National Academy/Royal Society Review

Britain, Germany, Sweden, France and the United States

Prepared for:

University Research Policy Directorate
Industry, Science and Technology Canada

Prepared By:

Goss Gilroy Inc.
Management Consultants
Suite 900, 150 Metcalfe Street
Ottawa, Ontario
K2P 1P1
(613) 230-5577

April 8, 1993

Table of Contents

Executive Summary

Introduction

A review of the academy structures in the United States, Britain, Germany, Sweden and France was carried out. The key findings of this review are summarized below. The purpose of the review was to obtain information on the organizational arrangements, the impacts on public policy, the perceived benefits, and the funding arrangements of academies.

As the scope and funding were limited, the study was based on interviews with key personnel representing the academies in each country, and a limited number of interviewees who are not directly part of the academy system. Documentation provided was also reviewed.

A list of the academies reviewed is attached to this summary.

Organization and Structure

History and Role

Academies generally have a lengthy history and tradition in the countries reviewed. Historically, academies were an important focal point for scholars in the sciences and the humanities, and once were the primary source of independent advice on important national issues. In some of the countries visited, the advisory role for the science academies was reported to have waned somewhat during the post-war period as governments developed internal structures, such as ministries, committees and special councils, to provide advice on issues of national concern. The role of academies, especially in science, has subsequently risen in importance in these countries as the need for independent, credible, and well-reasoned advice on important scientific issues has increased.

All of the countries visited, with the exception of Germany, have a small number of prestigious academies at the national level. Germany has a network of eight state-level (laender) academies connected through a Conference of Academies.

There has been a trend for the science academies to be focused primarily on issues related to basic sciences. To meet the need to address technological and industrial issues, some countries have established academies of engineering or applied sciences. Examples of these are:

- Britain - Royal Society of Engineering
- France - Sub-Committee of the Academy of Science (CADAS)
- Sweden - The Royal Swedish Academy of Engineering Sciences
- United States - National Academy of Engineering

In each of the countries visited, there are separate distinct academies (or divisions of academies) devoted to the humanities and/or the arts.

Academies were formed in many countries to foster the development of the arts, humanities, and sciences; to debate important national issues; and to provide independent public advice (solicited or unsolicited) on these issues. The objectives of the Royal Society (UK) provide an example of a typical statement of objectives:

- to encourage scientific research and its applications;
- to recognize excellence in scientific research;
- to promote international scientific relations and facilitate the exchange of scientists;
- to provide independent advice on scientific matters, notably to government;
- to represent and support the scientific community;
- to promote science education as well as science understanding and awareness in the public at large; and,
- to support research into the history of scientific endeavour.

It was found that all of the academies studied have quite similar objectives. An exception might be the National Academies of the United States, including the National Research Council[1], which operates under a role defined by Congress as "to respond to any requests from any department of the government for help on any subject of science or art". The mandate of the Academy Complex has been redefined to include:

---

[1] The US National Academies of Science, Engineering and Medicine and the National Research Council are referred to as the Academy Complex.

- initiating studies on topics the officers and governing board consider important, even though no government official requested the study;

- working in a variety of ways to strengthen the nation's scientific and engineering communities;

- collaborating in helping to coordinate international studies and representing the United States internationally;

- striving to improve education in science and mathematics.

All of the countries visited, with the exception of Germany, reported that science academies are now undertaking broad science and public policy studies, rather than just purely technical or scientific studies, in addition to their other traditional activities. This trend appears to be partly a reaction to the demand for these studies, and partly a reaction to a perceived need to demonstrate relevance in an era of limited sources of funding.

Administration

The academies are generally self-governed, usually by a board or council elected by the members. Generally, an administrative staff is responsible for day-to-day operations. A common feature of academies is the existence of an elected or rotated president or permanent secretary, and an executive director who is supported by permanent salaried staff. Members of academies are generally paid only a small honorarium and a compensation for expenses. The honourary position and prestige of the membership in the academy justifies the time (and out-of-pocket expenses) that may have to be paid by the members or their sponsoring organizations.

In all cases, agendas are set by the academies themselves, although most academies are responsive to requests from government authorities. Generally, a council or board is responsible for ratifying agendas that are established by the permanent secretary or president. An important characteristic of the academies is their independence with respect to responding to outside requests to review an issue of national concern. Moreover, academies stress that the process of studying an issue requires careful internal review of both the study terms of reference and the study results.

Membership

Academy membership usually is representative of the eminent scholars in the particular fields of interest to the academies. The French academies limit their membership and new members can only be inducted on the retirement or death of an existing member. Membership limitations are less of a concern for the Royal Society (UK), as the Royal Society has a larger approved membership complement than the French academies. In all cases, membership is by election.

The French academies contain a large proportion of academics, and attempt to attract multidisciplinary memberships. The Royal Society reported mainly academics in its membership. The Swedish academies have a large proportion of non-academic members. Generally, the newer applications-oriented academies tend to have more multidisciplinary memberships as well as more non-academics.

Outsiders have critiqued the academies in some countries on this basis. For example, it is felt that the Royal Society is elitist in character and does not admit enough younger members. There is criticism that a lack of multidisciplinary memberships undermines the credibility in areas that require a multidisciplinary approach. Concern was also expressed that the award of research fellowships favours existing fellows. Similar concerns were expressed in France.

In contrast, the process for electing members is considered by the academies themselves to be a mechanism for ensuring their continued eminent role, credibility and independence.

Young Academics

In most cases, academies perceive one of their roles to be the promotion of excellence in disciplines of interest. In some cases, academies provide post-doctoral fellowships for research grants to young academics. This was the case for the Royal Society and the British Academy as well as for the Swedish academies. In all of the academies, prizes are granted for excellence in research. For example, the French academies provide prizes for excellence in research, and the German "laender" academies award medals.

Linkages

In almost all of the countries reviewed, the academies are independent of government by statute and by historical precedent. Nonetheless, most of the academies receive some part of their funding from governments. In some cases, the academies are closely tied to government in terms of responding to issues of national concern.

The U.S. academy structure, including the National Academies of Science, Engineering and Medicine and the National Research Council, is organized under a congressional charter granted in 1863 to the National Academy of Sciences. It stipulates that the Academy "shall whenever called upon by any department of government, investigate, examine, experiment and report upon any subject of science or art".

The Royal Society perceives an important role to be advising on issues of national concern. The Royal Society has formal ties to the research councils and to the government. It has only informal ties to industry. As in other countries, industry ties occur mainly through the Royal Academy of Engineering. At the present time, a government review of the research structure in the UK is proposing a re-evaluation of the relationships between the Research Councils, the Royal Society, and the Royal Society of Engineering.

The Royal Swedish Academy of Sciences has formal linkages to government through board memberships and informal linkages to the research councils through joint participation on projects and informal cooperation. It also has a research granting function. Again, ties to industry occur through the Royal Swedish Academy of Engineering.

The French academies are funded by and have formal linkages to government through formal reporting requirements and annual budgetary reviews. They are not formally linked with the research granting process. Linkages with industry occur through a committee of the Academy of Science.

The German State academies are all closely linked to the State Governments and the Federal government, and to each other through the Conference of Academies. They are not involved or linked to the granting councils or to industry.

Funding of Academies

An important principle of academies is their independence from government. With respect to funding, however, most of the academies surveyed receive a part of their funding from government. A notable exception to this is the American Academy of Arts and Sciences in Cambridge, Massachusetts, which is funded from endowments. Other academies reported that in many cases they receive some of their funds from private endowments or legacies.

The British academies are funded primarily from government, with about 25% coming from other income sources. The Royal Society's budget in 1991-92 was £23 million with £18 million from government as a grant-in-aid.

The five German State academies are funded entirely by government on a shared basis between the federal and the provincial governments. The 1992 budget is DM 59.3 Million (around CDN $50 Million).

In Sweden, the majority of funds available originate with the private sector. Only the Royal Swedish Academy of Sciences receives a considerable amount from the government (13.3 million Swedish Kroner - about $2 million CDN). The Royal Swedish Academy of Engineering is funded partially from industry contributions of 100,000 Swedish Kroner from each participating company.

The French academies of the Institut de France were reported to be primarily self-funded from legacies and trusts. The Institut de France receives about 10 million French Francs (CDN $2.5 Million), but has internal resources of 240 million French Francs per year (CDN $60 Million). The French academies receive direct budgetary support through the Ministry of Education.

The U.S. Academy complex, consisting of the National Academies of Sciences, Engineering, and Medicine and the National Research Council reported that 85% of their funding ($202 million) is derived from government. Approximately 22% is for administration, 74% is for research and studies, and the remainder is for publication costs.

Impacts on Public and Science Policy Development

The actual reported impacts are based on the opinions of a small number of respondents in each country, as well as on published reports.

Each of the countries reviewed reported a slightly different experience with regard to impacts on public and science policy development. Some indicated that there has been an evolution in the academies' ability to influence science policy development. In both Britain and France, the academies have gone through a cycle during which they had great influence as advisors to governments, but subsequently lost this influence after the Second World War as governments expanded their Ministries concerned with Science and Technology and instituted new scientific advisory councils. The Royal Society and the Institut de France report that in the most recent decades their influence on science policy has increased as governments have sought expert opinion on increasingly complex scientific issues. Some contrary viewpoints agreed that the influence of the academies declined in both countries following the Second World War, but felt that their current influence (although increasing) was still not as great as formerly. The decline in influence is a result of the emergence of other structures such as councils, advisory functions, and ministries that are charged with providing advice.

There was agreement by most of those interviewed that independence and quality of input of the academies permits them to play a very unique and useful role in providing solicited and unsolicited advice on issues of national concern.

The situation in the United States is somewhat different, as the Academies of Science and Engineering and the National Research Council (NRC) have been specifically tasked in their charter to provide advice to government authorities. It appears that the science-advisory function of the American academies has been well institutionalized and is tapped extensively. The review indicated that NRC and Academy reports are considered authoritative and are cited extensively by policy-makers in both the administrative and legislative branches, as well as by outsiders.

The Swedish academies reported that they have a high official status, that their views are well respected, and that they play an important role as advisors on science policy and education.

In Germany, the influence of the five state academies occurs through the co-ordinating Conference of the Academies. The Conference acts to co-ordinate research and set priorities and to represent the academies with the federal government. In Germany, education and research are purposefully decentralized, and it appears that the impacts of the academies are primarily at the state level.

Some examples of impacts follow:

Sweden

- A government bill benefitted from information provided in the Royal Swedish Academy of Science study entitled "Engineers for the 21st Century".

- Criticism by this academy focusing on the education of economists for industry raised a serious debate and contributed to increased support for the education of economists.

France

Studies undertaken by the Institut de France have included:

- Risks of ionizing radiation and norms for protection;

- The greenhouse effect and climactic consequences - a scientific evaluation;

- Experimentation with animals: necessities, constraints and substitute methods;
- Research in genetic engineering: ways of improving its evolution and development;
- Report on biological research among the different sub-disciplines; and
- Pollution of the subterranean water aquifers in France.

The Institut considers that it frequently provides well-debated independent advice on policy issues, which is taken into account in government decision-making.

United States

Academy/Research Council reports are often viewed as the authoritative reference on a topic - a reflection of the thoughtful examination by committees of Research Council experts. As a result, the reports are routinely cited by members of Congress, executive branch officials, industry groups, nonprofit associations, and others. The reports are catalysts for new legislation, government policies, and private sector initiatives.

- A review of US export controls on high-technology products found that the regulations cost the nation's businesses about $9 billion annually and yet often were ineffective in protecting national security. The study concluded that the regulations in some cases penalize US exporters while still permitting access by the Warsaw Pact countries to many advanced technologies. Within a few weeks of the report's release, the Commerce Department issued new rules easing export controls on some products that already were widely available from US allies, and streamlining trade rules for other products.
- A committee that studied air quality aboard commercial airliners concluded that modern aircraft ventilation systems cannot effectively remove cigarette smoke despite designated smoking and nonsmoking seating areas. Citing possible adverse effects on the health of flight attendants and nonsmoking passengers, the expert panel recommended banning smoking on all domestic commercial flights. Congress subsequently passed legislation that prohibits smoking on domestic flights of less than two hours' duration.
- Following completion of a Research Council study which found that technologies for maintaining highways cannot adequately protect the nation's trillion-dollar system of roads, Congress implemented a five-year, $150 million program to accelerate research

on important maintenance problems. In addition, the law-makers charged the Research Council with managing the unique federal-state cooperative transportation program.

- The report, *Diet, Nutrition, and Cancer*, was the most comprehensive summary of current understanding of this complex and often confusing subject. Its recommendations inspired the federal government's National Cancer Institute and the non-profit American Cancer Society to issue similar dietary guidelines. The recommendations also helped motivate the meat industry and supermarkets to offer leaner products to consumers.

- An Institute of Medicine report urged major changes in the regulation of nursing homes. The report prompted congressional hearings on the subject and resulted in two bills that incorporated the committee's recommendations almost in their entirety. Subsequently, the Department of Health and Human Services proposed a major overhaul of its nursing home regulations, basing its reforms on the Institute's report.

- While major suppliers of childhood vaccines were discontinuing or threatening to cease production in response to injury-liability suits, an Institute committee issued a report detailing several options for resolving the public health crisis. The report's recommendations were later embodied in federal legislation.

- Congress established the National Commission for the Prevention of Infant Mortality partly in response to an Institute report documenting that prenatal care helps prevent premature birth and low birthweight. In addition, the report helped spur more than half the states to introduce legislation that would make prenatal care available under Medicaid.

Criteria for Success

There are certain conditions which appear to foster greater impacts on public policy.

- In cases where there is an academy of engineering or sub-committees of the science academy which are concerned with science applications, there appears to be a greater influence on science and public policy;

- The prestige and independence of the academies is an important factor in the influence the academy can exert in all of the countries reviewed. In the United States, the linkage to science policy formation appears to be well recognized and well-defined. In Britain, France, and Sweden, advice is frequently solicited but also may be unsolicited. However, the science policy linkages are apparently not as formalized or as well recognized.

It appears that to some extent, the academies have to "compete" for an influential role in public and science policy. From this perspective, the comparative advantage of the academies is their intellectual prestige and credibility. Therefore, although there may be other entities whose role is more directly concerned with public policy formation, the prestige and importance of the academies positions them favourably as an external advisor to policy-makers.

- The process of defining the content of studies and of reviewing their quality increases the prestige and perception of value of the science policy advice.

- The academies' history of being self-contained in selecting their work programs and of self-critiquing their own work through internal peer reviews, as well as their partial financial independence, contributes to a perceived impartiality and independence from official government policy.

- Member induction processes which result in very high quality standards for membership, and options to use outside resources such as associates and correspondents, contribute to the prestige of the academies.

Benefits

There are a number of benefits that flow from the existence of the academies reviewed. The benefits are quite common among academies, although the perceived importance of the benefits varies from country to country.

Benefits can be classed into the following general categories:

Promotion of Scholarly Work and its Discussion and Dissemination

Academies (in the Arts, Sciences, Humanities and Social Sciences) perceive one of their primary roles to be the promotion of knowledge and excellence in the disciplines included in the academy. In most cases an important set of activities involves:

- Holding members meetings at which new research or discoveries in the academies' disciplines can be presented, debated, and critiqued. This debate often leads to a critical assessment of the validity and value of the research and its implications;

- Publishing proceedings of meetings and periodic journals reporting on the meetings and debates of the academy;

- Promoting excellence in research and scholarly work through the provision of rewards for excellence; and,

- Supporting promising young researchers through special awards or scholarships and7 post-doctoral fellowships.

Representation of the Research Community

Academies also act as representatives of the research community in the sciences, arts, and humanities. For example, in France, it is believed that papers issued from the Academy of Science of the Institut de France are a statement on behalf of the French scientific community.

Academies are trying to form linkages to the community at large and to publicize current issues and trends in their disciplines.

Academies often act to strengthen international ties and to represent the research communities in their disciplines internationally.

Advice on Matters of National Concern

Another function of the various academies has been to study and issue reports on issues of national concern. While this function has always been important in the Academy complex in the U.S., it has become increasingly important to science academies in Europe.

The increasing complexity and sensitivity of issues in the physical, biological and social sciences has created a demand for independent advice that is considered to be of the highest quality. The French and British academies are augmenting their provision of this type of advice on both an unsolicited and solicited basis. There is a desire of academies in these two countries to insert themselves in debates on issues of national concern, not as lobby groups, but rather as independent sources of research and advice.

Some General Observations

1. In the countries visited, Academies have generally been established for very long periods of time. It is apparent that the success of the academies has been a result of institution building over a long time period.

2. In most of the countries visited, academies were established to fulfill an organizational void, to create an entity to foster learning and research, and to provide advice to governments. The membership of academies appears to have been drawn from the most eminent researchers and individuals in specific disciplines. In latter years, some of the rationale for academies has diminished as other institutions have been created to fulfill a similar function (national councils, government ministries, independent think tanks, etc.).

3. Despite this, academies continue to be important in the five countries visited. It was difficult to discern how effective they are in the formulation of public policy. However, the evidence presented indicated that they: provide credible, independent advice on policy matters to governments; act to represent the humanities and social sciences as well the physical and biological sciences in national debates; and, act to encourage excellence in research and the continued development of researchers.

4. In the countries visited, with the exception of the United States, the academies represent only a small part of the investment in research in the sciences and humanities and social sciences, and are only a small part of the network of institutions providing policy advice in the country.

5. The national academy structure in the United States appears to have generated the most evident impacts on public/science policy. This is probably due to the very clear mandate of the Congress, which specifies the role of the Academy Complex as one of responding to government-raised issues.

List of Academies/Institutes Reviewed

Britain

1. Royal Society
2. British Academy
3. Royal Academy of Engineering
4. Conference of Medical Royal Colleges

Germany

5. German Research Society
6. Max Planck Society for the Promotion of the Sciences
7. National Research Centres
8. German Conference of Education and Science
9. Federal-Provincial Commission for Education and Research
10. Frauenhofer Society

Sweden

11. The Royal Swedish Academy of Engineering Sciences
12. The Royal Swedish Academy of Sciences
13. The Royal Swedish Academy of Letters
14. The Royal Swedish Academy of Fine Arts

France

15. Académie Nationale de Médicine
16. Académie Française
17. Académie des Sciences
18. Académie des Sciences morales et politiques
19. Académie des Beaux-Arts
20. Académie des Inscriptions et Belles-Lettres

United States

21. National Academy of Sciences
22. National Academy of Engineering
23. Institute of Medicine
24. National Research Council
25. American Academy of Arts and Sciences

Country Summaries

Britain
Germany
Sweden
France
United States

Summary - Britain

1. Organization and Structure

Current Structure

- Science is represented at Cabinet level through the seat of the Chancellor of the Duchy of Lancaster, while technology falls under the Department of Trade and Industry. Research Councils are administered by the Office of Science and Technology (OST), whereas Academies are self-governing and independent of government.

- There are four academies in Britain: the Royal Society, the British Academy, the Royal Academy of Engineering and the Conference of Medical Royal Colleges. They are all self-governing and operate independently from government. Only informal links exist with industry.

Future Reorganization

- A recent White Paper on Science and Technology is likely to result in changes and simplifications of the overall structure of research in the U.K. Two relevant areas of concern included:

  - some overall rationalization of the activities of the Royal Society and the Royal Academy of Engineering was required to address potential overlap of the activities of the two academies; and,
  - the place of the British Academy within the overall system needed to be considered to avoid the potential overlap between the activities of the British Academy and the SSHRC.

Royal Society

- The Royal Society, founded in 1660, is the oldest and most eminent academy. It seeks to promote the natural sciences, including mathematics and all applied aspects such as engineering and medicine. A number of fellows hold senior industry positions.

- Distinguished individuals from Natural Sciences, almost exclusively academics, are elected on a highly selective basis as Royal Society Fellows. There is an elaborate internal system of nomination and election into the Society. In addition to 100 foreign members, there are currently over 1,000 fellows. Three divisions, national affairs, international affairs and services and administration, each account for a third of the 120 permanent staff.

- The Council, composed of 21 members, meets once every 6-8 weeks. The Council makes all decisions on behalf of the Society. The Society is administered on a day-to-day basis by a President and four Secretaries. There is a paid staff of 120 which is divided three ways: i) national affairs, ii) international affairs and, iii) services and administration.

- The agenda is established by the Council; however, it frequently responds to outside requests from government. An important programme of the Society seeks to increase public understanding of science. Other activities include the provision of research grants, awards, medals and prize lectures; support to research appointments; the publication of scientific papers; and diverse forms of international cooperation.

- A number of programs have been set up for young academics such as the University Research Fellowships and travel grants.

- The membership is reported to be mainly academic, and there is little by way of multidisciplinary memberships.

- There are important linkages with the Research Funding Organizations in the U.K. and there are formal linkages with government. Linkages with industry are informal. (This is a role for the Royal Academy of Engineering).

British Academy

- The British Academy, founded in 1901, focuses on the humanities and social sciences. It grew out of the Royal Society's decision to exclude the humanities. There are 575 Fellows, 350 of whom are under the age of 70. Senior Fellows are excluded from the Council.

- The agenda is independently set by the Academy.

- Due to the current absence of a research council with responsibility for the humanities, the British Academy has a Research Council function. This situation is expected to change with the likely creation of either a new Social Sciences and Humanities Council or two separate councils.

- Considerable effort is directed toward providing advice to government and other public bodies on issues related to the humanities and social sciences.

- Other activities of the British Academy include: grants for post-doctoral research, available to individuals and groups; post graduate awards; international exchange agreements; and collaborative research projects. The British Academy currently sponsors some 1600 post graduate students. Each year 30-35 post-doctoral fellowships are awarded.

- The British Academy has non-academic members, but all are elected for their academic expertise. There are multidisciplinary memberships.

- There are formal relationships with the government under a Memorandum of Understanding and funding arrangements.

Royal Academy of Engineering

(Note: the following information was provided by the Royal Society)

- The Royal Academy of Engineering, which targets practical applications, is closely linked with industry.

- A potential overlap exists between the Royal Academy of Engineering and the Royal Society as the latter perceives a need to distinguish itself from its partner academy.

Inter-academy Cooperation

- Cooperation between the academies occurs through the Science and Engineering Policy Studies Unit (SEPSU) and the National Academies Policy Advisory Group (NAPAG).

- SEPSU was established by the Royal Society and the Royal Academy of Engineering to " promote informed decision-making on science and engineering policy within the UK and Europe and to provide analysis of high quality on strategic issues for science and engineering to illuminate and encourage the policy debate".

- NAPAG, with representation from all four academies, was recently constituted as a multidisciplinary body to provide independent advice to government and other policy making bodies as well as information to the public.

2. Impacts on Development of Public Science Policy/Public Policy

- The Royal Society's powerful advisory function as the leader of the scientific community lasted until the 1930s. It declined with the advent in the 1940s of the Scientific Advisory Council, which served as the chief source of scientific advice to the government until its abolition in 1964. During the past decade, the advisory function of the Royal Society has increased considerably.

- Today, the Royal Society's impact on science policy results from:

  - its response to frequent requests for advice from government;
  - its research on particular issues including science education, human fertilization and embryology, and its current work on energy; and,
  - its formal representation on many government bodies.

- Its impact is underscored by the Society's eminence established by the integrity of the election process and its known independence from government.

- In its own view, the Royal Society is able to express itself candidly due to its independence. However, critics note a generally cautious approach and reluctance to present controversial opinions.

- The quality of the Society's analysis is perceived to be affected by the limited multidisciplinary character of the Fellowship, the reluctance to draw on the social sciences and other disciplines, and the inadequacy of resources available to service enquiries.

- The British Academy views its impact as related primarily to education and research; e.g., its representation on the structure of a national library.

- In contrast to the opinion of the academies and other interviews, Dr. Williams (Assistant Secretary, ABRC) considers that the academies do not participate in any great measure in government policy. In her opinion, government would contract out research if it wanted advice on policy issues.

- NAPAG provides a new mechanism for the four academies to jointly impact on U.K. science policy, although this has yet to be demonstrated in practice.

3. Perceived Benefits and Weaknesses

Benefits

- Society benefits from the U.K. academies due to their:

  - promotion of individual scholars, in counterbalance to Research Council support targeted to sectors;
  - support to academics through various scholarships, fellowships, and travel funds, and grant schemes, frequently targeted to younger academics;
  - provision of independent and authoritative opinion on scientific matters to government and other public bodies;
  - representation of the scientific community;
  - strengthening of international ties and cooperation; and,
  - publication of scholarly works, an important academy function.

- The Royal Society feels it has increased public understanding of science, especially through the Committee on the Public Understanding of Science (COPUS). However, J. Maddox, editor of Nature Magazine, questions the Society's success in educating the public while other critics note that the elitist character of the Society hampers its ability to interface with the general public.

Weaknesses

- Weaknesses identified in the Royal Society include:

  - its limited multidisciplinary character and lack of consultation with social sciences;
  - its elitist 'top-stratum' character which limits its ability to effectively represent ordinary bench scientists and contract researchers as well as to interface with the public at large;
  - its oligarchic management, characterized by an absence of internal debate and little opportunity for input from individual fellows;
  - a bias in the election process towards already established fields of study and institutions; and,
  - a tendency to award research fellowships and professorships to scientists who are already Fellows.

- Suggested reforms would enlarge membership to include younger researchers in direct contact with the rank and file and ensure collaboration with other major learned societies.

4. Sources of Funding

General Organization

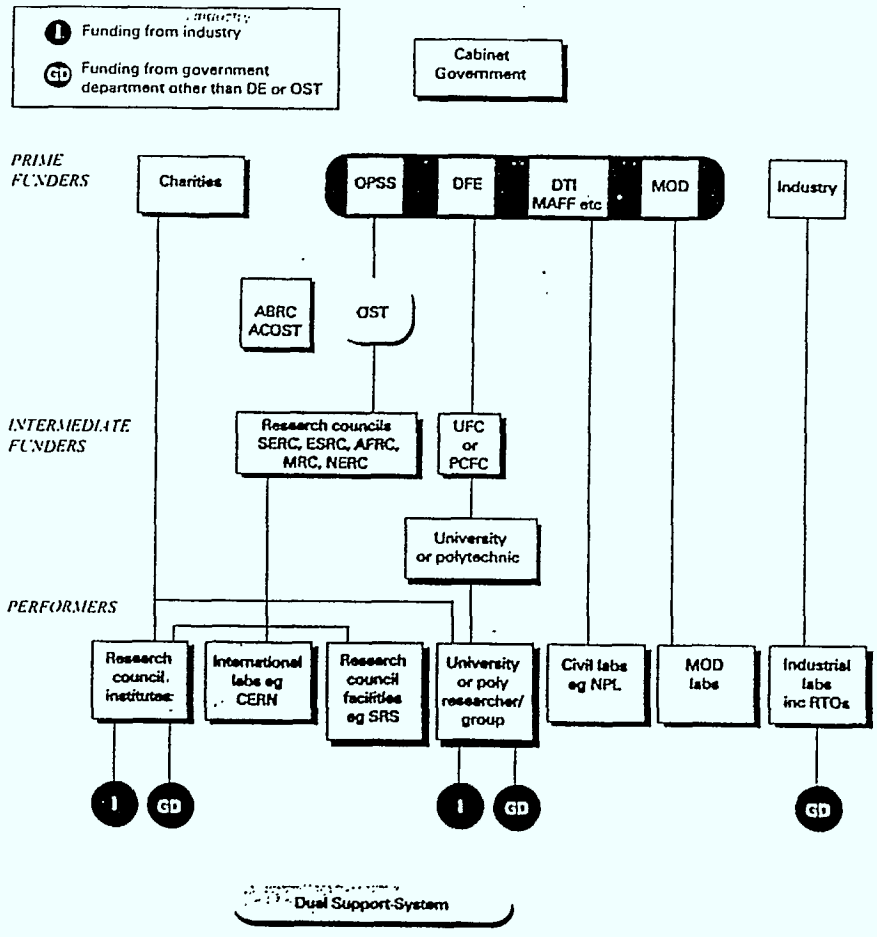
- Government is the major source of funding for the British academies, with private funding playing a secondary role. A parliamentary grant-in-aid is provided directly to the British Academy. Government funds for the Royal Society and the Royal Academy of Engineering form part of the general funding of U.K. research illustrated in **Figure 1** below.

- The Office of Science and Technology (OST) administers the Department for Education's (DFE) science budget, which accounted for 17% of the total U.K. £4.86 billion expenditure on research and development in 89-90.

- On the basis of recommendations from the Advisory Board for the Research Councils, the total science budget is allocated among the research councils and the two academies, the Royal Society and the Royal Academy of Engineering.

- In 1991/92, the two academies received £18.6 million or 2% of the total £934 million science budget.

Figure 1
Organisation of Research in the U.K.



OPSS: Office of Public Service and Science
DFE: Department for Education
DTI: Department of Trade and Industry
MAFF: Ministry of Agriculture, Fisheries and Food
MOD: Ministry of Defence

ABRC: Advisory Board for the Research Councils
ACOST: Advisory Council on Science and Technology
OST: Office of Science and Technology
UFC: University Funding Council
PCFC: Polytechnic and Colleges Funding Council

- The Academies do not sit on the Advisory Research Board for the Research Councils, whereas Research Council representatives do. Justified and priorized research projects are screened by the ABRC as part of the bidding process for extended or baseline budgets.

- In the U.K. academic research benefits form a dual support system. The research infrastructure is funded by the Universities Funding Council, whose budget from the Department for Education amounted in 89-90 to 15% of total U.K. expenditure on R&D. In addition, the Research Councils finance individual programs or projects at universities. A similar system operates for the polytechnics whose direct funding from DFE represented 1% of total R&D expenditure.

- Core funding for SEPSU comes from the two parent bodies and is augmented by private sector funds and income from contract research. The NAPAG intends to derive its core funding from private sources in order to ensure its independence.

Individual Budgets

- The Royal Society's total budget of £23 million includes £18 million from government and £5 million from private trusts and investment income. The funding from private trusts represents a new development. There is no indication that the level of funding will change in the immediate future.

- Funding for the British Academy consists of £20 million from government and £0.5 million from private sources. However, funding is likely to be significantly affected in the future by the establishment of a Research Council with responsibility for the humanities.

Summary - Germany

1. Organization and Structure

- In Germany, the term " academy" does not carry the same meaning as in other countries. Unlike many other countries, the Federal Republic of Germany has no national science academy of international standing, mainly due to the way academic life developed in Germany.

  The academies in Germany are all public corporations. They are predominantly state-supported and receive their funds from the Laender (provinces) in which they are located. In addition, they derive some funds from the Federal Ministry for Research and Technology (BMFT), and The German Research Society (DFG) and private foundations.

  Today, Germany's regional academies are small provincial institutions which together form the "Academies program". Although important from a philosophical, theoretical and cultural perspective, their agendas are specific and very limited.

  As associations of scholars, the academies' objectives have been to cultivate the exchange of scientific thought and to promote scientific research. There are eight provincial academies. Prior to the unification of Germany there were five: the Rhenish-Westphalian Academy of Science (Dusseldorf), the Göttingen Academy of Science, the Heidelberg Academy of Science, the Mainz Academy of Science and Literature and the Bavarian Academy of Science (Munich). The academies have also joined in a number of inter-academic projects. A majority of these projects relate to the humanities (e.g. compilation of a comprehensive dictionary of Classical Greek).

  In brief:

  a) The Göttingen Academy of Science has two sections, one for philology and history, the other for mathematics and physics. Among other things, this academy is famous for its history of early monasticism and for editing the Sanscrit Dictionary of the Turfan Findings.

  b) The Bavarian Academy of Science, founded by Elector Maximilian III Joseph, has two sections, one for philosophy and history, the other for mathematics and natural sciences. The Academy's activities include research on Bavarian and German history; editing the works of Max Weber, Fichter, etc.; research on glaciology; low temperature work; computer work; and publication of committee reports, proceedings and a yearbook.

c) The Mainz Academy of Science and Literature has, in addition to the two sections - mathematics and natural sciences, humanities and social sciences, humanities and social sciences - a special section for literature.

d) The Heidelberg Academy of Science has two sections, one for mathematics and natural sciences, the other for philosophy and history.

e) The Rhenish-Westphalian Academy of Science was given academy status in 1970. In addition to its purely scientific work, it has the task of advising the provincial government in the promotion of research. The Academy has two sections, one for the humanities, the other for natural sciences, engineering and economics.

- A Berlin-Brandenberg Academy of Science was formed in January of 1993 by a group of highly placed scientists. Membership is national rather than regional. The formation of this academy will likely impact on the influence of the German Research Foundation which derives its strength from its federal structure and the present system of allocating R and D funds.

- These academies coordinate their common activities under the auspices of the Conference of German Academies of Science.

- The functions, normally carried out by an academy in other western countries, are undertaken by a different research structure in Germany. This research structure has four major components:

  1) Max Planck Society for the Promotion of the Sciences (Max Planck Gesellschaft zur Forderung der Wissenschaften - MPG), which supports a number of individual institutes focusing on basic research.

  2) The German Research Society (Deutsche Forschungsgemeinschaft - DFG), which supports basic research and distributes funds to universities, academies and other institutions.

     - A " bottom-up" approach is used: as long as the research is scientifically valid, the researcher can undertake it.
     - DFG responds primarily to the scientific community.
     - Grants are covered by a contract between the foundation and the professor who is an autonomous employee of the state. Individual professors set their own agenda.

3) The Fraunhofer Society for the Promotion of Applied Research (Fraunhofer Gesellschaft zur Forderung der angewandten Forschung), whose research and development mainly covers micro-electronics, information technology, automation, production engineering, behaviour of materials and components, process engineering, energy and construction, environmental research, and technical and economic studies.

4) Prominent private sector institutes, known as the " Blue List" of institutes, which account for 70% of German scientific research.

- Research is also undertaken at National Research Centres (Grossforschungseinrichtungen) and at various foundations, such as the Humboldt Foundation.

- The National Research Centres were initially involved in nuclear research and subsequently expanded to cover basic research in physics and space research. The Humboldt Foundation, a non-profit incorporated foundation, grants research fellowships and awards to foreign scholars, internationally recognized scholars and to young German PhDs.

- All research institutes operate autonomously from government. They include a President and a Board of experts drawn from the discipline. A system of peer reviews govern applications from individuals.

- Interdisciplinary research is carried out at the project level while membership in institutes is normally not multidisciplinary.

- University-based research is guided by the fundamental principle of joint teaching and research. This principle dates back to Wilhelm von Humboldt's reform of Prussian universities in the early 1900s. Two university systems operate in Germany:
  1) " Fachhochschulen" , for the practice of individual professions; and
  2) Academic universities.

- In accordance with the Basic Law, education is the primary responsibility of the Laender. The federal government, the Bund, is responsible for the promotion of scientific research.

- The Standing Conference of the Ministers of Education and Cultural Affairs coordinates education policies at the Laender level.

- Two joint Laender-Bund bodies are involved in scientific research:

  i) the Bund-Laender Commission for Educational Planning and Research Promotion (BLK), which coordinates research policy and research budgets; and

  ii) the Science Council (Wissenschaftsrat), an advisory body whose members include prominent figures from the scientific community and representatives of both Bund and Laender.

2. Impacts on Development of Public Science Policy/Public Policy

- According to the German Conference of Education and Science, impacts from a university-based research project, for example in solar energy, occur in a three-fold way:

  1) the province establishes an area of study in this field;

  2) an individual university professor requests funds in this discipline; and,

  3) the German ministry establishes this as a main area for research and supports industry prototypes.

- One of the German Research Society's objectives is to " counsel parliament and public authorities on scientific matters". The public policy issues it has addressed have been primarily related to the organization and restructuring of universities in Germany; energy; and the environment. The scientifically-based statements released by the society to the public have also played a role.

- With its emphasis on applied research, the Frauenhofer Society has sought to support public decision-making, especially with regard to technological development and the introduction of new technologies.

- The federal Ministry for Education and Science notes that the government may seek to have work undertaken on a specific issue. It will then provide funds to research institutes and/or use government laboratories. In some instances, it will create a special institute, e.g. on climate change. In addition, scientists are aware of problems and target their research accordingly.

3. Perceived Benefits

- The benefits of the academies are primarily in the production of research works in the sciences and the humanities. In addition, the academies have been active in the support of research excellence through the award of prizes for research excellence. Finally, the academies have produced regular publications and a yearbook.

- The academies are also actively linked with foreign research establishments.

- The academies are viewed by the Federal Ministry for Education and Culture as indispensable and as fulfilling a fundamental role in culture, ethics and the economy.

- According to the German Conference of Education and Science, it is up to individual researchers to establish the benefits to society of their work.

4. Sources of Funding

- In Germany the vast majority of scientific research is funded (and conducted) by industry. The federal government and Laender provide some funding while contributions from private donations and endowments are relatively small. In 1990, public expenditure, by both levels of government, on research promotion in the former area of the Federal Republic of Germany, totalled DM 5.8 billion, while private sector funding (incl. endowments and donations) represented DM 44.1 billion.

- Amounts and sources of funds, both between private and public sector and between the two levels of government, vary considerably among individual institutions **(See Table 2 below)**:

  - National Research Centres receive the largest amount of public funds, i.e. DM 2.9 billion in 1992, with the federal government providing DM 2.59 billion.

  - The German Research Society receives 99.4% of its total funding, amounting to DM 1.5 billion, from the two levels of government. It supports 45% of university and international research.

  - State and Laender funds each account for 50% of the total public budget for the Max Planck Institutes. In 1992 this amounted to DM 1.15 billion.

- Funding for the Fraunhofer Society is provided primarily by the federal government, which allocated 89.9% of the society's total DM 0.347 billion public monies in 1992. In order to promote contract research for industry and state authorities, the actual amount of payment depends on the society's income from contract research.

- A total of DM 1.04 billion public funds, divided almost equally between the federal government and the Laender, were granted to the " Blue List" of institutions, whose primary source of funding is industry.

- Public funds for the Academies program (DM 59.3 million in 1992) were split evenly between the two government levels.

- Public funds are transferred directly by governments to Max Planck institutes, whereas universities, academies and other institutions receive public funds through the German Research Society.

- Industry both funds and conducts 70% of all research in Germany, mostly in the " blue list" institutes. Only 4% of the research funds to universities originates from industry.

- Future changes in funding levels will be related to the increased availability of funds at the level of the European community and to German reunification.

  - The Federal Ministry for Education and Science expects the German Research Society and the Max Planck institutes to benefit from a 4-5% increase in public funds. Increases for other institutes are not clear.

Table 2:

Joint Allocations by Federal Government and Laender to the Research Institutions Covered by the Outline Agreement on Research Promotion
(Million DM)

	1991			1992		
	Federal	Laender	Total	Federal	Laender	Total
National Research Centres	2,400.0	309,0	2,709.0	2,594.0	310.0	2,904.0
German Research Society	802.9	580.7	1,383.6	875.6	635.3	1,510.9
Max Planck Society	512.2	512.3	1,024.5	575.8	575.9	1,151.7
Fraunhofer Society	157.8	17.5	175.3	313.0	34.8	347.8
Blue List	264.6	239.7	504.3	534.4	509.0	1,043.4
Academies program	20.0	20.0	40.0	29.6	29.7	59.3
Total	**4,157.5**	**1,679.2**	**5,836.7**	**4,922.4**	**2,094.7**	**7,017.1**

Source: Federal Ministry for Education and Sciences.

Summary - Sweden

1. Organization and Structure

- A large number of national academies operate in Sweden as part of the private sector; i.e., independent of government. The term "royal" which frequently appears in the titles of these academies is a reference to the King's patronage. In Sweden, the King traditionally approves the statutes of the Royal Academy.

  Some of the better known of these academies include:

  - The Royal Swedish Academy of Engineering Sciences;
  - The Royal Swedish Academy of Sciences;
  - The Royal Swedish Academy of Letters; and,
  - The Royal Swedish Academy of Fine Arts.

- All of the academies are self-governed and set their own agendas. Their relationships with government are generally informal.

- The only formal links with industry have been established by the Royal Academy of Engineering Sciences where over 200 companies are represented on the Academy's Industrial Council.

The Royal Swedish Academy of Sciences

- Founded in 1739, the Academy has 300 Swedish members, including 161 under the age of 65, as well as a maximum of 161 foreign members. Research is undertaken in ten classes corresponding to individual disciplines, as well as in committees, e.g. the Environmental Committee and the Polar Research Committee.

- The research agendas are set by members through the Board of Governors or other initiatives. Other activities include international scientific exchanges, the coordination of world-wide research by the International Council of Scientific Unions (ICSU) and the publication of journals. In addition, the Academy is responsible for the provision of financial assistance and awards.

- The Academy is responsible for 7 research institutes (this number was previously much larger) and has access to a staff of 40.

- The Council of the Academy is the Governing Body, consisting of a President, three Vice-Presidents, the Secretary-General and twelve elected members. The Secretary-General, assisted by the permanent staff, is responsible for the day-to-day running of the Academy.

- The Academy has non-academic members in one of the ten classes. Generally it does not have multidisciplinary memberships.

- The Academy supports and encourages young academics through the provision of prizes, fellowships and other funds.

- Linkages with the research granting councils are informal but the linkages with government are quite formal. There are no formal linkages with industry as this is done through the Royal Swedish Academy of Engineering.

The Royal Swedish Academy of Letters

(**Note:** the following information is taken from documentation provided by the Royal Academy of Sciences.)

- Founded in 1753, the Royal Swedish Academy of Letters aims to promote research in the field of humanities and social sciences and to preserve Sweden's cultural heritage.

- Membership is basically divided into two classes: history and antiquities; and, philosophy and philology. However, a wide variety of other subjects are also represented. There are approximately 100 members, of whom a maximum of 50 are under 65.

- Research is carried out by four permanent scientific committees and a number of ad-hoc committees.

The Royal Swedish Academy of Engineering Sciences (IVA)

- It is the oldest engineering academy in the world and was founded in 1919. The academy's primary aim is to " promote engineering and economic sciences and industry for the benefit of society" .

- Of its 652 Swedish members, two thirds (2/3) are academics and the remaining third consists of industry leaders and government officials. They are elected into one of its twelve divisions which represent specific fields of technology and economics. The highly qualified staff numbers 70.

- A high priority is accorded to the environment and environmental technology, energy, and education and research policy. International collaboration as well as information and publication activities complement the academy's analytical work.

- Future efforts will include the identification of the changes that " must take place in Swedish industry and commerce and the community at large if Sweden is to make a place for itself in the emerging international community" .

The Royal Swedish Academy of Fine Arts

- The Royal Swedish Academy of Fine Arts dates back to 1735. As stated in its charter, its primary aim is to " promote the development of the visual arts and architecture" .

- Since the 1970s the Academy is no longer directly involved in training artists. However, it maintains active links, both nationally and internationally, with education.

- Academy activities include scholarships for artists and art students, exhibitions and conferences, as well as publications. Architects, painters, sculptors, and other artists are represented among the 70 members under the age of 65.

Research Councils

- Research councils, such as The Research Council for the Humanities and Social Sciences and the Research Council for Natural Sciences are structured along disciplinary lines.

- The Board of Research Councils (Forksningsradsnamden) is multidisciplinary and acts as both a state agency research council and an organization dispensing research grants. Its responsibilities include informing the public about costly equipment expenditures at universities.

- A new research Bill is expected in February 1993. It may change the direction of the Board.

2. Impacts on Development of Public Science Policy/Public Policy

- In Sweden, the national academies enjoy a high official status and their views are highly respected. They play a very powerful role as advisors to government on important issues.

- Although they have no formal consultative linkages with government, the academies occasionally function as government Boards. Government views them as part of a larger body of research institutes, councils and universities.

- Unsolicited advice is also provided to government. Commissions are conducted by the academies at the national level; e.g., on the environment. At the international level, they have served as mechanisms to officially deal with Eastern Bloc countries.

- The Royal Swedish Academy of Sciences plays a particular role with regard to environment, energy, education and science policy. Each year, the Ministry of Science reports to the Academy on its agenda.

- Higher education, energy issues, research and development and industry policy represent areas in which the Royal Swedish Academy of Engineering has had an impact. For example:

  - A government bill on future engineers benefitted from information provided in the academy's study entitled "Engineers for the 21st Century".

  - Criticism by this academy on the education of industrial economists raised a serious debate and helped contribute to increasing support to their education.

- The Royal Swedish Academy of Fine Arts is consulted by the Government Department of Culture on all matters pertaining to culture. In addition, this academy examines issues on its own initiative. For example, its opinion influenced the location of the Museum of Modern Art.

- The Board of Research Councils has had an impact on public policy on agriculture and food and contributed to the energy plebiscite by launching a vast scientific information campaign.

3. Perceived Benefits

- According to individual academies, Swedish society benefits from their existence due to:

  - the enhancement of national and international science;
  - systematic international cooperation;
  - the promotion of young scientists; and,
  - the provision of a neutral forum for discussion.

- The Royal Swedish Academy of Engineering sees itself as providing a multidisciplinary engineering " think tank". This "think tank" encourages the participation of young people and emphasizes a willingness to tackle difficult issues.

- The Ministry of Education identified the following benefits:

  - educated opinions on difficult questions;
  - scientific advice;
  - the general goodwill created in their own disciplines;
  - the creation of an environment for the arts and sciences, through the respect and authority they command;
  - a heightened national respect;
  - the preservation of language and culture; and,
  - tourism.

- The Academy Art School, in addition to the university art schools, benefit from the financial support of the Royal Swedish Academy of Fine Arts. Other benefits provided by this academy are derived from its function as a major public art centre (exhibition halls, collections and library) and its publication and translation of foreign documents in the arts.

- Forskningsradsnamden, the Board of Research Councils, hopes to contribute to an increased plurality and vitality in the Swedish research system.

- It also seeks to increase public awareness of the implications and importance of science and the humanities.

4. Sources of Funding

General Situation

- The majority of funds available to national academies originate from the private sector in the form of non-tax deductible donations and legacies.

- Government funding, consisting of grants and subsidies, is generally modest and expected to remain stable. Any savings achieved by cutting this funding would be marginal. One of the main purposes of these funds is to promote international cooperation. This is viewed by government as being a very important function. Only the Royal Swedish Academy of Sciences receives a considerable amount - Swedish Krona 13.3 million in 1990/91.

- Individual companies which sit on the Industrial Council of the Royal Swedish Academy of Engineering Sciences each contribute Swedish Krona 100,000. This amounts to 40% of the academy's total budget.

- The Board of Research Councils (Forskningsradsnamden) is an organization dispensing research grants. It receives approximately Swedish Krona 100 million to support research and information activities as well as Swedish Krona 220 million to purchase scientific equipment. It has formal and informal relationships with research councils and only informal relationships with academies. Its responsibilities include the allocation of research funds that are not earmarked by government.

  Proposals are submitted by the Board to the Minister of Education responsible for Universities and Research. The proposals are, in turn, submitted to parliament, which provides the allocated funds.

- Formal relationships with organizations dispensing research grants exist only for specific projects, e.g. the Estonian Academy project and the Swedish Polar Research Secretariat.

5. Individual Budgets

The Royal Swedish Academy of Fine Arts

- On an annual basis, the Royal Swedish Academy of Fine Arts receives several hundred million krona from donations. In addition, the government provides Swedish Krona 1.5 million; rental income amounts to Swedish Krona 4.0 million; while the restaurant and art galleries contribute Swedish Krona 6-7 million.

The Royal Swedish Academy of Engineering Sciences

- Government funding, which represents 10% of the total budget (i.e., Swedish Krona 50 to 55 million), contributes Swedish Krona 5.5 million; Industrial Council funds account for 40% or Swedish Krona 20 to 25 million; and, project income, derived from industry and different grant ministries, contributes the remaining 50% or Swedish Krona 25 million.

- The amount of government funding is expected to decrease in the future.

The Royal Swedish Academy of Sciences

- The total 1990/91 budget amounted to Swedish Krona 69.5 million. Government contributions to the Royal Swedish Academy of Sciences amounted to Swedish Krona 13.3 million and the Sweden-Soviet cooperative agreement added another to Swedish Krona 10.0 million. The Academy provided Swedish Krona 15.6 million from its own funds. The balance originated from research grants (Swedish Krona 12.3 million); contract earnings (Swedish Krona 6.5 million); journals (Swedish Krona 5.6 million); rental income (Swedish Krona 2.2 million); and, other sources (Swedish Krona 4.0 million).

Summary - France

1. Organization and Structure

France has a number of academies that occupy an important place in French society. Below is a discussion of the five academies belonging to the Institut de France, and the Académie nationale de médicine.

It is important to note that the French academies are steeped in tradition and history. It is this tradition and history that also provide part of the "mystique", independence and national importance of the academies.

Académie Nationale de Médicine

This Academy does not come under the aegis of the Institut de France. The Academy was established in December 1820 by royal ordinance, charged with the continuation of the work of the predecessor society of medicine, Royal Academy of Surgeons and the Society of the Faculty of Medicine, which were established in the 1700s. In 1829 the Academy was redivided into sections. Subsequent acts and ordinances have defined the number of members and the procedures of the academy.

The **Administration** of the academy is self-contained. The Academy is administered by a "bureau de l'académie" which consists of a:

- president
- perpetual secretary
- vice president
- treasurer
- assistant secretary (administrative)

There is an Administrative Council that is the main administrative decision making body. The council consists of the "bureau" and six other members of the academy. The Administrative Council is the main administrative decision-making body, however the day-to-day running of the Institute is done by the "bureau" and the Perpetual Secretary.

In addition, the Academy has an administrative staff directed by a Chief of Administrative Services who reports to the office of the perpetual secretary. There are 17 administrative staff.

Agendas are set by the Perpetual Secretary and approved by the "bureau". Meetings are held every week and follow a prescribed order. At each meeting, a special scientific work may be reviewed. The results of the work of the Academy includes Proceedings of the Meetings (which include the intellectual debate on items of scientific interest) and the reports of special commissions, members or Sections.

A debate occurs before reports are released. This provides a quality review of the work and the support for the intellectual value of the work by the Academy members.

An important function of the academy is the maintenance of a national library and archives.

Memberships. There are 130 members of the Academy. These members are divided into 8 sections.

Institut de France and the Associated Academies.

The Institut de France dates from pre-revolutionary France. The predecessor Royal Academies were abolished in post-revolutionary France and then revitalized under the aegis of the Institut de France. In the reconstitution of the Institut national des sciences et des arts in 1795, three sections were recognized: physical sciences and mathematics, moral and political science, and literature and art.

At the present time, there are five academies that comprise the Institut de France:

- Académie francaise
- Académie des Sciences
- Académie des Sciences morales et politiques
- Académie des Beaux-Arts
- Académie des Inscriptions et Belles-Lettres

Thus, the Institut has a very broad range of interests which include: language and its development, political issues and their study, the arts, the humanities and the sciences. The Institut and the Academies are the most prestigious and historic in France. Each of the Academies has its own rules of governance and its own objectives and traditions.

The following are common to all of the academies:

- a limited number of members and correspondents;
- the procedure of election of new members;
- weekly meetings;
- the principal of administration by the members through an administrative council, with the administrative oversight assigned to a perpetual secretary;
- a history of independence from the government in terms of election of members, selection of the program of work, expression of opinions and conclusions on issues in science and/or the humanities; and,
- considerable financial independence.

Administratively the Institut de France is a public legal entity, set up through a particular statute. It is theoretically under the control of the Ministry of Education. The State through the Ministry of Education provides each member with a very modest salary. The state also funds an administrative budget that covers overall administrative staff for the Institute de France itself and for each of the Academies.

The Institut de France has a collegial administration (composed of representatives of the academies). For efficiency reasons, a director of administration (chancelier) handles the day-to-day administration on behalf of the Perpetual Secretary. The chancelier and paid staff control the financial and administrative aspects for the Institut de France and to a great extent for the academies. A major part of the work of the administrative staff is the management of the substantial properties, funds, and legacies that belong to the various academies.

The administrative decisions that are made by the Council (composed of the perpetual secretaries of each of the academies and additional elected delegates) are, in certain instances, brought before the entire assembly of members. The council is headed by a President who is elected on a rotating basis from the Academies.

Agendas. Each of the individual Academies is responsible for the establishment of its own agendas and programs. The programs of each academy relate to their specific objectives:

- The Académie Francaise is concerned with the preservation and development of the French language;

- The Académie des Sciences vets new scientific discoveries and works brought forward by members. This academy also responds to specific science policy questions initiated internally or brought forward by the government;

- The Académie des Beaux-Arts is responsible for the key arts, debates on culture and society, etc.

- The Académie des Sciences morales et politiques is less active and important currently but was very important during the formative years of the Republic.

The agenda of each academy is set by the perpetual secretary and the administrative council. Each has rules of procedure and each produces proceedings of its meetings and issues special reports and anthologies of their work. What is very important is the independence of the academies in setting their own programs. These cannot be imposed by outside bodies.

The Academy of Science holds meetings weekly but also sponsors colloquia twice per year, and publishes proceedings of its meetings and other reports.

Weekly meetings are multidisciplinary and focus on an individual scientist presenting the results of his or her research, discoveries or theories. These are then questioned and debated and the proceedings published.

Members. It is estimated that about 80-90% are academics or former academics, however, members can have other professional backgrounds. For example, Beaux-Arts may include well-known and recognized artists, whereas Sciences Morales and Politiques includes ambassadors and ex-politicians.

L'académie des Inscriptions et Belles Lettres has 55 full time members and 20 foreign associates and 70 correspondents.

L'académie des sciences has 134 members and 151 correspondents and up to 120 foreign associates.

L'académie des Sciences Morales et Politiques has 50 members, 12 foreign associates and 60 correspondents.

In general, each academy defines its memberships and follows its own procedures for induction. As a general rule, memberships are multidisciplinary.

2. Impacts on Science Policy Development

Académie nationale de médicine

In discussing impacts it should be realized that the comments are based on a review with members of the Academy. The Academy has been very active and involved in scientific studies of medical and health issues. It is felt that the Academy has been an important source of advice for the Ministry of Health. Examples of reviews done by the Academy include an opinion on the probable course of development of AIDS in France.

The Institut de France

In general the academies address public policy issues in their respective domains. It should be noted that the academies respond totally independently and must decide on their own whether or not to study an issue. The resulting study or report is carefully vetted and debated by the Academy weekly meeting before being released. This provides peer review.

The discussion below pertains to l'Académie des Sciences

The Academy is involved in Science Policy development through various means. Until the 1920's the Academy was solicited frequently for its views on Science policy. This role went into a state of limbo until quite recently. During the decades subsequent to the second world war, the government established a national research structure for France which included Research Organizations, and Committees. This structure was tasked with the development of France's scientific policy orientation and its evaluation. Paradoxically, this did not leave a role for the Academy, but permitted it independence to freely monitor and comment on science policy direction and to provide advice and recommendations.

To perform this role the Academy and its sub-committee (CADAS), which is concerned with applied science in engineering and informatics, etc., has established a Reports and Studies Sub-Committee to which is submitted all position papers on science policy topics. These position papers are subsequently released in the name of the Academy. These papers are well debated and the conclusions and recommendations that emerge are considered to be the opinion of the French scientific community on a policy issue of national concern.

Each specific study or report is completed by a standing or ad hoc scientific committee. There are three permanent committees: the Committee on Space Research, the Committee on the Environment, and a Committee on Science, Technology and Strategy (with the participation of the Minister of Defence).

Studies undertaken have included:

- Risks of ionizing radiation and norms for protection;
- The greenhouse effect and climactic consequences - a scientific evaluation;
- Experimentation with animals: necessities, constraints and substitute methods;
- Research in genetic engineering: ways of improving its evolution and development;
- A Report on biological research among the different sub-disciplines; and,
- Pollution of the subterranean water aquifers in France.

The Academy considers that it frequently provides independent advice on policy issues, that is well debated and taken into account in government decision-making.

3. Benefits

The academies have provided a mechanism for carefully reviewing, debating and disseminating new discoveries and theories in the arts, humanities and sciences. The granting of prizes has had the effect of helping to motivate excellence in the arts, humanities and the sciences.

The Academies are considered an important advocate as well as monitor of trends and issues in the sciences, arts and humanities.

Specific benefits that have been derived from the Academy of Sciences have been:

- The weekly public meetings in which scientific discussions occur on current issues or discoveries in science. These discussions are summarized in the Academy's proceedings and quickly disseminated to all interested parties;

- The current proceedings of the Academy of Sciences often provide the first publicity of a new discovery in the sciences. The series in mathematics, mechanics, physics and chemistry as well as earth sciences constitute one of the best reviews of current discoveries in each respective field.

- The academy through its awards program, its new program of creating special university chairs funded by the academy, and its planned program of scholarships for post doctoral students, plays a role of supporting excellence in scientific research.

- The academy plays an important role as an independent advisor and monitor of government science policy and national science trends.

The key criteria for success appear to be:

- the independence of the academies and their history of being self-contained in selecting their work programs and self-critiquing their own work through internal peer reviews;

- financial autonomy which has resulted in less than 10% of the budget coming from the state;

- the induction process that has resulted in very high quality standards for membership and the option to use outside resources such as associates and correspondents as well; and,

- the high level of confidence placed in them as a result of their independence and membership.

What would not be undertaken without academies

Much of the scientific review and review of issues and papers might not be done without the academy structure. It should be noted that it is felt by some that the focus of the academies is on the promotion of excellence in their respective fields and not specifically as a think tank for the government. From this perspective there are other agencies that undertake research and policy studies on behalf of the government.

The academies do not fund research or act as granting councils.

4. Sources of Funding

Sources of funding - Académie de Médicine

The actual funds obtained from the state amount to about a million francs ($250K CDN). A principal source of funds for the Academy is its own resources that have been received through legacies and donations and placed into trust funds. These monies are used for prizes.

The financial resources appear to be used for the small staff, the real estate, and equipment, and a small compensation paid to the members. It is interesting to note that members are paid only a symbolic salary of about 5000 FF and as well as symbolic travel expenses. Thus, it is expected that the reward is from the honour associated with membership.

Budget allocations are provided by the Ministry of Education for the library (500,000 FF) and staff salaries and operations (600,000 FF).

Sources of funding - Institut de France

The academies are under the umbrella of the Ministry of Education and Culture. The state provides budget support for administrative staff and a small salary for each of the members. The Academies are very independent with respect to the definition of their own programs and with respect to the selection of their members.

There are no relationships between the academies and the granting institutions, and generally no formal relationships with industry.

The state budget for the Institut de France is about 10 MM Francs ($2.5 million CDN).

In comparison, the resources of the Institut and its member academies are approximately 240 MM francs ($60 million CDN) from properties and other legacies and donations. The Institut has an annual revenue of FF 241 million and expenses of FF 229 million.

The financial situation of each academy is quite different. For example, L'académie des Beaux-Arts, L'académie des Sciences Morales and Politiques, and L'académie Francaise receive very little from the government, whereas the others are more heavily funded.

Summary - United States

1. Organization and Structure

The United States has a number of academies and institutions providing scientific advice and influencing the development of science policy. Lewis Branscombe, Centre for Science and International Affairs John G. Kennedy School of Government, presented a useful taxonomy of U.S. science advisory functions, activities, and institutions which is presented below.

At least nine kinds of government functions are supported by formal institutional structures for the provision of outside advice:

- Regulatory processes and decisions - statutory advisory committees;
- Technology assessment - socio-technical agendas;
- Resource allocation - peer review and less formal methods;
- Program management - committees that track specific programs;
- Conduct of research whose outcomes will influence policy;
- Procurement strategies and decisions;
- High level policy - setting agendas for political decision;
- Administrative support - program evaluation, planning; and,
- Institutional performance - oversight committees for laboratories and agencies.

Advice to these functions is provided through many different institutional forms, here grouped into eight categories:

- Official and statutory advisory committees (such as the National Science Board and the Defense Science Board; EPA Science Advisory Board, PCAST, Presidential Commissions;
- The National Research Council and its governing Academies, The American Academy of Arts and Sciences;
- Agency level committees - tracking programs, recommending program priorities, evaluation specific laboratories, performing peer review;
- In-house think-tank (such as the Office of Technology Assessment);
- Contracted think-tanks, including quasi-governmental, hybrid institutions e.g. RAND, MITRE, Critical Technologies Institute;
- Individual advisors and consultants;
- Advocacy organizations (Natural Resources Defense Council, Greenpeace, Computer Professionals for Social Responsibility); and,

- Professional societies and federations of them (American Chemical Society, IEEE, American Association for the Advancement of Science).

From this context we have focused upon two organizations, the first of which is the Academy Complex and the other The American Academy of Arts and Sciences.

The Academy Complex

The Complex consists of four organizations: the National Academy of Sciences, the National Academy of Engineering, the Institute of Medicine and the National Research Council (Figures 1-4 at the end of this section illustrate the organizational charts of these four entities). The National Academy of Engineering of Engineering and the Institute of Medicine are organized under a Congressional charter granted to the national Academy of Sciences in 1863. The charter stipulates that the Academy "shall, whenever called upon by any department of the Government, investigate, examine, experiment, and report upon any subject of science or art..." The two Academies and the Institute are private, non-profit membership organizations each governed by its own council.

The National Research Council is an organization through which most of the studies of the Academy Complex are conducted. However, other mechanisms exist within the Complex for conducting studies and other activities. For example, the Councils of the two Academies and the Institute jointly sponsor the Committee on Science, Engineering, and Public Policy and the Government-University-Industry research Roundtable. The National Academy of Engineering sponsors engineering studies and other activities designed to assess and meet national needs, address special topics in engineering education and research, and explore means for promoting cooperation in engineering in the United States and abroad. The Institute of Medicine identifies concerns in medical care, research, and education and examines policy matters relating to public health, research, and education and examines policy matters relating to public health. Although the Institute of Medicine is not a part of the formal structure of the National Research Council, its program is subject to approval by the Research Council's Governing Board and its reports are subject to the requirements of the Report Review Committee.

The National Academy of Sciences

From its original 50 members, the National Academy of Sciences (NAS) has grown to include about 1,500 distinguished scientists and engineers. The membership is divided into 25 disciplinary sections in six classes: the physical and mathematical sciences, the biological sciences, engineering and applied sciences, the medical sciences, the behavioral and social sciences, and applied biological and agricultural sciences.

As a scientific organization, NAS publishes a scholarly journal, "The Proceedings of the National Academy of Sciences" and organizes symposia and meetings on issues of particular importance to its membership. The Academy bestows a number of highly regarded prizes and scientific awards - some that existed for decades - recognizing outstanding contributions of individual scientists. The Academy also maintains a strong network of contacts with scientific academies in other nations and serves as the convener of national committees adhering to the International Council of Scientific Unions.

In recent years the Academy has initiated a number of new activities for its members. The president and officers of the Academy meet with members in regional meeting held each winter in cities throughout the United States. The Academy's annual meetings, held each April, have been enlarged to include policy discussions on such issues as arms control, national security and the freedom of scientific communication, the status of scientific and mathematics education at the precollege level, science and technology and the future of the U.S. economy, the health threat posed by AIDS, and other topics of national concern.

The National Academy of Engineering

The National Academy of Engineering (NAE) was created by the National Academy of Sciences in 1964 to recognize the fundamental role of engineering and technology in modern society. Since then, NAE has elected over 1,300 members for their distinguished contributions to the science and practice of engineering. A principal role of the Academy has come to be the joint management, with NAS, of the National Research Council.

The National Academy of Engineering is an autonomous organization that, like NAS, conducts symposia, publishes special reports, participates in international activities, and awards medals and honours for engineering and public achievement. Among its activities have been a series of symposia on technology and society, many of which have identified issues for in-depth study by the National Research Council.

In recent years the NAE has begun to examine ways in which it can increase its visibility among professionals and the public and the visibility of engineering as a profession. It publishes "The Bridge" bimonthly as a means of communication with its members and with others in the engineering professions.

The Institute of Medicine

The Institute of Medicine (IOM) was created by the NAS in 1970 to work on matters affecting the status of medicine and the medical professions and the adequacy of health services for all sectors of society. The Institute now has 500 members, individuals, according to its charter, " of distinction and achievement, committed to the advancement of health science and education and to the improvement of health care." Unlike the NAE, the IOM is part of the National Academy of Sciences. It helps govern the National Research Council, its committees and panels are approved by the Research Council chairman, and it follows Research Council procedures in its studies.

Like its sister institutions, the Institute of Medicine cooperates with major scientific and professional societies. It also brings together organizations and individuals in national forums on major health policy issues.

The National Research Council

The National Research Council (NRC) was formed by the National Academy of Sciences in response to a request by President Wilson in 1916, as the United States was on the verge of entering World War I. It provided an institutional framework whereby large numbers of American scientists and engineers, both Academy members and nonmembers, could voluntarily serve the government through participation in NRC activities. The wartime effort was so successful that President Wilson perpetuated the NRC by Executive Order in 1918. The arrangement was reaffirmed in a second Executive Order signed by President Dwight Eisenhower in 1956.

The NRC has about 950 committees, panels, boards, working groups, etc. on which over 9,000 highly qualified scientists, engineers, physicians, and other professionals serve without compensation. This voluntary service, along with the procedures adopted by the NRC to ensure the balance and objectivity of its studies, are the hallmarks of its service to the country.

The NRC is governed by the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The presidents of the NAS and the NAE serve as the chairman and vice chairman, respectively, of the NRC Governing Board, which meets every two months to oversee the work of the organization. The Governing Board also includes 11 other members drawn from the governing councils of the two Academies and the IOM. A six-member Executive Committee of the governing Board meets monthly to review new NRC and IOM projects.

The NRC is organized into eight major units: the Commission on Behavioral and Social Sciences and Education; the Commission on Engineering and Technical Systems; the Commission on Physical Sciences, Mathematics and Resources; the Commission on Life Sciences; the Office of International Affairs; the Office of Scientific and Engineering Personnel; the Transportation Research Board; and, the Board on Agriculture. The Mathematical Sciences Education Board and the Strategic Highway Research Program are two special units within the NRC.

Most of the requests for NRC studies come from federal executive branch agencies; some are initiated internally as a result of the deliberations of NRC boards and committees. A few are proposed by nongovernmental external sources, while a growing number are mandated in Congressional legislation. For example, the 100th and 101st Congresses (in calendar years 1987 through 1990) requested a total of 54 studies by the Academy Complex. Nineteen of these mandates were enacted in the closing months of the 101st Congress.

The studies are conducted through the NRC's committee process, employing a wide cross section of the nation's leading scientists, engineers and other professionals who serve without pay. It should be noted that those professionals so employed, generally perceive that their careers are enhanced by serving on such prestigious committees. The process guides the acceptance of subjects for study by the institution, their examination by a committee of volunteers, and institutional review and approval of the committee's report.

Acceptance of a subject for study involves several stages, of which the last, and most critical, is its approval by the Executive Committee of the NRC governing Board or, on occasion, the full Board. In its decision to accept or decline a project, the Executive Committee considers the importance and timeliness of the question, its background, the audience, likely impact, the range of competencies that must be represented on the committee if the question is to be examined adequately, the appropriate level of effort, and the potential funding sources (for overhead and out-of-pocket costs only).

Once a project is under way, responsibility for ensuring adherence to the NRC process lodges primarily with the executive office of the cognizant unit of the NRC. This responsibility includes appointing members to the study committee and assuring that the committee's membership is properly balanced, that its expertise is appropriate to the task, and that the schedule necessary for timely completion of the project is maintained.

The final stage of the NRC process, that of review, falls under the aegis of the NRC Report Review Committee, whose task is to vouch for the credibility of the committee's work primarily by verifying that its conclusions and recommendations are supported by the body of the report, that the report addresses the charge given to the committee, that it is clearly written, and that its level of discourse is appropriate for the intended audience.

Published reports from the Academy complex are disseminated as widely as possible to ensure that they are brought to the attention of target audiences. Such efforts require staff and committee time and resources for briefings, broad distribution of free copies of reports, and related activities.

Agenda

The original agenda for the National Academy of Sciences was set by Congress in the Academy's charter; federal agencies could ask for studies on any subject of science or art. Now, agenda setting is divided. The officers estimate that about a third of the work is truly initiated within the federal government. That work involves a wide variety of technical matters and some newly discovered needs such as examination of the reasons for the explosion of the space shuttle Challenger. At least another third of its work results from interactive dialogue between government agencies and the National Research Council. The final third arises within the Academy complex itself.

The American Academy of Arts and Sciences

The American Academy of Arts and Sciences was founded in 1780 by a small group of scholar-patriots led by John Adams. The charter they adopted was " to cultivate every art and science which may tend to advance the interest, honour, dignity and happiness of a free, independent, and virtuous people".

While the originating body of the Academy was comprised of practical persons who have been characterized as mature scientists, the elected body is now comprised of professionals. The membership of the Academy reflects the full range of disciplines: mathematics, the

physical and biological sciences, medicine, the social sciences and humanities, business, government, public affairs, and the arts.

Today, the Academy has 3,150 Fellows and 550 Foreign Honourary Members, elected by their peers in recognition of distinguished achievement. In the past, criteria for election were dominated by published works. This resulted in the Academy electing mainly professors. As a consequence, the Academy, in the past 7 - 8 years has elected more business executives and persons with extra dimensions over and above academic credibility.

In the past, persons elected to the Academy were typically 30 years past completion of their PhD. Now the average age of those elected is 53. As well, the Academy is trying to increase its representation of women and minorities. This is being done by promoting the concept within the electoral bodies and also by striking special committees to search for qualified candidates. Also, while in the past the Academy elected only 80 new members per year for 21 sections, it now elects 125 members per year which allows for better representation from previously disadvantaged groups.

Nominations to the Academy are first screened by a committee and then voted upon by the existing members. If minorities receive equal votes, they are given preference. Women comprise 15% of newly elected members.

Agenda

Principal contributors to Academy studies are drawn primarily from its membership, and the topics selected for investigation therefore reflect the intellectual priorities of Academy members. This mode of operation distinguishes the Academy from other influential research organizations or "think tanks" whose agendas are often shaped by the research needs of outside agencies.

2. Impacts on Science Policy Development

The Academy Complex

Research Council reports are tools for the science and engineering communities, government policy makers, business leaders, private and public organizations, and interested citizens. Like the implements in a tool box, the findings, conclusions and recommendations in a report may be used as soon as they are available or they may lie in wait until a particular need or question arises.

When they are consulted, however, Research Council reports often are viewed as the authoritative reference on a topic - a reflection of the thoughtful examination by committees of Research Council experts. As a result, the reports are routinely cited by members of Congress, executive branch officials, industry groups, and nonprofit associations. In addition, reports can be catalysts for new legislation, government policies and private sector initiatives.

Some examples:

- A review of U.S. export controls on high-technology products found that the regulations cost the nation's businesses about $9 billion annually and yet often were ineffective in protecting national security. The study concluded that the regulations in some cases penalize U.S. exporters while still permitting access to many advanced technologies by the Warsaw Pact countries. Within a few weeks of the report's release, the Commerce Department issued new rules easing export controls on some products that already were widely available from U.S. allies and streamlining trade rules for other products.

- A committee that studied air quality aboard commercial airliners concluded that modern aircraft ventilation systems cannot effectively remove cigarette smoke, despite designated smoking and nonsmoking seating areas. Citing possible adverse effects on the health of flight attendants and some nonsmoking passengers, the expert panel recommended banning smoking on all domestic commercial flights. Congress subsequently passed legislation that prohibits smoking on domestic flights of less than two hours' duration.

- Following completion of a Research Council study that found that technologies for maintaining highways cannot adequately protect the nation's trillion-dollar system of roads, Congress implemented a five-year, $150 million program to accelerate research on important maintenance problems. In addition, the law-makers charged the Research Council with managing the unique federal-state cooperative transportation program.

- The report, *Diet, Nutrition, and Cancer*, was the most comprehensive summary of current understanding of this complex and often confusing subject. Its recommendations inspired the federal government's National Cancer Institute and the non-profit American Cancer Society to issue similar dietary guidelines. The recommendations also helped motivate the meat industry and supermarkets to offer leaner products to consumers.

- An Institute of Medicine report urged major changes in the regulation of nursing homes. The report prompted congressional hearings on the subject and resulted in two bills that incorporated the committee's recommendations almost in their entirety. Subsequently, the Department of Health and Human Services proposed a major overhaul of its nursing home regulations, basing its reforms on the Institute's report.

- While major suppliers of childhood vaccines were discontinuing or threatening to cease production in response to injury-liability suits, an Institute committee issued a report detailing several options for resolving the public health crisis. The report's recommendations were later embodied in federal legislation.

- Congress established the National Commission for the Prevention of Infant Mortality partly in response to an Institute report documenting that prenatal care helps prevent premature birth and low birthweight. In addition, the report helped spur more than half the states to introduce legislation that would make prenatal care available under Medicaid.

The organization's reports also have been influential in federal decisions on budget priorities in research.

- A Research Council committee's 15-year blueprint for a massive undertaking to map and sequence the human genome - that is, to describe the functions and locations of each of the approximately 100,000 genes contained within human chromosomes - was a major impetus in the establishment of a special National Institutes of Health office to sponsor and coordinate such research.

- Federal funding for mathematics research increased by about 65 percent from 1874 to 1989 largely as a result of recommendations by a Research Council committee that found the field to be seriously underfunded.

- A number of large instruments for astronomy and astrophysics research, including the Hubble Space Telescope and the Very Long Baseline Array, were funded on the basis of recommendations by Research Council committees.

- A Research Council appraisal of U.S. equipment for materials science research documented the need for a "cold" neutron-scattering facility, a void that could undermine U.S. competitiveness in the technologically important field. In response to the report, Congress chose to build such a facility at the National Institute of

Standards and Technology, a move that elevated U.S. research capabilities to a level equal to or above that of Western Europe and Japan.

- The National Science Foundation followed the advice of a National Academy of Sciences panel, virtually to the letter, in establishing guidelines for a series of national Science and Technology Centers. An earlier report to the National Science Foundation from the National Academy of Engineering had led to the creation of 18 engineering research centers located at universities throughout the United States.

- The United Nations voted to sponsor an International Decade for Natural Hazard Reduction following preparation of a formal proposal by a Research Council committee. The purpose of the Decade is to apply scientific knowledge to reduce the devastating toll of natural disasters, particularly in developing countries.

In some cases, the impact of Research Council reports is evident only many years after the study is completed. For example, in 1966 the Research Council issued the report, *Accidental Death and Disability: The Neglected Disease of Modern Society*, which underscored the need for preventive measures to reduce the heavy human and economic toll of injuries. The report generated some discussion, none of it leading to corrective measures. Nearly two decades later, Congress requested another study of injury - the cause of an estimated 2.5 million deaths since the first study was conducted. In its 1985 report, *Injury in America*, the second committee again documented injury-caused deaths and disabilities and detailed the many opportunities for research on controlling injury. This time Congress acted less than two months after *the report* was released by implementing the report's major recommendation - establishment and funding of a national program on injury control research at the Centers for Disease Control. Congress charged the new program with carrying out the recommendations in the Research Council report.

The Academies do undertake studies with foreign academies and are working to help better establish the Mexican academies. In the 1970's the Academy tried to work with the Royal Society of Canada to address acid rain but this was a failure. The impression was that the Royal Society was not prepared to assist in policy development.

The key criteria for success appear to be:

- a process that ensures the terms of reference for each study are clearly stated and can be addressed by the expertise available;

- a committee to undertake the study which is well balanced from the viewpoint of expertise; includes public and private sector input and regional input; and is representative of minorities and women; and,

- a concluding review process that ensures all issues are satisfactorily addressed and all conclusions and recommendations are supported by the findings.

The Academy's success depends upon the quality of its work and the above process ensures the quality is there. The other key criteria for the Academy was the legislative mandate which requires the Academy to address all issues. This has been very important in legitimizing the Academy's role in scientific issues of importance to Congress.

The American Academy of Arts and Sciences

The Academy addresses significant contemporary issues through the use of multidisciplinary analysis. Some examples include:

- The Academy's ongoing Fundamentalism Project was conceived in order to promote public understanding of fundamentalist movements as they were increasing at a surprising rate within many religious traditions. The first of a five-volume encyclopedic study, Fundamentalism Observed, was published in 1991. In response to the Gulf Crisis, project experts on Islamic movements collaborated in the summer of 1991 to produce a special volume, Islamic Fundamentalism and the Gulf Crisis, which assessed the impact of the war upon fundamentalist groups in the middle East.

- A study, Weapons in Space, undertaken at the height of the public controversy over President Reagan's Strategic Defense Initiative (SDI), presented a technical and political analysis of the SDI issue.

- Other Academy study topics include the influence of telecommunications and film on American society, future developments in artificial intelligence, society's response to the AIDS crisis, Arab-Israeli discussions on the future of the Middle East, and environmental change that may lead to acute social conflict.

As well, the Academy undertakes studies in cooperation with foreign academies (e.g., academies in Britain, Germany and France), in particular, in the area of arms control.

The Academy states that the key criteria for success are the quality of its work and its independence. Because it is not dependent on government funding, it is free to address any issue without fear of having to compromise or lose their funding sources. This is evidenced from the fact that they tend to address "soft issues", such as income distribution, which are not politically popular.

3.0 Sources of Funding

Academy Complex

Typically, about eighty-five percent of the Academy's funding come from the federal government, largely in the form of "soft funds" for each of the studies commissioned by federal agencies. The other fifteen percent comes from endowment and other private sources.

Fiscal Year 1991 Expenditures

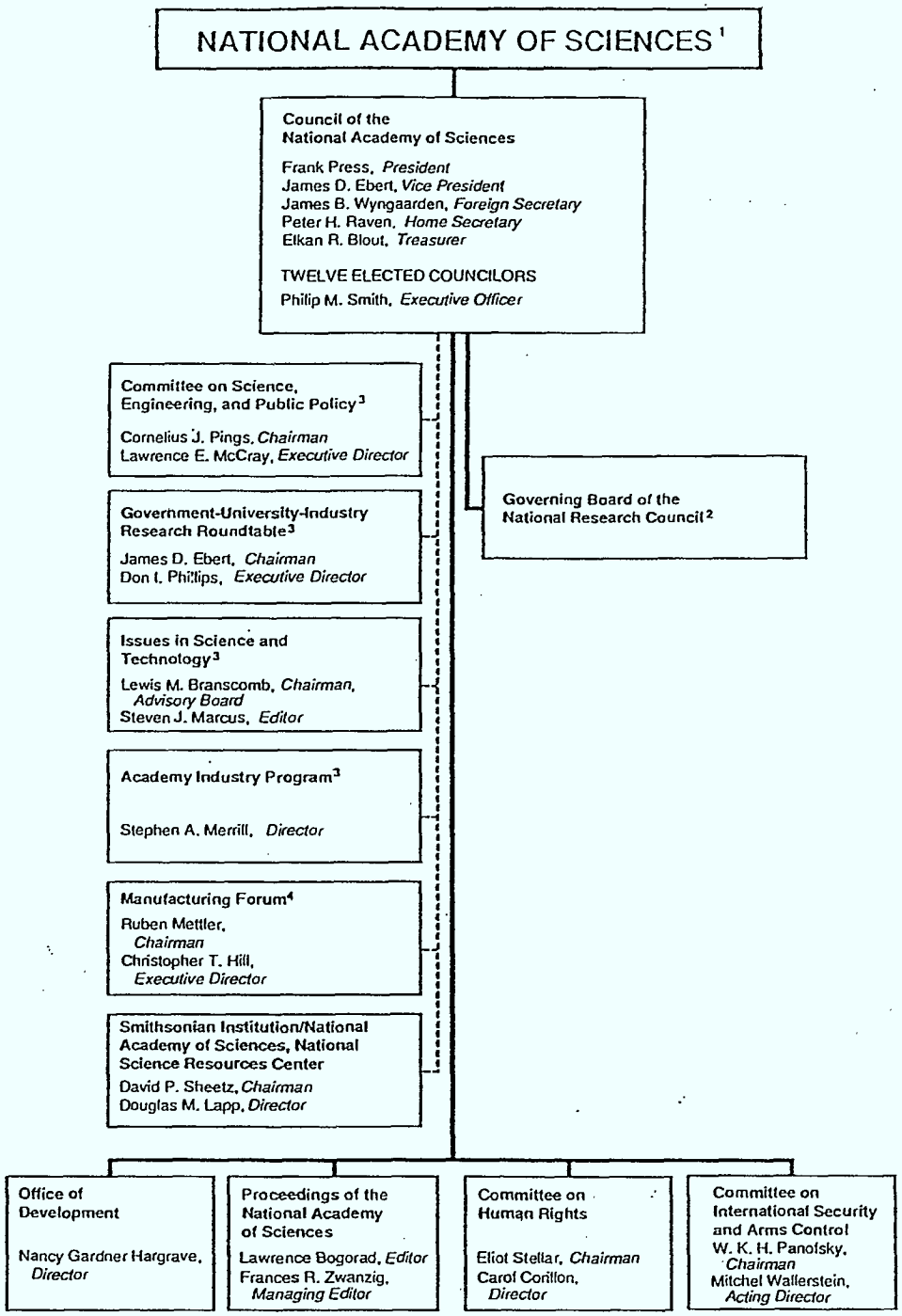
Government Contracts and Grants		$128,174,701
Private Grants and Projects	$19,311,734	
Academy-funded Projects	529,342	
Endowment and Trust Activities	412,346	
		20,253,422
Publication Activities		7,770,353
Administrative Costs		
Funded by Contracts and Grants	39,772,976	
Funded by Other Sources	6,011,986	
		45,784,962
		$201,983,438

American Academy of Arts and Sciences

The Academy has a small endowment and uses this money to fund proposals based upon issues identified by members of the Academy. These proposals are then presented to various philanthropic organizations for funding. The Academy typically undertakes 2-3 studies a year at an average cost of $150,000. The Academy does not receive much money from government, although they have been funded for "rescuing" America's commitment to provide funding for the Organization for Applied System Analysis.

The Academy stated that one of the weaknesses in its fund raising methods is a lack of private sector personnel on its Board of Directors. Fund raising is most effective when personal connections are in place; it is felt that prominent, private sector personnel on the Board could be effective in this regard.

Figure 1: Organization of the National Academy of Sciences



NOTES:

[1] Membership activities are administered through six Classes: physical and mathematical sciences; biological sciences; engineering and applied mathematical and physical sciences; medical sciences; behavioral and social sciences; and applied biological and agricultural sciences. The Classes are further divided into twenty-five disciplinary Sections; members of the Academy are permitted to choose the Section with which they wish to be affiliated.

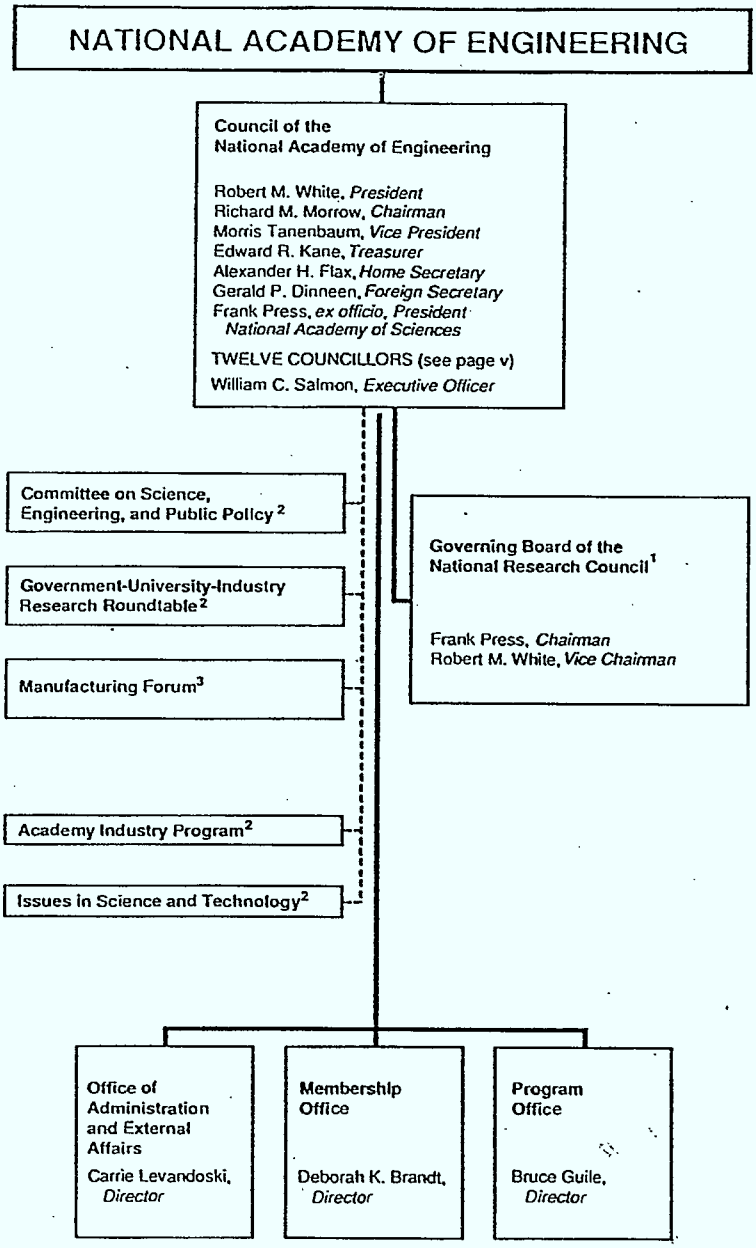
[2] The Governing Board of the National Research Council, the principal operating agency of the National Academy of Sciences and the National Academy of Engineering, is appointed from members of the Councils of the Academies and the Institute of Medicine. The president of the National Academy of Sciences serves as the chairman of the Governing Board.

[3] Sponsored jointly with the National Academy of Engineering and the Institute of Medicine.

[4] Sponsored jointly with the National Academy of Engineering.

March 1, 1991

Figure 2: Organization of the National Academy of Engineering



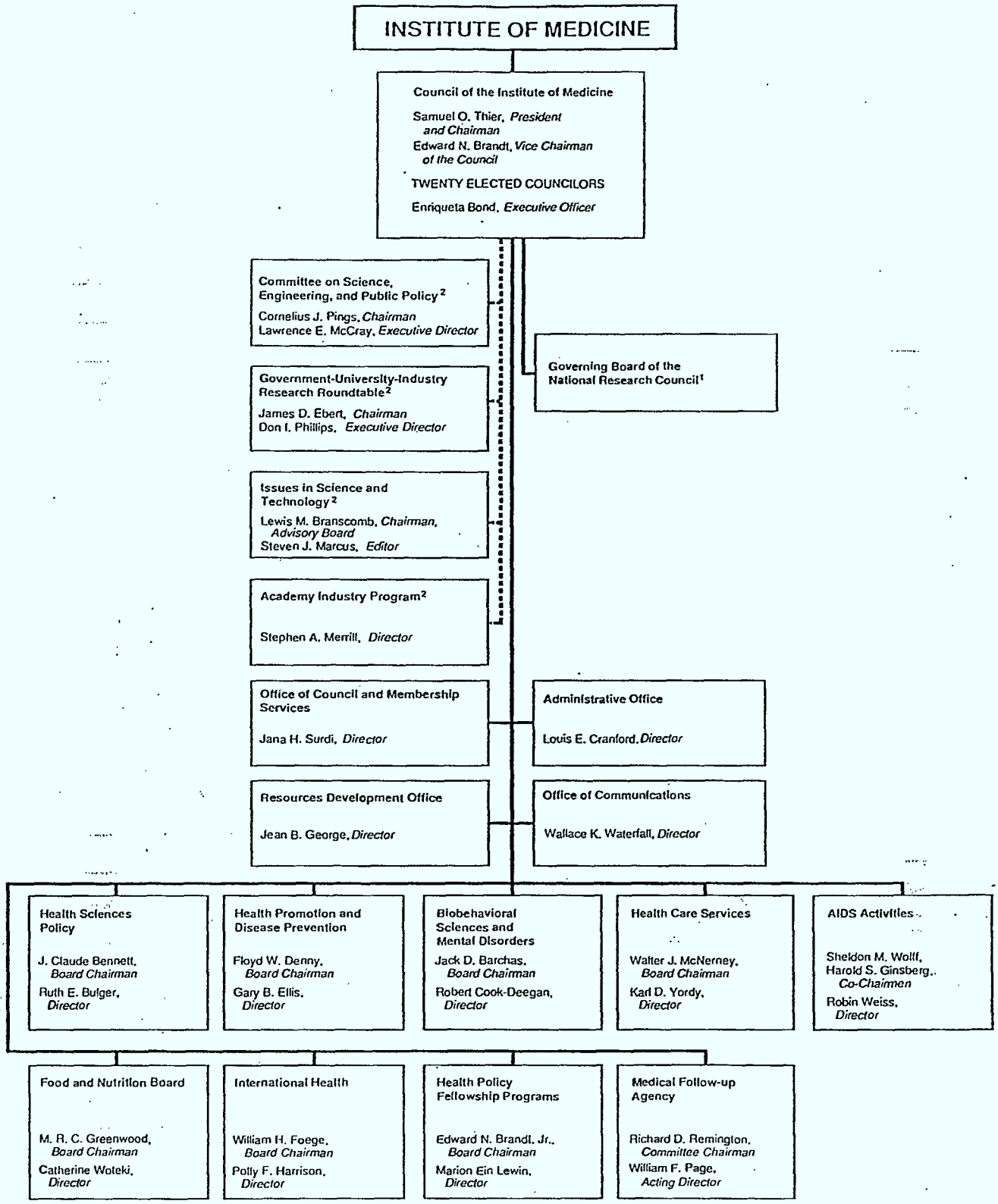
[1] The Governing Board of the National Research Council, the principal operating agency of the National Academy of Sciences and the National Academy of Engineering, is appointed from members of the Councils of the Academies and the Institute of Medicine. The president of the National Academy of Engineering serves as the vice-chairman of the Governing Board.

[2] Sponsored jointly with the National Academy of Sciences and the Institute of Medicine.

[3] Sponsored jointly with the National Academy of Sciences.

June 1, 1991

Figure 3: Organization of the Institute of Medicine



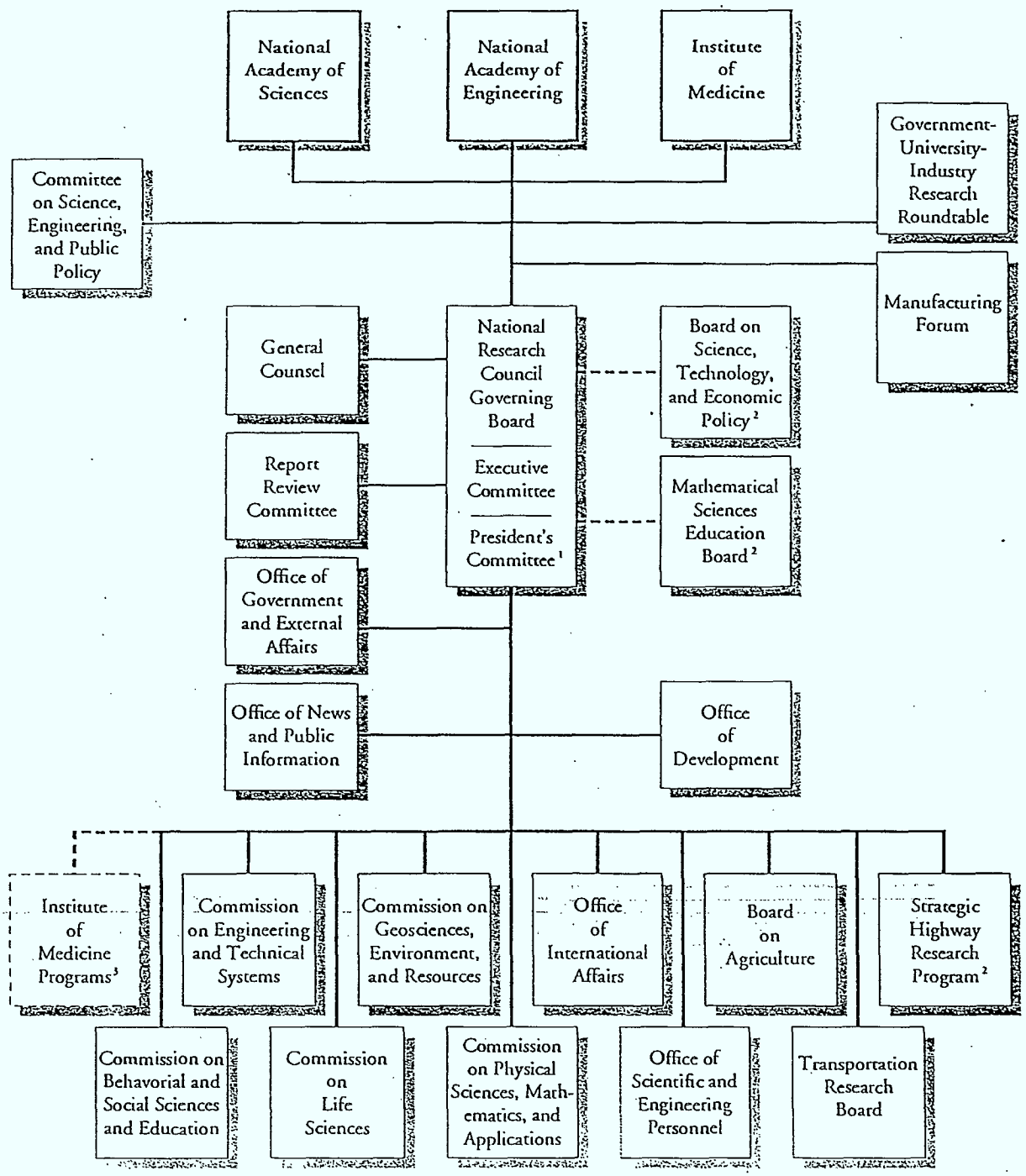
NOTES:

[1] The Institute of Medicine participates in the governance of the National Research Council through the appointment of two members including its president to the NRC Governing Board.

[2] Sponsored jointly with the National Academy of Sciences and the National Academy of Engineering.

March 1, 1991

Figure 4: Organization of the National Research Council



1. The President's Committee (presidents of NAS, NAE and IOM) administers the IOM Fund and the Program Initiation Fund.
2. The Mathematical Sciences Education Board, the Board on Science, Technology, and Economic Policy, and the Strategic Highway Research Program report to the Governing Board for program oversight and to the NRC chairman for management. The chairmen of these two units do not serve as ex-officio members of the NRC Governing Board.
3. IOM studies follow the procedures of the NRC.

Appendix A:

List of Interviewees

List of Interviewees

Britain

- Dr. P.M.D. Collins, Head, Science Policy Section
  Mr. Terry Garrett, Assistant Secretary (International Affairs)
  The Royal Society
  6 Carlton House Terrace
  London SW1Y 5AG

  tel: 071 839 5561
  fax: 071 930 2170
  telex: 917876

- Mr. John Maddox, Editor
  " Nature" Magazine
  4 Little Essex Street
  London

  tel: 071 836 6633
  fax: 071 224 3807

- Mr. Peter W.H. Brown
  Secretary of the British Academy
  20/21 Cornwall Terrace
  London NW1 4QP

  tel: 071 487 5966
  fax: 071 224 3807

- Dr. John Ziman, FRS
  27 Little London Green
  Oakley
  Aylesbury
  Bucks., HP18 9QL

  tel and fax: 844 237 464

- Dr. Angela Williams, Assistant Secretary
  Mr. Robin Ritzema
  Advisory Board for the Research Councils
  Sanctuary Buildings
  Great Smith Street St.
  London SW1P 3BT

  tel: Dr. Williams - 071 925 5961
  Mr. Ritzema - 071 925 5950
  fax: 071 925 6973

Germany

- Mr. Joachim Schmittgen
  Standinge Konferenz der Kultusminister der Lander
  in der Bundesrepublik Deutschland
  (German Conference of Education and Science)
  Nassestrasse 8
  5300 Bonn 1

  tel: 0228 501-0

- Dr. Hans Leutner, Director, International Scientific Relations
  Mr. Frank Grunhagen, Director of the Overseas Department
  Deutsche Forschungsgemeinschaft
  (German Research Society)
  Kennedyallee 40
  D-5300 Bonn 2

  tel: 0228 885 2231
  fax: 0228 885 2221
  telex: 17 22 83 12-dfg

- Ministerialrat Dr. Paulig
  Bund-Lander-Kommission fur Bildungsplanung und Forschungsforderung
  (Federal-Provincial Commission for Education and Research)
  Geschaftsstelle
  Friedrich-Ebert-Allee 39
  5300 Bonn 1

  tel: 0228 54 02-0

- Reinhard Schackter
  Federal Ministry of Education and Science
  Heinemannstrasse 2
  5300 Bonn 2

  tel: 0228 57 23 72

- Dr. Heinrich Pfeiffer, Executive Member of the Board of Governors
  Dr. Bettina Druschke, Grundsatzabteilung
  Alexander von Humboldt Foundation
  Jean-Paul-Strasse 12
  D-5300 Bonn 2

  tel: 0228 833-0
  fax: 0228 833 199
  telex: 8 85 627

Sweden

- Professor Hans Landberg, Secretary General
  Forskningsradsnamden
  Swedish Council for Planning and Coordination of Research
  Wenner-Gren Center
  Sveavagen 166, Box 6710
  S-11385 Stockholm

  tel: 46(8) 6100600 direct: 46(8) 6100626
  fax: 46(8) 6100633

- Dr. Bengt Thulin, Secretary to the Academy
  Britt Marie Bertillson, Director, Office for International Affairs
  Ingeniorsvetenskapsadkademien (IVA)
  Royal Swedish Academy of Engineering Sciences
  Greve Turegatan 14, Box 5073
  S-102 42 Stockholm

  tel: 46(8) 791 29 90
  fax: 46(8) 611 56 23
  telex: 171 72 IVA S

- Dr. Olof G. Tandberg, The Foreign Secretary
  Professor Carl-Olof Jacobson, Secretary General
  Kungl. Vetenskapsakademien
  The Royal Swedish Academy of Sciences
  Lilla Frescativagen 4, Box 5005
  S-104 05 Stockholm

  tel: 46(8) 15 04 30
  fax: 46(8) 15 56 70
  telex: 17073 royacad s

- Sonja Dahl, Assistant Under-Secretary, Head of the Division for Science
  Birgitta Lindencrona
  Ministry of Education and Science
  Mynttorget 1
  S-103 33 Stockholm

  tel: 46(8) 763 18 61
  fax: 46(8) 723 17 52
  telex: 13284 Mineduc S

- Bo Sylvan, Member of the Royal Academy of Fine Arts, Permanent Secretary
  The Royal Academy of Fine Arts
  P.O. Box 16317
  S-103 26 Stockholm

  tel: 46(8) 23 29 45

France

- P. Laplane, President
  Académie Nationale de Médecine
  16 rue Bonaparte
  75006 Paris

  tel: 43.26.96.80

- M. Peuchot, Director of Administration
  Institut de France
  23 quai de Conti
  75006 Paris

  tel: 44.41.44.41

- M. Leclant
  Académie des Inscriptions et Belles-Lettres
  23 quai de Conti
  75006 Paris

  tel: 44.41.43.10

- M. Pierre George, Member of the Academie
  Académie des Sciences Morales et Politiques
  23 quai de Conti
  75006 Paris

  tel: 44.41.43.26

- M. Germain, Perpetual Secretary
  Académie des Sciences
  23 quai de Conti
  75006 Paris

- M. Piccolo, Adjoint au Chef de Bureau des Affaires Juridiques et statutaires
  Aile C 5ème étage, Bureau C 507
  Direction de la programmation et du développement
  Universitaire: DPDV
  Sous-Direction des Establissements
  Ministère de l'Education Nationale et de la Culture
  61.65 rue Dutot
  75015 Paris

  tel: 40.65.60.11

United States

- Dr. Mitchel B. Wallerstein
  Deputy Executive Officer
  National Research Council
  National Academy of Sciences
  2101 Constitution Avenue, N.W.
  Washington, DC 20418

  tel: (202) 334-2168
  fax: (202) 334-1684

- Dr. Bob White
  President
  National Academy of Engineering (NAE)
  2101 Constitution Ave., N.W., Room 218
  Washington, DC 20418

  tel: (202) 334-3200

- Mr. Dave Beckler
  Associate Director
  Carnegie Commission on Science, Technology & Government
  1616 P St., N.W., Suite 400
  Washington, DC 20036

  tel: (202) 332-2221

- Mr. Lewis Branscromb
  J.F. Kennedy Institute
  79 J.F.K. Street
  Cambridge, Mass.

  tel: (617) 496-7466

- Mr. Joel Orlen
  Executive Secretary
  Academy of Arts and Sciences
  200 Beacon Street
  Cambridge, Mass.

  tel: (617) 576-5010

Appendix B

List of Documents Provided by Interviewees

List of Documents Provided by Interviewees

Britain

1. The Royal Society. Information folder.
2. The Royal Society. Annual report 1992. London: Royal Society.
3. The Royal Society. The Future of the Science Base. London: Royal Society. September 1992.
4. The British Academy. Annual report 1990-91. London: British Academy.
5. The British Academy. Directory 1992-93. London: British Academy.
6. Ziman, John. From Cosmopolitanism to Internationalism in the World of Science. (no date).
7. Advisory Board for the Research Councils (ABRC). Science and Technology: advice to the Chancellor of the Duchy of Lancaster. London: ABRC. 1992.
8. Advisory Board for the Research Councils (ABRC). Peer review: a report to the Advisory Board for the Research Councils from the Working Group on Peer Review. London: ABRC. November 1990.
9. Advisory Board for the Research Councils. Diagrams on government R&D expenditure and science budget.

Germany

1. Staendige Konferenz der Kultusminister der Laender in der Bundesrepublik Deutschland (KMK). Pamphlet in German. Bonn: KMK. September 1991.
2. Federal Republic of Germany. Report on the Development of Education: 1990-1992. Report to the 43rd Session of the International Conference on Education. Geneva. Bonn: KMK. September 1992. (German and English)
3. Secretariat of the Standing Conference of the Ministers of Education and Cultural Affairs of the Laender in the Federal Republic of Germany. Basic Structure of the Educational System in the Federal Republc of Germany. Bonn: KMK. June 1992.
4. Secretariat of the Standing Conference of the Ministers of Education and Cultural Affairs of the Laender in the Federal Republic of Germany. Beteiligung der Kultusministerkonferenz an der Diskussion um eine Aenderung des Grundgesetzes. (Correspondence in German re discussion on modification to the Basic Law). Bonn: KMK. July 1992.
5. Valentin von Massow. Organisation and Promotion of Science in the Federal Republic of Germany. Bonn: Inter Nationes. 1986.

6. Deutsche Forschungsgemeinschaft (DFG). Organization and Functions. Bonn: DFG. 1990.
7. Deutsche Forchungsgemeinschaft. Statistik 1991. (German, English and French). Bonn: DFG. 1992.
8. Deutsche Forschungsgemeinschaft. MAK- and BAT-Values 1992: Commission for the Investigation of Health Hazards of Chemical Compounds in the Work Area. Report No.28.
9. Federal Republic of Germany. Information on the Bund-Laender-Commission for Educational Planning and Research Promotion (BLK). Bonn: BLK. 1988.
10. Bund-Laender Kommission fur Bildungsplanung und Forschungsforderung (BLK). Akademienprogramm 1993: Aktualisierte Ubersichten uber die Anmeldung der Sitzlaender. (Information in German on Academies Program). Bonn: BLK. September 1992.
11. Fuhr, Christoph. On the Education System in the Five New Laender of the Federal Republic of Germany: Brandenburg, Mecklenburg-Western Pomerania, Saxony, Saxony-Anhalt, Thuringia. Bonn: Inter Nationes. 1992.
12. Fuhr, Christoph. Schools and Institutions of Higher Education in the Federal Republic of Germany.
13. Geimer, Hildegard and Reinhold. Research Organisation and Science Promotion in the Federal Republic of Germany. Munich: K.G. Saur. Extracts from book.
14. Federal Ministry of Education and Science. Basic and Structural Data: Education Statistics for the Federal Republic of Germany 1992/93. Bonn: Ministry of Education and Science.
15. Federal Ministry of Education and Science. Numerical Barometer: Some Educational Statistics 1992/93. Bonn: Ministry of Education and Science. (German, English and French).
16. Federal Ministry of Education and Science. Information sheets.
17. Alexander von Humboldt Stiftung. Information folder.

Sweden

1. Royal Swedish Academy of Engineering Sciences (IVA). Newsletters and pamphlets.
2. Royal Swedish Academy of Engineering Sciences (IVA). Statutes and Rules of procedure. Stockholm: IVA. 1992.
3. Royal Swedish Academy of Engineering Sciences (IVA). Engineers for the 21st Century. Stockholm: IVA. December 1992.
4. Royal Swedish Academy of Engineering Sciences (IVA). The Quality of Undergraduate Engineering Education in Sweden. A discussion document

compiled by the Educational Policy Committee of the Royal Swedish Academy of Engineering Sciences. Stockholm: IVA. 1991.

5. Royal Swedish Academy of Engineering Sciences (IVA). Best in Services: what can we learn from the world' s leading companies? Project plan. Stockholm: IVA. 1992.
6. Royal Swedish Academy of Engineering Sciences (IVA). Best in the World: what can we learn from companies with high productivity? Stockholm: IVA. 1992.
7. Royal Swedish Academy of Engineering Sciences (IVA). Energi för kommande generationer: en IVA studie om behov och forutsattningar for forskning och teknisk utveckling infor 2000-talet.(Energy for future generations - In Swedish). Stockholm: IVA. 1992.
8. Royal Swedish Academy of Sciences. Information document.
9. Royal Swedish Academy of Sciences. Foundation Statutes.
10. Royal Swedish Academy of Sciences. Pamphlet.
11. Royal Swedish Academy of Sciences. Verksamhetsaret 1991. (Annual report 1991 - in Swedish).
12. International Council of Scientific Unions. Universality of Science: handbook of ICSU' s Standing Committee on the Free Circulation of Scientists. With advice to the organizers of International Scientific Meetings. Paris: ICSU 1993.
13. Royal Swedish Academy of Letters. Information pamphlet.
14. List of Swedish Academies.
15. Royal Swedish Academy of Fine Arts. Stockholm: Royal Swedish Academy of Fine Arts. September 1978.
16. Royal Swedish Academy of Fine Arts. Meddelanden fran Kungliga Akademien for de fria konsterna 1991/92. (Annual report 1991/92, in Swedish).
17. Royal Swedish Academy of Fine Arts. Fredrik Magnus Piper and the Landscape Garden. (Swedish, English and German).

France

1. Bibliotheque de l'Académie Nationale de Médicine. Descriptive Pamphlet.
2. Institut de France. Annuaire Pour 1992. Paris.
3. Académie Nationale de Médecine. Annuaire 1993. Paris.
4. Germain, Paul, Secrétaire Perpétuel de l'Académie des Sciences. Le Souci de l'Avenir de la Science. Extrait de la Revue des Deux Mondes. Janvier 1993.
5. Institut de France. L'Académie des Inscriptions et Belles-Lettres. Additions et Complément à l'édition de 1938. Paris. 1988.
6. Institut de France. Académie des Sciences. Statuts. Paris. Gauthier-Villars.
7. Academia Europaea. Year Book 1992. 1988.
8. Institut de France. Académie des Sciences. Annuaire Pour 1992. Paris.

9. Institut de France. Académie des Insciptions et Belles-Lettres. Aux Sources de l'Egyptologie Européenne: Champollion, Young, Rosellini, Lepsius. M. Jean Leclant, Secrétaire Perpetuel. Paris. 1991.
10. Institut de France. L'Académie des Sciences. Programmes et Objectifs. 4 Février 1993.

United States

1. The American Academy of Arts and Sciences. Records 1991-1992. Cambridge, Mass. 1992.
2. The American Academy of Arts and Sciences. A Third Century of Intellectual Leadership.
3. National Academy of Sciences. National Academy of Engineering. Institute of Medicine. National Research Council. The Policy Partnership with the U.S. Government.
4. The Program of the Academy Complex. The Portfolio of Recent Reports and Activities. January 1992.
5. Canadian Science Council. Science and Technology Advice to the U.S.A. Government: Deficiencies and Alternatives. March 10, 1992.
6. National Academy of Sciences. National Academy of Engineering. Institute of Medicine and the National Research Council. A Report to the Task Force on Nongovernmental Organizations in Science and Technology, Carnegie Commission on Science, Technology and Government. Dael Wolfle. University of Washington. January 1990.
7. National Academy Press. New and Forthcoming Books, Summer/Fall 1991.
8. National Academy of Sciences. National Academy of Engineering. Institute of Medicine. The National Research Council: A Unique Institution. Washington, D.C.
9. Questions and Answers About the National Academy of Sciences, National Academy of Engineering, Institute of Medicine and the National Research Council. August 1991.
10. National Academy of Engineering. Technological Leadership in the Nation's Service. How Knowledge is Applied Today Determines How We Live Tomorrow. Washington, D.C.
11. National Academy of Engineering. Technological Leadership in the Nation's Service. Program Report, Fiscal Year, 1992.
12. Questions and Answers About the National Academy of Sciences, National Academy of Engineering, Institute of Medicine and the National Research Council. April 1990.

13. Carnegie Commission of Science, Technology, and Government. Science, Technology, and the States in America's Third Century. New York, NY. September 1992.
14. Carnegie Commission of Science, Technology, and Government. A Science and Technology Agenda for the Nation. Recommendations for the President and Congress. New York, NY. December 1992.
15. Carnegie Commission of Science, Technology, and Government. Facing Toward Governments. Nongovernmental Organizations and Scientific and Technical Advice. New York, NY. January 1993.
16. Carnegie Commission of Science, Technology, and Government. E³: Organizing for Environment, Energy, and the Economy in the Executive Branch of the U.S. Government. New York, NY. April 1990.
17. Carnegie Commission of Science, Technology, and Government. A Midpoint Report. David Z. Robinson, Executive Director. New York, NY. December 1990.
18. Carnegie Commission of Science, Technology, and Government. Science, Technology, and Congress: Expert Advice and the Decision-Making Process. New York, NY. February 1991.
19. Carnegie Commission of Science, Technology, and Government. Enabling the Future. Linking Science and Technology to Societal Goals. New York, NY. September 1992.
20. Carnegie Commission of Science, Technology, and Government. Science, Technology, and Congress. Analysis and Advice from the Congressional Support Agencies. New York, NY. October 1991.
21. Carnegie Commission of Science, Technology, and Government. Science and Technology in U.S. International Affairs. New York, NY. January 1992.