes will be phased in over the coming year. These will raise the visibility and coordination of S&T policy at the highest level of government. The position of the Minister for Science and Technology Policy, formally a junior minister, is now in flux, but is expected to become part of a Cabinet Office level operation that will include the Office of Science and Technology, and a more broadly empowered "General Science and Technology Council." More monitoring and evaluation are anticipated, and various working groups are involved in developing a new "basic plan."

Bibliography: Japan

Council for Science and Technology. (Web site) http://www.sta.go.jp/shimon/98cs.html (1998).

National Science Foundation, Tokyo Regional Office. *A Radical Restructuring of Japan's Postwar S&T Policy and Institutions: The Politics and Rationality of the New Century*. (National Science Foundation, Tokyo, 2000)

National Science Foundation, Tokyo Regional Office. *Follow-up of the Science and Technology Basic Plan: An Interim Summary*. (National Science Foundation, Tokyo, 2000)

NISTEP. (Web site). (http://www.nistep.go.jp/top-e.html).

Normile, Dennis. (in Science Scope) "Arima Out." *Science*. (Vol. 286, Oct. 8, 1999, p. 209).

Normile, Dennis. "Blue Laser Pioneer Seeks Greener Pastures." *Science*. (Vol. 287, Feb. 4, 2000, p. 782).

Science and Technology Basic Plan. (Web site) http://www.sta.go.jp/policy/kihonkeikaku/basicplan.html (1996).

Tanaka, Yoichi, and R. Hirasawa. "Features of Policy-Making Processes in Japan's Council for Science and Technology". *Research Policy*. (Vol. 25, 1996, pp. 999-1011).

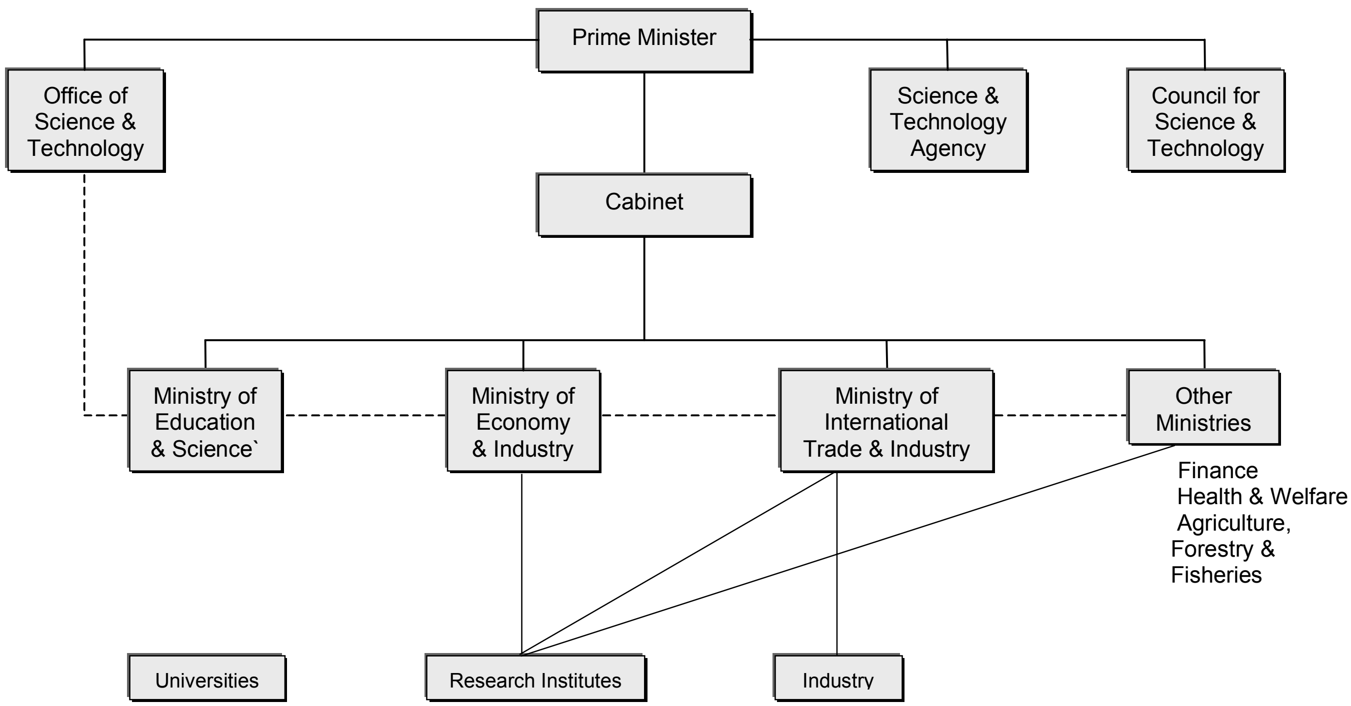
Tanaka, Yoichi. "Effect of Japan's Advisory Councils on Science and Technology Policy". *Technology in Science*. (Vol. 17, No. 2, 1995, pp. 159-173).

Tanaka, Yoichi. "Science and Technology Policy-Making Process in the Japanese Government". *International Journal of Technology Management*. (Vol. 8, No. 6/7/8, 1993, pp. 676-686).

The Science and Technology Resources of Japan: A Comparison with the United States. (Web site) (http://www.nsf.gov/sbe/srs/nsf97324/hilites.htm).

White Paper on Science and Technology. (Web site) http://www.sta.go.jp/policy/seisaku/e9806_5.html (1998).

Japan


Prime Minister
Office of Science & Technology
Science & Technology Agency
Council for Science & Technology
Cabinet
Ministry of Education & Science`
Ministry of Economy & Industry
Ministry of International Trade & Industry
Other Ministries
Finance
Health & Welfare
Agriculture, Forestry & Fisheries
Universities
Research Institutes
Industry

E. EUROPEAN UNION

The European Union (EU) is not a single national state, but an organization in which individual member countries are involved in decision processes that, among other activities, attempt to establish a number of research programs that are funded by the budget of its governing body. It does not fund basic research for the sake of simply advancing knowledge, but seeks to shape its research programs around two main objectives:

1) strengthening the S&T base of European industry in support of its international competitiveness; and
2) promoting research that supports other EU policies.

The EU's "Research and Technological Development" initiative is primarily operated by The Research DG, but includes other Directorates-General concerned with Enterprise, Agriculture, Transport and Energy, Information Society, and Fisheries, as well as the Joint Research Centers.All the EU's research effort is channeled through the "Framework" program, which is operated over a four-to-five year cycle involving an extensive democratic dialogue among the members in establishing its content and budget. The 5th Framework Program was adopted by the European Parliament and Council at the end of 1998 and covers the years from 1998 to 2002, with a budget of nearly 15 billion Euro. While the program definition process may include some specific field-oriented actions (e.g., the Parliament expanded the budget proposed for the 5th Program, but indicated a strong desire that increased resources be devoted to the life sciences), the overall structural categories of the program's budget are expressed largely in terms of social and economic goals. These include, for example:

- Quality of life and management of living resources;
- User-friendly information society;
- Competitive and sustainable growth; and
- Energy, environment and sustainable development.[1]

In addition to these "thematic" programs, "horizontal" programs deal with the international role of community research, promoting innovation and participation of SMEs, and improving the socio-economic knowledge base. Euratom research falls within the purview of the Framework Program, and particular attention is paid to involving "less favored" regions in the program. Collaboration includes that among Community members, as well as other international collaboration; in particular, the central and eastern European candidates for EU membership as well as Norway, Iceland, Liechtenstein, Israel, Cyprus, and, shortly, Switzerland are all fully paid-up participants in the Frameowrk Program. Most of the Framework program and other scientific activities are administered by the Research DG, with the Information Society DG an important part of the program, although, as noted above, other Directorates-Generals are involved.Once programs are established and approved by the European Parliament, most priority setting takes place within the process of issuing calls for proposals for each program and the evaluation of the resulting proposals. To summarize, it appears that the EU process sets priorities on broad themes in an elaborate consultative process among its members and interested sectors, or stake-holders, and seeks to match these with competitively evaluated proposals that are largely concentrated in applied areas of research.

Organization Chart

No official R&D organization chart is available for the European Union. Web site http://europa.org provides a directory listing Directorates and subdivisions with personnel, but no chart. is included. The major R&D activity, the Framework Program is largely developed and primarily carried out by the Directorate of Research, although the DG for the Information Society and other Directorates-General administers some of the research programs.

Bibliography: European Union

European Commission. *Second European Report on S&T Indicators 1997*. December 1997. EUR 17639.

"Towards a European research area." Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions. January 2000.

www.europa.eu.int

www.cordis.lu

F. United Kingdom

The United Kingdom (UK) has served as one of the leaders in efforts to develop models to assist in the development of government priorities for S&T. As early as the 1960s, the autonomy of government-funded researchers began to be questioned and the need for prioritization raised due to the high cost of research. By the 1970s, there was considerable concern about the ways in which government institutions impacted the balance between basic, "strategic," and applied research. By the next decade under the Thatcher government, the issues began to focus on two areas: 1) the need for the nation to be selective in its efforts due to limited resources, including setting priorities in basic research fields; and 2) the need to couple Britain's basic research effort, perceived to be of excellent quality, to the country's increasingly obvious problems of economic competitiveness, more broadly related to other social goals, especially health. The relationship of mission agency research to economic competitiveness became an important part of each agency's definition of its portfolio. Accountability and evaluation became important themes. A government agency report in 1986, *Exploitable Areas of Science***,** led to efforts to develop mechanisms for "technology foresight," that are now formally imbedded in the UK policy process.

A major landmark in the development of the current system was the 1993 White Paper, *Realizing our potential: a strategy for science, engineering and technology*. The result of a massive consultation effort across the stakeholders in the S&T system, the White Paper sought a reversal of the Rothschild approach adopted in the 1970s, in which government departments pursued their individual interests and left industry and academia largely alone on the matter of priorities. The White Paper recommended that partnerships among government, academic, and industrial science be pursued and subjected to tests of relevance to two national objectives: wealth creation and the quality of life – with the emphasis on the former.

The main points of the 1993 White Paper were:

1) The need for priorities;
2) The need to better engage industrial firms;
3) The need for better co-ordination of government funded S&T; and
4) Reorganization of the research councils.

Priorities, it was argued, needed to be set because countries could not sustain a presence in all of the growing fields of science, and could include a healthy dose of relevance without compromising excellence. With a keen eye on economic competitiveness, the Paper sought more effective innovation on the part of industry, especially through greater awareness and access to S&T, to be facilitated by a national Technology Foresight Program that jointly involved industry and the S&E communities. Government coordination was to be improved through the annual publication of a "*Forward Look*" that would provide the industrial and research communities with a current statement of government strategy. This would be prepared by the Office of Science and Technology (OST, moved from the Cabinet Office into DTI in 1995). Also responsible for the Technology Foresight Program and the research councils, OST represents the primary central coordinating agency, working with individual departments and with the ministerial advisory Committee on Science and Technology (CST). Some adjustments in field allocation were made, and the resulting six councils' activities coordinated by a Director-General of the Research Councils under the OST.

The British S&T system remains highly pluralistic, both in terms of the number of institutions and government agencies involved, and the variety of sources of public funding. In particular, funding for basic and "strategic" science is dual in character, flowing partially from the Department of Education and Employment, which provides funds for infrastructure, faculty salaries, and a core research agenda via the Higher Education Funding Councils (HEFCs) – under devolution, one for each part of the UK: England, Scotland, Wales, and Northern Ireland. The HEFCs provide funding to the universities for two purposes: teaching and research. While the universities enjoy a high degree of autonomy in spending the HEFC research funds, their programs are subject to a periodic Research Assessment Exercise (RAE) that examines work in particular fields. In terms of models developed by the United Kingdom, there appears to be increased international interest in the HEFC's REA exercises (Hagman, *Science*, January 28, 2000).

The second flow stems from the Department of Trade and Industry (DTI) through the Research Councils. For these funds, university researchers engage in competitive, merit-reviewed bidding for funds that come from the science budget of DTI/OST. The Councils' impact on priorities is relatively subtle: they are mission-oriented in the sense that they are field-defined, and can "nudge" applicants for funding in terms of program definitions. However, the governing boards include representatives from industry, giving them a voice in shaping programs. Each research council includes "users" – including industry – on its governing board (the Council), and is involved in various efforts to align their agendas and make them accessible to user interests. Otherwise, they have each developed their own operational approaches to priority setting.

Other funds may be derived from various government departments, industry, foundations, and international organizations. Thus, both the HEFCs and the Research Councils are in a position to influence priorities among fields, while there is a strong effort to link S&T to economic competitiveness through the influence of mission agencies and national exercises such as the Foresight exercise. Overall, in response to the Thatcher Government's concern that British science lacked clear direction and measures of achievement, a number of mechanisms have been embedded in the policy process that aim at setting objectives, coordinating policies, and evaluating outcomes.

The outcome of these efforts is reflected by the complex organization chart shown for the United Kingdom. Formally, UK science policy has several high level agencies with input at the highest levels of government. Most important is the Office of Science and Technology (OST), which is officially part of the Department of Trade and Industry (DTI). It is responsible for the science budget, the direct work of the seven research councils, the Council for Science and Technology, and the Technology Foresight Steering Group. It produces an annual *Forward Look of Government Funded Science, Engineering, and Technology*.

Two of the key players in setting and coordinating the S&T budget are attached to the OST: the Chief Science Advisor, and the Director General of the Research Councils. The Transdepartmental Science and Technology Group deals with coordinating cross-departmental matters for the Science Advisor and plays an important role in developing a large picture of trends that might have an impact on priorities and budget coordination.

Since the White Paper's recommendations were implemented, there have been some minor organizational changes made aside from moving OST into DTI. The Labour Government initially placed ministerial oversight of science in the hands of the President of the Board of Trade and elevated S&T affairs from a junior minister to the level of a Minister of State. Initially responsible for both science and energy, there is now an independent Minister for Science. The Labour Government has generally moved S&T policy up in the political hierarchy and increased the visibility of the CST. Supported by OST, the CST is made up of representatives from academia, business, finance, and foundations concerned with scientific research. It provides advice on strategic policies and the overall framework of S&T in Britain, but is quite distant from priority setting among scientific fields.

BIBLIOGRAPHY: UNITED KINGDOM

Anderson, J. and R. Fears (ed.) *Valuing and evaluating: assessment of the value of R&D in creating national and corporate prosperity.* (report on a symposium). (Moller Centre, Cambridge, UK, 1996).

"Competitiveness: Forging Ahead". (HMSO, May 1995, Cm 2867).

Georghiou, Luke. "The UK Technology Foresight Programme". *Futures*. (Vol. 28, No. 4, 1996, pp. 359-377).

Hagmann, Michael. "Support Grows for British Exercise to Allocate University Funds". In article: Mervis, Jeffrey. "Graduate Educators Struggle to Grade Themselves". *Science*. (Vol. 287, Jan. 28, 2000, pp. 568-570).

Healey, Peter and H. Rothman. Strategic Priority-setting in Science: The United Kingdom. (draft). (October 1998).

HMSO. *Annual Review of Government Funded Research & Development.* (series). (HMSO, London, 1991 *et seq.*).

Office of Science and Technology. *Forward Look of Government-funded Science, Engineering and Technology.* (Department of Trade and Industry, London, 1996 *et seq.*).

Office of Science and Technology. *Science, Engineering and Technology Statistics.* (Department of Trade and Industry, London, 1998).

Office of Science and Technology. *The Future in Focus: A Summary of National Foresight Programmes.* (Office of Science and Technology, Department of Trade and Industry, London, 1997).

Office of Science and Technology. *Winning through Foresight: Report on the Whitehall Audit of the Foresight Programme.* (Department of Trade and Industry, London, 1997).

Parliamentary Office of Science and Technology. *Science Shaping the Future?* (report summary). (Parliamentary Office of Science and Technology, London, 1997).

"Realising Our Potential: A Strategy for Science, Engineering and Technology". (HMSO, May 1993, Cm 2250).

Science and Technology in the United Kingdom. (Web site). http://strategis.ic.gc.ca/ssg/bi18164e.html

Senker, J. *Changing Structure, Organisation and Nature of European PSR Systems. United Kingdom: A Report for the European Commission.* (SPRU, University of Sussex, Brighton, 1998).

The Royal Academy of Engineering. *Measuring Excellence in Engineering Research.* (The Royal Academy of Engineering, Westminster, London, 2000).

White Papers:

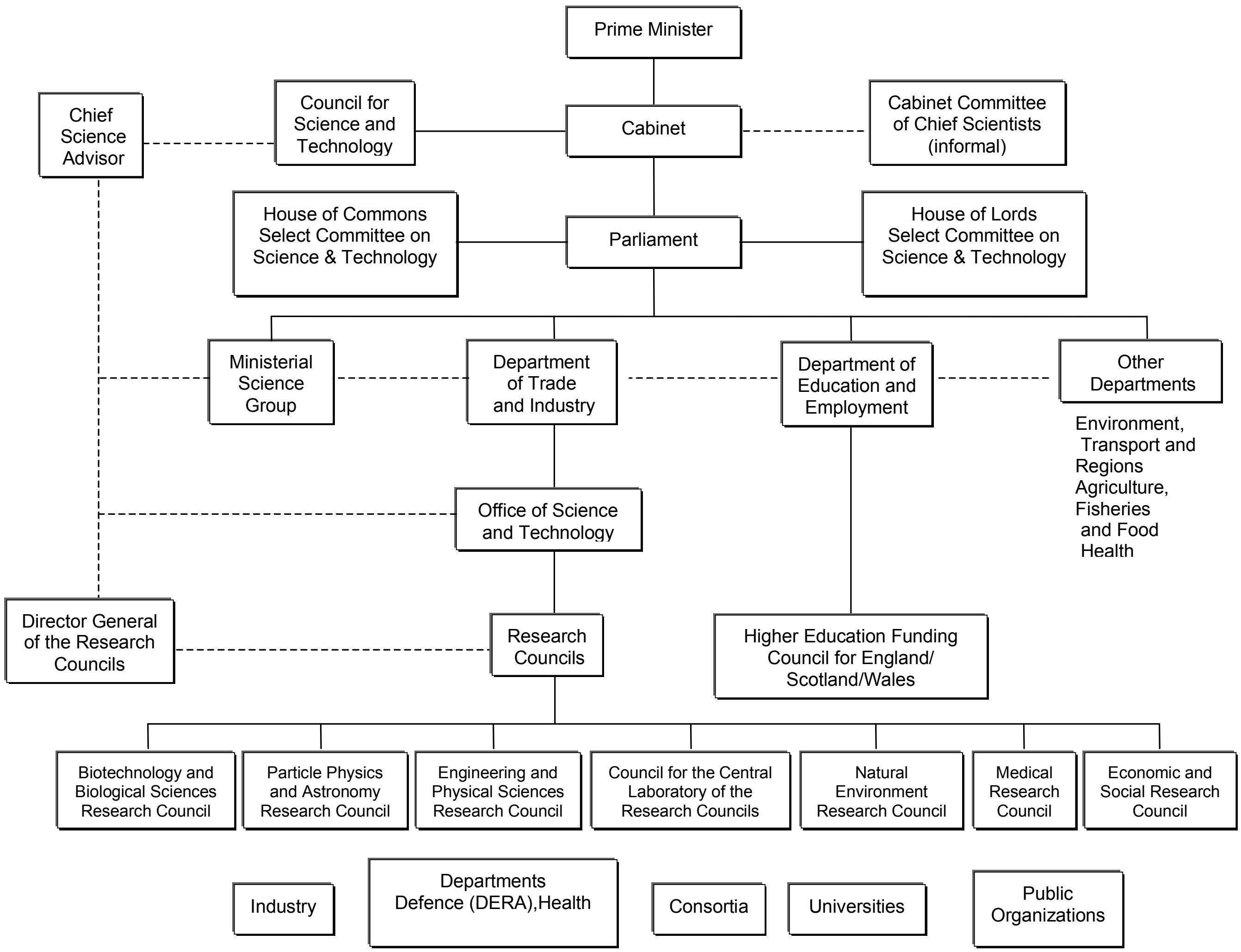
Realising Our Potential: A Strategy for Science, Engineering and Technology, Cm 2250 (London: HMSO, May 1993).

Competitiveness: Forging Ahead, Cm 2867 (London: HMSO, May 1995).

Excellence and Opportunity–A Science and Innovation Strategy for the 21st Century.(London: HMSO, 2000)

www.dti.gov.uk/scienceind/index.htm

UNITED KINGDOM



G. Republic of Korea

Like a number of countries, especially in Asia, the Korean S&T system is undergoing important changes. Some have their roots in the recognition by several countries – including Japan – that the original Japanese technology development model, with its heavy emphasis on reverse engineering and applied research, lacked the important dimension of a fundamental research base. Some time before S&T were elevated as a priority aspect of solving recent economic problems by the current government, the Koreans had funded a "Creative Research Initiative" (CRI) program intended to foster the development of a basic research culture as part of the R&D infrastructure. (Both Japan and China are involved in similar efforts.) Other ministries are involved in encouraging basic research, and efforts are being made to link industrial participation to this aspect of the research enterprise.

Prior to the 1990s, government efforts were concentrated in the Government Supported Research Institutes (GSRIs), primarily focused on individual industrial priorities. The GSRIs are subject to periodic evaluation and, in principle, have had the right to set their own priorities, although the government maintained a strong influence in consultation with industry. In the early 1990s, the Ministry of Science and Technology (MOST) initiated the "HAN Project" (Highly Advanced National Project), aimed at developing next generation technologies in a variety of high tech fields, such as semiconductor technology, nuclear reactor technology, functional bio-materials, environmental technology, advanced manufacturing system technology, and advanced materials for information, electronics and energy. Unlike the ensuing CRI program, the HAN efforts were more of a priority setting exercise in critical technologies that represented a logical follow-on to the GSRIs.

In the institutional configuration that existed until last year, the Science and Technology Policy Institute (STEPI) operated under MOST carrying out three basic functions. These included S&T policy research, support of international activities, and the distribution of research funds from the government budget in accordance with program guidelines by means that included grants, contracts, and institutional support.

Recent changes have spun off the Korea Institute of S&T Evaluation and Planning (KISTEP) from STEPI, retaining it under MOST with responsibility for research funding and R&D Evaluation. The other policy aspects of STEPI report to the office of the Prime Minister. Three advisory councils have been elevated from the level of the Prime Minister and Cabinet to the Presidential level. During the past year, KISTEP has led MOST through the first round of a comprehensively evaluative budget process that is expected, in time, to alter the content of the country's research portfolio significantly, although it is unlikely to alter greatly the distribution of funds among broad scientific fields or disciplines. A detailed description of this process is provided in Vol. II, Ch. VII.

BIBLIOGRAPHY: REPUBLIC OF KOREA

Baker, Michael. “Laid-Off Satellite Group Sets Up Shop”. *Science.* (Vol. 287, Jan. 21, 2000, p. 409).

Ministry of Science and Technology. *Science and Technology in Korea.* (The Technology Cooperation Bureau, Ministry of Science and Technology, Gwacheon, Korea, 1996).

Organisation for Economic Co-operation and Development. *Reviews of National Science and Technology Policy: Republic of Korea.* (OECD, Paris, 1996).

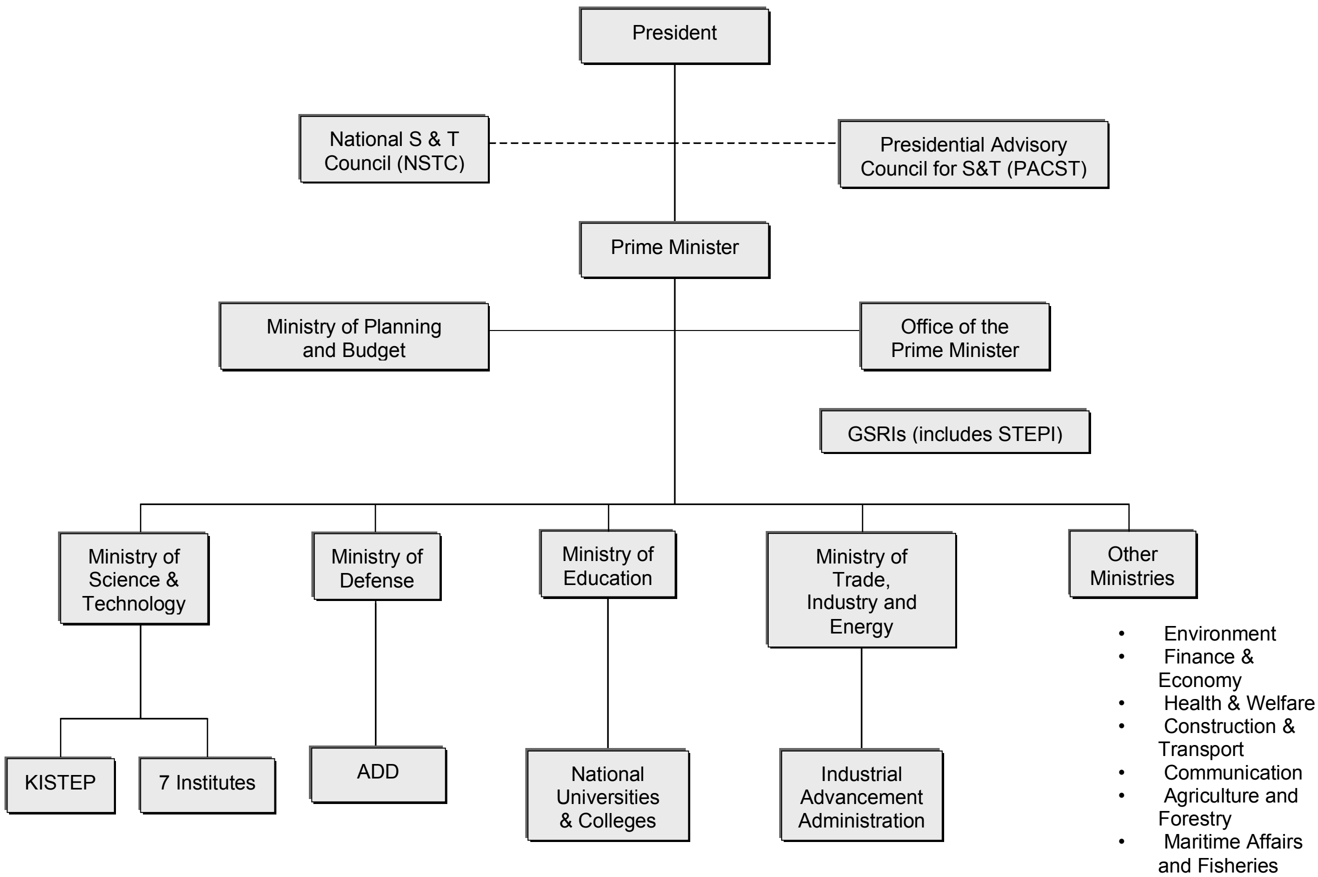
Park, Young-Il, Y. Lim, Z. Bae, and J. Lee. “Innovation in Korea”. *Science and Public Policy.* (Vol. 23, April 1996, pp. 77-90).

Science and Technology Policy Institute. *Report on the Survey of Research and Development in Science and Technology.* (Ministry of S&T, Korea, 1996).

Science and Technology Policy Institute. *Review of Science and Technology Policy for Industrial Competitiveness in Korea.* (Ministry of Foreign Affairs and Association of South-East Asian Nations, Seoul, Korea, 1995).

Wilson, David and J. Wilson. *Korea: A Science and Technology Profile.* (series). (The British Council, Manchester, UK, 1996).

Korea


President
National S & T Council (NSTC)
Presidential Advisory Council for S&T (PACST)
Prime Minister
Ministry of Planning and Budget
Office of the Prime Minister
GSRIs (includes STEPI)
Ministry of Science & Technology
Ministry of Defense
Ministry of Education
Ministry of Trade, Industry and Energy
Other Ministries
KISTEP
7 Institutes
ADD
National Universities & Colleges
Industrial Advancement Administration
• Environment
• Finance & Economy
• Health & Welfare
• Construction & Transport
• Communication
• Agriculture and Forestry
• Maritime Affairs and Fisheries

H. SWEDEN

Sweden is a small country whose scientific community enjoys a high reputation in international science and receives a high proportion of GDP investment (3.7%). It has a tradition of international peer evaluation of scientific programs and has sought to establish various mechanisms to link research to industrial innovation. Recent years have brought a number of changes to the structure of the Swedish S&T system, and it is now on the verge of further change as the consequence of a major examination of the structure of research funding that reported about one year ago (the "Hagstrom Report"). The government is now acting on report recommendations, as outlined in Vol. II, Ch. VIII.

It is difficult to characterize the nature of priority-setting in the Swedish S&T system and its recent evolution. Although the recent report emphasizes the need to place greater emphasis on the control of a basic research agenda by the nation's scientific community, substantial autonomy already exists. Three elements of the S&T structure impinge on the perception of priority setting:

1) the evolution of an agency from what was known as STU to NUTEK;
2) the addition of a Research Council for Engineering Science; and
3) the establishment of a set of foundations that are currently very well funded, but lack a clear mission and direction from public authorities in their legislated mission to support research.

NUTEK, the Swedish National Board for Industrial and Technical Development, is the successor organization to the STU, which wielded substantial funds in aid of industrially oriented research and the transformation of basic knowledge into innovation in the 1980s. NUTEK remains a major source of funds for research in universities and other research institutions, and is technologically oriented, but appears to be less directive in its perception of its mission than was STU and includes a strong engineering and science policy studies element.

In addition, a Research Council for Engineering Sciences exists alongside the more traditional Councils for Medical Science and the Natural Sciences. The Research Councils operate primarily on the model of investigator-initiated, merit-reviewed proposals and do little in the way of imposing priorities on the research community.

The Foundations were legislated into existence by a center-right/liberal government in the early 1990s and funded by the dissolution of funds derived from an industrial profits tax, where the funds were originally intended to provide greater power to wage-earners in the trade unions. The largest of these is the "Foundation for Strategic Science," which has established a program with the goal of defining strategic areas – currently bioscience, information technology, and such other base technologies such as materials science, energy research, and food production that are of importance for Swedish industry. The considerable resources available to the Foundations provide them with substantial leverage in establishing research agendas, and the Committee's report has suggested that the foundations have an excess of political independence. The thrust of the Hagstrom Report appears to recommend increased autonomy on the part of the Swedish scientific community in terms of setting priorities. Some aspects of the government response are outlined in a document included with the Swedish presentation in Volume II.

Bibliography: Sweden

Anderson, John B., et al. *Peers on Peers: Allocation Policy and Review Procedures at the Swedish Research Council for Engineering Sciences.* (Swedish Research Council for Engineering Sciences, Stockholm, 1997).

Brennan, Max, K. Burke, S. Forsen, and T. Stadtman. *Review of the Organisation and Working Methods of the NFR.* (Swedish Natural Science Research Council, Stockholm, 1998).

Nilsson, Annika and J. Rose. "Buffeted Community Braces for More Change". *Science.* (**Vol. 282**, Nov. 20, 1999, pp. 1401-1403).

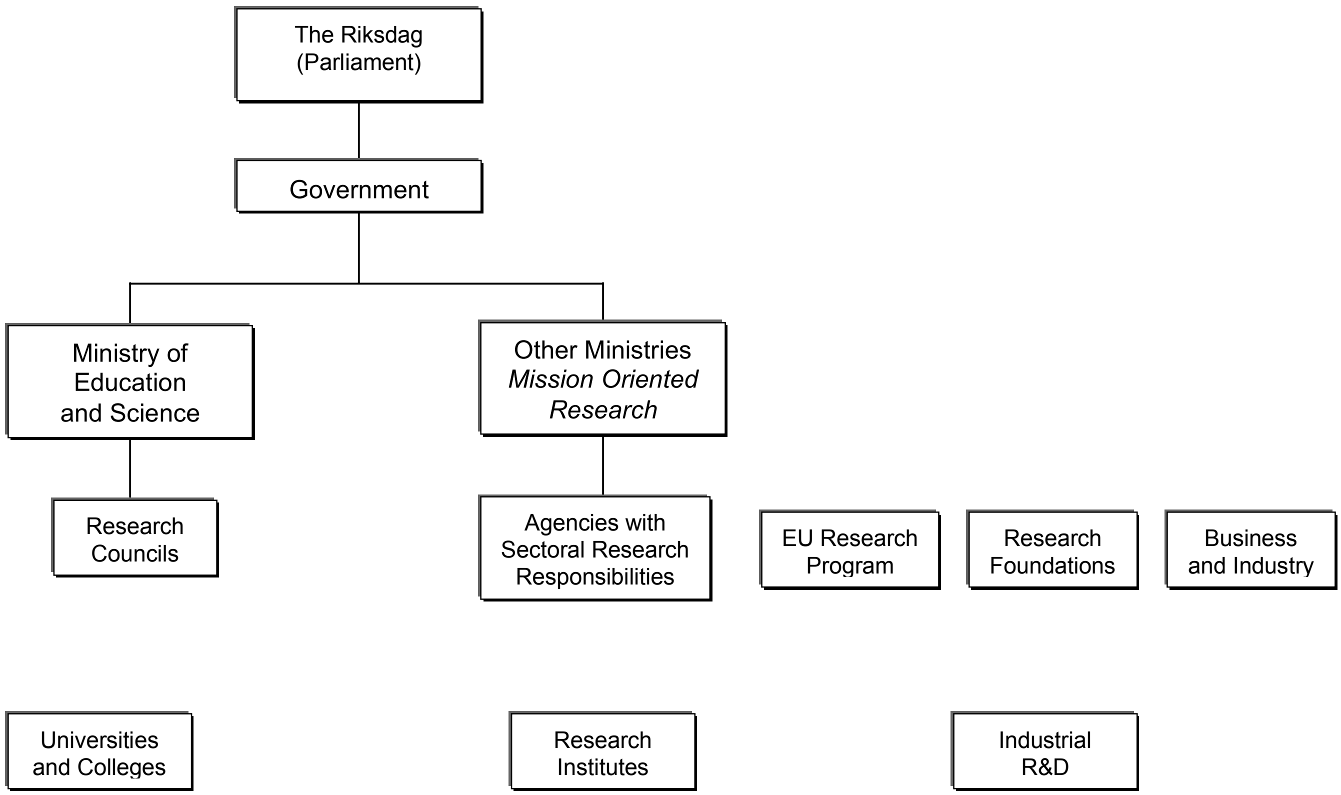
Policy of the Foundation

Swedish Natural Science Research Council. *International Evaluation of Plasma and Space Physics.* (series). (Swedish Natural Research Council, 1997).

Swedish Research Council for Engineering Sciences. (brochure). (Stockholm).

Swedish Research Foundations. *Stiftelsen for strategisk forskning: Policy of the Foundation.* (Stockholm, 1995).

SWEDEN


The Riksdag (Parliament)
Government
Ministry of Education and Science
Other Ministries *Mission Oriented Research*
Research Councils
Agencies with Sectoral Research Responsibilities
EU Research Program
Research Foundations
Business and Industry
Universities and Colleges
Research Institutes
Industrial R&D

I. Brazil

Brazil is the only country in the Americas that has a Ministry of Science and Technology (MCT) with broad oversight and policy functions at the national level. Its scientific infrastructure suffered badly during the "lost decade" of economic disarray. While Brazil's economic situation is still precarious, it has weathered fairly well the more recent financial crisess among developing countries during the 1990s.

Despite the centralizing influence of the MCT, the Brazilian system of S&T research remains dispersed among three agencies. Substantial funding is provided by CAPES under the Ministry of Education, largely in the form of scholarships, fellowships and post-doctoral funding. FINEP, which nominally funds research infrastructure (instruments, laboratory equipment, and the like), and the CNPq (National Council for the Development of Science and Technology – the Brazilian equivalent of the NSF) are both responsible to the MCT. In addition, the federal system of Brazil offers a state-based source of support for research. In principle, each state has a Foundation funded by a small percentage of its tax receipts intended to fund research projects. The most notable of these is that of the wealthiest state, Sao Paolo, FAPESP. It is a very well-funded and extremely efficient dispenser of research support (proposals reputedly are typically merit-reviewed in less than two months), but only operates within the state of Sao Paolo. Its recent achievements in the area of genomics are well recognized internationally. Other States are seeking to invigorate their state foundations in order to enhance regional development.

An important initiative of the Federal Government in S&T was the PADCT program (roughly translatable as "Program for the Development of Science and Technology"), carried out with a combination of national funds and loans from the World Bank. The initial phase of the Program (1985-1990) was of major significance in helping the Brazilian research community to weather bad economic times. During the second phase (1991-1996), however, the Program's primary objective of fostering a transparent merit review program was combined with a set of several priority fields. The program in now embarking on its third phase, PADCT III. The new phase has three foci: 1) continued support for merit-reviewed basic research in selected fields; 2) a major effort to involve Brazilian industry in cooperative efforts, especially with universities, in research efforts; 3) an enhanced capability on the part of Brazil to meet OECD standards in efforts at the monitoring and evaluation of research programs, including the production of international standard science and technology indicators.

In recent years, the fragmented nature of the support system has meant that many research projects had to be "shopped" from one support source to another: a piece of equipment from FINEP, a post-doctoral position from CAPES or the CNPq, etc. In this piece-meal situation, priority setting was essentially non-existent. A "one-stop shopping" component of PADCT III is an effort of unify projects and place them in a field-oriented setting for the review process. In fact, the most significant priority setting effort in Brazil emerged from the PADCT program itself, where it was determined to focus on seven scientific areas in the funding of research:

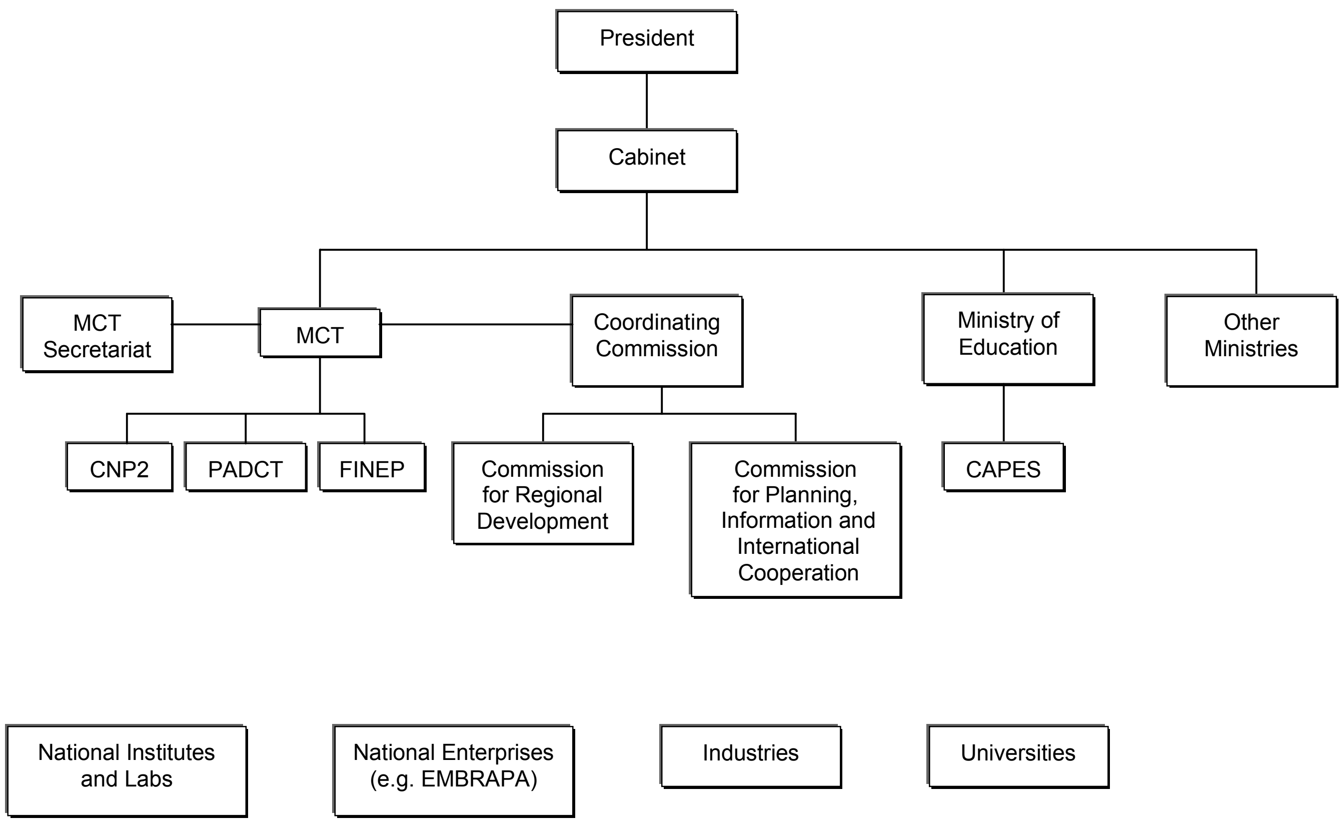
1) Environmental Sciences
2) Geosciences and Mineral Technology
3) Biotechnology
4) Chemistry and Chemical Engineering
5) New Materials
6) Instrumentation, and
7) Science Planning and Management.

A recent bibliometric assessment of publications by PADCT funded researchers during its first two phases suggested that the impact of their research was higher, although not universally so, than other Brazilian research in comparable fields, and generally showed favorable trends in its international impact over time[1]. It is unclear, however, to what degree the program was operated in a manner that created a "self-fulfilling prophesy." Its transparent merit review system meant that the researchers and projects that it funded represented Brazil's best capabilities. However, to the degree that the selection of fields attracted these capabilities to the PADCT program, it represents a field-oriented national priority setting exercise.

Science and technology represent a national priority and have been specifically included in the government's Pluri Annual Plan for 2000 –2003. In addition the Federal Government established recently new specific funds to support the area. [Some of the details are contained in the presentation by the Brazilian Symposium speaker contained in Volume II of this report.]

[1] Coward, H. Roberts, Roland Bardon. The Publication Productivity and Impact of PADCT-Funded Researchers in Brazil: A Bibliometric Analysis. Final Report. SRI International, 1997.

Brazil


President
Cabinet
MCT Secretariat
MCT
Coordinating Commission
Ministry of Education
Other Ministries
CNP2
PADCT
FINEP
Commission for Regional Development
Commission for Planning, Information and International Cooperation
CAPES
National Institutes and Labs
National Enterprises (e.g. EMBRAPA)
Industries
Universities

BIBLIOGRAPHY: OTHER COUNTRIES

UNITED STATES

Government Funding of Scientific Research. (National Science Board, Arlington, VA, 1997). NSB-97-186.

International Partnerships in Large Science Projects. (National Science Board, Arlington, VA, 1995).

Knezo, Genevieve J. *Research and Development: Priority Setting and Consolidation in Science Budgeting.* (issue brief). (Congressional Research Service, Library of Congress, 1998).

Payson, Steve. *R&D as a Percentage of GDP Continues Upward Climb.* (data brief). (Division of Science Resources Studies, National Science Foundation, Arlington, VA, 1999). NSF 99-357.

Roessner, J. David and B. Coward. *An Analytical Synthesis of Empirical Research on U.S. University-Industry and Federal Laboratory-Industry Research Cooperation.* (SRI International, Washington DC, 2000).

National Research Council, Committee on Criteria for Federal Support of Research and Development. *Allocating Federal Funds for Science and Technology.* (National Academy Press, Washington DC, 1995).

National Academy of Sciences, Committee on Science, Engineering, and Public Policy. *Experiments in International Benchmarking of US Research Fields.* (National Academy Press, Washington DC, 2000).

National Academy of Sciences, Committee on Science, Engineering, and Public Policy. *Evaluating Federal Research Programs.* (National Academy Press, Washington DC, 1999).

National Science Foundation, Division of Science Resources Studies, *Data Briefs*, numbered and dated series.

Australia

Australia's Science and Innovation System Background Information. (Web site). (http://www.dist.gov.au/science/pmsec/14meet/bground/s&t-sytm.html).

Australian Science and Technology Council. *Setting Directions for Australian Research.* (Australian Government Publishing Service, Canberra, 1990).

Priority Matters. (A Report to the Minister of Science and Technology). (Department of Industry, Science and Tourism, Canberra, 1997).

Science and Technology Analysis Section, Department of Industry, Science and Resources. *Science and Technology Budget Statement 1999-2000.* (Department of Industry, Science and Resources, Canberra, 1999).

Hungary

Balazs, K. *Changing Structure, Organisation and Nature of Public Research System (PRS) in Hungary.* (Technopolis, Brighton, 1998).