International Comparative Study of Approaches Used to Address Issues that Cut Across Science-Based Departments

Working Paper No. 23

Science Policy Branch
Environment Canada

Document de travail n° 23

Direction de la politique scientifique
Environnement Canada

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International Comparative Study of Approaches Used to Address Issues that Cut Across Science-Based Departments

Prepared for
Environment Canada

By

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March 31, 2003

Executive Summary

Approaches to addressing cross-cutting issues in science-based government departments were reviewed in five jurisdictions; Australia, New Zealand, United Kingdom, United States and the European Union.

All five jurisdictions have mechanisms to address horizontal or cross-cutting issues covering the full spectrum of activities from policy formulation to research. A four level framework was used to present these mechanisms; priority setting, departmental coordination, operational coordination and research coordination.

At the level of research coordination the mechanisms fall into three categories;

collaborative research centres with their own staffs and research budgets;

pooled resources collaborative research with dedicated budgets; and

coordinated collaborative research with distributed budgets.

In the absence of a strong culture supporting collaborative research, the first two approaches appear to offer better control over strategic directions and budget, and therefore offer better prospects for organizing cohesive collaborative research programs.

Desirable characteristics for an approach to collaborative R&D among government laboratories, based on the findings of this study, include the following;

An independent R&D activity with its own budget;
A strategic plan as framework for the R&D activity;
A governance structure that includes a consortium agreement, a board of directors and a lead agency responsible for coordination;
An R&D activity of critical mass over a long period of time (e.g.- 5+ years) to ensure meaningful results;
Processes for monitoring and evaluation.

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1 Introduction

The purpose of this report is to present approaches used in selected countries to address issues that cut across science-based government departments. The countries selected are Australia, New Zealand, United Kingdom, United States and the European Union.

The aspects that the report focuses on include priority setting, coordination of joint actions, governance structures and funding.

The methodology used was principally a review of the literature, supplemented by selected contacts with officials in some of the countries reviewed.

2 Australia

2.1 National Research Priorities

On 5 December 2002 the Prime Minister announced four national research priorities:

1. An Environmentally Sustainable Australia;
2. Promoting and Maintaining Good Health;
3. Frontier Technologies for Building and Transforming Australian Industries; and
4. Safeguarding Australia.

These four areas provide a vision for research by focusing research effort on key challenges for Australia today and into the future. They are to strengthen collaboration between research bodies and with industry, and build critical mass of excellence in those key research areas.

2.2 Coordination Committee on Science and Technology

The Coordination Committee on Science and Technology (CCST) brings together leaders of Commonwealth Government departments and agencies with an interest and expertise in science and technology. It facilitates networking, exchange of information, strategic thinking and coordination of activities in areas of S&T, and complements the work of the Prime Minister's Science, Engineering and Innovation Council (PMSEIC).

CCST was originally established through the May 1989 Commonwealth Government Statement Science and Technology for Australia.

The function of the CCST is to:

> Complement the work of the Prime Minister's Science, Engineering and Innovation Council (PMSEIC) through providing input, where appropriate, to the meetings of PMSEIC or its Standing Committee on matters of concern which may require a whole of government and stakeholders response;
> Bring together the heads or deputy heads of Commonwealth departments and agencies with an interest in science and technology;
> Exchange information and coordinate activities in areas of mutual interest; and promote consistency, coherence and effectiveness of Commonwealth Government science and technology policy and programmes.

CCST may examine selected **cross-portfolio issues**. In this way, CCST may assist policy development through an early 'whole of government' discussion of issues.

CCST may also address the specific portfolio issues raised by its members.

CCST Working Groups investigate significant issues and provide key papers for CCST Members to consider. These papers can prove important to the subsequent development of policy proposals (e.g. Major National Research Facilities; University-Industry interactions)

The membership of CCST is deputy secretaries of departments with science and technology interests, and heads of government research funding and research performing agencies. The Committee is chaired by the Deputy Secretary, Department of Education, Science and Training (DEST). The Chief Scientist of the Commonwealth of Australia is also a key CCST member, with a direct linkage to PMSEIC through his capacity as a member and Executive Officer of PMSEIC and as Chair of the PMSEIC Standing Committee.

Secretariat support for the CCST is provided by the Science and Technology Advisory Group, Science Group, DEST.

During 2002-2003, CCST meetings are to emphasise networking, address relevant PMSEIC issues, and hear from science agencies about the coordination arrangements and issues that facilitate their research planning processes. Meetings will also address major cross-portfolio issues. Occasional CCST Working Groups prepare issues papers for consideration by CCST Members.

Meetings are usually scheduled to occur three times annually.

2.3 *The Prime Minister's Science, Engineering and Innovation Council*

The Prime Minister announced the formation of the Prime Minister's Science, Engineering and Innovation Council (PMSEIC) on 18 December 1997.

The Council is the Government's principal source of independent advice on issues in science, engineering and innovation and relevant aspects of education and training.

The Council meets in full session, twice a year, to discuss major national issues in science, engineering and technology and their contribution to the economic and social development of Australia.

The Government sees an increasingly important role for science and technology in Australia's future and the membership of the Council complements the Government's plans for Australian industry, as outlined in the major 1997 industry statement, Investing for Growth.

To underpin its advisory role, the Council has resources to examine Australia's science and engineering capabilities and the effectiveness of their organisation and utilisation. The non-ministerial members constitute the Standing Committee of the Council, and oversee and contribute to studies and research aimed at improving understanding of the major, science, engineering and innovation issues.

The Council's terms of reference are

> to advise on important issues in science, technology, engineering and relevant aspects of education and training, including as they relate to economic growth, employment creation, the development of new industries and the sustainable development of new resources;
> to examine the contribution of science, technology and engineering to the innovative capacity and economic and social development of Australia;
> to enhance awareness in the community of the importance of science, technology and engineering for Australia's economic and social development;
> to examine Australia's science and engineering resources and the effectiveness of their organisation and utilisation; and
> to examine Australia's science and engineering infrastructure and the effectiveness with which it achieves the application of science and technology in the economic and social development of Australia.

The Council is supported by a secretariat located in the Department of Education, Science and Training.

2.4 Cooperative Research Centres

Cooperative Research Centres, generally known as CRCs, bring together researchers from universities, CSIRO and other government laboratories, and private industry or public sector agencies, in long-term collaborative arrangements which support research and development and education activities that achieve real outcomes of national economic and social significance.

The program emphasises the importance of developing collaborative arrangements between researchers and between researchers and research users in the private and public sector in order to maximize the capture of the benefits of publicly funded research through an enhanced process of commercialisation or utilisation by the users of that research.

The CRCs establish collaborative links between researchers and industry and other research users in order to create a multi-disciplinary, multi-institutional research environment focussed on addressing industry and user needs. These collaborative links are aimed at increasing efficiency and cost effectiveness of research and research training and make better use of research resources through sharing of major facilities and equipment.

As of July 2002, there were 62 CRCs spread over 40 locations across Australia. On average, a CRC would have some 30 full time researchers and an annual budget of $7 million (Aus) with about $ 3 million (Aus) coming from government. Funding is for 5 years, renewable twice. The structure can be either an incorporated company or unincorporated joint venture. All CRCs must at least adopt governance practices and fiduciary responsibilities consistent with those of an incorporated body.

2.5 Summing-Up

Australia has in place mechanisms to deal with horizontal or cross-cutting issues from the policy to the research level.

3 New Zealand

3.1 National Research Goals

The government has four research goals;

Knowledge; investing in people and skills;
Economy; investing in research to improve the economy;
Environment; investing in research to enhance the environment;
Social; investing in research to improve social well-being.

Research structures were fundamentally redesigned some 10 years ago. As a result little government research is undertaken 'in-house'. Most of it is purchased through the structures described below.

3.2 The Ministry of Research, Science and Technology

The Ministry of Research, Science and Technology (MoRST) develops research and innovation policies and manages the publicly funded part of the RS&T system on behalf of the

Government. MoRST works at the high level of policies, strategies and statistics. It contracts other agencies such as the Foundation for Research, Science and Technology to manage the actual funding of research and innovation
projects.

3.3 The Foundation for Research, Science and Technology

The Foundation for Research, Science and Technology (FRST) invests in research, science and technology (RS&T) on behalf of Government to enhance the wealth and well-being of New Zealanders. As the largest single investor in RS&T, it plays a key role in facilitating participation in the achievement of economic, environmental and social
benefits. In doing this, the Foundation is committed to:

Achieving outcomes — delivering benefits to the users of research;
Refocusing its investments so that they will add the greatest economic, social or environmental value;
Tailoring its investment approach to the needs and dynamics of each sector;
Achieving a balance between focussing on future needs and addressing current issues;
Working in partnership with users, providers and other funders to develop investment strategies, and negotiating portfolios of research that will achieve those strategies;
Delivering outcomes for Maori;
Ensuring social and environmental issues, and human capital development, are considered in all areas of investment;
Monitoring and evaluating its investments so as to make better investment decisions.

The Foundation is a Crown Entity with its own Act of Parliament. It is responsible for investing approximately $400 million (NZ) of public money per annum out of a Government science and technology annual budget of about $700 million (NZ).

The Foundation plays three pivotal roles in building the future New Zealand economy and society:

a) Purchasing public good RS&T, using a coherent investment decision framework. It seeks to maximize the public returns from the RS&T it supports. The Foundation:

Focuses on RS&T that may be of benefit to New Zealand, but is unlikely to be funded, or adequately funded, from non-governmental sources.
Ensures there is an adequate flow of trained people and new ideas to support the development and retention of competitive advantage and new high value-added exports.
Purchases RS&T that enables informed Government policymaking on a wide range of policy, regulatory and operational issues, such as on climate change, biodiversity, oceans policy, social issues and the development and advancement of Maori.
Ensures that the maximum value of RS&T is captured for New Zealand through the publication and dissemination of results and careful management of intellectual property.

Purchases so as to make commercial risk-taking and innovation by market participants easier to undertake.

b) Being an intelligent purchaser, engaging a wide range of stakeholders to establish its strategies and purchasing priorities. It focuses its actions in the innovation system where it can add most value. Its purchases enable others to take risks. Genuine wealth and well being creation requires much more than a passive funding process. The Foundation:

Brings together public-public and public-private partnerships (*emphasis added)* in RS&T to ensure that the research that is needed is done and that the results of it are taken up.
Fosters a wide range of connections and linkages among science providers and users.
Participates with other public funding and development agencies in the coordination of Government RS&T efforts.

c) Providing policy advice to Government on RS&T issues including:

The evaluation of RS&T purchasing performance.
The setting of broad science priorities.
The development of new programmes and Ministerial schemes.

3.4 Cross-Departmental Research Pool

The Cross Departmental Research Pool (CDRP) supports policy-related research in government departments. Departments are able to bid for funding to carry out research of critical cross portfolio interest. Since Departments themselves do not undertake much research, the work is done by external Crown Research Institutes. The CDRP is managed jointly by MoRST and FRST.

The CDRP's objectives are:

To fund high quality cross-departmental research, which will support Government's policies.
To catalyse new relationships and capabilities within and between departments so that over time departments take responsibility for investment in long term high quality research; and
To develop a portfolio of research activity divided between smaller, short term projects to catalyse new relationships and capabilities, and multi-year large-scale projects to provide key building blocks for Government's decision making.

The Government has selected six goals to guide decision-making regarding CRDP;

strengthen national identity and uphold the principles of the Treaty of Waitangy;
grow an inclusive, innovative economy for the benefit of all;

restore trust in Government and provide strong social services;
improve New Zealanders skills;
close the gap for Maori and Pacific people in health, education, employment and housing;
protect and enhance the environment.

As well as showing how proposals meet the above goals and departmental research strategies, they must have a robust evaluation and reporting framework. Departments must show that there are systems and processes in place for project evaluation and how results will be communicated among participants and to a wider audience. Proposals must also show where departments will obtain other sources of funding.

In 2003/04, it is expected that some $2 million (NZ) of new proposals will be able to be funded. Funds from the CDRP are transferred to the relevant lead department of a successful bid for the duration of the research project and appear in the departmental accounts. The funds are then transferred back to the Ministry of Research, Science and Technology at the end of the project to form part of the research funding pool again for reallocation to other successful project bids.

The selection of bids is done by committee of senior departmental officials and is a two stage process, with calls for expressions of interest followed by a more detailed application and assessment. A key selection criterion is the extent of collaboration between government departments on the bid. The bids are typically for up to three years and for amounts ranging from $50,000 to $500,000 per annum. The program, announced in 2002 will last for 5 years.

An example of a project funded under this program is the **Transmission pathways of pathogens from domestic livestock to water Project**. Ministry of Agriculture and Food, with strong support from the Ministry of the Environment and the Ministry of Health, has the mandate to identify the survival and movement of Campylobactor, Cryptosporidium, Giardia, Samonella and E-coli (all major sources of human illness) from livestock excreta into the freshwater system. Funding for the project is $629,000 (Aus) over 3 years.

3.5 Summing-Up

New Zealand has mechanisms in place to deal with cross-cutting issues from the policy to the research level. However, a major difference with other countries is that the major investor in research is an arms-length body, the Foundation for Research, Science and Technology.

4 United Kingdom

4.1 R&D Priority Setting

One of the central objectives is to make the most of the UK's science, engineering and technology skills and resources. Key to this is the promotion of standards of international

excellence in basic science. The Government is also dedicated to maximizing the contribution of the science and technology fields to the UK's economic development - and to the quality of life. The priorities are pragmatic and largely functional.

The Department of Trade and Industry (DTI) is responsible both for UK Science Policy (through the Office of Science and Technology-OST), and for promoting the development and use of technology by industry.

The Science and Innovation Strategy draws together all of the UK's science and innovation activities. These include support for the science base, space, aeronautics and energy research and development.

There is also a Council for Science and Technology on which sit the Chief Science Adviser, the Minister of Science and representatives from industry and academia. As well there is a Trans-Departmental Group on S&T supported by the OST to assist in the coordination of cross-cutting programs and activities.

4.2 Science and Research Review-2002

The UK Government recently published the findings of a review of the science and research[1]. One focus of this review was Government science (Civil Government R&D expenditures amounted to 1.57 billion pounds in 2002/03.)

The first recommendation was that Departments should publish costed R&D strategic plans. It was observed that Departments needed to have a more strategic outlook and link their research more closely to Departmental objectives.

Cross-cutting issues were given particular attention. The review examined three alternative approaches to deal with cross-cutting issues; central science budget, merged budgets and coordinated steering arrangements.

A Central Science Budget was rejected mainly because it was felt that this would take decisions on science spending away from decisions on overall departmental spending priorities.

Merged budgets, Departments contributing to a single pot under the leadership of a single Department and with shared steering arrangements to address specific issues, are in use. An example is the Interdepartmental Research and Information Working Group in the drugs research area, chaired by the Home Office, which monitors research programs and manages a ring-fenced budget. Other examples include the Sure Start initiative and work on health and mobile phones (see Section 4.4)

[1] HM Treasury, Department of Education and Skills, Office of Science and Technology, Department of Trade and Industry; Cross-Cutting Review of Science and Research; Final Report, March 2002.

In coordinated steering arrangements Departments hold their own budgets but research programs are coordinated by an interdepartmental group. An example is research on transmissible spongiform encephalopathies (TSEs) which is coordinated by the funders
Under the leadership of the Department of Health, under the oversight of a High Level Group chaired by the Government's Chief Science Adviser.

It was felt that merged budgets provided a stronger strategic direction than coordinated steering arrangements and it was recommended that 'the Government's Chief Science Adviser should explore the scope for increased use of merged budgets in cross-cutting areas of research'.

4.3 Government-wide Review of Cross-Cutting Issues

The science and research review presented above builds on a major Government-wide activity in this area, starting with the publication of the report 'Wiring it Up'[2] in 2000, prepared by the Cabinet Office's Performance and Innovation Unit.

This report recommends action in six key areas to improve the formulation and management of cross-cutting policies and services:

> stronger leadership from Ministers and senior civil servants to create a culture which values cross-cutting policies and services, with systems of rewards and recognition that reinforce desired outcomes;
> improving policy formulation and implementation to take better account of cross-cutting problems and issues, by giving more emphasis to the interests and views of those outside central Government who use and deliver services;
> equipping civil servants with the skills and capacity needed to address cross-cutting problems and issues;
> using budgets flexibly to promote cross-cutting working, including using more cross-cutting budgets and pooling of resources;
> using audit and external scrutiny to reinforce cross-cutting working and encourage sensible risk-taking; and
> using the centre (No. 10, the Cabinet Office and the Treasury) to lead the drive to more effective cross-cutting approaches wherever they are needed. The centre has a critical role to play in creating a strategic framework in which cross-cutting working can thrive, supporting departments and promoting cross-cutting action whilst intervening directly only as a last resort.

The central message of the report is that simply removing barriers to cross-cutting working is not enough: more needs to be done on a continuous basis if cross-cutting policy initiatives are to hold their own against purely departmental objectives. There is no simple or standard answer.

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[2] Cabinet Office, Performance and Innovation Unit; Wiring it Up; January 2000

A report to the Prime Minister on the implementation of the report was made in 2001. In 2002, the Performance and Innovation Unit gave way to the Prime Minister's Strategy Unit.

4.4 LINK Collaborative Research

The LINK scheme is the Government's principal mechanism for promoting partnership in pre-competitive research between industry and the research base. LINK focuses on areas of strategic importance for the future of the national economy. All new programs address priorities under the Government's Foresight program. Companies and research organisations throughout the UK can participate in LINK projects. Small and medium sized enterprises (SMEs) are particularly encouraged to get involved. Multinationals can also participate provided they have a significant manufacturing and research operation in the UK, and the benefits of research are exploited in the UK or European Economic Area.

LINK covers a wide range of technology and product areas from food and bio-sciences, through engineering to electronics and communications. Programs are sponsored by Government Departments and Research Councils. Each LINK program supports a number of collaborative projects involving partners from industry and the research base.

Participants in a LINK project must negotiate a collaboration agreement setting out the terms under which they will work together and share the results of the project.

Each LINK program is managed by a Program Management Committee (PMC) with members drawn from industry and the research base. The programme sponsors are also represented. The PMC; oversees the operation of the program; assesses project proposals and recommends projects for funding, taking account of the views of the program sponsors; monitors progress on projects and encourages commercial
exploitation and dissemination of research results.

The PMC is supported by a programme co-ordinator or manager who is: the first contact point for enquiries; an expert in the subject who will help potential participants to
develop projects and who will maintain contact with the participant throughout the project, offering advice on, for example, disseminating the project results.

Research Council sponsors of LINK projects will normally seek peer review of the research elements of a project, while Government Department sponsors will consider its industrial relevance.

Government Departments and Research Councils provide up to 50% of the total eligible costs of a LINK project with the balance of support coming from industry. The level of funding available to each participant will depend on the costs directly attributable to the project, in terms of the salaries of personnel working on the project, materials consumed, capital equipment purchased and other factors, such as licensing.

An example of a LINK activity is **the health and mobile phone research program** mentioned above, announced December 8, 2000, whose mandate is;

> to co-ordinate and scientifically manage a research program on the possible impact on health from mobile telecommunications. Account will be taken of public concerns and of other research conducted nationally and internationally;
> to invite research proposals for funding and
> (a) consider the proposals' relevance to identified priority areas in the program;
> (b) assess each proposal's scientific merit taking advice from independent experts if necessary in the light of any other relevant work;
> (c) making funding decisions
> to monitor the progress of the research program;
> to promulgate the dissemination of research findings.

UK government and industry are providing 7million pounds over three years to support this program. The program is sponsored by the Department of Health, Department of Trade and Industry (Radio Communications Agency), the Health and Safety Executive, the Scottish Executive, the Northern Ireland Executive and the Medical Research Council. The first 15 projects were announced on January 25th, 2002.

4.5 Summing-Up

The UK has given special attention to cross-cutting issues across government, both generally as well as on science and technology. A recent review as recommended that 'merged budgets' be given special attention when sponsoring research involving a number of government departments.

5 United States

5.1 National R&D Priorities

Unlike the Parliamentary System, where the government in power dictates, as in those countries mentioned above, the United States has a government system where the Executive proposes and the Congress disposes. Because of this interaction there will usually be differences in the final outcome from what the Executive proposes.

The Office of Science and Technology Policy (OSTP), in the Executive Branch, and the Office of Management and Budget (OMB) issued a budget-planning memo for 2004, which stated the following national R&D priorities; R&D for combating terrorism, networking and information technology, nanotechnology, climate change, molecular life processes and education. These priorities are to guide horizontal or interagency initiatives. However, as described below, the budgetary review process makes horizontal coordination difficult.

The mission orientation of R&D programs makes it difficult for policymakers to assess the overall health of the research enterprise, to coordinate programs among different agencies, and to address issues of balance among various scientific and engineering fields and disciplines.

The Office of Management and Budget (OMB), which has overall responsibility for the preparation of the President's budget, is able to provide some coordination, although it is hampered by the fact that the agencies that support R&D are treated individually in the budget review process. Some coordination also takes place under the National Science and Technology Council (NSTC) (see Section 5.3), an interagency body comprised of cabinet officers and the President. NSTC has organized a number of interagency initiatives in areas of R&D.

The level of coordination in R&D in the executive branch, although limited, is not matched by Congress. Congressional treatment of R&D, like most other aspects of congressional budget and policymaking, is characterized by fragmentation and diffusion of power. R&D programs are considered at two main levels in Congress, that of authorizations and that of appropriations. Authorizing committees (such as the House Science Committee and the Senate Committee on Health, Education, Labor, and Pensions) develop special expertise in the programs they oversee and review the substance of these programs. However, the legislation they prepare does not directly result in spending but only provides guidance and sets appropriations ceilings.

For discretionary programs, including R&D, the power to write the legislation that provides actual spending authority resides in the Appropriations Committees of the House and Senate. These committees are each divided into 13 subcommittees, each of which is responsible for a bill that controls one portion of the budget. Each subcommittee produces its appropriations bill separately from the others, and each bill is usually signed into law separately.

The division of the budget into 13 appropriations bills limits the extent to which it is possible to coordinate or trade off increases and decreases in agency R&D budgets in the congressional process. For example, three R&D agencies-NSF, NASA, and the Environmental Protection Agency (EPA)-come under the jurisdiction of the Subcommittee on Veterans' Affairs, Housing and Urban Development, and Independent Agencies. NIH appropriations are decided by the Labor, Health and Human Services, and Education subcommittee. This means, for example, that money used for the large increase in NIH's budget in FY 2002 did not come from the same pot of money that funds NSF and NASA.

5.2 President's Council of Advisors on Science and technology

On September 30, 2001, President Bush signed Executive Order 13226 to form the President's Council of Advisors on Science and Technology (PCAST). On March 28, 2001, President Bush named Floyd Kvamme PCAST's Co-Chair. PCAST was originally established by President George Bush in 1990 to enable the President to receive advice from the private sector and academic community on technology, scientific research priorities, and math and science education.

Since its creation PCAST has been expanded and currently consists of 23 members plus the Director of the Office of Science and Technology Policy who serves as the Council's Co-Chair. The council members, distinguished individuals appointed by the President, are drawn from industry, education, and research institutions, and other nongovernmental organizations.

5.3 National Science and Technology Council (NSTC)

The NSTC is a Cabinet level body that coordinates horizontal interagency R&D activities. The OSTP has the day-to-day responsibilities for the operation of the NSTC. The NSTC is the principal means by which the President coordinates S&T activities. The President chairs the NSTC. Membership consists of the Vice-President, Assistant to the President for Science and technology, Cabinet Secretaries and Agency Heads with significant science and technology responsibilities, and other White House officials.

The Council prepares R&D strategies that are coordinated across federal agencies to form and investment package aimed at accomplishing multiple national goals. The Council works through sub-committees focusing on specific national R&D priority areas.

5.4 An Example of Multi-agency Coordination: The Interagency Working Group (IWG) on Information Technology Research and Development (IT)

The Interagency Working Group (IWG) on Information Technology Research and Development (IT R&D) of the National Science and Technology Council (NSTC) and its Committee on Technology (CT) serves as the internal deliberative organization of the NSTC for IT R&D policy, program, and budget guidance and direction for the Executive Branch.

The IWG on IT R&D provides hands-on coordination for the multiagency IT R&D program. The IWG is made up of representatives from each of the participating IT R&D agencies and from the Office of Management and Budget (OMB), the Office of Science and Technology Policy (OSTP), the National Economic Council (NEC), and the National Coordination Office for IT R&D (NCO/IT R&D). The IWG coordinates planning, budgeting, and assessment activities of the multiagency IT R&D enterprise.

The major research emphases of the IT R&D effort are called Program Component Areas (PCAs). The work of each PCA is guided by a Coordinating Group (CG) of agency program managers. These groups, which report to the IWG, meet monthly to coordinate planning and activities of the multiagency projects in their specialized research areas. The PCAs evolve in response to changing research needs.

The NCO provides the technical and administrative support for the IWG, the PCA Coordinating Groups, and the President's Information Technology Advisory Committee (PITAC). The cost of

operating the NCO is shared by the participating agencies in proportion to their IT R&D budgets. The High-Performance Computing Act of 1991 (P.L.102-194) authorizes the functions performed by the NCO to support the IWG and the CGs. Executive Order 13035 authorizes NCO support for the PITAC. The National Science Foundation (NSF) serves as the host agency for the NCO.

In addition to the PCAs, the Federal Information Services and Applications Council (FISAC) is chartered to facilitate partnerships between the Federal IT R&D and non-R&D communities that promote early application of advanced computing, information, and communications technologies within the Federal government and provide input to the IT R&D program on technology needs of non-R&D agencies.

5.5 Summing Up

As illustrated above, there is a clear hierarchical line of responsibility covering the full spectrum of 'horizontality', from priority setting at the political level to the coordination of research activities.

6 European Union

6.1 Sixth Framework Program (FP6-2002-06)

The current Framework Program, like all previous ones, aims at encouraging R&D collaborations across European countries to strengthen the European Research Area (ERA). The program is open to individuals, firms, universities, research bodies and technology dissemination bodies. A major element of the Program that does this is called **cross-cutting activities** which are structured around various thematic areas of research, which are; Life sciences, genomics and biotechnology for health; Information society technologies; Nanotechnologies and nano-sciences, knowledge-based multifunctional materials and new production processes and devices; Aeronautics and space; Food quality and safety; Sustainable development, global change and ecosystems; and Citizens and governance in a knowledge-based society.

The European Commission (EC), the operational arm of the European Union, is responsible for the Framework Programs. Specifically, FP6 is the responsibility of and EC Commissioner for Research who is supported by two Directorate-Generals, one for Research and one for the Joint Research Centre.

6.2 Cross-cutting activities.

These activities are;

Research for policy support. The activities under this heading underpin the formulation and implementation of Community policies; in particular the common agricultural policy (CAP), the common fisheries policies (CFP), environment, energy, transport, health, development aid, consumer protection etc. Research in this area will be mainly carried out by means of Specific Targeted Projects and Coordination Actions. In duly justified cases, limited use can be made of Integrated Projects (IPs) and Networks of Excellence. The budget for this program is EUR 555 million.

New and Emerging Science and Technology (NEST). NEST is a new feature of the European research landscape, designed to help anticipate Europe's scientific and technological needs. It supports unconventional and visionary research that explores new avenues of science and technology as well as consolidating and accelerating the development of European capabilities in emerging research fields. A distinctive aspect of NEST is its flexibility: researchers will be given the freedom to develop and prove their ideas within the broadest possible limits, and the research themes to be supported will be selected on the basis of opportunities and needs. The budget for this program is EUR 215 million.

Specific SME Activities. SMEs are encouraged to participate in the activities implemented under the priority thematic areas within NoEs, IPs, and specific targeted research projects. In addition, two specific schemes for SMEs having a capacity to innovate but with limited research capacity are foreseen. Within these schemes - Collective Research and Co-operative Research ("CRAFT") - SMEs or groupings dominated by SMEs may entrust research work to solve their particular problems to research performers (research institutes, universities etc.). Ownership of the results will rest with the SMEs or the SME groupings. The budget for this program is EUR 430 million

International co-operation activities. International co-operation (INCO) represents an important dimension of the Sixth Framework Programme. As a contribution to a European Research Area open to the world, it will be implemented in the Sixth Framework Programme through three major routes:

- The opening of "Focusing and Integrating Community Research" to third country organisations with substantial funding;
- Specific measures in support of international co-operation;
- International activities under the heading of Human Resources.

The first two are implemented through the specific programme "Integrating and strengthening the European Research Area"(SP1). The third is part of the specific programme "Structuring the European Research Area"(SP2).

The budget is; 600 million Euro for international co-operation according to the second activity of the Treaty, of which 285 million Euro for participation from the targeted third

countries in "Focusing and Integrating Community Research 315 million Euro to fund "Specific measures in support of international co-operation"

The Joint Research Centre (JRC) is an integral part of the European Commission. It provides independent scientific and technical advice to the Commission, the European Parliament, the Council of Ministers and EU Member States in support of European Union (EU) policies. The main aim is to help to create a safer, cleaner, healthier and more competitive Europe.

Seven scientific institutes carry out research of direct concern to EU citizens. They provide technical know-how both directly and through co-ordinating and contributing to numerous broader networks linking industry, universities and national institutes.

The JRC is playing an important role in helping establish the European Research Area (ERA). And they are working closely with applicant countries to assist in the development of their understanding of the body of EU law as a support to the EU enlargement process.

The Directorate General and the Directorate for Science Strategy – responsible for positioning of the JRC in relation to ERA – are in Brussel, while the Directorate of Resources is at Ispra in Italy. The JRC institutes are located at five different sites in Geel (BE), Ispra, Karlsruhe (DE), Petten (NL) and Seville (ES). In total, they employ about 2150 staff (December 2001) including a large number of Europe's most skilled scientists. JRC staff are recruited from all over the EU and, increasingly, from the applicant countries.

They also work with more than 2000 public and private organisations – such as research centres, universities, regulatory bodies, local authorities, industrial associations and companies – in more than 150 major networks, including partnerships with applicant countries.

6.3 Strengthening the ERA

This is another element of FP6 that deals with horizontal issues.

Co-ordination of research activities. The objectives of Community action in this field is to contribute to the creation of the European Research Area (ERA) by stimulating and supporting programme coordination and joint activities conducted at national or regional level, as well as among European organisations, and thus help to develop the common knowledge base necessary for the coherent development of policies. These activities may be in any scientific and technological area, including in the thematic priority areas.

The thematic areas are:

- Coordination of national activities; Networking of national or regional programs (ERA-NET);
- Development of an integrated information system on national and regional research programs;
- Coordination at European level. Coordination and cooperation between Framework Programme and COST, EUREKA and other thematic international organisations (CERN, ESA, ESO, EMBL, ESRF, ILL etc.)

The budget for this activity is EUR 270 million.

Development of research/innovation policies encourage coherent development of research and innovation policies in Europe by early identification of challenges and areas of common interest and by providing policy makers with knowledge and decision-aiding tools.

The principal activities are:

- Analysis and studies relating to foresight, statistics and science and technology
- Indicators.
- Benchmarking of research and innovation policies at national, regional and
- European level.
- Mapping scientific and technological excellence in Europe
- Improving the regulatory and administrative environment for research and innovation

The budget for this activity is EUR 50 million.

6.4 Structuring the ERA

This is yet another element that deals with integration and cross-cutting issues.

Research and Innovation. Improving Europe's innovation performance by stimulating a letter integration between research and innovation and by working towards a more innovation-friendly policy and regulatory environment. Enhancing the propensity to turn research into useful and commercially valuable innovations.

Types of actions:

- Networking the players and encouraging interaction; encourage and validate initiatives to promote creation of innovative businesses exchange of good practices with regard to communication, training, transfer of knowledge;

- Encouraging trans-regional cooperation; promote exchange of information, facilitate transfer of good practice and put in place regional innovation strategies;

- Experimenting with new tools and approaches:

- Putting services in place and consolidating them; CORDIS, Innovation Relay Centres, Information and support services in the field of intellectual and industrial property rights and access to innovation funding;

  - Stepping up economic and technological intelligence; Innovation promotion in SMEs; Gathering, analysis and dissemination of information on S&T developments, applications and markets identification and dissemination of best practice;

  - Analysing and evaluating innovation in Community research projects.

The budget for this activity is is EUR 290 million.

Marie Curie Actions - Human resources and mobility provides broad support for the development of abundant and dynamic world-class human resources in the European research system, taking into account the inherent international dimension of research.

Types of actions:

- Host-driven actions; Marie Curie Research Training Networks providing the means for promoting the training of researchers within the frame of international collaborative research project; Marie Curie Host Fellowships for early stage research training (young researchers) and for the transfer of knowledge (experienced researchers); Marie Curie Conferences and Training Courses

- Individual-driven actions; Marie Curie Individual Fellowships for intra-European, outgoing and incoming international fellows;

- Excellence promotion and recognition; Marie Curie Excellence Grants providing support to teams of highest excellence; Marie Curie Excellence Awards aiming at public recognition of excellent former beneficiaries of EU mobility and training grants; Marie Curie Chairs to attract world-class researchers and encourage them to resume their careers in Europe

- Return and reintegration mechanisms; Support for the reintegration of researchers into scientific careers in Europe after their Marie Curie mobility period; Provision of opportunities for those European researchers who have spent long periods outside Europe and wish to return.

The budget for this activity is EUR 1580 million.

Research infrastructures promotes the development of a fabric of research infrastructures of highest quality and performance in Europe and their optimum use on a European scale.

Activity areas:

1. Transnational access to major research infrastructures for research teams and individual researchers
2. Integrating activities combining cooperation networks with transnational access and research projects
3. Integrating activities including networking activities only
4. Communication network development in conjunction with thematic priority 2 (Information Society Technologies) to establish a high-capacity and high-speed communications network for all researchers in Europe (GÉANT) and specific high performance Grids and test-beds (GRIDs).
5. 5. Design studies: feasibility studies and technical preparatory work for new infrastructures with European dimension
6. Development of new infrastructures: optimizing of European infrastructures by providing limited support in duly justified cases, alongside with other funding agencies

The budget for this activity is EUR 655 million.

Science and Society aims at developing structural links between institutions and activities concerned with the dialogue between the scientific community and society at large.

Thematic areas:

- Bringing research closer to society; science and governance: analysis and support best practice, develop new consultation mechanisms scientific advice and reference systems: exchange of experience and good practice; monitoring the production of scientific advice world-wide

- Responsible research and application of science and technology; ethic;: networking between existing bodies and activities, promotion of dialogue in a global context, awareness raising, training, research on ethics in relation to science and technology uncertainty, risk and the precautionary principle; analysis and best practice

- Stepping up the science-society dialogue and women in science; public awareness of science and science communication awards for scientific achievement, collaboration and communication promoting young people's interest in science and scientific careers of women and science.

The budget for this activity is EUR 80 million.

6.6 Instruments

To overcome past problems with the Collaborative Research Program of disbanding consortia when short-term research ends and the lack of 'critical' mass in projects, two new approaches are being used in FP6; Integrated Projects and Networks of Excellence.

Integrated Projects (IPs) are usually multidisciplinary projects of 'critical mass' of activities, expertise and resources with at least 3 participants from 3 different countries. The parties enter into a consortium agreement and one coordinator is named to interface with the FP6 authority. Projects last from 3 to 5 years and are chosen through peer review. FP6 will provide 50% of costs for R&D and innovation components, 35% for demonstration projects and 100% for consortium management and training.

Networks of Excellence (NoE) projects involving large numbers of researchers from across Europe; the larger the number of researchers the larger the grant. There is a legal minimum of 3 parties. The parties enter into a consortium agreement and one coordinator is named to interface with the FP6 authority. It is recommended that a governing board be appointed along with a scientific council of external experts. Projects last from 5 to 7 years and are chosen through peer review. There is a university training dimension to the projects. The Networks are expected to continue beyond the period of European Commission funding. The financial contribution is a fixed grant calculated on the basis of the value of the capacities and resources (amount of people involved) to be integrated, but not more than 25% of the cost. Proposals are evaluated by peer review using the following criteria;

Objectives and strategic impact; how the project fits within FP6;
Excellence of the participants and resources of the network;
Degree of integration and the joint program of activities;
Organization and management.

6.7 Summing-Up

The EU has created a special category of programs to address cross-cutting research issues. Two new mechanisms or instruments, the IPs and NoE, have been set in place in FP6 to overcome previous difficulties.

7 Analysis

7.1 A Framework

In a recent study, the Technopolis Group has presented a four level model of decision-making to assess its findings on horizontal R&D coordination[4]. This analytical framework is used to present the results of this study.

In this framework there are four levels of coordination;

Level 1 is the highest level. This involves setting overall directions and priorities across the whole National System of Innovation. It may be achieved through advice to government or by more binding means such as decisions of a cabinet sub-committee.

Level 2 is coordination among ministries, whose sectoral responsibilities otherwise encourage them to pursue independent policies. In practice this level of coordination may involve administrative aspects, policy issues or both. Sometimes an inter-departmental group also functions as the Level 1 coordination mechanism.

Level 3 is more operational, in an attempt to make the actions of funding agencies into a coherent whole. This level, too, can involve administrative coordination as well as more substantive coordination of funding activities, such as co-programming.

Level 4 involves coordination among those who actually perform research and innovation.

The activities of the five countries reviewed are arrayed against the above four levels of coordination in **Exhibit 7.1**

The following observations can be made regarding the characteristics presented in **Exhibit 7.1**;

> **Level 1**: R&D priorities range from very high level (Australia, New Zealand) to specific research domains (USA, EU) to pragmatic/functional approaches (UK). Some governments obtain the assistance of external advisers in setting their R&D priorities (e.g.-PMSEIC in Australia; Council on S&T in the UK; PCAST in the US);
> **Level 2**: All five jurisdictions have cross-departmental coordination mechanisms;
> **Level 3**: All five jurisdictions have some form of horizontal operational coordination mechanism;
> **Level 4**: All five jurisdictions have collaborative research programs that bring together researchers from publicly funded research institutions, universities and the private sector. The number of programs appears to depend on size with the EU having a very broad array of activities while smaller countries, like Australia and New Zealand have more targeted approaches.

While there are 'horizontal' mechanisms at all four levels, the 'vertical' integration of these mechanisms, from priorities to research activities, appears to be more developed, at least 'on paper', in New Zealand, the USA and the EU and more fragmented in Australia and the UK.

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[4] Technopolis Group: Research and Innovation Governance in Eight Countries; January 2003

Exhibit 7.1: Approaches to Cross-cutting Research Activities in 5 Jurisdictions

Country	1) Priorities	2)Depart. Coordination	3) Operational Coordination	4) Research Programs
Australia	- four high level gov. priorities	-Coordination Committee on S&T	-Department of Education, Science and Training	-Cooperative Research Centres
New Zealand	- four high level gov. Priorities	-Ministry of Research, Science and Technology	-Foundation for Research, Science, and Technology	-Cross Departmental Research Pool
United Kingdom	-pragmatic and functional Priorities	-Trans-Depart. Group on Science and Technology	–Research Councils	-collaborative R&D programs (eg-LINK)
United States	-specific gov. priorities	-National Science and Technology Council -OMB	-Interagency Working Groups	-collaborative R&D programs
European Union	-thematic directions	-Commissioner for Research	-Directors-Gen. for Research and for the JRC	–cross-cutting R&D programs (eg-IPs; NoEs)

Level 4 collaborative research programs fall into three categories; collaborative research centres, pooled resources collaborative research and coordinated collaborative research. These are reviewed below.

7.2 Collaborative Research Centres

Such centres are found in Australia (Section 2.4) and the EU-FP6 (Section 6.1).

Australia's Cooperative Research Centres (CRCs) program is about to undergo a major evaluation. An earlier (1997-98) more focused evaluation[5] came to the overall conclusion that the CRC program represents an effective investment of public money in R&D. The conclusions regarding the management of CRCs were as follows;

> A strong and effective role by CRC Boards in establishing objectives and reviewing performance is essential;
> CRC Directors must have clear authority to manage the resources of the CRC and be accountable for that performance;
> All CRCs should have a comprehensive strategic business plan that is updated annually and includes performance indicators, objectives with regard to research, commercialization, education, staff training, budget allocations and financial projections.

The evaluation also stressed the need to strengthen the governance structure of the program (ie- the CRC Committee that advises the Minister). For example, it was recommended that the CRC Committee play a more active role in evaluating the performance of CRCs and that appointments to the Committee be made on an individual basis rather than on an organizational basis.

The Joint Research Centres (JRCs) to the EU present core capabilities in seven laboratories linked to a multiplicity of other centres throughout Europe. However, an evaluation of JRCs recommended that linkages with other centres in member states be deepened and that their research activities be more focused[6].

A successful recent innovation has been the addition of a Management Support Unit to each institute. This has made practical a much greater degree of delegation of authority to local directors in matters of staff and internal budgeting[7].

7.3 Pooled Resources Collaborative Research

Examples are merged budgets in the UK (Section 4.2) and the Cross-Departmental Research Pool in New Zealand (CDRP) (Section 3.4). Control over strategic directions is maintained through governance structures and budgetary control of projects.

The CDRP was set up in order to bring government departments together to establish common research priorities, a process not carried out in the past. It has also brought science providers

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5 Mercer Don, Stocker John; Review of Greater Commercialization and Self Funding in the Cooperative Research Centres Programme; Department of Industry, Science and Tourism; 1998

6 Commission of European Communities; Mid-Term Review of the 5th Framework Programme for Research and Technological Development, Brussels, 23.10.2000

7 Five year Assessment Report Related to the Joint Research Centre; Covering 1995-1999; June 2000

together to develop solutions for key government problems. It has proved to be very effective in doing this[8].

7.4 Coordinated Collaborative Research

This approach is widely used in the USA and EU and in the UK as well. Budgets are distributed and held by participating research agencies. This can make it more difficult to control research activities.

An evaluation of US federal research programs by the US National Research Council recommended that a formal process be established to coordinate multi-agency research activities and a lead agency be given responsibility to coordinate activities[9]. This would help to overcome the fact that the Government Performance and Results Act (GPRA) evaluations are undertaken agency-by-agency. Some of the difficulties of horizontal coordination in the US system were described in Section 5.1.

An evaluation of the EU 5th Framework program also recommended better coordination of horizontal R&D programs[6].

7.5 Difficulties with Implementing Cross-Cutting Approaches

While structures are in place to create 'horizontal' or cross-cutting approaches to R&D, the question remains, are they effective? The following is an extract from the Technopolis Group report[4] that highlights the difficulties of cross-cutting approaches:

'The shift from a linear to a systemic approach to innovation is now part of the accepted rhetoric in most OECD countries, even though linear thinking, practices and routines are still widespread. Nevertheless, most countries are struggling with the question of how actually to implement such an integrated perspective. The heritage of institutions built up in a time where linear thinking was dominant is a major obstacle to adapting the governance structure to the new challenges. Compartmentalization between research and innovation and between sectors is a significant obstacle to a more integrative approach to research and innovation.

Barriers to integration can be significant. One is the major cultural difference that has grown up between the 'basic science ' and the 'research and innovation ' communities in the post War period. Integration of research and innovation activities across the sectoral responsibilities is strongly resisted in most systems. Partly this is because of legitimate concerns that individual

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8 Hayden Montgomery, Auckland University; private communication

9 National Research Council, Committee on Science, Engineering and Public Policy; Evaluation of Federal Research Programs: Research and the Government Performance and Results Act (1999)

ministries should be able to fulfill their sectoral responsibilities. Often, the risk of loss of control over activities or budgets is a key aspect – so that cross--sectoral innovation and research activities tend to become casualties in the traditional inter-ministerial turf wars.'

Although all three approaches to collaborative research reviewed in Sections 7.2, 7.3 and 7.4 can be made more effective, focused research programs with their own budgets, such as the CRCs in Australia, the JRCs in the EU, the merged budgets in the UK and the Cross-Departmental Research Pool in New Zealand, offer ways of overcoming the above difficulties.

However, as observed by William Smith of Auckland University; 'My own view from NZ and UK experience is that at end of day collaboration requires effective personal links and networking. Even in the UK where there is a pretty good structure for collaborative initiatives using the offices of the Chief Scientist, the system only seems to operate effectively where there is informal trust between staff in different agencies and departments'[10].

7.6 Towards A Model for Collaborative R&D

The following is a list of desirable characteristics for an approach to collaborative R&D among government laboratories based on the findings of this study;

An independent R&D activity with its own budget;
A strategic plan as framework for the R&D activity;
A governance structure that includes a consortium agreement, a board of directors and a lead agency responsible for coordination;
An R&D activity of critical mass over a long period of time (e.g.- 5 years) to ensure meaningful results.
Processes for monitoring and evaluation.

8 Conclusion

All five jurisdictions reviewed have mechanisms to address horizontal or cross-cutting issues covering the full spectrum of activities from policy formulation to research.

At the level of collaborative research programs, they fall into three categories; collaborative research centres, pooled resources collaborative research and coordinated collaborative research. In the absence of a strong culture supporting collaborative research, the first two approaches appear to offer better prospects for organizing cohesive collaborative research programs around strategic directions.

[10] William Smith, Auckland University; private communication

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