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SCIENCE AND TECHNOLOGY POLICY, RESEARCH PROGRAMME ORGANISATION AND EVALUATION IN THE UNITED KINGDOM

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Science and Technology Policy, Research Programme Organisation and Evaluation in the United Kingdom

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Introduction

Today funding of research is not simply a matter of providing funds for research but involves complex processes rooted in a science and technology policy for the country and involving the formulation of economic and research priorities, management of the research process, and monitoring and control of the research results and their applicability. The beginning of the 1970s marked the raise of importance of Science and Technology Policy. This followed directly from the realisation that irrespective of how large the allocated public funds for research these are usually insufficient to support research across the whole spectrum and that there should be some return on public investment in science.

Moreover, starting in the early seventies the general beliefs regarding the nature and social role of science and research as well as the practices used by STP policy makers underwent a radical transformation. Thus, the dominant perceptions of science and research as 'good' have shifted towards the more utilitarian view that these are 'useful'[1] and knowledge producers started being seen as major actors in the emerging 'knowledge society'. Closely related to this, the conviction that it is not possible to direct and plan research was abandoned in favour of devising policies and mechanisms for selectivity and prioritisation a particular expression of which was the rise of forecasting and foresight. Programmes and policies aiming to encourage the commercial application of research results have been continuously designed and consistently pursued by governments in the belief that this will aid innovation and thus increase industrial competitiveness. And finally, analytical frameworks for examining the various relationships maintained in the process of knowledge production and utilisation have emerged. Most influential among these are the National Innovation/Research Systems[2], the Triple Helix[3] and Mode 2 knowledge production[4].

The increased demands for selectivity and accountability in the process of funding research found an expression in changing the organisation of research whereby national and supra-national level research programmes started being set up. Organising and running research programme, however, is highly context sensitive. Thus, though an attempt has been made in this paper to make explicit some general rules in organising and running research programmes these have been derived based on practical experience of the UK research/innovation system and the initiatives of the Commission of the European Union. The paper starts by presenting the UK National Research/Innovation System, which is followed by a section on establishing research and technology priorities and evaluation of research programmes. Four examples of research programmes have been provided. *Please note that this is meant to be a working paper and therefore*

Since 1995 the DTI also incorporates the Office of Science and Technology (OST), which had been an independent Cabinet Office immediately following its establishment in 1992. OST is of major importance for the organisation of S&T in the UK and it co-ordinates the UK's science effort and allocates funds for a number of basic science oriented institutions, most importantly the Research Councils.

The UK EUREKA Office is also within the DTI. The DTI has an Evaluation Unit commencing and commissioning research evaluations.

Ministry for Agriculture, Fisheries and Food

The second largest civil RTD spender on the level of the federal government is the Ministry for Agriculture, Fisheries and Food (MAFF). MAFF is predominantly concerned with the farming, food and drink and fishing industries. It also deals with issues ranging from public safety and animal welfare to the protection of the rural and marine environments. This ministry is responsible for the negotiation and implementation of the EU's Common Agricultural Policy and Common Fisheries Policy.

Department of Health

The Department of Health is responsible for R&D expenditure in its area of competence, namely health care and social care through the National Health Service. The combined R&D budget of the DoH and the NHS totalled in excess of £403m in 1995-96. The Department does not have particular responsibilities for internationalisation of research.

Department for Education and Employment

The department has responsibility for education and training matters at all levels. Reporting to the DfEE is the Higher Education Funding Council for England (HEFCE) which funds teaching and provides the base line funding for research in universities and Higher Education colleges in England[6].

Executive Agencies

In the UK the institutions mediating the relationships between government departments and research performers (predominantly universities) are the Research Councils and the Higher Education Funding Councils[7]. In the context of the 'dual support system' the Higher Education Funding Councils allocate research funds to the universities in the form of block grants while the Research Councils have a broader scope (in theory any performer of research can apply for funds) and allocate research grants. The principles of selectivity and competition apply to both streams of funding[8].

Following the latest changes in the national research system the Research Councils are seven, namely:

- the Research Council for Biotechnology and Biological Sciences (BBSRC);
- the Research Council for Engineering and Physical Sciences (EPSRC);
- the Research Council for Particle Physics and Astronomy (PPARC);
- the Research Council for the Central Laboratory (CCLRC);
- the Research Council for Natural Environment Research (NERC);
- the Research Council for Medical Research (MRC), and
- the Research Council for Economic and Social Research (ESRC).

In terms of public funding for research the UK has developed the so called 'dual' funding system involving the Higher Education Funding Councils (HEFCs) and the Research Councils (RCs). The HEFCs provide basic funding to universities and higher education colleges and the RCs fund research across the whole spectrum of research performers (universities, independent research institutes, industrial research establishments) and also supports MSc and PhD students. While both funding streams are selective only the funding from the RCs is also competitive.

Yet another stream of funding involves the Government Departments directly. As pointed out in the previous section most Government Departments have their own research budgets with which they fund some (usually fairly applied) research necessary in their areas of responsibility. Most of these research funds used to fund the activities of the Governmental Research Labs but since the latest change during which these were either privatised or became independent agencies are subject to competitive bidding.

Please note that for the purposes of this paper it has been assumed that only competitive funding for research is subject to formulating research programmes.

R&D Programmes and Projects

Formulation of Programmes/Projects

Research Programmes are usually formulated in the context of distribution of competitive funding for research and are inevitably linked to established national/institutional priorities. *Research and Technology Foresight* is being increasingly used to identify emerging research opportunities and technological trends, and for informing decisions on the balance and direction of publicly funded science and technology.

Research and Technology Foresight

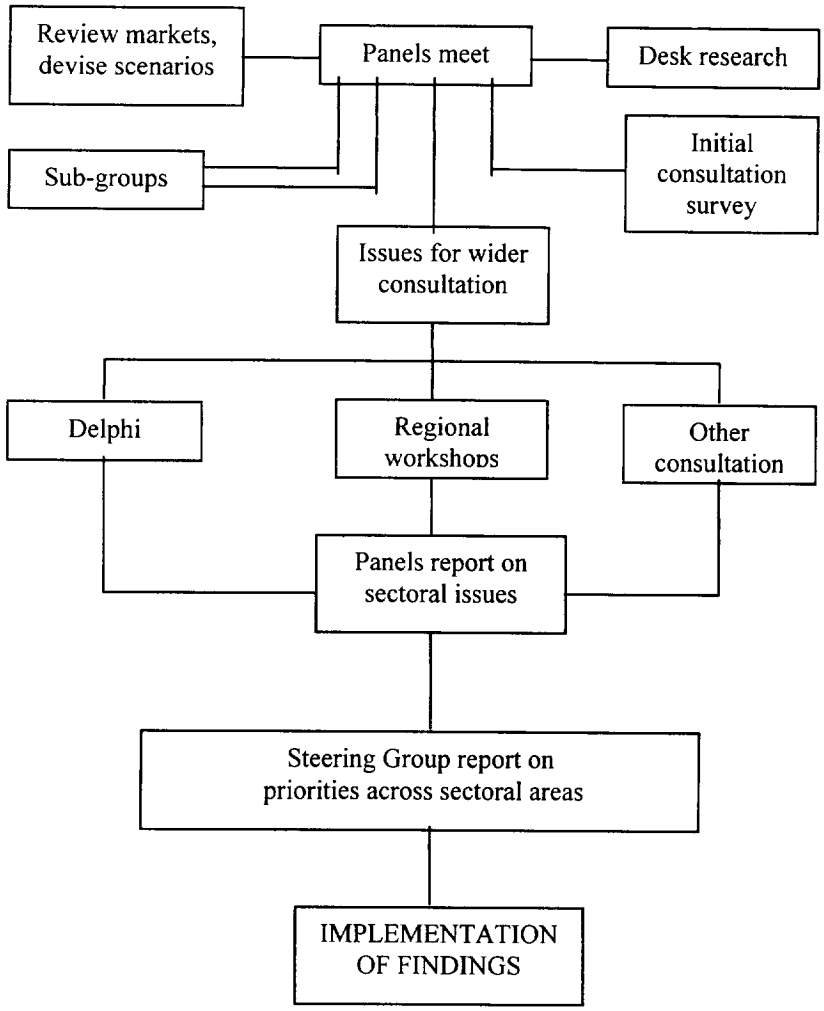
Foresight programmes have evolved rapidly in Europe since late 1980s and have paralleled activity in the rest of the world. Today Research and Technology Foresight (R&TF) has become a powerful instrument for science and technology policy-making at the national level while its possibilities at the supra-national level are being considered currently in the ASEAN and South American countries. In the European Union, the European Commission has explored the possibilities of using foresight methodology and integrating it into the EC's planning process[9]. Major programmes have been conducted (or are in progress) by the following European countries: Austria, France, Germany, Spain, the Netherlands, the United Kingdom, Finland, Ireland, Sweden and Hungary.

The UK Research and Technology Foresight Programme

The UK Foresight Programme began in 1993, having been announced by the Government White Paper on Science, Engineering and Technology 'Realising Our Potential'. From the outset the Programme combined the objectives of informing priorities for public spending on science, encouraging interactions between academe and industry and promoting a 'foresight culture' more generally. The initial Foresight Programme has been completed and the second one is currently underway.

The UK Foresight Programme was carried out in three main phases, namely pre-Foresight, main-Foresight and dissemination. The mechanics of the Programme are illustrated by Figures 1 and 2. From the Figures it can be seen that the pre-Foresight phase of the UK Technology Foresight Programme focused mainly on creating foresight awareness, identifying experts to participate in the process and to be consulted at later

Figure 2: Main Foresight phase



A new cycle of foresight began officially on April 1st 1999. Its objectives remain similar to the previous one, being to:

- Develop visions of the future – looking at possible future needs, opportunities and threats;
- Building bridges between business, science and government, bringing together the knowledge and expertise of many people across all areas and activities; in order to
- Increase national wealth and quality of life[12].

Structurally, the panels have been retained but their number has been reduced to ten. There is also a tendency for the panels to be more application oriented *and Health and Life Sciences* has become *Healthcare*. An important innovation is that some thematic panels addressing broad social and/or economic issues with cross-cutting implications for science and technology have been introduced. An example of such panel is *Crime Prevention*, which is funded by the Home Office (the ministry responsible for policing) and will feed directly into its crime reduction strategy. Each panel is expected to consider the two underpinning themes of education, skills and training, and sustainable development[13].

recent experience indicates an increase in the use of continuous evaluations[16]. These two approaches differ in several important aspects[17]:

i) in the context of a continuous evaluation information is collected and assessed continuously (and regularly) providing a reliable basis for timely corrective actions;
ii) in the case of continuous evaluations all information that has been collected relates directly to the subject(s) of evaluation and thus it dispenses with the necessity to extrapolate;
iii) several years into the continuous evaluation as data accumulates at least three types of analysis, namely "annual", "cumulative" and "historical", become possible;
iv) large one-off evaluation exercises require that the evaluation be carried out by a team of 'professional evaluators' while continuous evaluations can be run by an internal unit (although some external participation is also desirable). Continuous evaluations therefore allow for a high level of participation of the users of results into the evaluation process which in its turn deals successfully with problems that can arise in the context of implementation;
v) all information collected during a continuous evaluation is fully compatible, consistent and it reflects the complex dynamics of social processes;
vi) Implementing and running a process of continuous evaluation and monitoring is significantly less resource intensive than commissioning large exercises[18].

It is worth noting, however, that although the methodology of continuous evaluation appears to have some definite advantages when compared with more traditional evaluation exercises it cannot be a substitute for these. Whilst continuous evaluation provides a reliable basis for operational decision making it does not allow for a more strategic outlook.

Examples of R&D Programmes at National and Supra-National Level

LINK (UK)

The basic objective of the LINK initiative is to "offer a well established framework for collaboration between public and private sectors in support of science and technology (S&T) in areas of strategic importance to the national economy. LINK aims to enhance the competitiveness of UK industry, and quality of life, through support for managed programmes of pre-competitive S&T in market or technology sectors, and by encouraging industry to invest in further work leading to commercially successful products, processes, systems and services." LINK programmes are sponsored by various government departments and Research Councils and use a formula according to which government funds up to 50% of eligible costs of a LINK project with the balance coming from industry.

Since 1986 the LINK programme has been the government's principal support mechanism for collaborative research projects between industry on the one hand and publicly funded research performers such as universities, research council institutes, government research establishments, hospitals or independent research institutes on the other. LINK programmes cover pre-competitive research in a wide range of technology and generic product areas, within defined technology or market sectors. Each programme receives sponsorship from relevant government departments or research councils and consists of a number of research projects involving industrial and academic partners. Within each 2-3 year project, up to 50% of funding is received from the sponsoring department or research council with the industrial partner providing the balance of funds. Government spend in 1995-96 was some £33m.

Following a review, the LINK programme was re-launched in 1995 with a streamlined administration and greater strategic focus. Subsequent programmes have been closely aligned with Foresight priorities. As of

developed mechanisms for formal project management and monitoring (among others, the UK, Sweden, Spain, Portugal, the Netherlands and Italy) others do not have provisions for project monitoring (Greece, Germany and Austria, for example)[22].

In the context of EUREKA the bottom-up approach in initiating projects is consistently re-enforced. Face-to face interviews evidenced that this feature, combined with the low level of bureaucracy and a high level of flexibility contributes significantly to the attractiveness EUREKA has for its industrial participants.

Framework Programme (European Union and Associated Members)

EU R&D co-operation: a short historical overview

The evolution of European co-operation in research and development can be traced back to the 1950s when the formation of the European Coal and Steel Community (ECSC) concerned not only the joint coal and steel production of the members of the 1952 Treaty (Belgium, France, Italy, Luxembourg, the Netherlands and West Germany) but also co-operation in research into the technological and economic aspects of the area. The next major collaboration was the European Atomic Energy Community (EURATOM) which commenced in 1957 and encouraged research into areas related to nuclear energy. When the European Community was formed in 1967 by combining the three European Communities (EEC, ECSC, EURATOM), attempts to formulate consistent European research policy were made on the basis of examining the nature of research and policies in the member states. The intention of the member states to co-ordinate their science and technology policies and to encourage industrial research was reaffirmed at the Hague Summit (1969) but the task of co-ordinating the research effort was entrusted to a specifically established permanent committee called COST (Scientific and Technological Committee) and not to the Community[23].

In the early 1970s, under the influence of internal and external factors, the European Community's perceptions of its role in encouraging research and development underwent an important shift from carrying out direct research (EURATOM) and co-ordinating national research efforts to encouraging co-operation in research between the Member States, facilitating the movement of researchers, and creating networks of professionals working in European laboratories. Thus, in January 1974 its Council adopted four resolutions concerning science and technology, which required:

- the co-ordination of national R&D policies, facilitated by a Scientific and Technical Research Committee (CREST), which would help the Commission in gathering information about individual member's research policies and co-ordinating them.
- the establishment of a European Science Foundation to oversee developments in basic research. Organisations from 16 countries were to participate in its formation and thus it was not a Community institution.
- that the Community draw up its own science and technology policy, to integrate ongoing research; the main criterion for project selection being usefulness to Community objectives.
- the setting up of a preparatory system for European science policy.

Following these and similar policy and political developments, the European Strategic Programme for Research and Development in Information Technology or ESPRIT was set up. ESPRIT was inspired by concerns over a 'technology gap' with Japan and its pilot project cost the Community 11.5 Million ECU (50 per cent of the overall cost). Some of the rules which are in the basis of more recent European co-operation arrangements, such as the necessity for industrial involvement and international collaboration in R&D, were developed and piloted in the context of ESPRIT. As a parallel development the idea of developing a

7. Managing research programmes can vary significantly from case to case.
8. Where research programmes are concerned 'evaluation' is an inherent management tool supportive to the internal and external co-ordination of activities.

Notes and References

[1] Nedeva M., *Strategies for Change: A Comparative Analysis of the National Research System of Bulgaria and the National Research System of Britain*, PhD thesis, Manchester University, Manchester, 1997.

[2] Freeman, C., *Technology and Economic Performance: Lessons from Japan*, Pinter Publishers, London, 1987; Lundvall, B.A., 'Innovation as an Interactive Process - from User-Producer Interaction to National Systems of Innovation', in Dosi et al., *Technical Change and Economic Theory*, Pinter Publishers, London, 1988.

[3] Leydesdorff L., and Etzkowitz H., "Emergence of a Triple Helix of university-industry-government relations" Science and Public Policy Vol 23 (1996), 279-86.

[4] Gibbons M., et al., *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*, SAGE Publications, London, 1994.

[5] For more information see: Cunningham P., 'The organisation of UK science and technology', in Cunningham P. (ed) *Science and Technology in the United Kingdom*, Cartermill International, 1998.

[6] There are separate Higher Education Funding Councils for Scotland and Wales.

[7] There are three Higher Education Funding Councils (for England, Scotland and Wales).

[8] HEFCs funds are allocated on the basis of the Research Assessment Exercise and RCs funds are allocated following direct competition. The Research Assessment exercise is carried out every four years and participating departments are assigned marks from 1 to 5 star.

[9] Cameron H., Loveridge D., et al., *Technology Foresight: Perspectives for European and International Co-operation*, Report to the DGXII of the EC, April 1996.

[10] Nedeva M., et al., 'The use of co-nomination to identify expert participants for Technology Foresight', *R&D Management* Vol 26, No 2, April 1996.

[11] See: Loveridge D., Keenan M., 'The UK Technology Foresight Programme', in Cunningham P.,(ed.), Science and Technology in the United Kingdom, Second Edition, Cartermill International, 1998.

[12] See: http://www.foresight.gov.uk

[13] For more on this see: Georghiou L., 'The United Kingdom National System of Research, Technology and Innovation', to appear in Laredo P., Mustar P. (eds.) *National Systems of Research, Technology and Innovation*, Economica/Brookings 2000.

[14] For more on the issues of the 'audit' society see: Power M., *The Audit Society: Rituals and Verification*, Oxford University Press, 1997.

[15] For more on these issues see: Lapiere R.A., *A Theory of Social Control*, New York, 1954; and Lemert E.M, *Human Deviance: Social Problems and Social Control*, New York, 1967.

[16] A process for continuous evaluation was introduced by the EUREKA initiative and is being considered by COST and the Framework Programme.

[17] For more see: Sand F., Nedeva M., 'The EUREKA Continuous and Systematic Evaluation: An Assessment of the Socio-Economic Impact of the International Support Given by the EUREKA Initiative to Industrial R&D Co-operation', in *Proceedings of the APEC Symposium on the Evaluation of S&T Programmes among APEC Member Economies*, National Centre for Science and Technology Evaluation, Ministry of Science and Technology of China, 1998.

[18] Nedeva M., Cunningham P., COST: Towards a System for Continuous Evaluation and Monitoring, Report to the COST Secretariat, October 1998.

[19] Cunningham P., 'The organisation of UK science and technology', in Cunningham P.,(ed.), Science and Technology in the United Kingdom, Second Edition, Cartermill International, 1998.

[20] Please note that these figures are valid at the time of the Lisbon Ministerial Conference (June 1998)

[21] Members of EUREKA are the 15 countries of the EU, ten other European countries (including Central and Eastern European countries) and the EU as an additional member.

[22] See: *Evaluation of EUREKA Industrial and Economic Effects, Report to the EUREKA Secretariat*, 1993 (ISBN 2-11-087691-3)

[23] Norton M. and Hedgecoe, A. *The European Union and Research – EU Framework Programmes and National Priorities*, Parliamentary Office for Science and Technology, October 1996.

[24] According to these criteria Community involvement is justified with: i) research conducted on so vast scale that single Member States either could not provide the necessary financial means and personnel, or could only do so with difficulty; ii) research which would obviously benefit financially from being carried out jointly, after taking into account of the additional costs inherent in all actions involving international co-operation; iii) research which, owing to the complementary nature of work carried out at national level in a given sector, would achieve significant results in the whole of the Community for problems to which solutions call for research conducted on a vast scale, particularly in a geographical sense; iv) research which contributes to the cohesion on the common market, and which promotes the unification of European science, and technology, as well as research which leads where necessary to the establishment of uniform laws and standards. These criteria were complemented by an addition in the Single European Act according to which '...research which contributes to the strengthening of the Community's economic and social cohesion, as well as to the promotion of its harmonious and wide spread development, while maintaining its consistency with the objective of technical and scientific quality' is also eligible for Community support.

[25] Guzzetti L., *A Brief History of European Union Research Policy*, European Commission, DGXII, October 1995.

[26] Research Europe. Number 28, 19 February 1998.

'framework' to include the separate topics covered by Community policy and thus provide the means for developing of scientific aims and co-ordination of national research was emerging.

The Framework Programmes

The First Framework Programme (FP1) was approved in July 1983 and was to last from 1984-1987. Since legal reasons made it impossible to increase the funds already allocated to the different individual research programmes run by the Commission (around 3,750 MECU), the importance of the FP1 was, and still is, considered to be organisational rather than scientific. So, for example, the criteria justifying intervention in research and development with European Community funds used while formulating FP1, namely the *Reisenhuber criteria*[24], are still used to select programmes for Frameworks.

Also, in the context of FP1 three types of funding for projects were distinguished: i) *Shared Cost Actions* including research and technological development projects, technology stimulation and demonstration projects in which the Commission paid up to 50 per cent of the running costs of the project; ii) *Concerted Actions* which provide up to 100 per cent project co-ordination costs; and iii) *Direct Actions* which cover the 'in-house' research carried out by the Commission. These are still used when funding projects under the Framework Programme.

The discussions for the second Framework Programme - FP2 - (1987-1991) and the preparations for the Single European Act (enacted July 1987) coincided, resulting in a shift of perceptions over the role and functions of the Programme. Following the idea of European single market, FP2 was seen as a mechanism for unifying the European R&D necessary to underpin European economic competitiveness. Thus, the Single European Act added Title IV to the EEC treaty legally committing the Community to the implementation of research programmes, encouraging co-operation with industry and setting out the organisation of this research as a 'multi-annual framework programme'[25].

Since 1983, four Framework Programmes have been formulated and implemented and the fifth one is currently being negotiated. These have evolved in terms of their organisation and management, as well as thematically. Between FP1 and FP4 an absolute increase in allocated funds can be observed: FP1: 3,750 MECU; FP2: 5,396 MECU; FP3: 2, 6.600 MECU; and FP4: 12,300 MECU. Regarding FP5, the Council of Research Ministers have agreed a budget of 14,000 MECU although the budget requested by the European Parliament was 16,700 MECU. Whilst it is expected that further negotiations will achieve a budget of between 14,500-15,000 MECU, this is still a real terms decrease of about 2 per cent compared to FP4[26].

Key Points

1. Research Programmes are gaining importance in the context of national and international organisation of research.
2. Research programmes, their nature and modes of operation are context specific and depend on the organisation of the national research/innovation system, the goals and objectives of the institutions involved etc.
3. Research programmes and projects are associated predominantly with competitive funding for research.
4. Funding research through research programmes introduces a high level of flexibility in the research system.
5. Research programmes can be formulates to meet a wide variety of needs in the research systems and correspondingly can have variety of objectives. These are usually involved with specific national research and economic priorities.
6. Research and Technology Foresight is commonly used to outline national priorities (research, economic, political etc.).

November 1997, some 57 LINK programmes were underway, 24 of which were still open to new project proposals[19].

COST (Europe)

COST (European Co-operation in the field of Scientific and Technical research), promotes co-operation among national research programmes and was established by a Ministerial Conference in 1971 (CEC, 1991). Thus, it pre-dates both the Framework Programme and EUREKA. At present COST links over 25 member countries, including non-EU and non-EEA members. COST's objectives are to:

- provide a flexible framework for European co-operation in basic and applied scientific and technical research, including the creation and implementation of research projects of European significance, without formal constraints on particular research areas to be covered;
- encourage and implement international R&D activities corresponding to clearly focused needs, which are best conducted through such flexible co-ordination;
- promote pre-competitive R&D co-operation between industry, institutes, universities and national research centres, and to expand interdisciplinary approaches to R&D co-operation;
- create scientific networks and to promote and encourage new scientific talents.

The range of research areas covered by COST 'Actions' is wider than those of conventional research programmes and the research itself is funded nationally. As a rule, COST supports co-ordination and collaboration costs and its budget is formed by EU and member state contributions. The framework is governed and managed by a relatively complex but flexible system involving two secretariats and different operating procedures for domains supported by Directorates General VII, XII and XIII of the European Commission. The body responsible for strategic-decision making is the Committee of Senior Officials (CSO) and the domains and Actions are managed by Technical Committees (TCs) and Management Committees (MCs) respectively.

EUREKA (Europe)

The EUREKA Initiative was launched in 1985 to provide a framework for international collaboration in the area of advanced technologies among firms, research institutes and universities with the aim of strengthening the productivity and competitiveness of Europe's industries. Since its beginning EUREKA has endorsed a total of 1,415 projects (involving more than 7,000 participations) of which 511 are finished (cumulative cost: 10 512 Mecu), 668 on-going (cumulative cost: 6 223 Mecu) and 236 withdrawn[20].

EUREKA is a Europe-wide[21] initiative, its management, funding system and administrative structures are decentralised, the executive power and funding opportunities are with the EUREKA National Offices and decision making is a result of negotiations between National Representatives. It has always been EUREKA's aim to develop and maintain governance structures, which are *non-bureaucratic* and *flexible*. Thus, the overall management is provided through a set of bodies, namely the annual Ministerial Conference (National R&D Ministers or their representatives), the High Level Group (political level of decision) the Group of National Project Co-ordinators (practical co-ordination body) and the small central EUREKA Secretariat. In addition, a number of "Expert" or "Ad-hoc" groups are temporarily set up according to needs.

These decentralised procedures have led to visible differences in national approaches aiming to stimulate participation in EUREKA and decisions regarding the size and form of the public funding supporting these participations. So, for example, although public funding can vary from country to country it cannot exceed 50%. There are also variations according to the type of public funding provided. Some agencies provide grants while others offer low-interest loans. Similarly, while some National EUREKA Offices have

Running and Organisation

Organising and running research programmes is very highly context sensitive and it is difficult to find general rules. How a research programme is run depends on the specific features of the national research system, the organisation responsible for the programme and the type of research commenced under it. Usually, however, a designated manager organising the day-to-day activities and programme directors responsible for the intellectual content of the programme are appointed. Quite often the work of research programmes is overseen by a Steering Group. [oral presentation examples of how RC programmes are run]

An issue provoking heated debates is how much interference with the research process is acceptable. This issue is usually associated with more fundamental concerns regarding the 'academic freedom' or the lack of it. Getting into a discussion of the nature and possibilities for academic freedom is not among the aims of this paper. It suffices to say that while running research programmes the intellectual directions of research are influenced through their involvement with priorities. Otherwise the programme managers are content with following the organisational issues of the projects such as deadlines, achieving expected (and stated in the proposals) objective and outcomes etc.

Evaluation and monitoring

A sharp increase in the interest towards 'evaluation' in general and the evaluation of research programmes, initiatives and projects in particular, can be noted during the last fifteen years. This interest is both practical and methodological. Evaluations of research became practically relevant following two social developments, namely the exponential growth of the costs involved in research and the accompanying necessity for selectivity, prioritisation and accountability in the process of distribution of resources, and the rise of the 'audit' society[14]. Methodological developments followed in an attempt to provide policy-makers with reliable information and management tools.

At the most general level, the process of "evaluation" is a particular control mechanism and as such it is inevitable where social formations are concerned. Many social institutions, contrary to a deeply rooted belief, do not suffer from excessive levels of control but from 'bad' control[15]. In the case of research programmes this means that 'evaluation' should be seen as an inherent management tool, supportive to the internal/external co-ordination of activities, facilitating a higher level of social organisation and conducive to improved (and democratic) management procedures rather than as a complex of coercive measures.

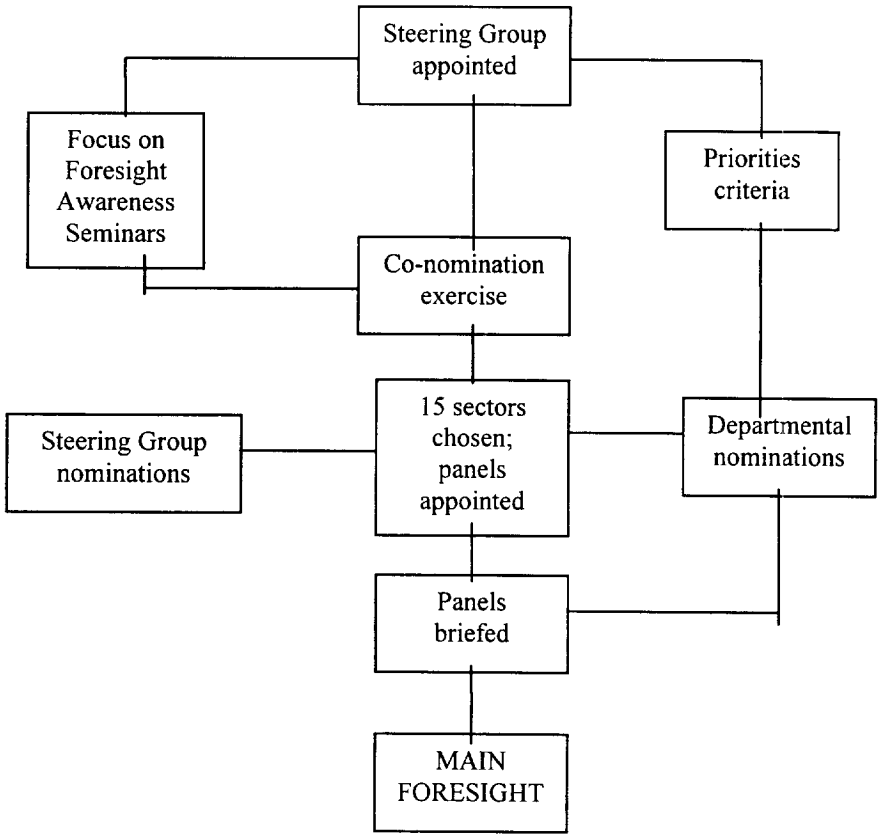
All research programmes exercise strong control and respectively apply evaluation techniques during the process of project selection and when projects are completed. In addition large evaluation exercises aiming to assess the functioning of the programme as a whole are being conducted.

Most evaluations aim to answer the question 'Is the programme doing well (achieving) what it set out to do?'. In other words if a particular research programme was set up to encourage university – industry collaborations an evaluation of this type would compare the functioning of the programme with the states objectives and if these are in congruence conclude that the initiative is working well. The objectives of the programme, however, are not questioned. There is another type of evaluations, strategic evaluations, which question the relevance of the objectives of the programme. In other words, the question is not any more whether the programme achieves what it has set out to achieve but whether it is trying to achieve the right thing.

"Evaluation" can be also viewed as an event or as a process. While more traditional approaches to the evaluation of research initiatives tended to see it as a one-off (or iterative) resource intensive exercise more

stages, selecting the sectors and appointing the panels. While the main research element at this stage was a co-nomination study[10] it is a predominantly political process.

Figure 1: Pre-Foresight phase of the UK Foresight Programme



In the main stage of foresight (see Figure 2) the panels were free to conduct their own research, but they were required to prepare the questions for the Delphi survey relevant to their sector. The panels also prepared scenarios for their areas, identified key issues and trends and consulted the relevant communities in a wide variety of ways. At this stage the emphasis was on a broad consultation carried out through a Delphi study[11].

In May 1995, following the publication of 15 reports from the sectoral panels, the Technology Foresight Steering Group Report, *Progress Through Partnership*, was published. The Steering Group synthesised the finding and recommendations of the panels and outlined 27 generic science and technology and 18 generic infrastructural priorities.

After the reports were published the programme entered the phase of dissemination. The most direct follow-up to the UK Foresight programme was a new funding initiative, the Foresight Challenge fund. Existing budgets for science were also influenced and it is estimated that about 54% of Research Council spending has been aligned with Foresight priorities of which £300 million was for new initiatives. A number of LINK programmes (amounting to more than £100m) have been launched or enhanced to reflect Foresight priorities.

The Councils are promoting and funding research, running institutes and programmes and most of them have policies for international co-operation in research. Each of the RCs has policies for participation in the Programmes of the EC.

Advisory Bodies

Providing advise on science and technology issues directly to the Prime Minister is the Chief Scientific Advisor (CSA) whose secretariat is located within the OST. The CSA has responsibility for reviewing the entire research system and sits on virtually every other important committee and advisory group.

The most important policy advisory group in the UK research system is the Council for Science and Technology. Established in 1993 the Council provides advice on the balance of UK science, engineering and technology and related policy issues to cabinet ministers. The membership of the CST consists of 14 high level and independent representatives from academia, industry, the City and charitable sponsors. It is chaired by the Cabinet Minister for Science and Technology on behalf of the Prime Minister. The Chief Scientific Advisor is the Deputy Chair and support is provided by the OST.

The House of Commons Select Committee for Science and Technology, and the House of Lords Select Committee also provide advice although their influence in the system is somewhat restricted.

Research Performers

There are three main types of research performers in the UK, namely universities, government research laboratories and industrial laboratories. Although all these receive funding from both government and industry the universities and government research laboratories are financed by predominantly public sources of research funding.

In the context of the UK national research system *universities* are the major performer of publicly funded research. Currently there are 109 universities in the UK. In terms of time of emergence these can divided into four distinct groups: ancient universities (Cambridge, Oxford and the Scottish ones), civic universities (these emerged in mid-last century and include Manchester), 'red brick' universities (emerged during the 1960s to accommodate the expansion of higher education and include Lancaster, Bath etc.) and the new universities (these are the ex-polytechnics that acquired the status of universities in 1993). Universities in the UK also vary according to their level of activity in research and some of these are predominantly teaching institutions.

Another performer of publicly funded research in the UK are the *Government Research Laboratories*. These used to function under ministries and the Research Councils. During the last ten years, however, the research organisations in the UK have changed to the extent that lately it is debated whether they should be called "government" research institutions. Some of the research organisations were privatised, others became executive agencies and yet another group are in a state of transition.

Funding Streams

According to its origin (sources) two main types of funding for research can be identified within any national research system, namely public funding provided by the government and private funding invested by industry. In some cases industry is a major player in the research financing game. In the UK, for example, industry funds over 60% of all research and although these funds are mostly invested in industrial research labs a proportion reaches publicly funded research performers such as the universities. It is obvious, however, that the industrial funding for research is generally outside the remit of the national Science and Technology Policy which is mostly concerned with decisions regarding public funding.

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The UK National Research/Innovation System

Input indicators

Data indicates that the Gross Expenditure of Research and Development (GERD) in the UK has been steadily declining between 1987 (2.19% of GDP) and 1995 (2.05% of GDP). Currently the relative spending on R&D places the UK behind countries such as the USA, Japan, France and Germany.

Almost two thirds of the UK's expenditure on R&D originates from non-government sources, including charities, overseas sources and private industry, the later contributing by far the largest share. The major part (around 85%) of the UK's research effort is categorised as civil R&D and in 1995 the total civil GERD formed 1.74% of GDP. About 66% of this was contributed by the private sector.

In terms of Government funded research spending on the science base (comprising science budget and expenditure by the higher education funding bodies) accounts for around 37% of the expenditure, Civil departments account for about 22%, and the remaining 35% is accounted for by the Ministry of Defence. About 5.6% of the expenditure goes to European Union science and technology commitments[5].

The number of scientists and engineers in the UK has grown slightly between 1985 and 1995 and currently stands at 145,792 people. Of these 58% are employed by business enterprises, 9% by Government research institutions and establishments, and the remaining 33% are employed by the Higher Education Institutions.

Output indicators

In 1995 the scientists and engineers in the UK have produced 54,781 publications. These constitute 26% of the publications produced by scientists and engineers working in 15 EU countries during the same year and also amounts to 2.6 publications per scientist and engineer. It is also worth noting that these publications have been referred to 224,990 or every publication has been cited on average four times.

UK scientists and engineers have applied for 3,863 patents in 1995 and 57% (2,218) of these have been granted.

During 1993-94 9,130 PhD Graduates were prepared in British universities.

Main Institutional Actors and their activities

Ministries

Department of Trade and Industry (DTI)

On the level of the federal government the Department of Trade and Industry (DTI) is the most important actor of the UK's S&T system and the biggest spender of civil RTD. The remit of the DTI is extremely wide ranging but its overall objective is to stimulate innovation, promote the development of a climate favourable for innovation and to enhance the competitiveness of UK business both at home and at the international level. In 1992 the DTI took over responsibilities for R&D expenditure in energy.