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TABLE OF CONTENTS

ABSTRACT

GLOSPERA investigated the origins and implementation of four case studies in international research cooperation to identify examples of good practice that could be applied when developing European science and foreign policy in the field of multi-national research cooperation: the Human Frontiers Science Programme (HFSP), Intelligent Manufacturing Systems (IMS), the Human Genome Project (HGP) and the Intergovernmental Panel on Climate Change (IPCC). GLOSPERA also analysed intra-European research collaboration programmes and projects, such as COST, Eureka and the EC Framework Programmes, classifying them into those which are exclusively intra- European Union (EU) and those which involve extra-EU elements.

HFSP and IMS were initiated 'top-down' by Japanese policy makers in Japan to counter perceptions in the West that they were unfairly using science developed elsewhere in the world to support their industries which were then dominant in world markets. HGP was initiated "bottom-up" by scientists driven by visions of advances in fundamental knowledge that would be made freely available to scientists worldwide and thereby facilitate important medical applications.

The IPCC is an *assessment project* as it involves reviewing existing research evidence to inform policy decisions. It was initiated “bottom up" by scientists who were concerned about the dangers of anthropogenic global warming. Although the IPCC's scientific findings are contested, the IPCC - together with the *scientific cooperation* programmes and projects - offers numerous valuable lessons about administration. There is always tension in research cooperation programmes between scientists wanting to extend scientific frontiers and administrators who design procedures to satisfy the policy makers' desire to ensure ‘value for money. Nevertheless, explicit recognition of the diverse interests of the various actors in the design of organisations and procedures could facilitate the achievement of good compromises between scientific research effectiveness and demonstrating an efficient use of the resources.

The three programmes, HGP, HFSP and IMS, contributed significant benefits to scientists and industry worldwide, made contributions to the knowledge, education and training of EU scientists, expanded their networks and their capacity for technological problem-solving. This has contributed to the EU's innovation capability and economic growth. While such benefits could have been restricted by intellectual property rights (IPR) problems, these effects have not been significant. However, such programmes take several years to establish, so by the time that HFSP and IMS were making their impacts, the foreign and trade policy motivations for their initiation had disappeared.

Accordingly, if the EU decides to initiate, or participate in, major international scientific cooperation projects to support its foreign policy objectives then such decisions need to take into consideration that programmes of this kind take several years to establish and even longer to achieve the intended impact. In the meantime its initial foreign policy objectives could well change radically, or even disappear. However, should the EU decide to participate in future international *scientific cooperation* projects, the concerted action format is recommended, as it expands the funds available and offers several other significant advantages. The need for international *scientific assessment* is likely to grow in relation to worldwide problems and the EC could draw several lessons from the IPCC experience to help formulate its policy in the event of initiating and/or participating in such projects.

1. EXECUTIVE SUMMARY

The **GLOSPERA Study** set out to investigate the origins, implementation modes and major evaluations of four case studies in international research cooperation, seeking to identify examples of good practice that can be applied to policy development within Europe.

The four case studies are:

- Human Frontiers Science Programme (HFSP)
- Intelligent Manufacturing Systems (IMS)
- Human Genome Project (HGP)
- Intergovernmental Panel on Climate Change (IPCC)

GLOSPERA has also analysed, although to a much less detailed extent, intra-European research cooperation programmes such as the EC's Framework Programmes of RTD (FPs), European Cooperation in the field of Scientific and Technical Research (COST) and the Europe-wide network for industrial R+D (Eureka), to consider features of these programmes which might be suitable for adoption at a global level.

GLOSPERA has developed practical ideas on how to deal with future international scientific co-operation

1.1. Defining International Research Cooperation in the European Context

Before conclusions could be drawn, it was essential to clarify the meaning of 'international research cooperation' in the European context. From the analysis it was concluded that research collaboration activities in Europe need to be classified into those which are exclusively intra-EU and those which involve an extra-EU element.

It is important to bear in mind a series of prevailing features:

- Individual member states still account for the overwhelming majority of European RTD spending. Also, the European component of international research cooperation has been based on the participation of individual states to a far greater extent than on the collective participation of European institutions.
- There has been a built-in preference for extra-European research cooperation initiatives to be organised in a concerted action format, because national governments want to choose the projects in which they participate.
- A successful European Research Area (ERA) could result in the growth of European-level research budgets as well as of national research budgets and may contribute to increasing the total European spending on research towards the target of 3% of GDP.

1.2. European Foreign Policy and International Scientific Cooperation

European foreign policy finds expression in both the international research cooperation initiatives of the EU and in similar initiatives led by individual member states.

The most important EU foreign policy objectives (foreign in the sense that they address relations with countries outside the EU), relate to the rest of Europe and are, in a sense, internal to Europe.

The establishment of ERA is liable to give added impetus to intra-EU research collaboration.

There is a mutual relationship between European foreign policy and European research policy. In some cases, research policy serves the needs of foreign policy (science for diplomacy); in other instances, foreign policy serves the needs of European science (diplomacy for science).

There is a consensus that the main principles governing the interrelationship between international scientific cooperation and European foreign policy are those of:

- Strengthening the international position of European S+T;
- Strengthening the international competitiveness of European industry;
- Enhancing the prestige of Europe globally;
- Contributing to good relations with, and the stability of, countries in the geographic periphery of Europe;
- Supporting developing countries, particularly in priority areas for European foreign policy;
- Accessing the best scientific knowledge from the rest of the world.

1.3. Analysing International Research Cooperation

The analysis conducted in the four case studies allows us to draw some general conclusions in terms of the origins, motivations and implementation modes of the international research cooperation programmes and projects.

- Some of the principal actors involved in establishing international research cooperation initiatives to secure these benefits include policy makers, administrators and scientists.
- There is a notable absence of public participation in the decision-making process for setting up international research cooperation.
- There is tension between scientists, who believe that they are driven mainly by the motivation of "advancing scientific frontiers", and the administrators who design and implement procedures to satisfy policy makers' desire to be seen as ensuring "value for money" on the public's behalf.

Top down and Bottom up approaches:

- *"Top down"* initiatives are originated by policy makers in response to policy aims. *Programmes* which have broad scientific aims and do not attempt to specify precisely the objectives to be achieved, or the scientific methodology for achieving them, are normally of this type. HFSP and IMS are examples. "*Big technology*" *projects* also tend to fall into this category,
- *"Bottom-up"* initiatives are those originated by scientists. *Projects* which have well defined scientific aims and objectives tend to be of this type. For example, HGP was initiated by scientists driven by a vision of exciting, clear, scientific objectives. Funding agencies were attracted by its clear goals and promise of advances in fundamental knowledge, to be made freely available to scientists worldwide, which would facilitate important medical applications.

- The IPCC is an *assessment project* insofar as it mainly involves reviewing existing research evidence and using the conclusions to inform policy decisions. It was initiated “bottom up" by scientists concerned about the dangers of anthropogenic global warming, however it evolved into an intergovernmental project. The IPCC's scientific findings are contested, as is the cost-effectiveness of the measures derived from them as incorporated in the Kyoto Process, but such issues do not fall inside our remit.
- Some “top down” initiatives, such as HFSP and Eureka, may subsequently be managed “bottom up”; insofar as decision making and administration are largely taken over by scientists.

“Centralised” versus “distributed” initiatives

- *Centralised* international research collaboration projects and programmes may involve centralisation of:
  - ***resource allocation***: for example when the budget is held and managed centrally, as in Eureka, COST and the FPs;
  - ***location*** of research activities: when a project takes place in a single laboratory, e.g. CERN;
  - centralised ***management of activities:*** when a single point exists for funding decisions and for assessing the outcomes of projects, e.g. HFSP.
- Concerted action projects/programmes are examples of distributed initiatives which are internationally coordinated with activities in each country funded from national budgets (e.g. Eureka, HGP).

“Big science” versus “Little science”

- “Big science” projects and programmes require very substantial investments, which are often difficult to finance and/or justify within national budgets, and are natural candidates for international research collaboration.
- “Little science” research activities are conducted by individuals, or small groups of scientists. While activities are geographically distributed, resource allocation and management may be centralised (e.g. HFSP) or distributed (IMS).
- Public investment in international research cooperation has the potential to enhance society's ability to solve complex problems and to expand its learning capabilities.
- The main benefits offered by publicly funded research are: increasing the stock of useful knowledge, training skilled graduates supporting new professional networks, stimulating social interaction, expanding the capacity for technological problem-solving, producing new instrumentation and methodologies, creating new firms and providing social knowledge
- European scientists' participation in HGP, HFSP and IMS have all contributed numerous benefits to European scientists and industry. They have all made contributions to the knowledge, education and training of EU scientists, have expanded their networks and their capacity for technological problem-solving. This has generally contributed to the EU's innovation capability and economic growth.

- It is important to address the issues of IPR from the outset; as was done in IMS.
- In the case of international scientific cooperation, the desire of countries contributing financially to establish *juste retour* for their investment causes further complications. *Juste retour* is the concept of a country receiving value for its investment; i.e. an appropriate return on investment from public budgets.

1.4. Conclusions and Policy Implications

- Centralised projects with international visibility which enhance the global prestige of the participating countries are the ones most likely to be implemented. They are the easiest to handle administratively and they produce the intangible benefit of the international prestige which is thought to be associated with such initiatives.
- A complete and universal solution to the inherent tension between scientists and administrators is impossible. However, recognition of the diverse interests of the various participants in scientific programmes and projects could facilitate the achievement of good compromises between research effectiveness and demonstrating to policy makers that public funds are being spent wisely.
- If the European Union decides to initiate, or participate in, international scientific cooperation projects, the concerted action format has several advantages, provided that bureaucratic requirements are restrained successfully: an overwhelming majority of spending in Europe is still undertaken by member states and concerted action expands the funds available and offers national governments the opportunity to choose which projects to participate in; and allows them retain more control over *juste retour* than they would have with centralised budgets under the control of the EC. Such decisions need to take into consideration that:
    - The two programmes initiated by Japan and paid for disproportionately by the Japanese government -HFSP and IMS- whilst benefiting global science cannot be shown to have brought benefits to Japanese science commensurate with the largely unilateral investment made. These programmes were initiated by the Japanese Government to counter perceptions that Japanese industry was gaining "unfair" commercial advantage by using the results of the investment by other countries in fundamental scientific research at a time when Japanese industry dominated world markets for manufactured products. By the time that HFSP and IMS had been established and were making an impact, Japanese industry was no longer dominant: in other words, the foreign policy motivation for these programmes had disappeared.
    - Given that any future significant international scientific cooperation programmes would take several years to establish, this experience indicates that an initiative for the EC to establish new "extra-European" international scientific cooperation programmes to support EU foreign policy needs, should be very carefully evaluated insofar as such foreign policy needs could well change radically, or even disappear, before the proposed programmes begin to achieve the intended impact.
- As IPCC scientists themselves suggest, it is likely that the requirement for international scientific assessment will grow, and it is possible that the EC will seek

to establish and participate in furthering such initiatives and will seek to draw some lessons from the IPCC experience in so doing.

- Scientific assessment may be the area of greatest need for humankind for international scientific cooperation, as globalisation has created problems that might best be tackled by concerted international efforts.
- Environmental issues other than global warming, such as AIDS, BSE and genetically modified (GM) foods, are examples of problems from which benefits might be secured from internationally co-ordinated scientific assessment. For example, a concerted global effort in relation to AIDS, involving scientific assessment, coordinated research and health policy might make a significant contribution to confronting the worldwide epidemic.

1.5 Planning European Participation

EU participation in new international scientific research initiatives should depend on factors such as whether participation can strengthen European science, benefit the international competitiveness of European industry, help European access to advanced scientific knowledge, or contribute to European foreign policy objectives.

Planning is inevitably difficult and complex. It should take full account of the nature of the projects or programmes involved in accordance with the taxonomy described and applied in this report. Effective planning involves making trade-offs between numerous feasible modes of cooperation:

- The flexibility and lack of tension between partners inherent in concerted action programmes are attractive. However, concerted action is infeasible for big science, has limited potential for helping developing countries, and proposal evaluation may be cumbersome.
- Policy and *juste retour* arrangements for concerted action programmes need to be separated from scientific administration. Day-to-day administration of basic research programmes should be entrusted to scientists.
- Initial proposal approval can be more efficient in centrally funded programmes, and can be used more easily to support researcher mobility, and to help developing countries. HFSP provides a model for such programmes in several respects.
- Big Science projects are generally initiated by scientists. While some such projects may offer enormous potential benefits to humankind, the risks of wasting enormous sums of money can also be very significant and should be carefully evaluated in considering participation.
- Establishing juste retour to countries participating in centralised projects is very difficult. However once such projects are established, coordination and administration are relatively simple.
- Organising projects in a distributed fashion facilitates juste retour arrangements but involves complex coordination mechanisms.
- It is advantageous to try to plan how IPR issues are to be dealt with as early as possible in the planning phase of international scientific cooperation projects and programmes.

- Global problems are classified into problems of scope and problems of scale. With the important exception of the IPCC, there is little evidence that national policy makers have sought to address global problems through international research cooperation and the existing international agencies lack both the resources and the political power to take up such initiatives.
- Globalisation has progressed to such an extent that is no longer possible for European policymakers to ignore the domestic impacts of decisions taken elsewhere.
- Even though science and technology pervade some areas of foreign policy, and the global importance of science and technology is generally recognised, diplomatic structures have not followed changes in relationships between science, technology and society. Systematic and strategic integration of science and technology needs into foreign policy is difficult to achieve because of the complex and distributed nature of the science system.

2. BACKGROUND AND OBJECTIVES

2.1 Background

The project GLOSPERA (Global Systems and Policy Design for the European Research Area) is the result of the interest of Josephine Stein (UEL) and Yoshiko Okubo (ISTM) to develop what could be termed the "European" component of a global review of international programmes and projects in the fields of Science and Technology.[1] After a successful application to the STRATA programme[2], a contract was signed between the EC and the institutions UEL (represented by J. Stein, the Project Coordinator) and ISTM (represented by Y. Okubo).

However, a series of difficulties arose in the relationship between the partners, which finally resulted in the Commission Services suspending the project while a Technical Review was carried out by Campbell Warden (EARMA[3]). After his recommendations had been accepted by the EC and implemented by the signatories to the Contract, the project was restarted. Shortly thereafter, the Coordinator suffered health problems and UEL made arrangements for another of its Senior Researchers, Alvaro de Miranda, to take on this responsibility. C. Warden was appointed to serve as Project Adviser and the UEL, in agreement with the Commission Services and ISTM, has also arranged for one of its Visiting Professors, Peter Senker, to contribute to the project's execution. Since the re-start of the project a positive professional relationship has developed among its participants and between the partner institutions. The initial analysis of interviews has been re-worked and this has been complemented by the interviews and literature review carried out since the project's re-start.

2.2 Objectives

The main objectives that the GLOSPERA project set out to achieve were:

- to identify best practices in organising international S&T cooperation through analysing European experience of global-scale multilateral research programmes and intra-European research cooperation programmes;

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[1] The global concerted action was coordinated by *Caroline Wagner* of the RAND Science & Technology Policy Institute in Washington, DC, who also directed the US study. The Japanese study was directed by *Prof Ryo Hirasawa*, under the auspices of the National Institute of Science and Technology Policy in Tokyo. *Dr Sungchul Chung* of the Science and Technology Policy Institute in Seoul directed the Korean study.

[2] Part of the EC's 5th Framework Programme of RTD.

[3] European Association of Research Managers and Administrators

- to analyse the implications of globalisation for policy design to maximise European access to world-wide knowledge and innovation resources;
- to develop new approaches to integrate scientific and technological expertise into the design of external relations policies of the European Union, including cooperation agreements for research itself.;

3. GLOSPERA METHODOLOGY AND RESULTS

3.1. Methodology

A) Introduction

The **GLOSPERA Study** set out to investigate the origins, implementation modes and major evaluations of four case studies in international research cooperation, seeking to identify examples of good practice that can be applied to policy development within Europe. The four case studies were:

- Human Frontiers Science Programme (HFSP)
- Intelligent Manufacturing Systems (IMS)
- Human Genome Project (HGP)
- Intergovernmental Panel on Climate Change (IPCC)

In order to be able to identify examples of best practice in European policy on international research cooperation that could be applied to its future development, an analysis of European international research cooperation projects, such as Eureka and COST, as well as the Framework Programmes, was also carried out. The GLOSPERA Study included a literature review, interviews with European experts and policymakers.

The GLOSPERA Study was the European component of a set of coordinated studies involving research teams in North America and East Asia. The four case studies were selected jointly by colleagues in each of the three "Triad" regions to reflect a combination of scientific and national interests, and to explore and analyse contrasting modalities of international S&T cooperation.

Each programme chosen for this study differed in the scale, objectives, motivations, structures and organizations. They also vary in the role of the EC in the programmes. In the IMS, the EC represents all member states, while in the HFSP it represents the interests of some member states. In the IPCC, the EC acts as an observer, while in the HGP it partially funded the project but was not a driving-force, owing to the fact that the project was nationally-based and did not take a European dimension. While the four case studies were chosen because of their “best practices” and “success stories”, it was revealed that the four examples of multilateral cooperation were not all necessarily “successful” in the same ways; each one having advantages and inconveniences. The definition of “best practice” appeared to be much more complex than anticipated; it became an important task to clearly define the conditions of the “best practices” and to establish a solid interview protocol.

In order to create a framework for drawing the conclusions and policy implications of the project, the following plan was developed:

1. Devise an analytical framework that provides a basis for understanding the concept of "international research cooperation" from the point of view of a multi-national Europe and for relating foreign and RTD policy on international research cooperation.
2. Create a classification of international collaboration projects.
3. Carry out an analysis of the case studies through an extensive literature search and interviews with the key actors.
4. Place the case studies into this classification and derive from the case studies a set of recommendations that would apply to each type of project.
5. Establish the conditions under which international collaboration should be undertaken in order to achieve the research objectives foreseen by European policy.
6. Derive from the case studies, and from the policy analysis, a set of recommendations that might be useful to inform policy with regard to future cases of international collaboration.

B) Preliminary interviews and the initial literature review

So as to develop the interview protocol to be used afterwards, the GLOSPERA Study started by questioning some EC experts[4] on the four case studies involving global-scale cooperation, with the objective of obtaining a preliminary description of many of the different features of these programmes, gathering documents, acquiring general information on the EC's participation in international cooperation and on the problems the EU is encountering when participating in global-scale cooperation. Through a thorough examination of the journals *Nature* and *Science* and an intensive search of web sites at the outset of the project, we were able to ascertain the historical development and the basic features of the programmes, in particular, the HFSP, the HGP and the IPCC. IMS has not been extensively documented in the journals; therefore the documents collected during the interviews at the EC were our major source of information. Interviewees were selected mainly through these literature and web surveys.

C) Interviews of bench scientists, research administrators and policy-makers

Throughout this report we place the main actors involved in creating and carrying out international research initiatives in three basic categories: scientists, research

[4] IMS: Paolo Garello (Information Society Directorate-General), Jyrki Suominen (Research Directorate-General), IPCC: Ib Troen (Research Directorate-General), HGP: Manuel Hallen (Research Directorate-General), HFSP: Bruno Hansen (Research Directorate-General). In addition: Gerard Riviere (Secretariat COST).

administrators and policy-makers. The basis of this classification is the fact that we believe that the role and functions which individuals undertake influence to an extent their interests and their actions.

Interviews were conducted with European experts in international RTD policy and management. This included (1) scientists associated with the four main case studies, or working in related areas of science and innovation; (2) key members of organisations involved in international RTD cooperation; (3) senior officials and policymakers. An Interview Protocol, composed of 10 questions addressed to all interviewees and 5 specific questions addressed either to scientists, administrators or policymakers, was drawn-up (see Appendix 1). The Interview Protocol was designed with the objective of deepening our understanding of the scientific, institutional and financial arrangements of international RTD cooperation. The Questions were related to: Motivation and objectives of cooperation; Organisation and structure; Evaluation system; Policy; Contribution to the European added value of participating in international cooperation.

A total of 37 scientists, administrators and policymakes were interviewed by UEL and ISTM. The breakdown of the interviewees is listed in Table 1 below (see Appendix 1 for the full interviewee list).

Table 1: GLOSPERA Interviewees

Program	Scientists	Administrators	Policy makers	TOTAL
Human Genome Project (HGP)	3	1	1	5
Intelligent Manufacturing Systems (IMS)	5	2	3	10
Human Frontiers Science Program (HFSP)	8	3	3	14
Intergovernmental Panel on Climate Change (IPCC)	3	1	--	4
Other	--	3	1	4
TOTAL	19	10	8	37

Some 28 interviews of scientists and administrators, along with an additional literature survey, enabled us to draw a clear picture of each programme, the organisation, the management and the differences between the programmes (see Appendix 4 for detailed programme description).

D) The GLOSPERA Network & Workshop

The GLOSPERA Network (from here on "the Network") of European experts in international research and political systems, collectively developed practical ideas for utilising scientific and technological knowledge in the formulation of European foreign policy in the field of international cooperation in S+T. The Network explored prospects for organising new scientific advisory structures in support of global international agreements and multilateral R&D cooperation, exchanged information and views on whether or not it is possible to develop best practice theory on setting up and participating in international R+D cooperation.

At the three-day Workshop, organised in London in October 2001, the Network members engaged in intensive, structured discussions on global systems and policy design, working to develop specific approaches and policy options for Europe. The objective of the Workshop was to provide an opportunity for the Network, colleagues from the other concerted action projects and additional experts in international S&T policy, to discuss the global S&T cooperation in the context of the ERA and European foreign policy design. It was also an opportunity for the Scientific Officers of the European Commission, who also participated in the Workshop, to express their expectations from the GLOSPERA project. The GLOSPERA Workshop was held in two parts: Part 1 was to exchange information on European and non-European perspectives on global S&T cooperation, and its implications for science policy and international relations. Part 2_was to develop specific ideas for improving the basis of European participation in global S&T cooperation programmes.

This workshop contributed in getting to know each other, and to clearly defining the specific expertise that each member could bring to the GLOSPERA objectives so that the project could be efficiently and effectively developed. It also contributed by clarifying the specific needs of the Commission and their expectations of the GLOSPERA Study.

During the winter of 2002-2003, a comprehensive review was carried out of what had been achieved so far and an analysis of the tasks that remained to be completed. In the course of this review, the research team came to realise that an enormous amount of relevant information and analysis had been published in books, papers and on the INTERNET since the literature review had been carried out at the beginning of the project. It became apparent that the remaining time and resources would be most effectively used by concentrating efforts on analysing this information rather than carrying out further interviews of the kind already conducted.

During the autumn of 2003, the Network also contributed by examining the interview results, literature review and policy analyses undertaken by UEL and ISTM, by means of an exchange of documents and a brainstorming meeting in Paris.

E) OECD Global Science Forum

As mentioned previously, rather than being a 'stand alone' project, GLOSPERA formed part of a series of reviews and also contributed to the Global Science Forum of the OECD, which is undertaking a related study on International Scientific Cooperation. In turn this provided opportunities for pooling knowledge and sharing regional perspectives and results worldwide. A Workshop on *Best Practices in International Scientific Cooperation,* jointly organised by the OECD and the Ministry of Education of Japan, was held in Tokyo in February 12-14, 2003. 22 presentations and discussions on best practices took place. Two GLOSPERA members participated in the Workshop.

3.2 Results

3.2.1. The meaning of international research cooperation for Europe: Research policy or foreign policy[5]

The issue of what constitutes "***international*** research cooperation" from the point of view of Europe has been approached through an historical analysis of 'European' policies towards "international" research collaboration. The very need to place the word 'Europe' in inverted commas is symptomatic of the problems that are involved, particularly when an historical approach is taken. Politicians and researchers normally use the words 'Europe' and 'European' alike in an unproblematic way. However their meaning often varies according to context and is sometimes ambiguous. On occasions 'Europe' refers to what we initially chose to call "Consolidated Europe". Consolidated Europe is geographically and dynamically defined to include all the countries that at any one time have been party to the various European treaties from Rome onwards and is currently made up of the countries that constitute the EU. The geography of Consolidated Europe has therefore changed over time. Consolidated Europe has an institutional expression through what we term "institutional Europe", those organs which give institutional and legal expression to Consolidated Europe. This 'institutional Europe' is normally defined as being made up of three pillars. The first pillar is composed of the European Communities, whose main organs are the European Commission, the European Council and the European Parliament. The second pillar is the Common Foreign and Security Policy and the third pillar encompasses police cooperation and cooperation in the area of criminal law.

[5] References for this section are included in Appendix 2 of this report

However, an analysis of the multinational research collaboration initiatives in which Consolidated Europe is involved, or has launched, demonstrates clearly that Consolidated Europe has an identity which transcends what is formally expressed institutionally. The European 'us' is strongly expressed both through the RTD policies of "institutional Europe" but also through the international collaboration policies of the individual countries that constitute Consolidated Europe. It is this quite sharp division between the concepts of 'us' expressed both individually through each member country of Consolidated Europe and collectively through 'institutional Europe', in contrast with the 'them' of all other countries and regions; which defines the ***foreign*** of what might be termed European foreign policy.

These ethos can be seen in the way European programmes, such as Eureka and COST, were established. Eureka was not an initiative of 'institutional Europe'. In some ways it was even set up as an alternative to 'institutional Europe'. However, Eureka was primarily an expression of European identity. Eureka was an initiative of French President Mitterrand in 1985, conceived of as a civilian European alternative to the U.S.'s Strategic Defence Initiative (SDI). Eureka, in common with most 'institutional Europe' RTD initiatives, was intended to strengthen the competitiveness of 'European' industry, primarily vis a vis the U.S. and Japan. Its management and administration were set up separately from that of the EC, mainly because the Commission was perceived as an inappropriate institution to handle the more downstream research that Eureka was meant to promote, but also because the vision of Europe contained within Eureka went beyond the Consolidated Europe of which the Commission was an institutional expression. Membership of Eureka, as that of the earlier programme, COST, went beyond the boundaries of Consolidated Europe, implying a vision that 'European' industry extended beyond Consolidated Europe and initially encompassed at least what might be described as Western Europe but excluded the Soviet block countries. Thus the initial vision of Consolidated Europe was that of a future in which the 'us' would encompass the whole of Western Europe, and possibly eventually Turkey. This vision is defined here as the "Greater Europe". Later, after the collapse of the Soviet Union, the vision of 'Greater Europe' came to include practically the whole of geographical Europe with the exception of Russia, whose position was seen at best as ambiguous. The membership of both COST and Eureka was extended to Eastern Europe but excluded the Soviet Union.

At all stages of its history 'institutional Europe', primarily the EC through its FP, implicitly expressed 'European' 'foreign' policy through its RTD programmes in a modulated way. The first layer of the policy is expressed through the way those countries which at any time are designated as Accession Countries are integrated. Here the main aim was to start to support the integration of those countries and promote eventual cohesion of the expanded 'Core'. This aim was implicit in the early FP, but became explicitly expressed formally in INCO II, when cooperation with "European countries preparing to join the EU" was introduced as one of the areas covered by it as a sub-programme of FP5 dedicated to "Confirming the International Role of Community Research".

The second layer of 'foreign' policy expressed in the FP regarded the special place that the remainder of the countries of 'Greater Europe' have in the external relations of Consolidated Europe. RTD policy towards these countries follows the dual 'foreign' policy aim of supporting these countries towards a possible future integration and the wider aim, which also constitutes the next layer, of helping to ensure friendly relations with, and stability in, the countries that border Consolidated Europe. These aims inform the inclusion of the area "Cooperation with the Newly Independent States and the Central and Eastern European Countries not in the pre-accession" of INCO II.

The third layer of foreign policy regarding stability and friendly relations with border countries is what informs the INCO II areas of "Cooperation with the Mediterranean Partner Countries".

The fourth layer of 'foreign' or 'external relations' policy expressed through the FP is the one with respect to the countries that have been inappropriately named the 'industrialised countries'[6] in the FP. Here the predominant aim is not derived from 'foreign' or 'external relations' policy but from RTD policy. It is that of supporting the 'excellence' of 'European' S+T by accessing the most advanced knowledge that exists outside its borders. This, in turn, is expected to help enhance the competitiveness of 'European' industry.

[6] Here we prefer the terminology 'economically advanced countries', which is more consistent with the 'knowledge-based economy' theory, which currently informs EU policy.

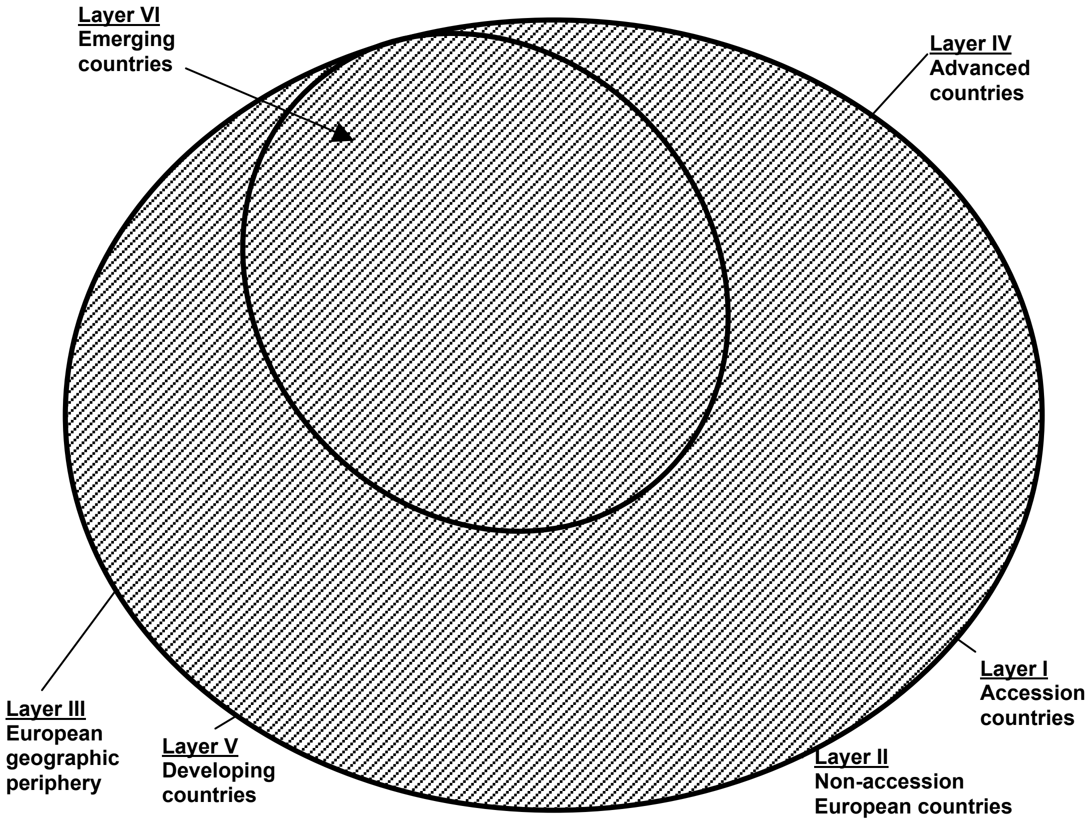

Fig. 1 The 6-layer model of the 'foreign' aspects of 'European' RTD policy

The fifth layer concerns the relations of 'Consolidated Europe' with the developing countries. Here again the 'foreign' policy aims prevail; in this case that of helping the development of these countries. This was expressed in the FPs through the "S+T for Development" programmes, which began in 1983 under FP1 and continued under the INCO programmes of FP4 and FP5. S+T cooperation agreements have also been signed with Brazil, Chile and Argentina which express foreign policy aims with respect to MERCOSUR and with South Africa, which includes a strategy towards the African, Caribbean and Pacific (ACP) group of countries.

A sixth layer of foreign policy expressed in RTD policy concerns emerging nations. This is the most recent and includes a framework agreement with South Korea established in 1996 (which has been deepened recently through a meeting in 2003 in Brussels between the EC Research Commissioner Busquin and South Korean S+T Minister Ho Koon Park), which set the aim of establishing an S&T agreement between the EU and South Korea. The emergence of China has also led to a desire to incorporate China into EU RTD programmes. This began under FP5 and was deepened under FP6. The importance of this cooperation was underlined when China joined Galileo, the European project to develop an alternative to the US's GPS satellite system by 2008 and agreed to pay one fifth of its cost (€230m). The development of Galileo has been strongly opposed by the US. Galileo represents Europe's desire to compete with the US globally in high technology and to develop an independent defence capability.

India, whose relations with Consolidated Europe began as a developing country under the 'S+ T for Development' programmes, can be considered to have recently moved to this category. In the 2003 S&T Cooperation Agreement with the EU, India's expertise in S+T in particular fields is recognised and the agreement aims to mutually benefit the RTD activities of both parties.

From the point of view of this model, intra-Consolidated Europe research collaboration promoted by the EC through its FPs would not be classified as 'international' from the point of view of Consolidated Europe, as they do not involve any 'foreign' countries.

However, programmes such as Eureka, COST and most of the European 'big science' and technology projects, such as CERN, the Institut Laue Langevin (ILL) and the European Synchrotron Radiation Facility (ESRF), which have been set up through direct inter-governmental agreements outside the auspices of 'institutional-Europe', must be viewed as 'international' in the way they are organised, even though their ethos is that of a Greater European 'nationalism'. They share with 'institutional-Europe' a vision of the interests of the future 'Greater Europe'.

In the previous analysis of Consolidated Europe's 'foreign' policy, as expressed through the RTD programmes, one obvious omission should be noted. It is the absence of any strategy for dealing with the research required for the solution of global problems which can only, or best, be tackled at a global level by international research cooperation.

This absence is not peculiar to the EU. All of the countries that have the means, and should share the responsibility for tackling these problems collectively, do not have a systematic policy towards this issue. The reasons for this situation are beyond the scope of this study and would require further research. However, a hypothesis that could be pursued is that the spending of 'national' budgets has to be justified in terms of *juste retour*[7] to the nation. Global problems will normally be seen as the province of international organisations that, however, lack the resources to sponsor the necessary research, or the political power to demand them from the national governments.

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[7] *Juste retour* is the concept of a country receiving value for its investment, i.e. an appropriate return on investment from public budgets. This is normally defined in the narrow sense of actual tangible financial returns. Here the concept is being used in a wider sense that includes intangible returns such as increase in the international prestige of the country or, as in the case of Japan's proposal of HFSP and IMS, the neutralisation of international criticism which would have negative consequences to the trade interests of the country.

For any country, or for the EU, to launch an international research collaboration initiative, the justification would have to be in terms of the benefits that such initiative would bring to the country or to Europe. The examples of nationally initiated international research collaboration that have been examined as part of this research, namely the HFSP and the IMS programmes, both launched by Japan, unfortunately do not provide much evidence that benefits for Japan commensurate with the investment made have been obtained in the short term, or even in the long term.. The foreign and trade policy needs of Japan to demonstrate that it was contributing to global research in basic science, and not just benefiting commercially from the investment made by the U.S. in this area, was an issue of the 1980s. It has since ceased to exist as Japan is no longer seen as a major threat to U.S. economic interests. Japan continues to be, by far, the major contributor to the budget of HFSP and as the justification for this in terms of *juste retour* does not exist, the stability of the programme in the longer term is uncertain. IMS, funded on a different basis but initiated for similar reasons, does not address what might be called a global problem. Its method of operation, involving complex approval mechanisms for each application for funds, designed to ensure that financial contributors are obtaining *juste retour,* is perceived as less than optimally efficient from a scientific point of view.

3.2.2. Classifying international research cooperation initiatives

As a result of the analysis of the case studies and of the published literature on international research collaboration projects and programmes, such as the Centre Européen de Recherche Nucleaire (CERN), the ESRF, European Southern Observatory (ESO), the ILL, ESPRIT, RACE, Eureka, COST and the FPs, the following scheme for classifying such initiatives was developed.

Actors

We have divided the main actors involved in setting up, undertaking and administering international research cooperation initiatives into 3 categories: *policymakers*, *administrators* and *scientists*. This categorisation relates to the roles and functions which individuals undertake rather than to their educational background or "formation". Inevitably, the boundaries between roles are sometimes blurred.

The study has produced some evidence that the primary actors are the policymakers and the research scientists. They have identities and actions significantly defined by their perception of their main responsibility. Politicians, normally the primary policymakers insofar as they have policy decision-making powers, see themselves responsible to the public (or the electorate). Scientists, on the other hand, see their primary allegiance being to a Mertonian notion of Science, the disinterested pursuit of truth, the advancement of the frontiers of Science[8]. Administrators, defined by their function of having to administer research activities and funds, do not have a common, separate identity. In some cases they see their primary function as responding to the needs of policymakers; in other cases they respond mainly to the needs of scientists and of Science. Government officials or scientific civil servants are classed as administrators. They owe their primary allegiance to policymakers and share with them an allegiance to a notion of the public interest, although they may see themselves as more "objective" because they are non-party political. Such administrators are sometimes responsible for designing policies, but in this capacity they are not generally policy*makers* insofar as they lack final decision making powers. Also policy proposals are always circumscribed by the designers' understanding of what is politically realistic- i.e. what policymakers will accept. Research administrators also design contracts, and establish and implement financial regulations so as to meet policymakers' requirements for ensuring value for money. But administrators' success in ensuring that scientists deliver according to contract specifications and financial regulations does not always guarantee value for money. Moreover, the constraints resulting from the application of administrative regulations sometimes detract from the quality of scientific work, even though this is unintentional.

There are other kinds of administrators who see their primary allegiance as being to scientists and to Science. Some administrators of HFSP fall into this category. The HFSP programme was designed deliberately to be responsive to the needs of scientists (*bottom up*-see below).

The primary tension is therefore between the different perspectives of scientists and of policymakers, with scientific administrators playing intermediary roles. It is this tension which underpins the main difference between "top down" and "bottom up" initiatives (see below for a discussion of these categories).

This classification is offered more as a hypothesis based on some *prima facia* evidence produced by the study rather than as a firm result. Further research would be required to confirm or refute it.

International scientific co-operation can further be classified according to several criteria:

8 By this classification we do not mean to imply acceptance that the scientists' self-image is an accurate one. We are well aware of the debates which surround the question of the neutrality of science and of the critiques of the Mertonian analysis. We also do not wish to take a position on whether policymakers or scientists should be the final arbiters on what is best for Science. What the research has done is to identify that the different perspectives of the main actors sets up a tension which affects the process of setting up and carrying out international collaboration research initiatives. As a result, the outcome has to be negotiated. This makes the identification of 'best practice' problematic. The question would then be: best practice *for whom*?

- between programmes and projects in relation to their scientific objectives;
- between bottom-up and top-down in relation to the origins of the initiative;
- between centralised and distributed in relation to their organisation;
- between concerted actions and joint research in relation to their coordination mechanism;
- between research production and research assessment;
- between research initiatives with and without short term commercial implications;
- between big science and little science.

A) Programmes and projects

The aims of international research collaboration initiatives can differ a great deal. However they can in general be classified into two broad categories and the following definition of terms will be used in the remainder of this report:

Programmes

Programmes have broad scientific aims and do not attempt to specify precisely the objectives to be achieved, or the scientific methodology to achieve them. Of the case studies, the HSFP was initiated with the aim of promoting international basic research on the brain and the molecular mechanisms of biological functions, by awarding research grants and fellowships through international peer review and by staging frequent workshops. Similarly, the IMS initiative had a broad aim to encourage global cooperation in the development of manufacturing technologies and systems. Other international initiatives, which have the characteristics of programmes, include Eureka, the European initiative to develop pre-competitive, but market oriented industrial research and development and the Framework Programmes.

Projects

Projects, as opposed to programmes, have well defined scientific aims and objectives. The HGP, with its very specific objective of determining the DNA sequence of the entire human genome, is a typical example of a project. Similarly, the IPCC aims specifically to provide scientific advice to the global community through its periodic assessment reports on the state of knowledge of the causes of climate change, its potential impacts and options for response strategies.

B) 'Top down' and 'bottom up' initiatives

The main actors involved in establishing international research cooperation initiatives are policy makers, research administrators and the scientists themselves. An understanding of the process through which this type of initiative is set up, involves an analysis of the roles of these actors. Policy makers in general are responsible for providing the resources and have to be convinced of the public usefulness of the initiative. In establishing international cooperation, therefore, policy makers will be concerned by issues of *the benefits* for the countries that they represent. Administrators have to guarantee that the resources provided are indeed used in accordance with the objectives agreed by the policy makers in a cost effective way. Scientists, on the other hand, tend to see themselves as pursuing the advancement of the frontiers of science in ways that only they and their peers are qualified to judge. They often resent administrative procedures designed to ensure that "value for money" has been achieved. The different interests of the main actors produce tensions which have to be managed if the initiative is to be successful[9]. The characteristics of international research cooperation initiatives will therefore tend to differ according to whether they have been initiated by the scientists themselves and primarily conform with the objectives of science (*bottom up*); or whether they have been initiated by policy makers primarily in pursuit of policy objectives (*top down*).

Our research has shown that international cooperation research projects tend to be driven "bottom up". The HGP was initiated by a group of scientists driven by a vision of an exciting clear objective. Similarly, scientists concerned about the dangers of anthropogenic global warming initiated the IPCC. Scientists, who then convinced policy makers of the case for providing the necessary resources, initiated all the major European international Physics projects such as CERN, ESRF, and ILL.

Programmes, on the other hand, tend to be initiated "top-down" by policy makers in response to policy aims. Of the case studies, both the HFSP and the IMS programme, whilst involving researchers from the outset, were launched more in order to fulfil certain foreign policy aims of Japan at the time, rather than the specific requirements of science.

Similarly, major European S+T research programmes such as ESPRIT, Eureka, and the FPs were all initially launched "top-down" in response to the perceived technology/innovation-gap between Europe, on the one hand, and the U.S. and Japan, on the other.

However, in the course of their development, some "top down" initiatives may subsequently become effectively managed "bottom up", in the sense that decision making and administration are largely undertaken by scientists, mainly on the basis of peer review methodology. This was the case with programmes such as HFSP and Eureka.

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9 The actual situation is, of course, rather more complex than the picture created by the scientists' self-image. The politics of scientific research is complex and subject to a variety of factors, including personal and career ambition. However, the point that is being made here is that it is mainly the difference between the primary ethos of scientists and that of policymakers which sets up a tension between these actors.

C) Centralised and Distributed Initiatives

The concept of ***centralisation*** of international research collaboration projects and programmes may be understood in three different senses:

> (i) centralisation of resource allocation.
>
> This occurs when either the decision to support a particular proposal is made at one central point and this automatically releases the necessary resources, or when the budget is held and managed centrally. Eureka, COST, the European FPs, CERN, ESRF, ILL and ESO are examples.
>
> (ii) geographic centralisation of research activities
>
> This tends to apply in the case of projects which take place in, or create, a single research laboratory. CERN, the ILL, the ESO, and the proposed ITER (International Thermonuclear Experimental Reactor), all fall into this category.
>
> (iii) centralised management of activities
>
> In such initiatives, a single point exists for funding decisions and for assessing the outcomes of projects. All the examples considered by GLOSPERA fall into this category, except IMS.

HGP is unusual in that it was coordinated informally without ever establishing a formal centralised management or administrative structure. Funding was distributed insofar as each country funded its own research activities. However, it could be argued that HGP was not truly an international research collaboration project, because such a high proportion of the funding and the research activities originated in and took place in the United States. In the latter stages of HGP, the only significant participant outside the U.S. was Britain's Sanger Centre funded by the Wellcome Trust, the world's largest medical charitable trust. De facto decision making towards the end of the project involved mainly informal coordination between two U.S. government funded organisations (NIH and DOE), the top management of the five principal US and UK laboratories then involved in HGP, and the Wellcome Trust. Our research has established that this is an unusual - perhaps unique - situation in international research collaboration.

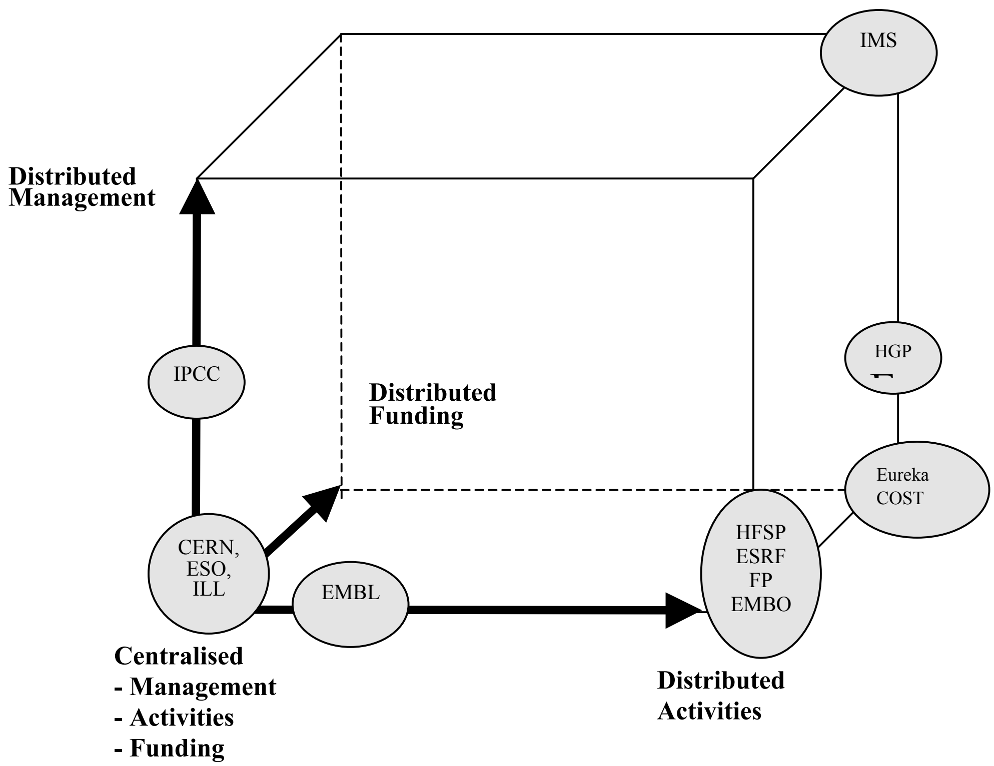

Fig. 2 Centralisation and Distribution in International Research Cooperation

D) Concerted action and Joint Research initiatives

Concerted action projects/programmes are internationally coordinated with the activities in each country funded from national budgets (Eureka, HGP, IPCC, COST, and IMS). It follows that the activities and the funding of concerted action projects and programmes are necessarily distributed, although the management and administration may be centralised, as is the case with Eureka, IPCC and COST.

Joint research projects/programmes are those that are funded from a central fund (CERN, HFSP, FP, and EMBO). The funding and management of joint research initiatives are necessarily centralised but the activities may be distributed, as is the case with HFSP and the FP. EMBO has two aspects to its operation. The European Molecular Biology Laboratory (EMBL) can be regarded as partially geographically centralised, insofar as it runs a main laboratory in Heidelberg (Germany), with outstations in Hamburg (Germany), Grenoble (France) and Hinxton (U.K.), and an external research programme in Monterotondo (Italy). EMBO's other activities are distributed insofar as they involve the granting of fellowships, the financing of workshops and the publication of the EMBO Journal, all of which are not location specific.

E) “Big science” and “little science” initiatives

The process whereby scientific research gradually moved from a spontaneous activity (*little science*) to a organised activity carried out in large research laboratories and involving collaboration in teams (*big science*) was first analysed by De Solla Price in his now classic ‘Big Science, Little Science’. “Big science” projects and programmes require not only very substantial investment of capital, which are often difficult to find and justify in national budgets, but also complex administrative procedures. “Big science” projects are therefore natural candidates for international research collaboration and some of the earliest projects, such as CERN and the ILL fall into this category. The proposed ITER (International Thermonuclear Experimental Reactor) is another example currently under discussion[10]. Such projects tend to fit well the foreign policy aims of potential partners insofar as they are internationally very visible and can therefore contribute greatly to national prestige on the international stage, an important criterion of most foreign policy initiatives. Another reason why “big science” activities may find favour with both policy makers and research administrators is that *juste retour* arrangements are easier to negotiate and evaluate post-facto. “Big science” activities are almost always initiated “bottom up”, as only scientists are able to identify suitable research needs and opportunities. What might be termed “big technology” projects, however, have more complex origins and a greater initial participation of policy makers. This was the case with both Concorde and the Airbus projects.

“Little science” research activities tend to be conducted by individuals or small groups of scientists. They are normally justified in terms of the Mertonian norms of science and aim to move forward its frontiers. International collaboration activities in this form are distributed. The research activities undertaken under the FPs so far can be classified largely as “little science” activities, although in FP6 the European Commission has taken a decision to move more towards a “big science” approach to build ERA projects . The activities of EMBO and HFSP can be classified largely as “little science” activity, although the EMBL would fall into the De Solla Price classification of “big science”.

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[10] ITER could perhaps be better classified as a “big science” project aimed at creating “big technology” . “Big technology” projects have many of the characteristics of the “big science” projects in that they require large scale resources, but they aim to have direct practical applications whether commercial or not. The dividing line between “big science” and “big technology” projects is not altogether well defined insofar as “big technology” projects often require the previous solution of fundamental scientific problems. The European Space Agency, formed through the fusion of a “big science” project, the European Space Research Organisation (ESA), and a “big technology” project, the European Launcher Development Organisation (ELDO), demonstrates this point clearly.

HGP started off as a "little science" project but became "big science" with the development and use of new, expensive and highly automated methods to facilitate completing the enormous amount of work involved. However, as pointed out previously, unusually, HGP never developed a formal centralised management, administrative or funding structure.

F) Research initiatives with or without short-term commercial implications.

Our research has shown that it is important to consider whether the international research collaboration initiative is one involving research initiatives without commercial implications, or whether it is a more downstream initiative with IPR or industrial implications. The dividing line between the two, however, is undoubtedly becoming harder to draw, and, to an extent, contentious. Increasingly, national governments and the EU are requiring scientific activities to demonstrate their social and economic relevance in order to obtain funding and commercial activities are increasingly looking to scientific knowledge to drive innovation. Although the legal framework within which EU programmes operate confine them to pre-competitive research, several have been evaluated in terms of their contributions to improving European competitiveness. It would surely be more appropriate to view the principal objectives of such programmes as to their contribution to ensuring that Europe has the scientific, technological and skills base to compete in the long-term, insofar as there is no way that they can deliver international competitiveness in the short-term. Nor can such programmes ensure by themselves that EU firms assume leading roles in the development and application of new science and technologies. However, they have been successful to a considerable extent in encouraging collaboration between firms and research institutions across the EU. They have also created opportunities for increasing many European scientists' skills and knowledge, and these are, surely, more appropriate criteria by which they can and should be evaluated.

The history of HGP demonstrates some of these difficulties clearly. The initial vision was developed under a Mertonian ethos. Eventually commercial considerations affected the development of the publicly funded project profoundly. Celera was founded on the basis of a different scientific approach to sequencing the human genome, and on expectations of profits from the patenting of genome sequences. The HGP's need to compete with Celera's claims for the superiority of its approach so as to ensure continuing support from the US Congress had several very important effects on HGP's policies and development.

G) Research Production and Research Assessment to Address Global Problems

All the initiatives examined by GLOSPERA, except one, involve international collaboration in conducting scientific research production. The one exception is IPCC which can best be described as an international research ***assessment project***. Such projects do not aim to conduct research but to assess the existing research on a particular subject in order to inform policy. The analysis of only one assessment project makes it difficult to derive general conclusions for this type of initiative.

An important objective of GLOSPERA had been to identify the implications of globalisation for policy design on international research cooperation .Our research has shown that there are few examples of significant initiatives in this area. IPCC is an exception, but, despite the great care IPCC architects took to review a wide range of scientific evidence and the sophisticated mechanisms developed to arrive at a consensus of global scientific opinion, the project has been highly controversial. Moreover, its results, as embodied in the Kyoto Protocol, have been rejected by the United States and other governments. It has been suggested by some commentators that the Kyoto process is now "stalled". However, following the US withdrawal, the EU ratified the Kyoto Protocol, committing itself to reducing its greenhouse gas emissions by 8% in 2008-2012 compared with 1990 levels, and has adopted a wide range of measures with the aim of securing this objective. Measures adopted have included the Commission's Directive on Greenhouse Gas Emission Trading, which entered into force in October 2003. Other measures involve: improving energy performance of buildings, promoting the generation of electricity from renewable energy sources, promoting co-production of heat and power, and reducing greenhouse gases from transport, including measures on fuel taxation. In relation to transport, measures have been adopted towards the objective of shifting from road and air transport to rail and water as well as from private to public passenger transport. It is anticipated that the overhaul of the Common Agricultural Policy (CAP) agreed in 2003 will lead to emissions reduction in agriculture.

With the important exception of the IPCC, there is little evidence that national policy makers have sought to address global problems through international research cooperation. and the existing international agencies lack both the resources and the political power to take up such initiatives. It may be relevant to note that, ***before*** the creation of the IPCC, the scientists who initiated it had already defined the threat of global warming, together with the broad lines of the desirable responses to it. This served to establish the consensus on which the IPCC and the subsequent Kyoto process is based; and ensured that neither IPCC reports, nor the Kyoto process, were disrupted by the major scientific controversies that continued, but mainly outside the IPCC.

Nevertheless, there is a demonstrable need for international research collaboration on global problems of scope[11] and global problems of scale[12]. Issues such as AIDS, BSE, the environmental impact of GM crops and the health implications of GM foods, atmospheric and marine pollution, which affect many countries and, in some cases, the whole world, could all be profitably tackled through research and assessment projects involving international cooperation. To establish the reasons why such international research collaboration has not yet been initiated would require further research.

H) International scientific cooperation and foreign policy

"…the concept of science policy as part of foreign policy is important. They are clearly connected. Technical and medical scientific results are of major economic importance; results in social science are always political in some way, and therefore research policy is crucial to each national state and thus also to its relations to other nations[13]. However, even though science and technology pervade some areas of foreign policy, and the global importance of science and technology is generally recognised, diplomatic structures have not followed changes in the relationship between science, technology and society[14].

It has been suggested that the distinction made by Smith and Katz (2000) between three models of collaboration can help to put international science in context for application in a foreign policy perspective[15]. Their three models are "Corporate partnerships" - highly formal collaborations initiated by more than one group with the goal of securing access to external resources. These are high profile 'megascience' activities such as the Human Genome Project (HGP) and the International Thermonuclear Experimental Reactor (ITER). The second model is less formal "team collaboration", motivated by the need for multidisciplinary skills and experience. Examples of these are the Intelligent Manufacturing Systems Initiative and the Human Frontier Science Project. The third model is "Interpersonal collaboration "–a diverse category with activities dependent on the personal relationships between researchers or research groups.

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[11] *Problems of scope* are defined as problems that transcend national barriers and are therefore best dealt with at international level.

[12] *Problems of scale* are defined as problems whose solution requires resources that transcend the capacity of individual nations.

[13] Melin, G., (2004) Comments on draft sections of GLOSPERA Report
[14] Pereira, T. S. (2002) 'International dimension of research in Portugal: the European Research Area and beyond' *Science and Public Policy*, 29, 6, pp.451-461
[15] Wagner, C. S. (2002) 'The elusive partnership: science and foreign policy' *Science and Public Policy*, 29, 6, pp. 409-417

This formulation applied to funds supplied to government facilitates additional distinctions to be made which assist the analysis of international collaboration in a foreign policy context. Funds for international scientific collaboration are allocated through formal and informal mechanisms: in the US funds dedicated to formal collaborations are committed in the federal budget to support specific programs. Funds spent on informal collaboration are those that emerge from research activities where scientists link with foreign counterparts in the course of research- these activities form the bulk of international science. Finding new ways to integrate or to communicate better between science and foreign policy requires understanding the global network that is created by collaboration. However, the diffused and decentralized structure of science decision making has restricted governments' ability to use it as an explicit policy tool: the ability of governments to influence research directions is reduced or changed by the presence of internationally distributed research. Nevertheless, those responsible for development and implementation of foreign policy may find that by working with scientists in global fora they may learn to operate in the loosely structured dynamic networks of international science.

I) Global Scientific Cooperation and the Foreign Policy of the European Union

Stein[16] suggests that "Globalisation has progressed to such an extent that it is no longer possible for national policymakers to ignore the domestic impacts of decisions taken elsewhere, whether by other countries, supranational entities such as the European Community or by technology-based multinational corporations". International scientific co-operation can contribute to good foreign relations through sharing costs, risks and benefits and by assisting in the development of mutual understanding among nations[17]. But from the point of view of policymakers, investments by a nation or other entity can only by justified by benefits to the nation or entity which they represent. International scientific cooperation can contribute to the alleviation of international conflicts, but it may sometimes be damaged by international relations problems. The inter-relationships between science, technology and foreign policy are changing. But while informal, bottom-up and bilateral cooperation flourish, a more systematic approach may be needed.

The respective foreign policy responsibilities of the European Community and individual nations are complex and dynamic and often overlap[18]. The European Community has a

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[16] Stein, J. A.(2002A) 'Globalisation, science, technology and policy', *Science and Public Policy*, 29, 6, p. 402

[17] Wagner, C. (2002) op. cit.

[18] Stein, J. A. (2002B) 'Science, technology and European foreign policy: European integration, global interaction', *Science and Public Policy*, 29, 6, pp. 463-477

network of science counsellors around the world and also relates to international science and technology related organisations such as UNESCO, OECD's Global Science Forum and the IPCC. The European Union has numerous Scientific and Technology cooperation agreements. European Union Science and Technology cooperation with countries outside the EU has mainly developed within the Framework Programme: international agreements have given other countries access to Framework Programmes on a case-by-case basis. European countries - and increasingly the European Community as an entity- participate in global-scale Science and Technology cooperation, including "megascience" projects such as ITER and multilateral programmes such as HFSP, IMS and HGP and provide scientific support for the IPCC. Each of these is an exceptional arrangement and each is bound up with foreign policy dynamics. European co-operation with countries outside the European Union has been bottom-up and led by Science and Technology policy rather than foreign-policy led and provides an unofficial context rather than a specific strategy.

Stein[19] points out that globalisation- scientific, technological economic and cultural- together with the emergence of global issues such as sustainable development and climate change have begun to stimulate demand for greater co-ordination between science and technology and foreign policy in many countries – including the USA, the UK and the EU. Indeed a European Commission document[20] recommends explicitly that strategy should focus on "developing scientific and technical activities useful to the implementation of EU foreign policy." It recommends, "enlisting the scientific and technological resources of the EU and third countries" to respond jointly to world problems such as food safety, environmental protection, health and diseases associated with poverty. The document goes on to outline European foreign policy objectives for which scientific and technological co-operation with various world regions and EU co-operation partners would be valuable elements.

But the instruments available to the European Union to conclude international agreements are limited, and like other countries, the European Union is confined largely to bilateral and case-by-case arrangements. In the light of the impact of globalisation, this piecemeal approach to policymaking may be inadequate. However, the failed Canadian attempt to achieve strategic integration between foreign and science policy, reviewed briefly at the end of the next section of this Report, shows how difficult such integration is to achieve.

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[19] ibid

[20] European Commission (2001) *The international dimension of the European Research Area,* COM/2001/346 final

J) Globalisation and individual countries' approach to international scientific co-operation

(i) Small countries in the EU

Scientific and technical expertise is often difficult to find in small countries, such as Greece and Portugal, which rely more on international sources of such expertise. They have relatively few scientists and engineers, a low level of scientific output and rely heavily on international scientific cooperation. There are no scientific attaches in Portuguese or Greek embassies and the scientific collaboration portfolio is handled by low level officials[21].

Greece

Greek international collaboration policy has three principal strands: bilateral co-operation, cooperation within the EU and cooperation with international, mainly intergovernmental, organisations.

Its geographical location has given Greece a significant role in supporting the EU's foreign policy in the context of the recent enlargement of the EU. International R & D cooperation has strengthened Greece's links with other member states. It has also facilitated exploitation of Greece's links with its diaspora, and with the colleagues of Greek scientists when they studied abroad. Greek participation in European research programmes in the early 1980s acted as a stimulus to Greek collaboration with scientists inside and outside the EU which had previously been negligible. Greek participation in European Community programmes focuses heavily on Information and Communications Technology and sustainable growth. However, the success of international co-operation is constrained by the dispersion and lack of focus in Greece's scientific and technological activities, by the small size of the Greek economy, low R&D budgets, and the absence of strong high-technology industry.

Portugal

Portugal has a relatively internationalised research system: about half of its publications are produced in international collaboration and a high proportion of its patents have foreign co-inventors. Since1970, a high proportion of Portuguese scientists and engineers and technologists have been trained abroad, encouraged by the state. In addition, internationalisation has been a central objective of national Science and Technology policies. But the implementation of national scientific and technology policies is based more on bottom-up activities initiated by scientists than on top-down priorities.

[21] Amanatidou, E. (2002) 'Foreign policy and international FR & D collaboration policy in Greece', *Science and Public Policy*, 29, 6, pp. 439-450; Pereira, T. S. (2002) op. cit.

Portuguese participation in international programmes such as HFSP and IMS has been low and there is little Portuguese scientific involvement in the IPCC's activities[22].

(ii) Countries outside the European Union

Korea

Korea used international scientific cooperation as a means of achieving economic development. When Korea began to industrialize it was a poor developing country with poor resources and production facilities and, despite its large population, a small domestic market. As a consequence of geographical and economic factors, Korea had to rely on foreign sources of capital and technology. It resorted to informal mechanisms such as importation of capital goods and reverse engineering to acquire new technology. As industrial development continued in the 1980s, the technological needs of Korean industries became more complex and sophisticated. The Government considered it needed to build indigenous R & D capability at this stage. However, its efforts in this direction did not succeed at first because of Korea's limited stock of research experience and other forms of relevant knowledge. Accordingly, the Government launched a major programme of international R & D cooperation in 1985 which continued until 1997. Most government funds were devoted to cooperation with advanced industrial countries –over half was spent on collaboration with Japan, the United States and Germany. Only 2 per cent of the total fund was spent on co-operation with developing countries. On this basis, Korea then built up its indigenous R & D capability successfully.

Korea now seeks to take a new role as a global player and to participate actively in multilateral and bilateral efforts which aim to enhance global welfare, but it has to go much further to become a significant participant in global scientific and technological cooperation. For example, Korean participation in HGP was very small, but the Korean Government began to promote genome research seriously after HGP was completed. Until recently, Korea was not permitted to participate in HFSP, probably because of perceptions that Korea's scientific capability was insufficiently developed to justify its participation. Recently, there are signs that such perceptions are changing, and it is likely that Korea will participate in HFSP in the near future. However, Korean participation in the IPCC has been slight.

Korean experience suggests that international scientific and technological cooperation may be effective in helping developing countries to build their scientific and technological capabilities, especially when it is supported by the growth of absorptive

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[22] Pereira, T. S. (2002) op. cit.

capacity which is stimulated by a well-educated and trained workforce and the development of indigenous R & D capacity.[23]

Canada

Canada has fewer researchers per capita and lower expenditure on research and development as a proportion of GDP than most other advanced countries in membership of OECD, although the high quality of Canada's academic and industrial research is widely recognised internationally. Canadian researchers' cooperation with researchers in other countries is high and rising: Canada is highly dependent on access to scientific and technological knowledge produce elsewhere for a high proportion of its economic development. In 1982, the Cabinet argued that international science and technology collaboration needed to be considered as a means of supporting Canada's economic and foreign policy goals. Nevertheless, Canada's bilateral and multilateral agreements have not been reviewed systematically, Canada's research agencies still adopt ad hoc, incremental approaches, and its international science and technology relations agenda remains unstructured. "Canada's approach to developing a strategic capability of integrating science and technology into its international trade and foreign relations agenda has remained largely stagnant, while its domestic strategy for S & T, shaped by significant changes to the nature of knowledge, has flowered". [24]

[23] Chung, S. (2002) 'Catching up through international linkages: science, technology and the Korean experience', *Science and Public Policy*, 29, 6, pp. 431-437

[24] Dufour, P. (2002) 'Taking the (right?) fork in the road: Canada's two-track approach to domestic and international science and technology', *Science and Public Policy*, 29, 6, pp. 419-429, p.420.

4. CONCLUSIONS AND POLICY IMPLICATIONS

Despite the complexity of drawing ‘best practice’ conclusions for European RTD and foreign policy from an examination of case studies, the analysis has led to the development of a model for understanding the implications of the different formats of research collaboration initiatives involving European countries individually and collectively. Such initiatives need to be classified into those which are exclusively intra-‘Consolidated-Europe’ and those which involve an ‘extra-Consolidated Europe’ element.

Intra-‘Consolidated Europe’ initiatives are focussed on the countries of the EU. Although such initiatives involve international research cooperation in the sense that they involve collaboration between researchers from more than one country, they are primarily driven by the internal needs of ‘Consolidated Europe’. The classic examples of intra-European research initiatives are the successive Framework Programmes. This type of proposal is likely to come directly from ‘institutional Europe’, primarily the European Commission. Its main aim is the strengthening of the identity and structures of ‘Consolidated Europe’. The decision to set up the ERA will give added impetus to the fact that intra-‘Consolidated Europe’ research collaboration will be increasingly aimed at reducing the inter-national aspect of such collaboration and strengthening its pan-Consolidated European nature. Although this has not been stated explicitly, the logic of the ERA, if successful, will surely lead to a gradual strengthening of the pan-European research budget(s) relative to national ones, as well as resulting in leveraging greater investment in R+D by the private sector so as to increase the total spending on research towards the target of 3% of GDP across the EU.

The term “international research collaboration” in the context of GLOSPERA therefore needs to be seen as those research initiatives that involve collaboration between Consolidated-Europe and countries outside. Such initiatives involve an element of foreign policy and therefore it is necessary to consider their implications both in terms of RTD and of foreign policy. However, historical experience has shown that European participation in such projects has usually been organised through the European national programmes rather than through the structures of ‘institutional Europe’.

This is also true of European research cooperation initiatives set up ‘top down’ from within Consolidated Europe but which involve collaboration with countries outside Consolidated Europe and therefore have a foreign policy dimension, such as Eureka and COST.

However, the broad principles of the interface between European RTD and foreign policy are often tacitly accepted by all the main players in ‘Consolidated Europe’ and inform all such initiatives whether they originate from the European Commission or from one or a group of European countries. These principles are those of:

- Strengthening the international position of European S+T;
- Strengthening the international competitiveness of European industry;
- Enhancing the prestige of Europe globally;
- Contributing to good relations with, and the stability of, countries in the geographic periphery of Europe;
- Supporting developing countries, particularly in priority areas for European foreign policy;
- Accessing the best scientific knowledge from the rest of the world.

There are also some other more ad hoc foreign policy objectives which may arise from time to time in response to specific international conjunctures. Such appears to have been the reasons for associating Israel to the European RTD programmes.[25]

Because the funds available for extra-Consolidated Europe research collaboration initiatives from national budgets are much greater those from the budget controlled by the EC, the Commission is faced with three choices:

- Commit some of its limited budget to such initiatives at the possible expense of internal objectives.

- Obtain additional resources from the national budgets to be committed to a fund which it will control and which will make up the European contribution to international research collaboration initiatives.[26]

- Try to organise European participation in international research collaboration initiatives on a concerted action basis in which the majority of the European contributions come from the national budgets of the EU countries, but where the Commission plays the coordinating role.

The relationship between foreign policy and research policy can be envisaged as ‘science for diplomacy’ when science and technology policy takes the needs of foreign policy into account; or as 'diplomacy for science' when the needs of science and technology are considered when formulating foreign policy. The preceding conclusions derive largely from an analysis of how the needs of European foreign policy have been taken into account by European science and technology research policy. There have been individual

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[25] See Appendix 2 for a further elaboration of this point.

[26] Past experience has shown that this will not be easy and that European countries with significant research budgets will normally prefer to participate individually in international collaboration research initiatives if they have to commit their own research funds rather than through the Commission.

examples of foreign policy objectives being met by using the needs of science, such as HFSP and IMS. However, the systematic and strategic integration of the needs of science and technology into foreign policy is very difficult to achieve. The one attempt to accomplish this integration, by Canada, has ended in failure.

This failure is largely because science systems are very complex and highly distributed. It is very difficult therefore for foreign policymakers to understand them and to take their needs into account when formulating policy.

Programmes and projects

Our research has led to the conclusion that, in general, international research programmes are started "top down" by policy makers largely in response to perceived policy needs. Projects, on the other hand, are normally launched 'bottom up' by scientists in response to clear scientific objectives, which can only or best be served by international cooperation. They are usually 'big science' projects requiring resources which are difficult to obtain from a single country.

There are a number of factors that are combining to make it more likely that the demand for 'big science' projects will continue to increase. These are:

- science is becoming increasingly capital intensive;
- 'big science' projects are more likely to be supported by policymakers than a collection of relatively small projects which are less visible and would also lead to a dispersion of resources;
- policy makers implicitly recognise that *juste retour* arrangements are easier to set up and evaluate in centralised big science projects;
- science policy in most advanced countries is tending increasingly to focus public research funds in 'centres of excellence', which compete internationally with each other. This is likely also to favour the development of international 'networks of excellence' in competition with each other tackling 'big science' problems.

Centralised and Distributed Initiatives

Centralisation and distribution needs to be considered in 3 dimensions: geographical location of research activities; management and administration; resource allocation.

Our research has established that all 'big science' initiatives are to a large extent centralised in all respects. Examination of the particularly interesting HGP project, which changed in nature from a largely 'little science' to a largely 'big science' initiative during its lifetime, demonstrated that the process led to an increasing level of centralisation in all the above categories. The bulk of the important research was conducted at a few large centres, the funds came essentially from the US government through two state agencies, NIH and DOE, and through the Wellcome Trust in the UK in the later stages.

International research collaboration programmes tend to be distributed in at least one of the 3 respects. Our research has shown that distribution of the management (in the sense of the decision making process), particularly if combined with distribution of funding, creates problems as in the case of IMS. The coordination costs are high and the time consumed militates greatly against the efficiency of the research. Also it is essential to separate out any arrangements to ensure *juste retour* from the ongoing administration of the research programme. Arrangements designed to ensure *juste retour* should be handled centrally and largely at the outset so as not to unduly burden researchers.

The European experience has shown that concerted action programmes which have distributed funding and distributed activities can be efficient and successful if they have a centralised decision-making process with a mechanism for guaranteeing the timely release of resources by all funders following a positive decision. COST and Eureka are good models in this respect.

Concerted Action and Joint Research Initiatives

Concerted action initiatives involve distributed funding normally released from national research budgets on a project by project basis. They can involve *a la carte* choice in which countries can choose whether or not they wish to participate in a particular project covered by the programme and will only be required to fund the activities in which they participate. Concerted action programmes are therefore necessarily geographically distributed and involve distributed funding.

The advantage of concerted action programmes is that *juste retour* arrangements are automatically taken care of by the original decision taken by each country whether to participate and at what level and therefore need not unduly burden the subsequent administration of the project. For a concerted action to succeed, the decision making mechanism has to ensure that once a central decision is taken to support a proposal, this will automatically and simultaneously release the necessary resources from all the contributing countries.

Joint research initiatives are those in which participating countries contribute to a central fund and the research is conducted jointly at a centralised location to which the researchers from each participating country travel. Such initiatives normally involve 'big science' research requiring expensive large scale equipment. Examples are CERN, the ESRF and ILL. As we have seen, the motivation for policymakers to fund such initiatives normally includes the perceived foreign policy benefit that involvement will bring because of the international prestige that they will obtain from participating in such high profile projects. Equally important is the benefit which national scientific research will derive from participation. As such motivation derives from international competition between countries, such initiatives are never, as far as we have been able to establish, truly global.

This classification is of particular relevance to the EU. The participation of 'institutional Europe' in concerted actions is very difficult to organise successfully and meaningfully as the funds come from individual European countries and efficient arrangements require direct participation by the funding countries in the ultimate decision making mechanism. It would appear that it would be even more difficult for 'institutional-Europe' to play a central role in concerted action international research programmes involving cooperation with non-European countries unless a significantly higher proportion of the research budgets of Europe are held by 'institutional Europe' than is currently the case. The role that the Commission can usefully play is that of representing the collective interests of those European countries without significant research budgets of their own.

Participation by 'institutional-Europe' in joint research initiatives is also complex for similar reasons. Joint research initiatives, as we have already concluded, normally require large investments. It will be difficult for the EU to give a substantial direct contribution from its central research budget without jeopardising its internal research priorities. However, only a substantial contribution would guarantee 'institutional Europe' a key role. On the other hand, if the European contributions come directly from the member countries of the EU, each country will normally expect some form of *juste retour* to its investment, even if this is only in the form of intangible benefits to its science system. This could be detrimental to the aims of ERA insofar as it will tend to reinforce the separate nature of the individual science systems rather than to contribute to their integration.

The examples examined of joint research initiatives involving international collaboration have been organised on a limited multi-lateral basis and have been informed by foreign policy considerations of national prestige for the countries involved, as well as by considerations of the benefits to their own scientific or industrial activities. They are not open global projects to advance basic scientific knowledge or to solve global problems.

It is conceivable that 'bottom up' demands from the world's scientific community for the resources necessary for advancing the frontiers of science will reach such levels that policymakers will be forced to consider developing global mechanisms for responding to such pressures. It may be that the international fusion project ITER can be considered to be the first example of this trend.

International Research Cooperation for the Solution of Global Problems

Our research has not considered any examples of international research cooperation set up as ‘top down’ initiatives seeking to contribute to the solution of global problems. Even the IPCC was initiated ‘bottom up’ by concerned scientists rather than by policymakers in search of solutions to world problems.

Yet arguably it is in this area that the greatest need for humankind exists. Globalisation has increasingly thrown up issues and problems that clearly require a concerted international effort if they are to be successfully tackled because the problems transcend national borders and have been rendered even more difficult to tackle at national level due to the processes associated with globalisation. During the course of this research the world media has constantly been highlighting global problems. Tackling these problems clearly requires concerted global efforts, and this is likely to involve both research and assessment in most cases.

The absence of previous examples of global initiatives to tackle global problems of scope and of scale does not demonstrate an absence of need but the absence of appropriate instruments. Our research has demonstrated, perhaps paradoxically, that the process of globalisation has not been accompanied by a parallel process which would lead to the interests of nation states being modulated by a strengthening of supra-national global institutions. The difficulties experienced by the EU in achieving such a process at the regional level are a testimony to the problems involved.

Planning European Union participation in new international scientific cooperation initiatives: Summary Recommendations

The following constitutes a check list of questions and issues that our research suggests should be taken into consideration when the EC is contemplating EU participation in a major new international research cooperation initiative:

Should Europe be involved through the European Union?

To answer this question positively there should be positive answers to most of the following:

- Does it fit in with the EU’s priorities in scientific research as expressed through the ERA and the Framework Programme?
- Does it bring benefits to European science?
- Does it strengthen the international competitiveness of European science?
- Will it allow European science to have access to the most advanced scientific knowledge in the world?
- Will it contribute to the development of ERA?

- Could it bring benefits to European industry and European competitiveness?
- Will it help meet the objectives of European foreign policy? In particular will it:
  - contribute to good relations with, and the stability of, countries in the geographic periphery of Europe?
  - support developing countries, particularly those in priority areas for European foreign policy?
  - enhance the international reputation of Europe?
- Do the benefits outlined above outweigh the opportunity costs of participation to the European Commission research budget?
- Could the European Commission coordinate the participation of all or some of the member countries?

It will also be necessary for the EC to take into consideration whether the initiative being envisaged is:

(i) a programme?

Programmes have broad or multiple scientific objectives and are normally initiated “top down” by policy makers to fulfil policy objectives.

or

(ii) a research project?

Projects have well defined scientific objectives and are normally initiated “bottom up” by scientists in response to precise scientific needs usually involving problems at the frontiers of science.

or

(iii) an assessment project

Assessment projects do not normally involve carrying out research. They are intended to assess the best available international scientific knowledge and opinion on a particular topic of interest to policymakers in order to inform policy decisions.

<u>If a programme</u>-

- is it/should it be?:

  (a) **concerted action**

  In a concerted action programme a central fund exists only to support coordination activities. Funding for research is provided by the national authorities of the participating countries.

  or

(b) **centralised funding**

In a centralised funding programme a central budget exists to support all activities: research, coordination and mobility.

For concerted action programmes

Advantages

- A concerted action programme, particularly if the *a la carte* principle is followed, allows each country to evaluate the benefits to itself of each proposal and gives it the freedom to decide whether to participate and provide the necessary funds to its researchers. This methodology automatically deals with concerns that countries might have about obtaining benefits commensurate with their investment since their own researchers and research institutions will be the sole direct beneficiaries of their research investment and minimizes the potential for disagreements over the way a central fund has been distributed.
- Administrative arrangements are easier to handle since participating national institutions and researchers will account for the use of funds to national funding bodies following well-established and well known national accounting procedures.
- Central funds are available only to support international meetings and other coordination activities. This will make the cost of coordination immediately apparent and the subsequent evaluation of the costs and benefits of international cooperation easier to establish.
- Insofar as concerted action will involve researchers largely working independently in each country but coordinating their activities, this methodology minimizes the tensions created by attempting to integrate approaches rooted in different national science systems.

Disadvantages

- not appropriate to support and help develop the scientific capacity of the less well-off countries with small national research budgets.
- cannot be used to support geographically centralized "big science" or "big technology" international cooperation.
- the process of setting up and approving proposals can be lengthy and onerous and requires considerable seed resources on the part of those developing proposals. It can only be used for supporting substantial initiatives.

- concerted action will not involve scientists from different countries actually physically working together unless further funds are made available centrally to support the mobility of researchers. It is therefore not the most efficient method of harmonising scientific cultures, working practices and quality assurance systems.

Guidelines for the success of a concerted action programme

- the mechanisms for handling policy issues and any *juste retour* arrangements should be separated from the ongoing administration of scientific aspects. The setting up of an Administrative Board with high level representatives of both the policy makers and the scientists of the various countries where policy matters can be decided and a consensus reached between the policymakers and the scientists can be reached is a good way of achieving this.
- if the programme aims to support basic science research, the day-to-day administration of the programme and of the initiatives which it funds should be under the control of scientists and should not be burdened by the need to demonstrate *juste retour* on an ongoing basis.
- proposals to be funded by the programme should be initiated 'bottom-up' if the programme is designed to support basic research. This will involve scientists in persuading their national funding authorities that the particular proposal should be supported.
- use the *a la carte* mechanism for minimizing bureaucracy and ensuring that *juste retour* is dealt with at the outset and does not unduly burden the ongoing administration. The decision by the individual countries whether to support a particular initiative will involve the country in evaluating the likely benefits of the proposal at this stage. Countries that do not feel the benefits to be commensurate with the proposed investment will just decline to participate in that particular action.
- a particular proposal should be funded only if:

  (i) it is supported by the funding authorities in each country of the participating scientists.

  (ii) the number of countries agreeing to participate reaches the minimum established.

  (iii) it is found by a central approval mechanism to meet the overall objectives of the programme and the criteria for scientific quality established by peer review.
- the central approval mechanism should involve both national funding authority representatives and scientific representatives in order to simultaneously evaluate whether the proposal meets the scientific quality criteria and the policy objectives.

- final central approval of a proposal should ensure timely release of funds by all the national funders in order not to create coordination and scheduling problems for the research.

If a centralised funding programme

Advantages

- initial approval of proposals can be more efficient than in the case of concerted action as there is no need to obtain prior support from multiple national agencies.
- frees researchers from having to demonstrate the value of each proposal to their own national authorities as well as to the central administrators of the programme.
- suitable for supporting smaller scale initiatives.
- can be used more easily to support mobility of researchers either separately or as part of a funded initiative- can be used to support initiatives that involve co-locating researchers from several countries working together in a laboratory.
- is suitable for transferring resources from richer to poorer countries and therefore for supporting the development of science in less advanced countries.

Disadvantages

- setting up of the programme initially can be difficult as issues of cost and benefit for individual nations should be settled at this stage on the basis of broad principles regarding contributions of the participating countries to the central fund. This is so as to avoid burdening unnecessarily supported research initiatives with administrative arrangements designed to measure their benefits to individual countries as well as to the programme as a whole. Agreeing the principles can be difficult;
- disagreements regarding cost and benefits to participating nations may be settled by setting up procedures to measure the costs and benefits to each participating nation of the research initiatives funded by the programmes so that they can be assessed in subsequent evaluations of the programme. This may result in compromising the efficiency of the research by burdening researchers with over complex administrative arrangements;
- periodic evaluation of the programme, including an assessment of the distribution of costs and benefits to participating countries, may lead some countries to wish to review their contributions. This could lead to significant variations in the size of central budgets.

Guidelines for the success of a centralised funding programme

- all issues of cost and benefit for individual countries should be resolved when the programme and associated fund are first set up. These issues should be reviewed only periodically as part of the evaluation of the programme and should not create over-complex administrative procedures for the research activities;
- if the programme aims to support the development of basic science, then the day to day administration of the programme and of the fund should be under the control of researchers in order to maximize its research efficiency. This may mean setting up an administrative structure controlled by researchers. The administrative structure of HFSP involving a Secretary General and a Secretariat who are scientists is a good model;
- more complex administrative procedures may be required if the programme is designed to support more "downstream" research or the policy aims are as important as, or more important than, the scientific ones. An example of this type of programme is the European Framework Programme.
- policy issues should be largely the concern of an overseeing body which should include both scientists and policymakers from the participating nations. The HFSP Board of Trustees is a good model for this.

If a Research Project

Is it a "big science" project?

"Big science" projects are normally initiated by scientists seeking to address scientific problems which lie at the frontiers of science and which require resources which may be greater than could be sustained by an individual national research budget.

The first issue that the potential partners will have to establish is whether there is a genuine scientific need that requires the combined efforts of several countries and that the potential benefits to science and to society are commensurate with the resources being sought. This should involve wide ranging consultation involving leading scientists, policymakers at least in the areas of research and foreign policy, and also the public and their democratic representatives. Politicians are susceptible of being influenced by enthusiastic lobbies of scientists and often sympathetic to this type of project because they are normally highly visible internationally. Undue weight may therefore be given to the publicity benefits that they bring.

The day-today administration of "big science" projects should be controlled by scientists and their institutions although they will be ultimately accountable to policymakers and to the public and private institutions which provide the funding.

Is the project centralised or distributed?

Centralised 'big science' projects normally require the use of large scale facilities which will have to be co-located. Distributed projects involve the coordination of scientific activities carried out in various countries. The nature of the project will normally determine whether it is centralised or distributed. Unlike programmes, this is not normally a matter of choice.

Issues for centralised projects

Centralised "big science" projects raise the complex issue of geographic location and how to establish *juste retour* when the primary beneficiary will be the country where the facilities are located. Policymakers are liable to perceive that location of the project within a particular country will bring disproportionate benefits to that country in several areas:

(i) its economy, through the multiplier effect which a large scale investment brings;

(ii) its international prestige, as normally "big science" projects are highly visible and attract considerable international media attention;

(iii) its science system, since it is likely to have easier access to the project than those of other countries.

Establishing *juste retour* to all the participant countries becomes a difficult issue and involves complex political negotiations at the highest level.

The problem then becomes how to reward other participating countries appropriately. The research has not identified a blueprint for achieving this and each case has to be considered on its own merits.

Centralised projects, once established, have few coordination problems and are comparatively easy to administer.

Issues for distributed projects

If the project is susceptible to be organised in a distributed fashion, *juste retour* arrangements are easier to handle or are non-existent, but coordination issues become more complex. It will become necessary to set up ongoing coordination mechanisms. The coordination needs to involve primarily scientists and their institutions. Coordination costs are likely to amount up to 20% of the total project costs.

Is it a research project to address a global problem?

Global problems can be classified into two main categories: *problems of scope* and *problems of scale*. Problems of scope are those which transcend the borders of a single country. Problems of scale are those that can best be addressed by harnessing the resources and knowledge of several countries.

Our research has identified few examples of this type of international research co-operation. None of the case studies considered falls into this category. Although the need for this type of project is growing due to the process of globalisation, there are few signs that instruments for meeting this need are being developed. The hypothesis is put forward that the continuing prevalence of the interests of nation states militates against the development of these instruments. This type of project is likely to involve distributed research with little international visibility and therefore unlikely to meet the foreign policy motives which often lead countries to invest in international research cooperation.

Whilst therefore no specific conclusions can be drawn for this type of project, it is likely that some of conclusions arrived at in the case of "big science" and assessment projects will also apply to this type of project.

If an Assessment Project?

Assessment projects are distributed by nature and involve essentially coordination. They are normally multi-disciplinary as the policy issues they address are likely to cross disciplinary boundaries.

Issues for Assessment Projects

- the relationship of the scientists who will have to carry out the assessment to the policymakers;
- the policy recommendations which they make will have to be approved by policymakers but they must be based on a consensus of as wide a scientific opinion as possible. There is a danger that assessment projects may be proposed by lobbies of scientists which do not include all the principal disciplines which could impinge on the policy under consideration;
- accordingly, it would be advantageous for the EC to consult widely with scientists and policy analysts to try to ensure that participation in any assessment project embraces all the principal relevant scientific disciplines.

Intellectual Property Rights (IPR)

In the light of the wide range of IPR issues which can arise in the context of the wide range of conceivable international cooperative science projects and programmes, it is impossible to prescribe firm detailed IPR guidelines. However, there is clear evidence that it is very advantageous to take a significant amount of effort to think through the IPR issues likely to arise in a particular project or programme and to draw up IPR guidelines before initiating a project or programme; and to draw heavily on previous experience –e.g. of the Framework Programmes or IMS – in drawing up those IPR guidelines.

5. DISSEMINATION

5.1. Dissemination during the Project

Conferences, Workshops

A three day Workshop was held in October 2001 at the University of East London where the Network members discussed the status of the concerted action as well as future plans for research cooperation. They also developed specific ideas for improving the basis of European participation in global S&T cooperation programmes and considered ways to improve the links between science, technology and diplomacy at the global level. The Network conducted intensive, structured discussions on global systems and policy design, working to develop specific approaches and policy options for Europe as well as on the research and played prominent roles in the Workshop.

Moreover, the partners presented papers in the following Workshops:

- Josephine Stein presented a paper at the OECD/GSF meeting, Paris, January 2000 ,
- Yoshiko Okubo presented a paper at the OECD/GSF meeting, Paris, June 2001
- Josephine Stein and Yoshiko Okubo presented papers at the OECD/GSF meeting, Paris January 2002
- Josephine Stein presented a paper on “Globalisation, Science, Technology and Policy” and Yoshiko Okubo presented a paper on “Networking as a Strategy in Intra-European Scientific Collaboration Activities” at the MEXT/OECD Global Science Workshop on Best Practices in International Scientific Cooperation in February 2003 in Tokyo.

Publications

Josephine Stein was guest editor of a special issue of ***Science and Public Policy*** on "Globalisation, Science, Technology and Policy" (Volume 29 Number 6, December 2002). Her paper "Science, technology and European foreign policy: European integration, global interaction" considers how European S&T cooperation developed in the context of international relations, and pointed out that linkages between international S&T cooperation and foreign policy are rarely explicit and not systematic.

Effie Amanatidou's paper "Foreign policy and international R & D collaboration policy in Greece" notes that Greece's geographical position as the south-east border of today's EU, together with its long established ties with other countries in the region and its support for the EU's foreign policy, makes Greece a key player in EU enlargement. This role is envisaged as placing even more emphasis on international S&T cooperation.

Tiago Santos Pereira's paper "International dimension of research in Portugal: the ERA and beyond" distinguishes between 'science for diplomacy ' where scientific and technical resources are important resources for developing foreign policy; and 'diplomacy for science' where S &T are a concern of foreign policy. It suggests that small, less-advanced countries, such as Portugal, are often more concerned with the latter.

5.2. Dissemination Plans

Journal articles

1. Y. Okubo with M. Zitt, Networking as a Strategy for Scientific Publication, Science and Public Policy (forthcoming).

2. We have found that international research cooperation initiatives tend to differ according to whether they have been initiated by the scientists themselves and primarily conform with the objectives of science (*bottom up*); or whether they have been initiated by policy makers primarily in pursuit of policy objectives (*top down*). The GLOSPERA authors propose to write a paper that will explore these issues.

3. In the context of international research cooperation, most analyses treat the words "Europe" and "European" as unambiguous. However, the research has shown that for the analysis of various programmes - COST, EUREKA, the Framework Programmes - to be helpful in the development of European "foreign policy" requires a careful definition of what is meant by "Europe". The results of GLOSPERA include the development of a significant new methodology for approaching such problems, and de Miranda and Okubo propose to write a paper exploring this key issue.

4. The IPCC, unlike the other programmes and projects considered in GLOSPERA, is an international scientific assessment project. There is a demonstrable need for international research collaboration on such global problems, and we propose to write a paper elaborating that need, drawing on our IPCC case study.

The GLOSPERA authors have published extensively in international journals which specialise in publishing papers on science policy - such as “Research Policy”, “Science and Public Policy”, and “Science, Technology and Human Values”. We are confident that such journals will welcome papers on topics such as those outlined above.

Proposed Workshop

We propose to convene a session on international scientific cooperation at the 5th Triple Helix International Conference in Torino, Italy in May 2005. GLOSPERA authors, Network members and concerted action partners will reflect on the implications of this report for European science co-operation and foreign policy.

Websites

Subject to EC agreement, the EXECUTIVE SUMMARY together with the complete report will be displayed prominently on the University of East London and the ISTM websites.

6. ACKNOWLEDGEMENTS

The authors express their sincere appreciation of the role of Josephine Stein because without her energy and dedication in putting together the original proposal, GLOSPERA would never have existed. She coordinated the early part of the project, was also responsible for organising the successful GLOSPERA Workshop at the University of East London, and for carrying out several interviews which yielded data and insights which made significant contributions to the case studies.

We are also most grateful to the participants in our Workshop and members of the GLOSPERA Network for their advice and comments including Efthymia Amanatidou, Greece; Terttu Luukkonen, Finland; Göran Melin, Sweden; Bernard Kahane, France; Paloma Sanchez and Cristina Chaminade, Spain; Tiago Santos Pereira, Portugal; Wim van Deelen, Netherlands, and Caroline Wagner, USA.

We could not have completed this work without the helpful cooperation received from the scientists, senior administrators and policy-makers whom we interviewed. We also wish to thank Damian White for having carried out some of the interviews for the project.

Additional thanks are due to Efthymia Amanatidou, Cristina Chaminade, Terttu Luukkonen, Göran Melin, Paloma Sánchez, Tiago Santos Pereira, and Halla Thorsteinsdottir for their helpful and extensive written comments on the GLOSPERA 'work in progress'.

Bernhard Kahane's contribution to the discussion of the GLOSPERA project conclusions and to the classification scheme used for drawing these was invaluable. Bernhard Kahane, Cristina Chaminade and Campbell Warden participated in the final GLOSPERA meeting and made a major contribution to the elaboration and editing of the final report.

The advice and wise counsel of Campbell Warden, our Project Advisor, was essential for the successful conclusion of this project. Without his helpful intervention at a critical stage the project would never have been completed.

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We are most grateful to the European Commission for supporting this project[27] and in particular for all the help and advice received from the European Commission Services. However, the contents of this Report and the opinions expressed should not be attributed to the EC; the final content of this report and its conclusions are the sole responsibility of the authors.

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APPENDIX 1: GLOSPERA INTERVIEWEES AND INTERVIEW PROTOCOL

1. Glospera Interviewees

HFSP		
Name	**Position**	**Institution**
Dr. Gilles Bonvento	Scientist	Lab. de Recherches Cérébrovasculaires
Prof. Peter Holland	Grant Holder	Division of Zoology University of Reading
Dr. Andrew Mackie	Young Grant Holder	Dept. of Molecular Biology, King's College, London
Dr. Annalise Pastore	Grant holder	Molecular Structure Division Nat. Institute for Medical Research, London
Dr. Jean-Luc Popot	Grant holder	Physico-Chimie Moléculaire des Membranes Biologique
Dr. Geoffrey Richards	Scientist	CNRS-INSERM Université Louis Pasteur
Prof. Jean Rossier	French rep on HFSP Scientific Cttee	UMR 7637 du CNRS "Neurobiologie et Diversité Cellulaire"
Prof Claudio Stern	Grant Holder	University College London
Dr. Torsten Wiesel	Secretary-General	HFSP, Strasbourg
Mr.. Takayuki Shirao	Deputy Secretary General	HFSP, Strasbourg
Mr. Patrick Vincent	Director of Administration and Finance	HFSP, Strasbourg
Dr. Martin Reddington	Director of Research Grants	HFSP, Strasbourg
Dr. Takashi Shimizu	Director of Research Grants	HFSP, Strasbourg
Dr. Danuta Krotoski	Director of Fellowships	HFSP, Strasbourg

HGP		
Name	**Position**	**Institution**
Dr. Daniel Cohen	Scientific Director, Genethon	Genset - Centre de Recherche Génomique
Dr Jonathan Grant	Head of Policy	Wellcome Trust
Prof. François Gros	Director	Pasteur Institute
Mr. Michael Morgan	Director of Research Partners and Ventures	Wellcome Trust
Dr. Jean Weissenbach	Directeur Général	Genoscope

IMS		
Name	**Position**	**Institution**
Dr. Bertrand Braunschweig	Directeur Expert	Institut Français du Pétrole
Alain Brenac	Officer	Ministère de la Recherche, Paris
Peter Bunce	Program Director	CAM-I Consortium for Advanced Manufacturing - International, Poole
Patricia Hall-Farrell	Retired Officer	DG Information Society European Commission
Olivier Rerolle	Director of European Affairs	ADEPA
Alain Roumiguier	Sales Manager	ADEPA
Willy van Puymbroek	Head of Sector	DG Information Society, European Commission
Dr Robert Wing	Coordinator, FutureHome project	Civil Engineering Dept. Imperial College London

IPCC		
Name	**Position**	**Institution**
Marc Gillet	Chargé de mission	MIES – Mission Interministérielle sur l'Effet de Serre
Dr. Jean Jouzel	Scientist	Laboratoire des Sciences du Climat et l'Environnement GIF-SUR-YVETTE CEDEX
Hervé Le Treut	Research Director	CNRS Laboratoire de la Météologie Dynamique
Prof. Michel Petit	Deputy Director-General for Research	École Polytechnique

OTHER		
Name	**Position**	**Institution**
Eric Banda	General Secretary	European Science Foundation
Rolf Linkohr	Rapporteur, European Parliament Research Committee	European Parliament
Jean-Eric Paquet	Deputy Head of the Private Office of Commissioner Busquin	European Commission
Maurice Bourène	First Counselor, Scientific and Technological Affaires, EU delegation to Japan	European Commission

2. Interview Protocol

Name of interviewer:

Date of interview:

Case study: HFSP HG IMS IPCC

Willing to respond to pilot questionnaire? Yes No

Institution:

Address:

Main telephone number:

Website:

Name of interviewee(s):	Current & prior positions & roles	Contact details (phone/fax/e-mail)	Comments

Interviews will be conducted with 60 European experts in international RTD policy and management: scientists associated with the four main case studies or working in related areas of science and innovation (SCI), key members of organisations involved in international RTD cooperation (ADMIN), senior officials and policymakers (POL).

Key questions are in **boldface type**, to be asked of all interviewees. Other questions to be asked of all categories of interviewees are in normal roman typeface. Questions for scientists, administrators or policymakers are in *italics* and marked as indicated. {Optional questions are in curley brackets}.

<u>Motivation and objectives</u>:

1. **What in your opinion motivates (policymakers, researchers and companies) to develop cooperative science and technology ventures in the context of your particular field or discipline? What considerations are used in deciding whether subnational, national, European or global levels of cooperation are most appropriate?**

2. **How were decisions made and negotiations undertaken in the case of this particular programme (HFSP, HG, IMS, IPCC)? How have the outcomes served to benefit or to detract from European science and innovation?**

3. **How does the programme relate to or interact with policies of the European Union?**

<u>Organisation and structure:</u>

4. (ADMIN) *What are the formal programmatic arrangements (including funding mechanisms and proposal review procedures)? Are these simpler, comparable to, or more complex than those of the European Community Framework Programme? What types of people and institutions participate in the research? Briefly, what are the best and worst features of the programme?*

5. **Who are the principal actors responsible for establishing the programme, and for shaping scientific content and programme objectives? To what extent are scientific priorities set and programme management done collectively; to what extent are priorities determined locally? To what extent are women involved in the research, and in programme management and policymaking? To what extent are Europeans involved?**

6. (ADMIN) *How are programme objectives and priorities decided and communicated, and how does this compare with intra-European research cooperation programmes such as the Framework Programme, COST, ESF and EUREKA? What are the statistics on proposal submission, evaluation and funding?*

7. **What areas of science and innovation are relatively over-represented or neglected?**

8. **Has there been controversy over the organisation or management of the programme, and if so, what did it pertain to (e.g. *juste retour*, IPRs, scientific orientation) and how has it been resolved?**

Evaluation:

9. What evaluations have been done, and what is your *own* opinion of the appropriateness, effectiveness and utility of the multilateral programme (for Europe and more generally)? What aspects of the programme have been particularly successful, and why?

10. What is the "European added value" of participation (in HFSP, HG, IMS, IPCC)?

11. (SCI) *How does the scientific quality of the research in the programme compare to similar research supported at subnational, national or European level? Why is this the case (e.g. presentation and profile of programme, numbers and quality of proposals, proposal evaluation timescale, barriers to entry/participation)?*

Policy:

12. (POL) *What informal criteria, if any, would be useful in assisting decision makers in determining whether collaboration should be international, European or global?*

13. What European-level structures or procedures might be developed to more systematically assess the need for global-scale multilateral RTD collaboration (e.g. European Commission, ESF, new scientific advisory bodies)? How might European proposals for new global programmes be stimulated, evaluated and negotiated?

14. {How should the public sector and independent organisations divide responsibility for fostering international collaboration? Are traditional roles shifting? How can the European Commission and governments in Europe and around the world best work together with industry, international organisations and other non-governmental actors to create robust support for multilateral RTD? }

15. Once a need is agreed, how should new multilateral RTD collaboration programmes be designed, implemented and evaluated? What specific models or features of international cooperation, either intra-European or in the programme under discussion (HFSP, HG, IMS, IPCC) have the most potential for further development at global level (e.g. evaluation, differentiation of scientific/non-scientific objectives or global level)? What key lessons could be applied on the basis of your own experience?

APPENDIX 2 - EUROPEAN POLICY AND INTERNATIONAL RESEARCH COOPERATION- AN ANALYSIS

Introduction

The purpose of this paper is to analyse the evolution of European RTD policy with particular reference to how *international* research cooperation has been viewed and dealt with. Through such an analysis some insights will hopefully emerge that will be an important contribution towards developing an appropriate strategy and tools for European participation in international research cooperation.

The paper is divided into two parts. In Part 1 a theoretical framework for understanding the concept of 'international' from a European Union point of view is developed. This is necessary because the concept has a degree of complexity for the European Union that it would not have for a traditional nation sate. All intra-European Union research cooperation is international in the sense that it involves more than one country. However, from the point of view of the European Union, such research is 'internal' rather than 'international'. Thus the linking of research and 'foreign' policy in the context of the European Union requires the prior definition of the meaning of 'international' in this context. The model developed introduces the concept of 'Consolidated Europe' which encompasses the entity created by the various treaties which led up to the creation of the European Union and the countries which were party to the treaties at any one stage and defines as 'international' from the point of view of 'Consolidated Europe' only those research activities involving countries not directly involved in the treaties.

In Part 2 the framework for analysing international research from a European Union point of view as developed in Part 1, is used to inform an analysis of the historical evolution of European RTD policy with particular regard to the concept of 'international'.

The paper concludes with some suggestions for the lessons to be drawn from this analysis for European Union policy on international research cooperation.

Part 1: The Meaning of International Research Cooperation for 'Europe'

The concept of *international* research cooperation clearly has a different and more complex meaning from the standpoint of 'Europe' and of the European Union than it would have for a traditional nation state. When trying to arrive at some conclusions of historical experience in international research cooperation for the RTD and 'European' foreign policy, it is difficult to avoid from an analytical perspective the prior question of what constitutes 'Europe'.

The importance of this question is immediately apparent when trying to draw lessons from the now considerable historical experience in intra-European research cooperation. Is such cooperation 'international'? How could lessons be drawn from it for the coordination between RTD and 'foreign' policy? From the point of view of the European Union it is difficult to consider intra-European Union cooperation as 'international' whilst it clearly is for the individual countries involved in it. The process of drawing lessons therefore requires the development of a previous analytical framework from which such central prior questions can be answered.

What constitutes 'Europe' can perhaps best be approached from the point of view of foreign policy analysis. For this area of research, an understanding of 'Europe' should clearly be central to an analysis of its *foreign* policy. However, theoretical academic work with regard to European foreign policy is still at a relatively early stage. Research in foreign policy analysis has so far been largely conducted from the unproblematic point of view of the nation state. This is a situation recognised and addressed by Brian White in a recent paper entitled "Foreign Policy Analysis and European Policy" and addressed in general by a forthcoming book .[28]

Here the issue has been approached through a historical analysis of 'European' policies towards "international" research collaboration using a methodology of textual analysis of official documents concerning European RTD initiatives involving international cooperation to uncover the underlying foreign or external relations policy logic which they imply. The very need to place the word 'Europe' in inverted commas is symptomatic of the problems that are involved particularly when a historical approach is taken. The words 'Europe' and 'European' are normally used by politicians and researchers alike in an unproblematic way. However their meaning often varies according to context and is sometimes ambiguous. On occasions 'Europe' refers to what we have chosen to call ***Consolidated-Europe***. 'Consolidated Europe' is geographically and dynamically defined to include all the countries that at any one time have been party to the various European treaties from Rome onwards and is currently made up of the countries that constitute the European Union. The geography of "Consolidated Europe" has therefore changed over time. "Consolidated Europe" has an institutional expression through what we term "institutional Europe", those organs which give institutional and legal expression to 'Consolidated Europe'. This 'institutional Europe' is normally defined as being made up of three pillars. The first pillar is composed of the European Communities, whose main organs are European Commission, the European Council and the European Parliament. The second pillar is the Common Foreign and Security Policy and the third pillar encompasses police cooperation and cooperation in the area of criminal law.

However, an analysis of the multinational research collaboration initiatives in which 'Consolidated-Europe' is involved or has launched[29] demonstrates clearly that 'Consolidated Europe' has an identity that transcends what is formally expressed institutionally. The European 'us' is strongly expressed both through the RTD policies of "institutional Europe" but also through the international collaboration policies of the

[28] White, B. (2003) 'European policy analysis and European foreign policy', paper given to the *FORNET Working Group 1: Theories and Approaches to the CFSP,* London School of Economics, 7/8 November http://www.fornet.info/documents/White_presentation%20November%202003.pdf, downloaded 29 January 2004. The paper is based on a chapter of a forthcoming book

[29] See Appendix 3 for the key details of the most significant initiatives which have been analysed through a literature review.

individual countries that constitute 'Consolidated Europe'[30]. It is this quite sharp division between the 'us' expressed both individually through each member country of 'Consolidated Europe' and collectively through 'institutional Europe' and the 'them' of all other countries and regions which we take to define the *foreign* of what might be termed European foreign policy.

This ethos can be seen in the way European programmes such as Eureka and COST were established. Eureka was not an initiative of 'institutional Europe'. In some ways it was even set up as an alternative to 'institutional Europe'. However, Eureka was primarily an expression of European identity. Eureka was an initiative of French President Mitterrand in 1985 conceived of as a civilian European alternative to the U.S.'s Strategic Defence Initiative (SDI). Eureka, in common with most 'institutional Europe' RTD initiatives, as we shall see, was intended to strengthen the competitiveness of 'European' industry primarily vis-a-vis the U.S. and Japan. Its management and administration were set up separately from that of the European Commission mainly because the Commission was perceived as an inappropriate institution to handle the more downstream research that Eureka was meant to promote, but also because the vision of Europe contained within Eureka went beyond the 'Consolidated Europe' of which the Commission was an institutional expression[31]. Membership of Eureka, as that of the earlier Cooperation Scientifique et Téchnique (COST), went beyond the boundaries of 'Consolidated-Europe', implying a vision that 'European' industry extended beyond 'Consolidated-Europe' and initially encompassed at least what might be described as Western Europe but excluded the Soviet block countries. Thus the initial vision of 'Consolidated-Europe' was that of a future in which the 'us' would encompass the whole of Western Europe, and possibly eventually Turkey. This vision is dynamically defined as the "Greater Europe"[32].

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[30] Roy Ginsberg (2001) in his book The *European Union in World Politics* has defined European foreign policy as 'the universe of concrete civilian actions, policies, positions, relations, commitments and choices of the EC (and EU) in international politics' (quoted in White (2003), op. cit., p.4). This restricts the expression of foreign policy to what we have called 'institutional Europe'. Here we argue that European foreign policy is also expressed in the actions and statements of the individual states that constitute 'Consolidated Europe'.

[31] Peterson, J. and Sharp, M. (1998) *Technology Policy in the European Union*, Basingstoke: Macmillan and Sandholtz, W. (1992) *High-Tech Europe: The Politics of International Co-operation*, Berkeley : University of California Press

[32] Recently the EC has articulated an overlapping concept termed 'Wider Europe' (European Commission (2003) *Wider Europe-Neighbourhood: A New Framework for Relations with our Eastern and Southern Neighbours*, COM (2003) 104 final) devised as a foreign policy statement in the context of the forthcoming enlargement of the EU. Although the term Wider Europe is not precisely defined in the Communication, it includes countries beyond the borders of both the European Union and geographic Europe addressed through the concept of 'Neighbourhood' of the European Union. 'Wider Europe' and 'Neighbourhood' are concepts designed to help 'to avoid drawing new dividing lines in Europe and to promote stability and prosperity within *and beyond (our emphasis)* the new borders of the Union' (ibid, p.4). Ukraine, Moldova, Belarus and the Southern Mediterranean countries are included as part of the 'Wider Europe'. Arguably the EC's concept of 'Wider Europe' does not make any distinction between our second and third layers of foreign policy. We have chosen to retain the distinction because historically there is some evidence that 'Greater Europe' countries outside 'institutional Europe' are included in the concept of 'European industry' expressed in RTD programmes but this is not the case of

Later, after the collapse of the Soviet Union, the vision of 'Greater Europe' came to include practically the whole of geographical Europe with the exception of Russia whose position was seen as ambiguous. The membership of both COST and Eureka was extended to Eastern Europe. Russia is included in Eureka but not in COST.

At all stages of its history 'institutional Europe', primarily the European Commission through its Framework Programmes, implicitly expressed 'European' 'foreign' policy through its RTD programmes in a modulated way. The first layer of the policy is expressed through the way those countries which at any time are designated as accession countries are integrated. Here the main aim was to start to support the integration of those countries and promote eventual cohesion of the expanded 'Consolidated'. This aim was implicit in the early Framework Programmes, but became explicitly expressed formally in INCO II when cooperation with "European countries preparing to join the European Union" was introduced as one of the areas covered by INCO II, the sub-programme of FP5 dedicated to ""Confirming the International Role of Community Research".

The second layer of 'foreign' policy expressed in the Framework Programmes regarded the special place that the remainder of the countries of 'Greater Europe' have in the external relations of 'Consolidated Europe'. RTD policy towards these countries follows the dual 'foreign' policy aim of supporting these countries towards a possible future integration and the wider aim, which also constitutes the next layer, of helping to ensure friendly relations with and promoting stability in the countries which border 'Consolidated Europe'[33]. These aims inform the inclusion of the area "Cooperation with the Newly Independent States and the Central and Eastern European Countries not in the

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countries outside Greater Europe, with the possible exception of Israel. Our 'Greater Europe' could be considered to be roughly equivalent to the membership of the Council of Europe. This currently includes 45 countries.

For a further analysis of the Wider Europe concept, see also Emerson, M. (2004) *The Wider Europe Matrix*, Brussels: Centre for European Policy Studies.

[33] These aims, as expressed in the RTD programmes, overlap with the recent aims of the Council of Europe which in 1989 adopted as its main purpose: acting as a political anchor and human rights watchdog for Europe's post-communist democracies; assisting the countries of central and eastern Europe in carrying out and consolidating political, legal and constitutional reform in parallel with economic reform; providing know-how in areas such as human rights, local democracy, education, culture and the environment. 'About the Council of Europe' http://www.coe.int/T/e/Com/about_coe/ downloaded 13 March 2004. The position of Russia in 'Greater Europe' has been ambiguous as it is sufficiently large and powerful to provide an alternative pole to the European Union. Russian politicians have complained that Russian industry is kept out of Europe. However, the concept of a 'Common European Space' first raised by the European Commission as a carrot to convince President Yeltsin to cooperate in 1999 (Walker, M. (1999) 'War in Europe: West tries to lure Russia back into partnership EU strategy: Planning for post-Yeltsin era', *The Guardian*, May 17) and reiterated at the Putin-Prodi summit meeting in Moscow in May 2001 (Traynor, I. (2001) 'Prodi invites Russia to dump dollar for euro', *The Guardian*, 18 May) is being pursued by the Russians in order to try to integrate Russia more into 'Greater Europe' (Anon (2003) 'Russia looks towards a Common European Space', *Pravda*, 11 March 'http://english.pravda.ru/politicsmain/18/88/354/11205_space.html downloaded 13 March 2004), without, however, relinquishing Russia's independent foreign policy role (http://english.pravda.ru./politics/2003/01/27/42586.html downloaded 13 March 2004)

pre-accession" of INCO II[34], itself a continuation of INCO I's 'Cooperation with Central and Eastern European countries (CEC) and with the Newly Independent States (NIS) of the former Soviet Union'.[35]

The third layer of foreign policy regarding stability and friendly relations with border countries is what informs the INCO II areas of "Cooperation with the Mediterranean Partner Countries"[36]. The third and fourth layers of foreign policy are covered by the EC's Wider Europe concept previously mentioned.

The fourth layer of 'foreign' or 'external relations' policy expressed through the Framework Programmes is the one with respect to the countries that have been somewhat inappropriately named the 'industrialised countries'[37] in the Framework Programmes. Here the predominant aim is not derived from 'foreign' or 'external relations' policy but from RTD policy. It is that of supporting the 'excellence' of 'European' science and technology by accessing the most advanced knowledge that exists outside its borders[38]. This, in turn, is expected to help enhance the competitiveness of 'European' industry. This policy has been underpinned more recently through a series of bi-lateral scientific cooperation agreements with such countries which include Australia (1994), Canada (1996) and the US (1998). One is currently under discussion with Japan.

The fifth layer concerns the relations of 'Consolidated Europe' with the developing countries. Here again the 'foreign' policy aims prevail, in this case that of helping the development of these countries. This was expressed in the FPs through the "Science and Technology for Development" programmes which began in 1983 under FP1 and continued under the INCO programmes of FP4 and FP5. Science and Technology cooperation agreements have also been signed with Brazil, Chile and Argentina which express foreign policy aims with respect to MERCOSUR and with South Africa which includes a strategy towards the African, Caribbean and Pacific (ACP) group of countries.

A sixth layer of foreign policy expressed in RTD policy concerns emerging nations. This is the most recent and includes a framework agreement with South Korea in 1996 which has been deepened recently through a meeting in 2003 in Brussels between European Union Research Commissioner Busquin and South Korean Science and Technology Minister Ho Koon Park which set the aim of establishing a science and technology

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[34] http://www.cordis.lu/inco2/src/res-a-1.htm , downloaded 7 March 2004.

[35] http://www.cordis.lu/inco/home.html, downloaded 7 March 2004

[36] This was articulated through the Euro-Mediterranean Partnership launched at the 1995 Barcelona Conference, between the European Union and its 12 Mediterranean Partners, called the Barcelona Process. The 12 Mediterranean Partners, situated in the Southern and Eastern Mediterranean are Morocco, Algeria, Tunisia (Maghreb); Egypt, Israel, Jordan, the Palestinian Authority, Lebanon, Syria (Mashrek); Turkey, Cyprus and Malta; Libya has observer status at certain meetings (http://europa.eu.int/comm/external_relations/med_mideast/intro/)

[37] Here we prefer the terminology 'economically advanced countries' which is more consistent with the 'knowledge-based economy' theory which currently informs European Union policy.

[38] For instance, in FP5 this was expressed as: "An international co-operation dimension … which will allow the European research community to benefit from the knowledge and expertise of third countries and institutions, through their participation in projects of the 5th Framework Programme". http://www.cordis.lu/inco2/ downloaded on 12 March 2004.

agreement between the EU and South Korea[39]. The emergence of China has also led to a desire to incorporate China into EU RTD programmes. This began under FP5 and was deepened under FP6[40]. The importance of this cooperation was underlined when China joined Galileo, the European project to develop an alternative to the US's GPS (Global Positioning System) satellite system by 2008 and agreed to pay one fifth of its cost (€230m)[41]. The development of Galileo has been strongly opposed by the US. Galileo represents Europe's desire to compete with the US globally in high technology and to develop an independent defence capability.[42]

India whose relations with 'Consolidated Europe' began as a developing country under the 'Science and Technology for Development' programmes, can be considered to have recently moved to this category. In the 2003 Science and Technology Cooperation Agreement with the EU, India's expertise in science and technology in particular fields is recognised and the agreement aims to mutually benefit the RTD activities of both parties.[43]

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[39] http://europa.eu.int/comm/research/iscp/countries/korea/ko-doc1.pdf downloaded on 12 March 2004.

[40] Sanders, J. (2002) 'EU-China Relations' http://europa.eu.int/comm/research/iscp/countries/china/cn-doc5.pdf downloaded on 12 March 2004.

[41] Morris, A. (2003) 'China joins Galileo GPS project', PRC News, 21September http://www.prcnews.com/archives/000238.html downloaded on 14 March

[42] Berthelsen, J. (2003) 'GPS, Galileo, and the China factor', *Asia Times Online*, 2 May http://www.gpsworld.com/gpsworld/article/articleDetail.jsp?id=71262 downloaded on 14 March

[43] 'EU and India to co-operate on Science and Technology' http://europa.eu.int/comm/research/iscp/countries/india/in-doc1.pdf downloaded on 12 March 2004

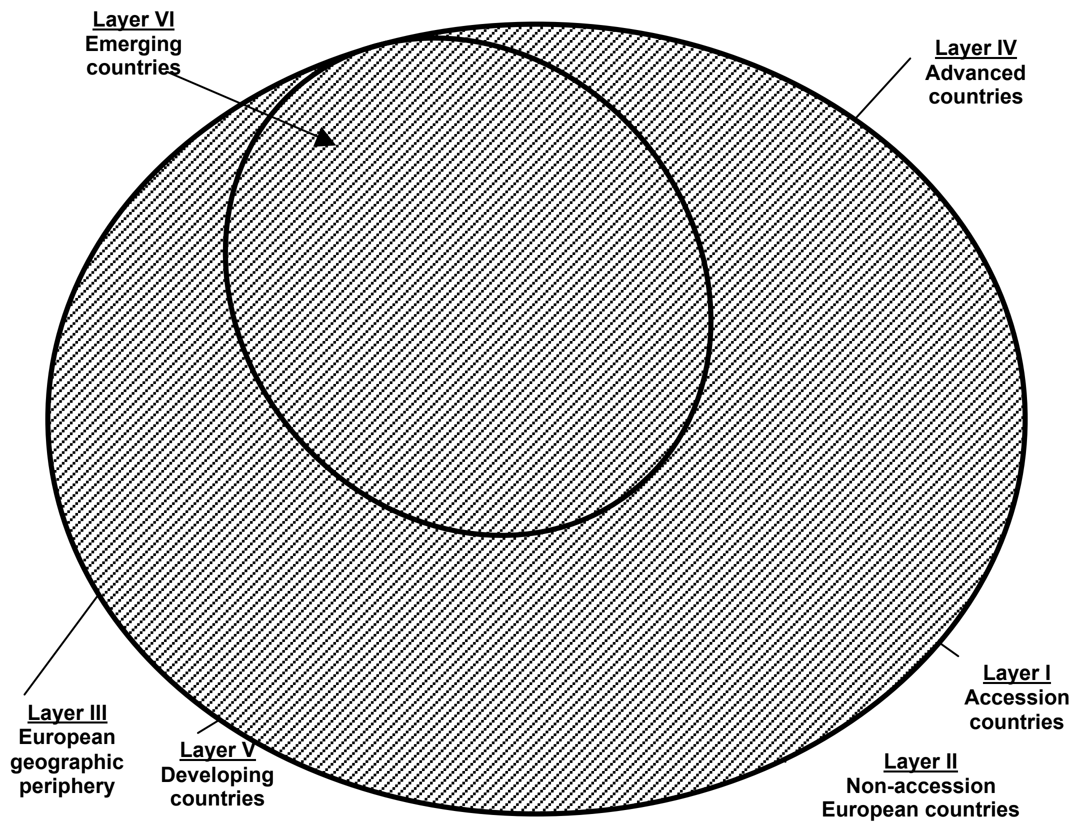

Fig. 1 The 6-layer model of the 'foreign' aspects of 'European' RTD policy

From the point of view of this model, intra-'Consolidated Europe' research collaboration promoted by the European Commission through its Frameworks Programmes would not be classified 'international' from the point of view of 'Consolidated Europe' as they do not involve any 'foreign' countries[44].

However, programmes and projects such as Eureka, COST and most of the European 'big science' and technology projects such as CERN, the Institut Laue Langevin, the European Synchrotron Radiation Facility which have been set up through direct inter-governmental agreements outside the auspices of 'institutional-Europe' must be viewed as 'international' in the way they are organised even though their ethos is that of a Greater European 'nationalism'. They share with 'institutional-Europe' a vision of the interests of the future 'Greater Europe'.

[44] The Framework Programmes have increasingly been opened to foreign participation. However, their primary purpose is to promote internal European co-operation. The opening up of the FPs to 'international' co-operation is largely an expression of European foreign policy, although it also supports particular RTD objectives.

In the previous analysis of 'Consolidated Europe' 'foreign' policy, as expressed through the RTD programmes, one obvious omission should be noted. It is the absence of any strategy for dealing with the research required for the solution of global problems which can only or best be tackled at global level by international research cooperation.

This absence is not peculiar to the European Union. All countries that have the means and should have the responsibility for tackling these problems collectively do not have a systematic policy towards this issue. The reasons for this situation are beyond the scope of this study and would require further research. However, a hypothesis that could be pursued is that the spending of 'national' budgets has to be justified in terms of *juste retour*[45] to the nation. Global problems will normally be seen as the province of international organisations which, however, lack the resources to sponsor the necessary research or the political power to demand them from the national governments.

For any country or for the European Union to launch an international research collaboration initiative the justification would have to be in terms of *juste retour* to Europe. The examples of nationally initiated international research collaboration that have been examined as part of this research, namely the Human Frontiers Science and the Intelligent Manufacturing Systems programmes launched by Japan do not unfortunately provide much evidence that *juste retour* for Japan has been achieved in the long term. The foreign and trade policy need of Japan to demonstrate that it was contributing to the global research in basic science and not just benefiting commercially from the investment made by the U.S. in this area was an issue of the1980s. It has since ceased to exist as Japan is no longer seen as a major threat to U.S. economic interests. Japan continues to be by far the major contributor to the budget of HFSP and as the justification for this in terms of *juste retour* no longer exists the stability of the programme in the longer term must be in doubt. IMS, funded on a different basis but initiated for similar reasons, does not address what might be called a global problem. Its method of operation, involving complex approval mechanisms for each application for funds, designed to ensure that financial contributors are obtaining *juste retour*, is perceived as less than optimally efficient from a scientific point of view.

Part 2: The Evolution of 'European' RTD policy with particular reference to International Research Cooperation

Cooperation in scientific research dates back at least to World War II. The process whereby scientific research gradually moved from an individual (little science) to a bureaucratised activity carried out in research laboratories and involving collaboration in teams (big science) was first analysed by De Solla Price in his now classic 'Big Science, Little Science'[46]. Of the basic sciences, Physics was the first to be affected. The Los Alamos atomic bomb project was perhaps the first example of a major cooperative

[45] *Juste retour* is the concept of a country receiving value for its investment, i.e. an appropriate return on investment from public budgets. This is normally defined in the narrow sense of actual tangible financial returns. Here the concept is being used in a wider sense that includes intangible returns such as increase in the international prestige of the country or, as in the case of Japan's proposal of HFSP and IMS, the neutralisation of international criticism which would have negative consequences to the trade interests of the country.

[46] Price, D.L. S. (1963) *Little Science, Big Science*, New York: Columbia University Press

project and whilst U.S.-based, it already included some international cooperation with Britain.

Publicly funded international cooperation in scientific and technological research in Europe also has a long history. The 1951 European Coal and Steel Community Treaty which encouraged technical and scientific research aimed at increasing efficiency and safety in the iron and steel industry (At. 55) was signed and came into force the following year (http://www.cordis.lu/coal-steel-rtd/coal/home.html). The foundation of the Centre Européen de Recherche Nucléaire (CERN) dedicated to fundamental research in Nuclear Physics dates back to 1954. CERN was another early example of the requirements of 'big science' in Physics.

In 1957 the Treaties of Rome were signed and came into force in 1958. The first of the two treaties, the European Atomic Energy Community (EURATOM) Treaty, encouraged research in nuclear energy and established the Joint Research Centre, a cost-sharing contract research programme and procedures for the co-ordination of national research projects. A five-year research programme (1958-1962) was specified in the original Euratom Treaty.

In 1964 the European Molecular Biology Organization (EMBO) was created in order to promote research in molecular biology in Europe. A secondary aim was "the development of a strong transnational approach to molecular biology".[47]

During the 1960s, the presence of a `technological gap' between the USA and Europe, and a `brain drain' or emigration of skilled people from Europe to America was perceived. The 'technology gap' concept was crystalysed by the OECD's Committee for Science Policy General Report which was produced as a result of a request to the OECD by the ministers of science and technology of the member states in January 1966 to study the links between science and the economy. This research pointed out the fact that whilst the U.S. spent 3.4% of GNP on R&D, the average for OECD Europe was only 1.5%[48]. The need for increased cooperation between Member States to meet the challenge was suggested. The OECD report was published around the same time as the appearance in France of the highly influential book by Servan-Schreiber "Le Défi Americain"[49] which highlighted what it termed the invasion of Europe by U.S. business interests and culture.

Both the OECD report and Servan Schreiber's book drew attention to a problem which had already been perceived by policy makers in the Community. The very fact that the OECD report was commissioned by ministers indicated the degree of disquiet already in existence.

'Consolidated Europe', the six member countries that at the time made up the European Economic Community, reacted collectively to this situation and began to develop initiatives to bolster the position of 'European' science and technology, with initiatives that clearly demonstrated that for them the term 'European' corresponded to a vision of 'Europe' that extended well beyond their collective borders to countries situated in geographical Europe but within what might be called their collective sphere of influence.

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47 From the EMBO web site http://www.embo.org/organisation/index.html downloaded 21/10/2003.

48 Sandholtz, W. (1992),op.cit., p.71

49 Servan Schreiber , J.J. (1967) *Le Défi Americain*, Paris: Denoel

In 1964 the Council of Ministers of the six member states of the EEC decided to establish a "Committee for Medium Term Economic Policy". This Committee, in turn, set up in 1965 a working party on Scientific and Technical Research Policy, known as PREST (Politique de la Recherche Scientifique et Technique). In 1967 the first report from PREST, the Marechal Report, proposed European cooperation in seven areas of scientific research: informatics, telecommunications, transport, oceanography, materials, environment and meteorology and to open this cooperation to 13 other European countries outside the EEC. The acronym COST (derived from its initial full title in French of *Coopération européenne dans le domaine de la recherche scientifique et technique*) was chosen to describe this programme. The first 7 COST Actions were eventually adopted at a Ministerial Conference involving the Research Ministers of the 19 COST countries in November 1971.

However, no further COST actions were taken until 1978. COST had been set up as a truly multinational initiative. COST Actions could be established *a la carte* in the sense that any group of COST members could propose a new COST Action on a 'bottom up' basis. This meant that any group of scientists from a minimum number[50] of member countries could propose an Action. Initially, however, in order to obtain funding the Action needed to have both the approval of COST and of the Parliaments of each country participating in the Action. COST approval involved the agreement of the Conference of the Research Ministers of the COST member countries on the basis of a proposal of the COST Committee of Senior Officials. *Juste retour* for the proposed Action was therefore democratically scrutinized at national level, but the procedure made the setting up of a COST Action extremely difficult. It was not until 1978 that the procedure was streamlined as a result of a "Memorandum of Understanding" adopted by the Council of Ministers of the EEC.[51] After that COST Actions came into existence through the signature of a 'Memorandum of Understanding' by the countries involved in the particular Action following approval by the COST Committee of Senior Officials[52]. Once an Action was approved its management reverted to a Management Committee composed of national scientific representatives of the participating countries normally chosen from amongst the scientists involved in carrying out the research, COST created an interesting mechanism for resolving the tension that normally exists between the scientists' need for a simple decision-making process on the basis of scientific need and the policy makers' and public officials desire for procedures that will ensure *juste retour*.

Other research cooperation initiatives proposed after the European Community was created in 1967 by combining the three European Communities (EEC, ECSC, EURATOM) through the 1965 Merger Treaty, had limited success because of the intensely nationalistic nature of the R&D policies of the individual countries.

However, the problem of the competitiveness of European industry was being perceived by the individual countries of the European Community largely in national terms. The result was the development of the "national champion" industrial policies of the 1960s and 1970s which made an effective competitiveness RTD policy at the Community level

[50] Currently this minimum number is 5.

[51] Fedi, F. (2001) 'Thirty Years of COST', Opening Address of the *Telecommunications: Access for All? Conference,* December 3-4, Leuven: Belgium downloaded from http://www.stakes.fi/cost219/procfediThir.doc on 9/10/2003

[52] For a further analysis of the COST procedures see the Appendix 3

difficult to implement. It was not until these "national champion" policies were perceived to fail at the end of the 1970s that the European Commission was able to begin to implement the cooperation policies that had been foreseen in the 1957 treaties.[53]

Meanwhile, the general thrust towards international scientific and technological research cooperation, particularly in the areas of "big science", continued to increase. In 1962 the European Southern Observatory, an astronomical observatory located on Cerro La Silla peak, Chile, was set up by a consortium made up of Belgium, Denmark, France, Germany, the Netherlands, and Sweden[54]. ESO is currently supported by ten countries: Belgium, Denmark, France, Germany, Italy, the Netherlands, Portugal, Sweden, Switzerland and United Kingdom. [55] In 1967 the Laue-Langevin Institute was set up by France and West Germany in order to create a source of neutrons for civil nuclear research. It was eventually also supported by a further 8 countries[56]. In 1974 the European Science Foundation, dedicated to promoting international cooperation in scientific research in Europe, was created. In 1975 a first meeting of European scientists took place to consider the idea of setting up a European synchrotron for the production of hard X-rays. The decision to build the European Synchrotron Radiation Facility (ESRF) in Grenoble was taken in 1984 and ESRF opened its doors to users in 1994. [57]

As we have noted, by means of the Merger Treaty the European Commission had made efforts to establish comprehensive science and technology policies under its own auspices, but these were thwarted by the prevailing nationalistic policies of the member states. Eventually, the Commission, on the initiative of a new Science, Research and Education Commissioner, Ralf Darendhorf, changed its approach and began to try instead to coordinate the research policies of the member states through the setting up of a committee of high level government representatives called CREST (Comité de la Recherche Scientifique et Technique)[58].

An important step in the development of Community policy was the adoption by Council in 1974 of four resolutions in the field of science and technology. These related respectively to the coordination of national science and technology policies, the development of a science and technology action programme, the setting up of an action programme on forecasting, assessment and methodology and the participation of the Community in the European Science Foundation.[59]

In 1975 the Commission attempted to set up cooperation in the field of telematics in order to build up the competitiveness of European industries in this area which had come to be seen as economically crucial. However, its initiatives met with little national support.

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[53] Sandholtz (1994), op. cit
[54] http://www.1upinfo.com/encyclopedia/E/EuropnSO.html downloaded 22/10/2003
[55] http://www.eso.org/gen-fac/eso-info.html downloaded 22/10/2003
[56] *La Recherche* , http://www.larecherche.fr/data/351/03510661.html downloaded on 21/10/2003
[57] Key dates given in the ESRF web site http://www.esrf.fr/AboutUs/CompanyInfo/KeyDates/ downloaded 22/10/2003
[58] ibid
[59] Georghiou, L. (2001) 'Evolving frameworks for European collaboration in research and technology', *Research Policy*, 30, p.p.891-903, p.892

Also national computer companies complained that they had little voice in the preparation of the programmes. As a result the initiatives largely failed[60].

By 1977 there were cooperation programmes in nuclear fusion, biology and radiation protection, applied metrology and Community Bureau of Reference, coal and steel, energy conservation, new sources of energy, plutonium recycling and storage of radioactive waste. However, the link with industrial policy was still not established.[61]

The pressures to establish such a link became stronger as the world recession which followed the OPEC oil price rises intensified after 1974 led to increased international competition. The appointment of Viscount Davignon first as the Commissioner responsible for the internal market and industrial affairs (1977-81) and then for both industrial and science technology policy (1981-1985) constituted an important step in linking RTD and industrial competitiveness policies. It was during the period of office of Commissioner Davignon that the European Round Table of Industrialists was established in 1981. This group of leading European industrialists were influential in getting national governments to support the pilot phase of ESPRIT[62].

There were two collaborative projects aimed at industrial competitiveness initiated in this period which took root and eventually succeeded. The first was in the civilian aircraft industry. European governments had already conceded that national initiatives in this industry designed to increase competitiveness with the U.S. which totally dominated the world market were no longer viable. The Airbus project began with discussions amongst governments, aircraft builders and airlines in 1966. The discussions led to the formation in 1970 of an international consortium, initially involving France and West Germany, later joined by the UK and Spain. Under French leadership, the project eventually gave birth to the Airbus family of aircraft[63]. The first of the Airbus aircraft, the A300B, was launched at the 1969 Paris air show.

The second initiative was in space exploration with the signing in 1964 of the European Launcher Development Organisation (ELDO) and the European Space Research Organisation (ESRO) conventions. In 1974 ELDO and ESRO were merged and the European Space Agency was set up. ESA has since run an impressive number of successful projects[64].

The period of the 1960s and 1970s can therefore be characterised as one in which the importance of international scientific cooperation, particularly in order to meet the challenges from the U.S., became increasingly recognised in Europe but one in which the national obstacles to cooperation largely prevented efforts from yielding generalised results. The few examples of success occurred in areas of “big” science and technology in which a consensus had already been reached that national solutions were not viable. On the other hand, it was in the 1970s that the first steps in the setting up of a European Community RTD cooperation policy were taken.

[60] Sandholtz (1994), op. cit
[61] Georghiou, L. (2001), op. cit., p.282
[62] Georghiou, L. (2001), op. cit., p.893
[63] ibid
[64] ibid

It was not until the 1980s that international cooperation began to take off. However, in order to fully understand the factors that led to this phenomenon, it is necessary to briefly trace the development of research cooperation elsewhere in the world since these eventually also had a significant impact in Europe. Cooperation was becoming a phenomenon affecting most advanced economies, not just Europe.

National collaborative research has a long history in Japan and was initially actively promoted by the Japanese Ministry of International Trade and Industry (MITI). The Japanese VLSI project involving cooperation in semiconductor research between major Japanese firms, initiated by MITI in 1976[65], was widely perceived as being responsible for the international success of the Japanese microelectronics industry with the Japanese coming to dominate the world computer memory market in the 1980s. The general perception in the West of the need to learn from Japanese methods which became generalised in the late 1970s and early 80s[66] led to the importance of collaboration in research becoming more widely recognised. This was reflected by the passage in the United States of the National Cooperative Research Act of 1984 which eventually led to the establishment of the Advanced Technology Program[67]. In addition to promoting for the first time collaborative research between U.S. firms in order to improve their international competitiveness, the policy embedded in this act also constituted a departure from the established view that publicly funded research was appropriate in relation only to academic research or in the area of defence.

By the end of the 1970s, in Western Europe, concern about the growing technology gap with Japan had been added to the previous worry about the gap with the U.S. Between 1982 and 1985, three international collaboration projects were set up with the aim of promoting the international competitiveness of European high technology industries, which by then were being seen as of strategic importance in promoting productivity in most manufacturing industries. They were: ESPRIT (European Strategic Programme for Research and Development in Information Technology) (1982-1994), RACE (R&D in Advanced Communications Technologies in Europe) (1987-) and Eureka (European Research Coordination Agency) [68]. Two of the programmes, ESPRIT and RACE developed under the auspices of the European Commission. The third, Eureka, received a Secretariat independent of the Commission and eventually grew to encompass 33 European countries. All were set up in the shadow of the Japanese challenge. Eureka was in addition influenced by the U.S. Strategic Defence Initiative (the so-called Star Wars) and had a defence dimension. It was also more downstream oriented than either RACE or ESPRIT. Its commercial orientation contributed to it being established outside the framework of the European Commission whose structures were not considered to be suitable to deal with commercially-oriented operations[69].

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[65] Ferguson, C.H. (1983) 'Chips: the U.S. versus Japan', *Technology Review*, August-September, re-printed in Forester, T. (ed.) (1985) *The Information Technology Revolution*, Oxford: Blackwell

[66] de Miranda, A. (2003) 'TQM and inequality: the Triple Helix in historical perspective', *Science, Technology and Human Values*, 28, 1, pp.34-51

[67] Georghiou, L. (1998) 'Global Co-operation in Research' , *Research Policy*, 27, pp. 611-626

[68] ibid and Sandholtz, 1992, op. cit

[69] Sandholtz (1994), op. cit.

The emergence of the European RTD policy

When the pilot phase of ESPRIT was launched in 1983, there was still no explicit Community R&D policy. Research programmes in various areas had been implemented on an ad hoc non-systematic basis, generally in response to a perceived crisis.

The first rationale to justify R&D at the European level was agreed in 1983 in the form of the so-called `Reisenhuber criteria' which were established to provide guidelines on projects appropriate for Community activity[70]. According to these criteria, Community involvement was considered to be justified in the following cases:

- research conducted on so vast a scale that single Member States either could not provide the necessary financial means and personnel, or could only do so with difficulty;
- research which would obviously benefit financially from being carried out jointly, after taking account of the additional costs inherent in all actions involving international cooperation;
- research which complemented work carried out at a national level in a given sector and addressed problems which could only be tackled via the combined efforts of Member States;
- research which contributes to the cohesion of the common market, and which promotes the unification of European science and technology; as well as research that leads, where necessary, to the establishment of uniform laws and standards.[71]

The legal basis of an explicit science and technology policy at the European Union level was first specifically defined in the Single European Act (SEA) of 1987. It was with the passing of the SEA that European Union policy in research and technological development and the commitment to develop cooperation were fully established. The SEA gave the Community new formal powers in the field of research and technology. The 5 year framework programmes were first established in this treaty, as was the setting up of specific activities within the framework. Article 130f of the Act highlighted the need to promote the competitiveness of Community industry at an international level and the need "to strengthen its scientific and technological basis". The article also enshrined the need to promote cooperation by stating that the Community would "encourage undertakings, including small and medium size undertakings, research centres and universities in their research and technological development activities; it shall support their effort to cooperate with one another, aiming, notably, at undertakings to exploit the internal market potential to the full…"[72]. In pursuit of the objective of enhancing the international competitiveness of Community industry, Article 130g also made provision for the "promotion of cooperation in the field of Community research, technological

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[70] Guzzetti, L. (1996) 'A Brief History of European Union Research Policy', Brussels: Commission of the European Communities', October, pp. 71.

[71] UK Parliamentary Office of Science and Technology (1996) Summary of the 'Research and the European Community' Report of POST, downloaded from http://www.parliament.uk/post/pn083.pdf on 19/9/2003

[72] Single European Act of 1986, downloaded from http://www.eurotreaties.com/singleuropeanact.pdf on 13/10/2003, p.15

development and demonstration with third countries and international organisations"[73]. Article 130h required member states to coordinate their RTD policies and programmes and authorized the Commission to promote such coordination. The means the Act established for the implementation of these research and technological development provisions was the setting up of a "multiannual framework programme" (Article 130i)[74] to be adopted by the Council following consultation with the European Parliament and the Economic and Social Committee (Article 130q)[75].

In addition, an important provision was that European Community RTD policy should be coordinated with all other European Community policies concerned with the general well being of citizens and the overall Community goals of cooperation. The overall aim of promoting European economic and social cohesion and reducing disparities between regions and the backwardness of the least favoured regions was highlighted in article 130a and the relationship between RTD and economic and social policy was emphasised by requiring the Council to consult the Economic and Social Committee when deciding on the Framework Programmes.

The Single European Act effectively added "cohesion" to the Reisenhuber criteria. According to Georghiou, the criteria formed the basis for the 'principle of subsidiarity' embodied in the Maastricht Treaty and, at least in principle, mark the delineation between national and Community level policy for the promotion of research cooperation[76].

The Single European Act can be seen as an important landmark in creating an RTD framework for 'institutional Europe'. It also set up an implicit and explicit link between European RTD and foreign policy by requiring RTD policy to promote the *international* competitiveness of European industry and to promote research cooperation with countries outside 'institutional Europe'.

The Framework Programmes

As the previous analysis implies, the development of a European Community RTD policy was primarily the result of efforts by the European Commission. The setting up of intra-European RTD collaboration programmes preceded the establishment of a legal basis for them through the Single European Act. The First Framework (1984-1988) was already nearing completion when the SEA gave the framework programmes legal standing. However, the fact that Eureka was set up outside the control of the Commission demonstrates that the thrust towards international cooperation in the 1980s went wider than the interests of the Commission in promoting European integration.

The First Framework Programme (1984-1988)

With a view to improving co-ordination, the Community launched the First Framework Programme (FP 1) in 1984. The FP1 was the first coordinated RTD policy instrument at European Union level. The Programme was intended to provide a wider framework within which individual programmes could find a place within the overall FPs and interact beneficially with each other.

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[73] ibid, p.15
[74] ibid, p.16
[75] ibid, p.17
[76] Georghiou, L. (2001), op. cit., p.893

Following the introduction of the FP1, the proportion of funding devoted to energy research declined, while research to improve industrial competitiveness rose from 17% to 32% in three years, with more than half of the total going on indirect action rather than being undertaken by the JRC[77].

The Second Framework Programme (1987-1991)

FP2 was designed to respond to the objectives established by the Single European Act, with its stress on research related to the needs of industry and the realisation of the Single Market. 60% of the programme funding was for industrial research; information and communication technologies received a larger support than previously, while the overall importance of energy declined considerably.

The programme also introduced a new theme, 'social cohesion', and the additional criterion referred to `research which contributes to the strengthening of the Community's economic and social cohesion, as well as the promotion of its harmonious and widespread development, while maintaining its consistency with the objective of technical and scientific quality'[78].

The Third Framework Programme (1990-1994)

FP3 overlapped FP2 by two years, to ensure continuity of research for continuing programmes. The share of information and communications technologies actually fell slightly; the share of energy continued to fall, while there was a significant rise in funding for the area of `human capital and mobility', concerned mainly with training initiatives. FP3 specifically identified COST actions as "contributing increasingly" to it. It also determined that links with relevant long term Eureka projects would be established or strengthened.[79]

The Fourth Framework Programme (1994-1998)

FP4 is the first to have followed the Maastricht Treaty of February 1992, which had a significant effect on European research - notably the addition of Article 130f, which expanded Community research from the "scientific and technological bases of Community industry" to include "all the research activities deemed necessary by virtue of other Chapters of the Treaty".[80] Under the Maastricht arrangement, the programme is to encompass all Community RTD activities, whatever their form and whichever common policy they fall under, including basic research, basic industrial research, applied research, technological development, and demonstration projects[81].

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[77] www.europarl.eu.int/stoa/publi/167406/chap1.en_htm

[78] ibid.

[79] "Framework programme of Community activities in the field of research and technological development, 1990-1994" Cordis RTD Programmes Record No. 164, downloaded http://dbs.cordis.lu/cordis-cgi/srchidadb?ACTION=D&SESSION=59412003-10-13&DOC=1&TBL=EN_PROG&RCN=EN_RCN:342&CALLER=PROGLINK F

[80] Parliamentary Office of Science and Technology (POST), Report Summary of "The European Union and Research – EU Framework Programmes and National Priorities", October 1996.

[81] "Framework programme of Community activities in the field of research and technological development, 1994-1998" ,downloaded http://dbs.cordis.lu/cordis-cgi/srchidadb?ACTION=D&SESSION=-1296392003-9-25&DOC =1&TBL=EN_PROG&RCN=EN_RCN:342&CALLER=PROGLINK

The Treaty of Maastricht set down that the objectives of the Framework Programmes should be both competitiveness and cohesion. Cohesion meant that "the Community shall aim at reducing disparities between the levels of development of the various regions, and the backwardness of the least favoured regions, including rural areas" (Article 130(a), Title XIV).

The Maastricht Treaty strengthened the role of the framework programmes by making them the locus for all RTD actions of the Community. It also broadened the scope of Community research policy by allowing them to be directed to support areas of Community policy other than the competitiveness of industrial policy.

In 1993, the concept of the "information society" became enshrined in Community policy through the publication of the influential Delors report. [82] This was closely followed by the publication in 1994 of the Bangemann report[83], following which "building the information society" became a central concern of Community policy[84]. Since the 'information society' was based on the development and diffusion of high technologies, this strengthened significantly the profile of RTD policies within Community policy as a whole, particularly in relation to information and communication technology policies.

FP4 for the first time placed the external relations of 'institutional Europe' prominently on the agenda of RTD policy by making international research cooperation an important part of the programme. FP4 introduced INCO I, the first explicit programme of RTD cooperation with third countries and international organisations, as one of its four central objectives. The programme aimed to respond to a twofold challenge with a clear and coherent international cooperation programme:

1. To coordinate the already existing activities related to scientific and technical cooperation with third countries which were organized either in the context of the previous Framework Programmes or outside it. During the period that these Framework Programmes were running, scientific cooperation was developed as part of the Framework Programmes only with the developing countries, while scientific cooperation with the Mediterranean countries, the Asian countries and the Latin American countries was also taking place outside the Framework Programmes.
2. To deal with the political changes that took place in the Central and Eastern European countries after the fall of the Berlin Wall.

Based on the basic principles of "mutual benefit" and of "subsidiarity", the INCO programme covered four areas:

[82] European Commission (1993) *Growth, Competitiveness and Employment*. COM(93) 700, 5 December

[83] European Council (1994) *Europe and the Global Information Society*. Brussels: European Council

[84] de Miranda, A. and Kristiansen, M. (2000) 'Technological Determinism and Ideology: The European Union and the Information Society', paper delivered at the 3rd. *Policy Agendas for Sustainable Technological Innovation* International Workshop, London, UK, 1-3 December

Cooperation with other European Cooperation Frameworks:

COST (European Cooperation in the field of Scientific and Technical Research), Eureka (A Tool for Industrial Renovation) and certain international RTD organizations.

Cooperation with Central and Eastern European countries (CEC) and with the Newly Independent States (NIS) of the former Soviet Union**:**

INCO - Copernicus (financing and management of joint research activities and joint initiatives) «project by project» participation in certain Action 1 (Erasmus Mundus Masters Courses), Action 3 (Partnerships with third-country universities) and Action 4 (Projects aimed at enhancing attractiveness) initiatives, RTD programmes and possibility of financial assistance and European Union participation in INTAS and ICST.

Cooperation with Non-European industrialized countries**:**

S&T cooperation agreements with third countries (Canada, Israel, South Africa, USA), «project by project » participation in certain RTD strands of specific European Union programs and Japan / Korea research grants

Cooperation with developing countries (DC)**:**

INCO - DC which provides for the possibility of financial assistance being given to developing countries on a « project by project » basis for participation in certain Area 1 RTD Programmes.

INCO had a budget of 575 million ECU, nearly 5% of the total FP4 budget of 11.7 BECU[85].

The Fifth Framework Programme (1998-2002)

The Fifth Framework Programme significantly shifted the emphasis of RTD programmes by strengthening the role of social objectives. FP5 needed to be based on the twin pillars of scientific excellence and social and economic relevance.

Extra-European RTD cooperation policy was developed and reinforced under the Fifth Framework Programme. It highlighted the importance of extra-European Union cooperation by setting up a continuation of INCO I, an INCO II entitled "Confirming the International Role of Community Research", focusing on specific RTD activities relevant to certain third countries or regions and not addressed by other programmes of FP5. INCO II with a budget of 475 million euro had a smaller budget than INCO I, but the role of extra-European cooperation was strengthened by requiring all its other specific programmes to include "an international cooperation dimension which will allow the European research community to benefit from the knowledge and expertise of third countries and institutions, through their participation in projects of the 5th. Framework Programme"[86]. The number of areas covered by INCO II increased to 5, setting in each

[85] CORDIS "Framework programme of Community activities in the field of research and technological development, 1990-1994", Record Control No. 342, downloaded from http://dbs.cordis.lu/cordis-cgi/srchidadb?ACTION=D&SESSION=59412003-10-13&DOC=1&TBL=EN_PROG&RCN=EN_RCN:164&CALLER=PROGLINK_EN13&DOC=1&TBL=EN_PROG&RCN=EN_RCN:342&CALLER=PROGLINK

[86] CORDIS "Framework programme of Community activities in the field of research and technological development, (1998-2002)", Record Control No. 624, downloaded from

region different priorities and rules. Top position in the European Union's research policy agenda was given to research cooperation with pre-accession countries.

Areas covered by INCO II were:

- European countries preparing to join the European Union.
- NIS (former USSR), CEEC not in the pre-accession.
- Mediterranean Partner Countries.
- Developing countries.
- Emerging Economy and Industrialised Countries.

INCO2 is dedicated to co-ordinating its activities with other European intergovernmental organisations involved in research cooperation, COST and Eureka.

ERA and the Sixth Framework Programme

In 1996 the OECD added the concept of the 'knowledge-based economy' to that of the 'information society' through a report with that title. According to this report:

> "Knowledge is now recognised as the driver of productivity and economic growth, leading to a new focus on the role of information, technology and learning in economic performance. The term '*knowledge-based economy'* stems from this fuller recognition of the place of knowledge and technology in modern OECD economies"[87].

Central to the development of the knowledge-based economy is the 'science system'. According to the report,

> "the **science system**, essentially public research laboratories and institutes of higher education, carries out key functions in the knowledge-based economy, including knowledge production, transmission and transfer"[88].

However, in the OECD, the science system is

> "facing the challenge of reconciling its traditional functions of producing new knowledge through basic research and educating new generations of scientists and engineers with its newer role of collaborating with industry in the transfer of knowledge and technology. Research institutes and academia increasingly have industrial partners for financial as well as innovative purposes, but must combine this with their essential role in more generic research and education" [89].

This view of the OECD was incorporated into European policy with the publication in January 2000 of European Commissioner Philippe Busquin's policy document: "Towards a European Research Area"[90]. This document pointed to the significant and growing gap between the European Union and its major competitor economies, namely the U.S. and Japan, in terms of the importance of scientific research. It pointed to the

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http://dbs.cordis.lu/cordis-cgi/srchidadb?ACTION=D&SESSION=59412003-10-13&DOC=1&TBL=EN_PROG&RCN=EN_RCN:164&CALLER=PROGLINK_EN13&DOC=1&TBL=EN_PROG&RCN=EN_RCN:342&CALLER=PROGLINK

[87] Organization for Economic Co-operation and Development (1996) *The Knowledge-Based Economy*, Paris: OECD, p.4

[88] ibid, p.7

[89] ibid

[90] Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions (2000) 'Towards a European Research Area', COM (2000)6, Brussels: Commission of the European Communities

much smaller percentage of GDP which the European Union allocated to research (an average of 1.8%) compared to the U.S. (2.8%) and to Japan (2.9%) and to the evidence that the gap may be growing. It raised once again the issue of the "brain drain" from Europe to the U.S. by highlighting the fact that there are twice as many European higher education students studying in the U.S. than there are U.S. students studying in Europe and that a significant proportion of European students tend to remain for a long time or permanently in the United States. In terms of employment, the report stressed that in Europe there are only 2.5 researchers in firms for every thousand employees whilst the corresponding figure in the U.S. is 6.7 and in Japan 6.0. The report also points to the fact that the trade gap in high technology products between the European Union and the US was Euros 60 billion in 1998, up from Euros 12 billion in 1992.

The report therefore argues that in Europe "the situation concerning research is worrying" and that "Europe might not successfully achieve the transition to a knowledge-based economy"[91]. It also raises concerns with regard to the implications of this situation for employment in Europe by stating:

> "If technological progress creates the jobs of tomorrow, it is research that creates the jobs of the day after tomorrow. The current trends in research could therefore have a negative influence on the development of employment in Europe in the years ahead."[92]

The report further raised questions as to whether Europe possessed the research competencies needed to achieve the transition to a knowledge-based economy. It identified the basic cause behind this anxiety as the compartmentalisation of public research systems and the lack of co-ordination and coherence in the manner in which national and European research policies are implemented.

The concepts developed by the OECD which led Commissioner Busquin to propose the setting up of the European Research Area became central to the overall strategic aim of European policy, set at the Lisbon Meeting of the European Council (23 and 24 March 2000). The aim established by the Lisbon Council meeting was to make Europe *the most* competitive economy in the world, a substantial enhancement of the previous competitiveness policy. The decision to set up the European Research Area was taken as a step in this direction. According to the Presidency Conclusions, paragraph 12:

> "Given the significant role played by research and development in generating economic growth, employment and social cohesion, the Union must work towards the objectives set out in the Commission's communication 'Towards a European Research Area'"[93].

The stress placed on R&D in promoting economic growth, has been given added resonance by the aim of "preparing the transition to a knowledge-based economy and society"[94], also set at the Lisbon Council Meeting.

In pursuit of these overall aims, ERA intends to move the European Union towards:

- a common European research policy;
- a greater *coordination* of national research policies;
- a much greater *integration* of Europe's research efforts and capacities.

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[91] ibid, p.4

[92] ibid, p.5

[93] Lisbon European Council (2000) 'Presidency Conclusions' downloaded from http://ue.eu.int/en/Info/eurocouncil/index.htm on 13/10/2003

[94] ibid, Paragraph 5

In order to help with the common European research policy Commissioner Busquin set up the European Research Advisory Board (EURAB), a group of 45 European experts.[95]

The objectives of the creation of the European Research Area are:

- More coherent implementation of national and European research activities and greater European cohesion in research base;
- Closer relations between the various organisations of scientific and technological cooperation in Europe;
- More coherent use of existing public instruments and resources;
- Create a critical mass of financial and human resources ;
- More dynamic private investment;
- More abundant and more mobile human resources;
- Improving the attraction of Europe for researcher from the rest of the world.

ERA's goals include the harmonization of patent law, support for large-scale infrastructure projects and existing centres of excellence, and the creation of new 'virtual' centres using networking technology.

There are three major policy directions featuring the ERA scheme: (1) concentration of research efforts, resources and means, (2) creation of new means enabling concentration, and (3) fostering researcher mobility.

First, the principle of concentrating the research effort and resources to selected priority fields and to a smaller number of projects was formulated and adopted. Concentration is essential to integrate national potential, achieve the 'critical mass' required by scientific and technological progress in a global world, and to acquire the added value of European research. However this orientation requires a quite difficult political choice which had been largely avoided in previous framework programmes. Owing to the lack of priority setting in the previous European RTD programmes the research effort was considered to have been spread too widely and too thinly. The main strategy of ERA is directed at trying to avoid such problems[96].

Second, new implementing instruments were specifically created to enable concentration of research efforts.

Third, it aimed to stimulate mobility of researchers to train researchers and spread knowledge in Europe. Removing obstacles to mobility, creating equal conditions and opportunities for scientists throughout the European Union, the harmonisation of social-security rights, and mutual recognition of degrees and diplomas were given a high priority.

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[95] http://www.cordis.lu/era/eurab.htm downloaded 22/10/2003

[96] Anon (2000) 'Europe frames fresh funding initiative for research', Nature 410, p.4.

The Sixth Framework Programme (2002-2006) in the context of ERA

FP6 is being formulated according to radically different governing hypotheses in order to achieve greater focus and a better integration of research efforts on the basis of an improved partnership between the various actors in the ERA. This followed a negative conclusion of the Davignon panel which carried out in 1997 a 5 year review of the Framework Programme:

> "In the Panel's view, the Framework Programme is not fulfilling its promise. It lacks focus and is underachieving. This is not the fault of individuals but of a structure which inhibits the formulation of real strategy and makes effective implementation difficult."[97]

Underlying these plans was a determination by Commissioner Busquin to move away from non-scientific agendas and to foster world-class RTD collaborations. Thus, the Sixth Framework Programme aims to boost big science[98]. Commissioner Busquin hopes the new scheme will help to integrate research capacities across Europe and pave the way for a pan-European research area. "Ostensibly" gone from his plan is *cohesion*, whereby laboratories from less-well-developed countries are included in collaborations thanks to affirmative action[99].

The main focus of the FP6 is the creation of a European Research Area as a vision for the future of research in Europe. It aims at scientific excellence, improved competitiveness and innovation through the promotion of cooperation, greater complementarity and improved co-ordination between relevant actors, at all levels.

FP6 is thoroughly re-designed in the light of the project to develop the European Research Area. It was designed above all to be a structuring *instrument* for realising the new scheme. As a result it features two major innovations: concentration on a few priority areas to achieve a critical mass of finance and knowledge, and creation of new implementing instruments, namely *networks of excellence* and *integrated projects* of a much larger order of magnitude than previous Community research projects, and the possibility of providing European support for *joint research* initiatives by several Member States[100].

The new research programmes aim to address the following issues:

- insufficient and dispersed investment;
- insufficient human resources in research;
- limited capacity to translate scientific breakthroughs into innovation and competitive products and services;
- fragmentation of research policies in Europe.

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[97] Davignon, E. et al (1997) '5 year assessment of the European Community RTD Framework Programmes', Brussels Commission of the European Communities quoted in Georghiou, L. (2001), op. cit., p.900

[98] Framework programme aims to boost big science, Nature 411 (2001), p.626.

[99] Anon (2002) 'Summits that matter', Nature 415, p.457

[100] 'Sixth Framework Programme (2002-2006): European research steers a new course', interview with Philippe Busquin, April 3, 2002, European Research News Centre. Downloaded from: http://europa.eu.int/comm/research/news-centre/en/pol/02-03-pol01.html.

To address these issues, the new framework programme is organised around 3 targets:

1. Focusing and integrating European research.
2. structuring the European Research Area;
3. strengthening the foundations of the European Research Area.

The activities carried out under the first heading are intended to assemble a critical mass of resources and support a high level of integration of research capacities in Europe in areas of the particular importance for the competitiveness of European industry or the major political and social implications of the issues in question. Seven priority thematic areas have been selected. These will receive eighty percent of the funding available (13,345 million euro)[101].

The priority thematic areas are:

- genomics and biotechnology for health;
- Information Society Technologies;
- nanotechnologies, intelligent materials and new production processes;
- aeronautics and space;
- food safety and health risks;
- sustainable development;
- citizens and governance in the European knowledge based society.

The second heading covers “Research and Innovation”, “Human Resources and Mobility”, “Research Infrastructures” and “Science and Society” (2,605 million euro). 1,580 million euro will go to Human Resources and Mobility, a considerable increase compared to FP5. The objective of activities in this area is to stimulate technological innovation, utilisation of research results, transfer of knowledge and technologies and the setting up of technology businesses in the European Union regions[102].

The third heading covers support activities, co-ordination and coherence of development of policies (320 million euro). The objective in this area is to stimulate and support programme co-ordination and joint actions among Member States and among European organisations as well as to develop the common knowledge base necessary for coherent development of policies. The activities may be implemented in any scientific and technological area including the thematic priority domains.

In the FP6, priorities have been reduced to better focus on progressive integration of activities. Instead of supporting large numbers of unrelated projects, FP6 will fund a much smaller number of large, integrated projects. The average size of Framework grants—previously around 1.5 million euros per project—will rise by an order of magnitude. The average size of a project in FP6 could be up to 10 times the size of an FP5 project, and the Commission intends that this will lead to a drop in the number of proposals received by a factor of up to 20 in comparison with FP5. To attract Europe’s

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[101] Decision No 1513/2002/EC of the European Parliament and of the Council of 27 June 2002 concerning the 6th framework programme of the European Community for research, technological development and demonstration activities, contributing to the creation of the European Research Area and to innovation (2002 to 2006), Official Journal of the European Communities, August 29, 2002.

[102] Ibid.

best scientists to the FP6, the Commission has also suggested ways of simplifying grant application procedures and project management[103].

New Instruments of the FP6

There are five instruments in the FP6 of which three are new, and two are "traditional" as they are similar to those in FP5.

- Integrated Projects (new);
- Networks of Excellence (new);
- Participation in national programmes carried out jointly (new);
- Stairway of excellence (traditional – specific targeted research projects and co-ordination actions as in FP5);
- Specific support actions (traditional – as in FP5).

The new instruments are the means to implement research in the *priority thematic areas* of the FP6, and are characterised by their capacity to mobilise a critical mass of expertise and by the structuring and integrating effects they are expected to have on European research.[104]

The Integrated Project (IP)

IP is a strategic grant designed to boost the Community's competitiveness or to help solve major societal problems by mobilising the necessary critical mass of RTD resources and competence. Medium and large size projects will be supported.

IPs will be implemented in seven priority thematic areas to support directly objective-driven research. They must contain a research component and may contain technological development and demonstration components as well as a training component. They will have clearly defined objectives in the transfer of S&T knowledge and shall be directed at obtaining specific predefined results in terms of products, processes or services. FP6 will strongly support industrial participation in large 'integrated' projects[105].

Networks of Excellence (NoE)

NoEs are primarily created to address the fragmentation of European research and strengthen excellence on particular research topics by networking resources and expertise. A NoE will have a joint programme of activity, consisting of at least three components: a programme of jointly executed research; a set of integrating activities; and activities designed to spread excellence. FP6 will provide a fixed grant for creation

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[103] Europe frames fresh funding initiative for research, Nature 410 (2001) 4. Also, European Framework Programme takes shape, Loughborough University, UK (2002) downloaded from: www.lboro.ac.uk/service/ero/fund/fibapr02/european.htm.

[104] ibid.

[105] Integrated Projects, compiled by the European University Association, downloaded http://www.europea.eu.int./comm/research/nfp/pdf/provisionsimplementingip-28022002.pdf, 28 Feb. 2002. For FP6 instruments: Towards the Sixth Framework Programme, European Commission Research DG, June 2002 was also referred.

of network as an incentive to attain lasting integration of research activities in a specific topic. This instrument aims to make the best use of Europe's research resources[106].

The stress on the Centres of Excellence and their networking is clearly aimed at concentrating resources in cutting-edge research where the competition with the U.S. in particular is seen to be most important. It also hopes that the overall level of bureaucracy and the bureaucratic burden on the Commission will be reduced by transferring a large part of the administration of the programmes to the Centres of Excellence leading each of the Networks. Each large-scale network will be funded with as much as 20 million euros over five or more years.

Networking of national programmes (Article 169)

In order to construct the European Research Area, the European Union member states were called to progressively open their national research programmes to European participation. This instrument aims to integrate several national programmes on a particular topic and bring them to a European-level of research. Joint implementation of national/regional programmes e.g. through harmonised work programmes and common, joint or co-ordinated calls for proposals, will be possible through this arrangement[107].

"Article 169" refers to an article in the updated Treaty of Rome that enables the Community to participate in research programmes undertaken jointly by several Member States or Associated States. Article 169 was available for use in previous framework programmes, but has not been used so far. It is therefore a new attempt at creating research competencies through co-ordination of national efforts.

By contrast to IP and NoE instruments which are designed to integrate individual researchers' competencies, projects under Article 169 is a fusion of several national level research programmes, and will be much bigger in scale than the IP or NoE projects. Its use therefore will be restricted to research initiatives that are beyond the scope of the IPs or NoEs.

Cohesion in FP6

The fundamental difficulty of the European Union's procedure is to keep a fair balance between long-term goals and political realities which are always in conflict. Leading scientific European Union nations, for instance, are pleased with plans to support fewer, larger projects and delegate much of the management to the labs involved. But the Central and Eastern European nations intending to join the European Union (and who already participate in Framework) complain that this will cut them out of the picture. They argue that the FP6 favours countries that already have a strong science base[108]. Successful integration of these nations, meanwhile, is a major component of the ERA

[106] Networks of Excellence, compiled by the European University Association, downloaded http://www.europea.eu.int./co (2002)mm/research/nfp/pdf/provisionsimplement-net-excel.pdf, 28 Feb. 2002.
[107] FP6 Instruments, compiled by the European University Association, downloaded http://www.europea.eu.int./ eur-lex/en/com/ene/2001/com2001_028en01.pdf., 2001.
[108] Anon (2001) 'Eastern Europe decries EU research proposal', Nature, 411, p.512.

proposal. Thus FP6 confronts the same old dilemma of the previous European Union programmes, that they must serve a multitude of masters with divergent demands from widely disparate national innovation systems[109].

Cohesion will become a more current and complicated issue with the enlargement of the Union. While in the FP5, 'cohesion' concerned Greece, Portugal, Ireland and Spain, fairly homogeneous political and cultural background nations in the EU, the new comers of the Central and Eastern European nations will increase heterogeneity in the EU, with average GDP per capita 40% less than that of the present 15 Member States, 8 out of 10 countries entering the European Union in 2004 are former Communist bloc countries, with the whole 10 countries' scientific knowledge production not even attaining the level of Spain alone. Meanwhile disparities among different countries and regions in the present Member States have not yet disappeared[110].

Cohesion policy is no longer as explicit in the mainstream FP6 orientation, and it is dealt with under the international activities of the FP6. It has been in sort mixed into the "enlargement" policy. In the FP6, *competitiveness* has been given priority, and it is to develop in a more straight forward manner, whereas *cohesion* gave away to the higher political priority of integrating new countries into the EU. Thus, the specific 'competitiveness/cohesion combination' mode of European style cooperation has somewhat changed, and competitiveness is pursued by the more 'standard method' of concentration of resources and competencies. 'Enlargement' has received a central attention, and international RTD policy has been formulated with a great emphasis on the enlargement/integration. Thus the ERA scheme became fairly Eurocentric, based on concentration and integration.

This new orientation however does not resolve the need of a cohesion policy in the overall ERA scheme. The development of the R&D infrastructures cannot be completely left to the Structural Funds, for with the decentralised granting of the Structural Funds, there is a danger of fragmentation of efforts and funding principles[111]. There is still a need to launch new types of initiative to enhance development in less developed regions countries.

Opening of national programmes

In FP6, national funding agencies are asked to open their programmes to researchers Europe-wide. However, one of the reasons why research has not been co-ordinated at the European-level until now is precisely because national governments cautiously guard their right to make most of the big research funding decisions. The European Union's research directorate has had a hard time bringing coherence to European science.[112] 95%

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[109] Anon (2001) 'Storm clouds over Brussels', Nature, 411, p.871

[110] Okubo Y. (2001), The European Union's Policy for Enhancing Global Competitiveness: Development of a European Research Area, The Journal of Science Policy and Research Management 16, No. 3/4 133-149.

[111] Luukkonen, T. (2001), 'Old and new strategic roles for the European Union Framework Programme', *Science and Public Policy*, 28, 3, pp. 205-218

[112] Anon (1999) 'Research Chief wants to make science matter', Science 286, pp.2065-2067.

of science in Europe is still funded and conducted in single nation states. Governments and funding agencies supervise their spheres of influence to their specific clients[113].

Thinking in the European Union is still dominated by the notion of *juste retour*, in which participation in European Union programmes is proportional to financial contributions. All states try to get back what they have paid in. Whether the European Union's member states will ever put the goal of continental cohesion in science ahead of their individual national interest is an open question. To break free from such limitations, the Community promotes a flexible approach in which individual research agencies of the member states, with or without the involvement of the European Commission, are encouraged to come together to support projects of mutual interest in an application of the 'variable geometry' principle – countries participate in European actions on a voluntary basis with a lack of any obligation to include partners from a particular country for reasons of political or financial equity. But depending on such initiatives of each Member State is an ambiguous procedure, hindering the Commission from envisaging any long-term activity. In addition, there is a danger of putting weight on the variable geometry principle without a veritable cohesion policy. Well connected labs in scientifically large nations will surely benefit the most, and the small groups in research-limited countries can be technologically excluded[114]. In reality few policy makers or scientists have a clear idea of how this principle could be translated in practice[115].

Besides, there is insufficient incentive to integrate national funding efforts. There are no policy instruments to force national research agencies to collaborate. It lacks a powerful legal mechanism[116]. In fact, the ERA lies in the 'willingness' of national officials and representations of pan-European research organisations to turn their enthusiastic statements into action. The single European research area is a noble goal, and FP6 is a major opportunity in that direction, but it would be unwise to rely too much on the goodwill of the member states[117]. The European Union's Framework research programme is primarily concerned with making Europe more economically competitive and inevitably gets influenced by the political agendas of member states. If the heads of state don't also provide high-level backing, both for the Commission and within their own countries, Europe's technological and scientific competitiveness seem certain to weaken in the longer term.

International Cooperation in the Sixth Framework Programme

Intra-European research cooperation is central to the concept of the European Research Area. However, there is a shift of focus for this cooperation in relation to previous policies. In particular the strengthening of the policy of concentrating resources in order to achieve *excellence* in the priority research areas and of developing *networks of excellence* in order to make Europe the global leader in those areas will have major

[113] Anon (1999) 'Implementing the European Research Area, Science 295, (2002) 443.
[114] Georghiou L. (2001), 'Evolving frameworks for European collaboration in research and technology', *Research Policy* 30, 891-903.
[115] Anon (2001) 'Storm clouds over Brussels'), *Nature* op. cit.
[116] Anon (2001) 'Science sans frontiers', *Nature,* 413, pp.768-770.
[117] Anon (2002) 'Strategy for Framework 6', *Nature*, 407, pp.545.

implications for researchers throughout Europe, particularly for those left out of those networks. The Commission has attempted to deal with the obvious problem that concentration of resources on major players potentially contradicts the aim of fostering *cohesion* by requiring the *Networks of Excellence* to spread excellence beyond their boundaries[118].

A shift in the focus of intra-European cooperation is the desire to create coherent common research infrastructures. A key step in this direction has been the creation of EIROforum. The EIROforum is a collaboration between seven European intergovernmental scientific research organisations that are responsible for infrastructures and laboratories. The EIROforum members are: European Organisation for Nuclear Research (CERN), European Fusion Development Agreement (EFDA), European Molecular Biology Laboratory (EMBL), European Space Agency (ESA), European Southern Observatory (ESO), European Synchrotron Radiation Facility (ESRF), Institut Laue–Langevin (ILL). The relationship of EIROforum to the overall aim of ERA is made clear in the EIROforum and is described in its own web site:

> "As world leaders within their respective fields of science, the seven member organisations of the EIROforum constitute the vanguard of European science, enabling European scientists to engage in truly cutting-edge research and be competitive on a global scale"[119].

Extra-European Cooperation

Research cooperation that is international from the point of view of 'Consolidated Europe' has been strengthened in FP6 as a contribution to the concept of 'an ERA open to the world'[120]. Such cooperation in FP6 has a number of different objectives:

1. *Enabling European research to benefit from the knowledge and expertise of third countries and institutions*.

The instrument for achieving this is the creation of an international dimension in all the thematic fields of the specific programme "Focusing and integrating Community research" as well as in the "Specific activities covering a wider field of research" which will enable third country researchers to participate. This falls in the category that has been previously identified as the fourth layer of foreign policy expressed in the RTD programmes, in which the RTD aims predominate over those of foreign policy. €285m has been earmarked for this in the "Specific activities covering a wider field of research" specific programme and in the 'Thematic Priorities'.[121]

2. *Supporting the Community's external relations and development aid policies*.

This enables the continuation of what has been identified as layers 2 and 3 of foreign policy as expressed in RTD programmes. €315m have been earmarked for the purpose of

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[118] CORDIS: What is FP6?: Instruments: Networks of Excellence http://www.cordis.lu/fp6/instr_noe.htm downloaded 22/10/2003.

[119] http://www.eiroforum.org/ downloaded 21/10/2003

[120] EC (2003) 'Compendium of work programme extracts concerning international co-operation throughout Framework Programme VI', ftp://ftp.cordis.lu/pub/fp6/docs/inco_compendium_sp1_0703.doc downloaded 13 March 2004

[121] ibid, p.2

supporting the participation of developing countries, Mediterranean countries, the Western Balkans, Russia and the NIS.

3. *Supporting the international mobility of researchers* in the context of the specific programme "Integrating and strengthening the European Research Area". This aims to attract to Europe the best and most promising researchers from third countries as well as promoting the training of European researchers abroad.

Although the programme states that it also aims to "help ensure Europe's strong and coherent participation in research initiatives conducted at international level in order to push back the boundaries of knowledge or help to resolve the major global issues"[122] the means by which FP6 hopes to achieve this are not clear.

Conclusions

The question of what constitutes 'international' research cooperation and what is 'foreign' policy in the context of a 'Europe' that is composed of individual nations but which has also an institutionalised existence in the organs of what is currently the European Union is a complex one. The concept of 'Consolidated Europe' was introduced to describe the countries which have been bound together by the various European treaties since the Treaty of Rome and which currently make up the European Union. 'Institutional Europe' was used to refer to the organs of Consolidated Europe. From the point of view of Consolidated Europe intra-Consolidated Europe research cooperation is not considered as international. However, the RTD programmes of Consolidated Europe have a foreign policy dimension insofar as they include relations with countries and scientists beyond its borders. An analysis of the international cooperation dimension of these programmes and of European international research cooperation programmes set up outside the auspices of 'institutional Europe' by groups of individual countries demonstrated that there is a consistent expression of European foreign policy across both types of programmes. Thus the notion of 'Europe' and of European foreign policy is owned both by 'institutional Europe' and by the individual nations that make up 'Consolidated Europe'.

The analysis of the relationship between foreign policy and research policy as expressed in European RTD programmes led to a 6-layer model:

The first layer of the policy is expressed through the way those countries which at any time are designated as accession countries are integrated. Here the main aim was to start to support the integration of those countries and promote eventual cohesion of the expanded 'Consolidated Europe'.

The second layer of 'foreign' policy expressed in the FP regarded the special place that the remainder of the countries of 'Greater Europe' have in the external relations of Consolidated Europe. RTD policy towards these countries follows the dual 'foreign' policy aim of supporting these countries towards a possible future integration and the wider aim, which also constitutes the next layer, of helping to ensure friendly relations with, and stability in, the countries which border Consolidated Europe.

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[122] Sixth Framework Programme: Specific measures in support of international co-operation (INCO) Work Programme SP1-10, p.4 http://www.mcyt.es/vipm/pdf/indice/l_wp_2002_en.pdf downloaded 21/10/2003

The third layer of foreign policy regards stability and friendly relations with countries in the neighbourhood of Consolidated Europe.

The fourth layer of 'foreign' or 'external relations' policy regards the economically advanced countries. Here the predominant aim is not derived from 'foreign' or 'external relations' policy but from RTD policy. It is that of supporting the 'excellence' of 'European' science and technology by accessing the most advanced knowledge that exists outside its borders. This, in turn, is expected to help enhance the competitiveness of 'European' industry.

The fifth layer concerns the relations of 'Consolidated Europe' with the developing countries. Here again the 'foreign' policy aims prevail, in this case that of helping the development of these countries.

A sixth layer of foreign policy expressed in RTD policy concerns emerging nations. In relation to these countries the aim is both for European science to take advantage of their fast developing scientific capacities but also to help strengthen the relationship with countries whose influence on the global stage is rapidly increasing.

The analysis of the historical evolution of European research and technological development policies with specific reference to international research cooperation reveals a number of clear features:

1. The initial impetus towards international cooperation, dating back from the immediate post-World War II period, came from scientists involved in "big" basic science research fields requiring resources that were beyond the capabilities of individual countries. They were enabled through ad-hoc consortia of countries who wished to respond to the "bottom up" initiatives[123]. Such initiatives gave rise to all seven of the European research institutions which today make up EIROforum. However, there seems to have been no acceleration in the rate of formation of this type of organisation over time. They are almost all related to the physical sciences, particularly Physics and Astronomy. These institutions all addressed what might be described as research *problems of scale*. The one exception was the European Molecular Biology Organisation.
2. "Top down" intra-European international cooperation began largely as result of concerns about the competitiveness of European industry with regard first to the U.S. (late 1960s) and later to Japan (late 1970s), particularly in industries considered as key to economic growth, such as information and communication technologies.
3. The early efforts in the 1960s to respond to competitiveness worries at the European rather than national level were led by the European Commission, but met with considerable obstacles because national governments conceived of the problem largely in national terms, except in the case of "big technology" where it was already clear that the financial and technological resources required were beyond the capacity of individual nations. Such was the case of civilian aerospace and space research.

[123] "Bottom up" initiatives are defined as those that are initiated by the scientists themselves and "top down" initiatives as those that have been set up by policy makers to suit policy objectives.

4. The effort to develop "top down" research cooperation in the key information and communication technology industries, pre-competitive but downstream, eventually succeeded as a result of a coordination of research and industrial policy supported by top industrialists through the European Round Table of Industrialists. ESPRIT was an early expression of this and it involved academic scientists in universities and public laboratories and researchers in private companies.
5. A tension developed early as to who should drive and coordinate "top down" international cooperation which mirrored the perennial European dichotomy between an "institutional Europe" and the individual countries of 'Consolidated Europe'. The European Commission is seen as the main repository of the federal forces and policy makers from member states often favour initiatives where individual nations retain their autonomy. This tension was played out in relation to the setting up of Eureka. Eureka developed as an autonomous project involving cooperation between individual European nations rather than a Community project despite the Commission's efforts to become its coordinator. COST, although initiated by the Community, also developed outside its structures. The co-existence today of intra-European Union research cooperation coordinated by the Commission and wider European initiatives such as Eureka and COST is seen as an obstacle to the development of a coherent RTD policy.
6. The Reisenhuber criteria attempted to define clearly what R&D should be conducted at European rather than national level. It reserved for the European level, research problems of scale beyond the capacity of individual nations, problems which would benefit financially from being addressed internationally after the transaction costs of cooperation were taken into account and research that can only be undertaken by a combined effort of the Member States and which complemented national research. It also sanctioned to be carried out at European level any research which contributes to cohesion and which promotes the unification of European science and technology and the setting up of common laws and standards. The Fifth Framework Programme added to these criteria research which contributed to the social objectives of the Community. ERA has attempted to encompass these in the concept of research which contributes to "European added value". However ERA appears to remove the explicit need to address social and cohesion objectives, subsuming these in a vague clause which states that it is legitimate to support at European level research that "links with the Union's priorities and implementation of its policies"[124].
7. The significance of RTD policy and of international cooperation has been enhanced by the adoption in general European policy of the theories of the "information society" and of the "knowledge-based economy" which emphasise the important role that technology, particularly ICTs, and knowledge generation play in the development of the modern economy and society.
8. Extra-European cooperation in European RTD policy has been mainly directed at:

[124] 'What is the ERA?: What European added value?' http://euoropa.eu.int/comm/research/era/leaflet/en/era04_en.html downloaded 22/06/03

- supporting the aim of achieving excellence in the priority research areas. This in turn is implicitly and explicitly linked to the overall aim established by Lisbon Council of making the European economy the most competitive economy in Europe. The FP6 measures for supporting the international mobility of researchers and for improving the conditions of research and researchers in Europe can all be understood in this light.
- Supporting the aims of European Union external relations policy.

9 Whilst globalisation is seen in general terms as an important driver of change, the implications of this are not systematically addressed in European RTD policy. Research is becoming an increasingly important tool of international cooperation, i.e. foreign policy[125]. However, mechanisms for organising multilateral global scientific cooperation and international scientific advice are still lacking in the Community. A strategy for European participation in the solution of global *problems of scope* and global *problems of scale*[126] appears to be absent from European RTD policy. The GLOSPERA case studies all represent in one way or another examples of such problems. European participation in them has been either left to individual countries (HGP, IPCC[127]) or developed in an ad-hoc way (IMS, HFSP). The case studies also demonstrate that there are increasing "bottom up" pressures for pushing the boundaries of science through international cooperation. These will continue to build up as more of what are seen by scientists as the fundamental problems of their science become problems of scale or problems of scope. As the economy and society is seen to become increasingly dependent on the production of leading-edge scientific knowledge, so the political influence of scientists and technologists will increase. The concept of "global added value" might be relevant here. However, the self-interest of nations and the desire for *juste retour* create powerful barriers to the development of appropriate mechanisms for developing international research cooperation for the solution of global problems.

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Sharp, M. (1998), 'Competitiveness and cohesion-are the two compatible?' *Research Policy* 27, 569-588.

[125] Linkohr R. (Rapporteur) (2003), 'Investing in research: an action plan for Europe', Committee on Industry, External Trade Research and Energy, European Parliament

[126] *Problems of scope* are problems which transcend national and even regional boundaries. Climate, atmospheric and marine pollution, fisheries and conservation problems are examples of problems which are often problems of scope. See Sandholtz (1994) op. cit.

[127] In IPCC the European Union has observer status

APPENDIX 3 - SUMMARY OF KEY ORGANISATIONAL ARRANGEMENTS OF SOME EUROPEAN INTERNATIONAL RESEARCH COOPERATION INITIATIVES

COST

COST was an early expression of pan-European international research cooperation to improve the international position of Europe's science and technology. It was a proposal of 'Consolidated Europe', the six EEC countries, but it was set up as a result of a conference of the research ministers of 19 European countries in 1971.

COST operates as a *concerted action* international collaboration research programme *a la carte*. There is no central budget to fund research activities. These are funded out of the national research budgets of the countries participating in a particular COST Action. Procedures ensure that if a new Action is approved by COST centrally, the necessary resources from national budgets will be guaranteed. The *a la carte* principle means that COST member countries are able to choose which Actions they participate in.

A new COST Action is initiated *bottom up* by a group of scientists from at least 5 countries that are COST members. A COST Technical Committee composed of national representatives expert in the area covered by the Action both advises on the completing the proposal and evaluates the proposal in an advisory capacity to the COST Committee of Senior Officials (CSO). CSO is mainly composed of the COST National Coordinators. These are the representatives of the COST countries governments to COST. CSO is the decision making and the highest organ in COST. Members of the Technical Committee are appointed by the National Coordinators.

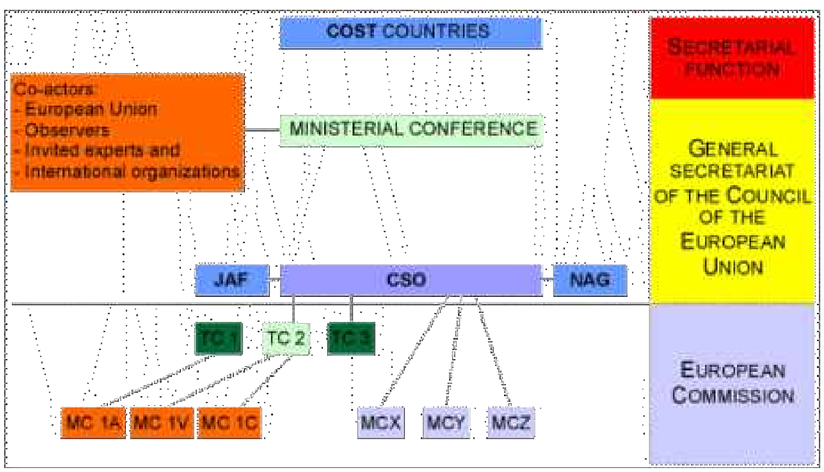
The COST Action comes into force when the interested countries sign a 'Memorandum of Understanding' supporting the Action. Approval of a COST Action through the 'Memorandum of Understanding' is meant to commit the various governments involved to providing the necessary resources. It is the responsibility of the relevant National Coordinators to ensure that the funds are actually forthcoming. The National Coordinator is normally an official of the Science and/or Research Ministry of the relevant country.

Each Action, once approved, has its own Management Committee composed of one or two scientific experts representing the countries participating in the Action. They are normally participants in the research activities of the Action. This ensures that day to day management of the Action is in the hands of the researchers and minimises bureaucracy associated with ensuring *juste retour,* which the researchers often resent claiming that it takes up time which could be more profitably spent carrying out research. Once the Action is under way, the Technical Committee plays the role of quality control and assessment.

The role of central COST structures is therefore mostly that of coordination. The central budget is provided mainly by the European Union through the Framework Programmes, most recently through INCO. However, this is a relatively small sum. In 1998 it amounted to 16 million ECU[128]. More recently it has been estimated that a central COST expenditure of between 15 and 25 millions of EURO has levered several billions of EUROs in research per year and succeeded in networking between 20,000 and 25,000 scientists across the 34 COST countries.[129] Until recently the European Commission provided the Scientific Secretariat. Under a recent agreement, this is being transferred to the European Science Foundation but its budget will be provided as a grant from the budget of the "Coordination of Research Activities" programme of FP6. The grant to COST will be at least 50 M€ and up to 80 M€.[130]

Various evaluations[131] of COST have reported considerable satisfaction of the researchers participating in COST Actions with the operation of COST. In general COST is seen as more flexible and less administratively burdensome than the European Framework Programmes. However, the application of the Framework Programme administrative rules to the administration of the relatively small amount of COST central funds which cover such costs as international meetings are still seen as producing undue bureaucracy.[132]

COST contains an expression of European foreign policy which largely fits the model developed in a previous appendix of this report. Although it is an inter-national collaboration research programme, it aims to support European science and technology. The 34 COST countries which are full members of COST represent largely Consolidated Europe's vision of Greater Europe. Israel is included as a Cooperating State.[133]



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128 Nissinen, M. and Niskanen, P. (1999) *COST-Scientific Co-operation on Researchers' Terms*, Technical Research Centre of Finland (VTT) Publication 388

129 Busch, N.E. et al (2002) 'An assessment of COST' a report with recommendations presented to the COST Committee of Senior Officials downloaded from http://www.bib.fsagx.ac.be/coste21/ftp/report/assessment-2002-03-07.pdf on 3 February 2004

130 http://www.cordis.lu/coordination/cost.htm dowloaded 3 February 2004

131 See, *inter alia*, Busch, N.E. et al (2002) *op. cit.*; Nissinen, M. and Niskanen, P. (1999) *op. cit.*; PREST, CSIC/IESA, ESSOR, ISI, NUTEK/TEPKOL (1997) 'COST Evaluation', Unpublished document.

132 Busch, N.E. et al (2002), *op. cit.,*

133 Israel's role in European RTD policy is dealt with at greater length later on in this document.

ESPRIT

ESPRIT (European Strategic Programme in Information Technologies) was an initiative of 'institutional Europe'. It was the first European RTD initiative specifically aimed at improving the competitiveness of European high technology industries. It was established in the period after Étienne Davignon became Commissioner for Industry in 1977. Davignon also took over the portfolio for science and technology policy in 1981. In 1979-80 Davignon set up the European Round Table of Industrialists made up of the heads of 12 major European ICT companies. This group was crucial to the setting up of ESPRIT. The industrialists were instrumental in pressurising their respective national governments into supporting the programme. ESPRIT was designed to involve European large companies, SMEs, universities and research institutes in developing cutting edge pre-competitive but downstream research in ICTs.

The pilot phase of ESPRIT was launched by the European Commission in 1982 with funding of 11.5 MECU from the European Community. This phase attracted over 200 proposals from 600 companies and institutes with a combined value of 50 MECU. Thirty eight projects were chosen by the Commission, with the advice of a senior executive committee that included national IT officials. Approximately 70 percent of the funds ended up going to the Twelve Roundtable companies that had prepared the program and were thus already in a position to submit relevant proposals. The ESPRIT budget was managed by the Commission.

ESPRIT I (1984-88) began with a total budget of 750 MECU, the sum that had been requested by the Commission.

The Commission had overall responsibility for managing the program. It did so through its Information Technology Task Force (ITTF), a body which was initially independent of the Commission's Directorates, but which later became DGXIII. ESPRIT also had three other administrative bodies, the ESPRIT Management Committee (EMC), the ESPRIT Advisory Board (EAB), and the Steering Committee. The EMC was made up of two representatives from each of the member governments. The EMC had the final power to approve all projects and was required to approve (by qualified majority) each project worth 5 MECU or more. This was the process by which *juste retour* could be scrutinised by the member governments. However, Sandholtz argues that *juste retour* was never an issue in ESPRIT.

The EAB was the body made up of researchers participating in ESPRIT and played a technical advisory role. Its 16 members were appointed as high level experts on a personal capacity. Initially half the members worked for Round Table companies, the other half for SMEs, universities and research laboratories.

The ESPRIT Steering Committee had the remit of outlining the work plans every year and had a substantial input from the Round Table companies. The work plans were then fleshed out by technical panels.

The proposals submitted had to fit the criteria established by the work plans. This made ESPRIT a largely top down programme. Review committees made up of technical experts appointed by the Commission through the ITTF evaluated the proposals and submitted a short list to the ITTF. Following a review of the short list by members of ITTF and additional appointed experts, the Head of ITTF made a final list of projects to be submitted for approval to the EMC.

The following extracts from Sandoltz's book make the remaining arrangements clear:

"Once projects receive approval, the Commission signs a contract with each consortium partner. When the contract is signed, the consortium receives an advance of 30 percent of the Commission contribution. The partners are jointly and individually liable for fulfilment of the terms of the contract. One of the partners serves as the consortium leader (or manager) and acts as liaison for the project with the Commission. Within the ITTF a number of project managers keep tabs on an assigned set of projects. Each project manager must submit a monthly report on activities and progress. A larger evaluation involving outside experts retained by the Commission takes place every six months at the Commission, not at the work sites. Further disbursal of EC funds depends on satisfactory evaluations.

Regarding intellectual and industrial property rights, contractors in a project have equal ownership and equal rights to exploit the results, with specifics to be agreed on among themselves. Participants in different ESPRIT projects have privileged access to the results of another project if those results would enhance their ESPRIT work. Other EC companies can acquire the rights to knowledge generated in ESPRIT on a regular commercial basis. The Commission retains the right to require an ESPRIT participant to grant licenses if it does not wish to exploit results itself."[134]

The first mid-term review of ESPRIT concluded that ESPRIT was a considerable success. It was estimated that international cooperation added overhead costs (travel, coordination) of about 10 to 20 percent of project costs, but that nevertheless cooperative R&D was more beneficial than isolated efforts. ITTF management of the programme was deemed extremely efficient and at least as efficient as national research programmes. Nevertheless there were complaints by researchers about the bureaucracy involved in administration, particularly the cost of putting together the proposals and the requirement for monthly reports. This lent support to the view expressed during the setting up of Eureka that the Commission was an inappropriate body to manage downstream European RTD programmes (see below).

ESPRIT II (1987-80) was set up as part of the Second Framework Programme (FP3) (1987-91) following the Single European Act (1985) which had given the Commission the role of encouraging industrial R&D. The budget for FP2 proposed by the Commission

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[134] Sandholtz, W. (1992) *High-Tech Europe: The Politics of International Co-operation*, Berkeley: University of California Press, p. 183-4. Most of the information in this section came from this book.

for FP3 was 10.3 BECU, a substantial increase on the 3.7 BECU budget of FP1. However, following opposition from several countries, particularly the UK, it was eventually approved at 5.2 BECU. Of this, 1.6 BECU had been allocated to ESPRIT.

Countries belonging to the European Free Trade Association (EFTA) were allowed to participate not just as subcontractors (as under Phase I) but as contracting partners. Non-EC partners would have to pay their own costs plus, when appropriate, a share of the operational expenses. ITTF became DGX13.

ESPRIT III (1990-94) had a decreased budget of 1.35 BECU partly because by then Eureka was under way. Coordination with Eureka and in particular JESSI was a condition imposed by the Council when approving the programme[135].

ESPRIT I was essentially an intra-European research collaboration programme and as such did not contain any foreign policy dimension. The first layer of foreign policy began to be expressed in ESPRIT II when the inclusion EFTA countries was proposed, but this was a very restricted concept of "European industry". The strict definition of "European" was expressed in the rules regarding the international diffusion of the research results. IBM Europe, which had been allowed to participate as a European firm because it conducted research activities in Europe, complained that it was not allowed by ESPRIT rules to pass on research results to its U.S. parent. One of its executives complained that "the discriminatory provision in the Commission research contract that prohibits the dissemination of confidential information into affiliated companies residing outside the European Community, if the parent company is not EC based. . . . It means that Bull can transmit confidential information to Zenith, or Philips to Signetics, but that IBM France cannot transfer information to IBM in the United States, nor can IBM Germany or IBM Italy for that matter"[136]

The final call of the ESPRIT programme had a deadline of June 1998. It was replaced by the IST Programme in FP5.[137]

[135] Peterson, J. and Sharp, M. (1998) *Technology Policy in the European Union*, Basingstoke: Macmillan

[136] quoted in Caldwell Harris, M. and Moore, G. E.(Eds) (1992) *Linking Trade and Technology Policies-An International Comparison of the Policies of Industrialized Nations*, Washington, D.C.: National Academy Press, p.136

[137] http://www.cordis.lu/esprit/

EUREKA

Eureka is a European programme which promotes European cross-border research cooperation between industry and academic research institutions and which thus "contributes to the competitiveness of European industry on the world marketplace"[138]. It was the initiative of President Mitterrand of France in 1985 and was set up in response to the U.S.'s Strategic Defence Initiative (commonly known as Star Wars). The fear was that SDI would increase the gap which already existed between Europe and the U.S. in high technology industries as U.S. government subsidies to these industries would translate into commercial advantages in the market. A further worry was that SDI would also act as a magnet to European scientists and lead to an acceleration of the 'brain drain' from Europe. Eureka was approved in 1986 by a conference of 17 nations.[139] These included both EEC countries and countries outside the EEC and the initiative corresponded to a Greater Europe vision of what could be included in the term "European industry"[140].

In the negotiations that led to the setting up of the programme, an early issue was the role to be played by the European Commission. The Commission argued, through its President Jacques Delors, that it should play a major role in Eureka and was supported by the smaller EEC countries that saw the Commission as providing some protection from the domination of the large countries. However, the 3 largest countries, France, Germany and the United Kingdom, were adamantly opposed to this and had the support of countries outside the EEC.[141] They wished to avoid too much power in the area of research and technological development being concentrated in the hands of the Commission, which was already playing a major role in both ESPRIT and RACE and was running the recently established Framework Programme. However, another important reason was that Commission procedures were seen as too bureaucratic to administer a downstream research programme with commercial implications.

The founding ministerial conference for Eureka was held in Paris on 17 July. The seventeen countries that took part, represented through their foreign and research ministers, were the 10 members of the EEC plus Spain, Portugal, Sweden, Norway, Austria, Finland, and Switzerland. The EC was also present. It can therefore be seen that at this stage Eureka was seen as an expression of the 'Greater Europe' vision of the time[142].

The 'big three' favoured a decentralised administrative structure with minimum bureaucracy. This view prevailed and Eureka became a 'concerted action' programme with a central coordination, approval and evaluation mechanism but with research funding provided largely from the national budgets of participating countries rather than a central budget.

The procedural mechanism adopted early on by Eureka is made clear in the following extract from Sandholtz's book:

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[138] http://www.eureka.dlr.de/en/eureka/profile.html downloaded 7 February 2004

[139] Sandholtz, W. (1992) *op. cit.*

[140] See Appendix 2 of this Report for a more detailed discussion of this issue.

[141] Sandholtz, W. (1992), *op. cit.*

[142] See Appendix 2 of this report for an explanation of this concept.

"The process for launching a Eureka project is as follows. Each country appoints a High Representative to coordinate Eureka work in her country. Once firms or institutes have agreed on a project, each one approaches the Eureka coordinator in its home country. Each coordinator verifies compliance with Eureka objectives and criteria and informs the other national coordinators of potential projects. Once all the participants have earned the Eureka approval of their home governments, the High Representatives meet as a group to inform the Eureka Council of Ministers (consisting of representatives of the national governments and the Commission) of the approved projects. The Council of Ministers, the highest executive body, therefore merely announces the projects that have already been approved. The High Representatives also prepare the meetings of the Council of Ministers, which has a rotating chair … the Secretariat comprised seven administrators (plus a small secretarial staff), headed by the Frenchman Xavier Fels. The four largest EC countries and the Commission would each contribute 13.7 percent of the operating costs of the Secretariat, with the remainder shared by the other countries."[143]

Eureka takes a 'bottom up' approach. Project ideas can be sent to the Eureka secretariat which will then forward them to the national secretariats of the countries involved. Following appraisal, the project is then submitted to the High-Level Group for a decision, after which it can be launched. New projects to be supported by the member countries are announced at the annual ministerial conference.

The lack of central funding "freed the programme from the blight of *juste retour*"[144].

Various assessments saw Eureka as a very successful programme. Sharp and Peterson (1997) consider that Eureka's 'bottom up' methodology is particularly suitable for programmes in biotechnology or environmental technologies which are likely to lead to 'basic technological research' which enhance the internal research skills of firms. Indeed, they go so far as to suggest that the Eureka methodology should supersede the 'top down' methods which have become "familiar and rather comfortable for the Commission"[145]

Amongst Eureka's greatest successes was the Joint Sub-micron Semiconductor Initiative (JESSI) which is credited with being responsible for returning European firms to the forefront of the world semiconductor industry. Half of the costs of JESSI were born by the participating firms, 25% by the national governments of the participating countries and 25% by the European Commission from Framework Programmes budgets[146].

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[143] Sandholtz, W. (1992), *ibid*, p. 282

[144] Review of Peterson, J. and Sharp, M. (1998) *Technology Policy in the European Union*, Basingstoke: Macmillan, *Euroabstracts* , February 1999, http://www.cordis.lu/euroabstracts/en/february99/feature1.htm downloaded 7 February 2004

[145] Peterson, J. and Sharp, M. (1998) *Technology Policy in the European Union*, Basingstoke: Macmillan, cited in Lundvall, B-A and Borrás, S., 1997, *The globalising learning economy: Implications for innovation policy* DG XII, Commission of the European Union, page 87.

[146] Hobday, M. (1995) 'The technological competence of European semiconductor producers', *Working Paper Number 11*, Brighton: Sussex European Institute http://www.sussex.ac.uk/Units/SEI/pdfs/wp11.pdf

JESSI also was the object of a controversy around what constitutes ‘European industry’. When the British computing ‘national champion’ ICL was taken over by the Japanese company Fujitsu in 1991, ICL was excluded from further participation in JESSI.[147]

Eureka could be seen as an initiative of ‘Consolidated Europe’. Its main driver was France following a particular vision of the interests ‘Europe’. The dominant players became the national governments of the 3 largest countries of the EEC. It became institutionalised outside the framework of ‘institutional Europe’. Its inter-governmental administrative and ‘concerted action’ structure made it an inter-national programme. However, ‘institutional Europe’ was a significant player in its own right through the direct representation of the European Commission in both the High Level Group and in the Ministerial Conference and through its contribution to research funding as the example of JESSI demonstrates. The complex interrelation between the inter-national and the ‘institutional Europe’ expression of European interests is a constant dimension of all policies.

The foreign policy dimension to the programme expresses the modulated approach of ‘Consolidated Europe’ RTD foreign policy with its first layer supporting the cohesion of Greater Europe. An element of foreign policy which does not quite fit the model is the inclusion of Israel in Eureka. In 1998 Israel was proposed to join Eureka and became a full member in 2000. A paper circulated in 1998 by Manuel Marin, European Commissioner responsible for Middle East affairs, to the EU's Council of Ministers sought to create linkage between Israel's participation and the Middle East peace process.[148] Israel had for a long time held a special position in European foreign policy in general and RTD policy in particular. The first Cooperation Agreement between the EEC and Israel dated back to 1975 and Israel had entered the Fourth Framework Programme in 1996.

The European foreign policy dimension of Eureka continues with its current expansion to include the Mediterranean countries.[149]

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[147] Caldwell Harris, M. and Moore, G. E.(Eds) (1992) *op. cit.*, p.136

[148] Anon (1998) ‘Israel expects invitation to join eureka R&D program’, *Computergram International*, April 23, http://www.findarticles.com/cf_dls/m0CGN/n3396/20517223/p1/article.jhtml downloaded 7 February 2004

[149] See Appendix One of this Report for an explanation of the European foreign policy model.

APPENDIX 4 - CASE STUDIES

Human Frontier Science Program (HFSP)

BACKGROUND

In the 1980s, Japan was severely criticized by the international community (especially the USA), for being a free rider in relation to basic science- for using “basic scientific knowledge" created by Western nations for its own technological development without, in return, making commensurate contributions to the accumulation of the world's scientific knowledge. The Japanese government decided that it should respond to such criticisms. One such response was represented by IMS (see separate report) and the other was HFSP.

HISTORY

In 1986 a feasibility study was carried out by leading Japanese scientists under the auspices of the Japanese Prime Minister's Council for Science and Technology, to explore possible means of encouraging international collaboration in basic research. A wide range of sciences including environmental and earth sciences w ere considered and examined closely. It was decided that the proposed program should concentrate on basic research on complex mechanisms of living organisms, specifically the human brain. Discussion was expanded from Japan to include scientists from the G7 summit nations and the European Union, resulting in the "London Wise Men's Conference" in April 1987, which endorsed the suggestion.

Nakasone, the Japanese Prime Minister, decided that the Venice Economic Summit in June 1987 presented an ideal opportunity for proposing the concept of the Program formally. Japan noted its desire to increase its contribution to international basic research. The Summit partners and the Chairman of the European Community welcomed the Japanese initiative and decided that it should be implemented as soon as possible

At the “Wise Men’s Conference” composed of scientists from the summit nations held in Bonn in 1988, it was decided that the Program should promote international basic research on the brain and the molecular mechanisms of biological functions by awarding research grants and fellowships through international peer review and by staging frequent workshops An International Scientists Committee representing the seven Economic Summit countries and the European Commission defined the Program's organization and its activities, research areas and selection procedures. It also decided that the headquarters would be located in Europe. At first, the Japanese government planned to locate the office in Switzerland, but the summit nations objected. London, as an English speaking city with a long tradition of scientific research, soon became the strongest candidate for the location of the Secretariat. However in February 1989, President Mitterand proposed to the Japanese Prime Minister Nakasone that the Secretariat should be located in France

This personal intervention by the French President influenced the Japanese government. The French national government and the local government in Strasbourg offered financial support, the government contributing $1.6 million a year partly as a quid pro quo for the Strasbourg location (Maddox, 1992 and interviews).

Intergovernmental conferences were held in 1989 in Tokyo and Berlin which resulted in endorsement of the plan by the participating governments. It was agreed to implement the HFSP for an initial experimental phase of three years. In order to ensure a timely start, Japan agreed to contribute significant funding to the HFSP during this initial three-year phase, with the remaining support coming from other partner countries termed the Management Supporting Parties (MSPs). Agreement was also reached at the Berlin meeting to locate the Secretariat at Strasbourg. The peer review process was established and the first awards were made in 1990. HFSP was the first international grant-making research organization where scientists' applications for funds were subject to peer review. (Rall, 1993)

An Intergovernmental Conference was held in Berlin in June, 2002. It considered that the scientific value of the HFSP warranted its continuation for a further five years. A working group was set up to consider the future finances, status and scope of the program. These are due to be discussed at the next Intergovernmental Conference to be held in Switzerland in 2004.The participating governments agreed that the aims, objectives, and mission of the Program would "continue to be the provision of a unique and important contribution to fundamental research of the highest quality, based on international peer review. The representatives reaffirmed the value of the Program's emphasis on interdisciplinary science, encouragement of researchers early in their careers who are expected to play an important role in originating creative research, and international and especially intercontinental collaboration, including training and mobility. In this respect, new initiatives introduced such as the Young Investigators' Grants, and the Career Development Awards are particularly welcome." (Joint Communiqué, 2002, interviews).

OBJECTIVES

The Human Frontier Science Program is an international research-funding program, supported by nine governments, to support the neurosciences and molecular biology in two areas: brain functions; and biological functions, using molecular level approaches... (Wagner et al, 2002). The main intention of the HFSP is to foster intercontinental collaboration in fundamental research on biological functions, through a program based on international peer review. Molecular biology and neuroscience are both undergoing radical transformation. Increasingly molecular biologists are moving from the study of one or two molecules in isolation to the exploration of complex systems. Similarly, in neuroscience, there is a melding of approaches that unites the study of single molecules and neurons with system-wide approaches. HFSP aims to be at the forefront in the development of a new interdisciplinary language of living systems. In addition, it has several subsidiary goals such as involving younger researchers.

BUDGETS AND FINANCIAL CONTRIBUTIONS

HFSP currently has an annual budget of about $50 million. The following Tables show the dominance of Japan's financial contributions, which rose from nearly $10 million in 1989 to more than $30 million in 1993 to a peak of $37 million in 1997, staying at around that level until 2001, dropping back to $31 million in 2002.

In 1997, Japan was still contributing 80 per cent of HFSP's budget. After 1997, the contribution of MSPs other than Japan increased while the Japanese contribution stabilised. In 2000, the Japanese share of contributions still amounted to 75 per cent of the total, and continued to fall. However, even in 2002, Japan still provided 64 per cent of HFSP's total budget. The USA's contribution has risen quite rapidly in recent years, but only accounted for $8.6 million, 19 per cent of HFSP's budget in 2002.

In principle, contributions are determined by states' GNP. In Europe, the Economic Summit countries pay their own contributions to HFSP, but the EC contributes on behalf of the other EU member states. In 1993, the combined GNP of these (then) eight member states was about equal to the GNP of France or Germany, but the EU contribution to HFSP was far less than that. Accordingly, the EC agreed to increase its contribution to HFSP in 1993-94 to bring its contribution into line with the major EU countries. Between 2001 and 2002, there was a substantial increase in the EC contribution which reached $2.73 million in that year, bringing the total EU contribution including France, Germany and the UK to nearly $8 million - 17 per cent of HFSP's total budget - not far short of the contribution by the USA.

Table 1: Contributions from MSPs in US$million per fiscal year at budget exchange rate

FY	Canada	France	Germany	Italy	Japan	Switzerland*	UK	USA	EU
1989	–	0.46	–	0.02	9.94	–	–	–	–
1990	0.20	1.65	0.29	0.33	28.95	–	–	–	–
1991	0.00	1.62	0.91	0.44	28.44	0.40	–	0.04	0.15
1992	0.40	1.32	0.77	0.19	29.57	0.40	0.51	0.04	0.18
1993	0.33	1.25	0.81	0.18	31.30	0.40	0.54	3.50	0.91
1994	0.54	1.56	0.99	0.18	34.01	0.40	0.59	3.50	1.11
1995	0.53	1.74	1.22	0.19	35.65	0.59	0.58	3.50	1.00
1996	0.26	1.37	1.17	0.18	36.73	0.51	0.63	4.00	0.92
1997	0.25	1.47	1.02	0.17	37.38	0.53	0.76	4.00	0.87
1998	0.45	1.70	1.25	0.29	35.84	0.58	0.76	4.50	1.11
1999	0.44	1.75	1.60	0.29	35.77	0.61	0.75	5.00	1.68
2000	0.45	1.58	2.10	0.26	37.38	0.55	0.75	5.50	1.52
2001	0.51	1.16	2.20	0.68	37.05	0.52	0.80	7.39	0.87
2002**	0.83	1.60	1.75	0.00	31.25	0.64	1.60	8.60	2.73

The figures for contributions up to FY 1999 are earmarked. From FY 2000 to FY 2002, real payments are given.
*****Switzerland became an MSP in 1991*
******payments received as of the end of FY 2002 (exchange rate, 31.03 2003)*

Table 2: **Evolution of Expenditure on awards (in US$million)**

FY 1990	10.40
FY 1991	24.28
FY 1992	29.83
FY 1993	34.86
FY 1994	39.67
FY 1995	40.23
FY 1996	41.06
FY 1997	42.85
FY 1998	43.29
FY 1999	42.63
FY 2000	44.86
FY 2001	45.98
FY 2002	51.20

Source: HFSP Annual Report 2002-3 pages 47 and 48

OPERATIONS

The primary mechanisms through which the HFSP carries out its mandate is through providing:

Research grants to international joint research teams working in one of the two main research themes. There were 4,098 applications between 1990 and 2001 and 529 awards, the average success rate for applicants being 12.9%. In Award Year (AY) 2001, out of 1,299 applicants in 386 applications, 208 (16%) were female. Out of 185 awardees in 53 awards, 18 were female (10%).

Long-term fellowships for young scientists to allow them to stay for up to two years in top-flight international research laboratories, working with leading researchers, coming in contact with other disciplines, learning state-of-the-art laboratory techniques, and so forth. The fellow must either be from an MSP country or intend to work in a laboratory in one of the member countries. There were 7,284 Long-Term Fellowship applications and awards applications from 1990 to 2001 and 1,630 awards, with the average success rate being 22.7%. Of the 665 applications for 2001, 37% of the applications were made by female candidates and 63% by male applicants. Out of the 81 awards offered in March 2001, 31% were offered to female applicants and 69% to male applications.

Short-term fellowships for up to three months at research institutions abroad, which allow scientists to become familiar with novel equipment or techniques, initiate new projects, make contacts, and so forth. Eligibility rules are the same as for long-term fellowships (in 2002-3, short term fellowships accounted for less than 1.5 per cent of HFSP total fellowship expenditures).

Workshops for various purposes, especially those focusing on interdisciplinary topics. (ARA/PREST 1996 pages 1-4,)

ADMINISTRATION

The Board of Trustees has overall responsibility, and the Council of Scientists is responsible for the scientific program. Both consist of two members from each of the MSP countries. In addition, there are four Review Committees, one each for research grants and fellowships in each of the two main research areas. These Review Committees, with the assistance of external reviewers who participate by post, carry out the peer reviews of applications. The Secretariat in Strasbourg manages administration. (ARA/PREST 1996 page 6)

The HFSP Secretariat is headed by a Secretary General (SG) who is required to have a wide knowledge of science and the ability to move the major program into these areas. It is not a major administrative job, but one that requires intellectual leadership. Any of the HFSP member countries may nominate candidates, who are screened by the Council and voted on by the Board of Trustees. (Tocchini-Valentini, 1992 Swinbanks et al 1992)

The HFSP Secretariat consists of assistants (permanent) and directors who are on short term contracts. The Secretariat currently consists of 13 people, who aim to secure maximum efficiency while keeping running costs to a minimum.

HFSP devotes only 5% of its budget to overhead costs. Technology is used to the maximum extent possible. For example, submission of a letter of intent for grant applications has been set up recently using the HFSP web site so as to speed up the initial review procedure. Each member of staff tries to resolve problems by him/herself whenever they arise.

Secretariat Personnel are linked together within the Secretariat (not all of them are always in Strasbourg), and with the outside world through the internet. The Secretary General is often away but is in touch frequently with the staff in Strasbourg.
Three Auditors conduct the internal auditing on the financial status and activities of the HFSP. They are appointed by the Board of Trustees. Their task is to ensure that the system does not rely too much on one particular person (interviews).

Interviews tended to confirm that the selection process for awards was highly regarded by applicants. While the processes for processing grant applications are now regarded as generally very satisfactory, there were some early problems. For example, it was reported in 1991 that MITI researchers and many others at national research laboratories were deterred from applying by extremely rigid bureaucratic regulations. (Swinbanks 1991a and 1991b)

Typically, HFSP funds three year research projects. The application procedure starts with the applicant sending in a short proposal via the Internet. The applicant receives a response two months later. Some applicants - typically about 20% are selected at this stage and invited to send a complete proposal of about 15 pages. About half of the full grant applications are funded. Overall, about 12% of those submitting short proposals are funded. The whole process from submission of short proposal to award of grant only takes six months. The rapidity of the selection process is one of the remarkable elements of the HFSP. In addition, its flexibility, simplicity, efficiency, effectiveness and transparency are extraordinary. In comparison, it took a year and a half to receive the results of an application for a 5th Framework Program (FWP) research grant. (Interview: A recipient of Neuroscience Research Grant)

It is easy to apply to the HFSP. It does not require a detailed 3-year research plan. Fundamental research should be imaginative and it is impossible to write a very detailed 3 year plan for it. The simplicity of HFSP's application form is remarkable. When you are doing basic science it is impossible to predict concrete results, spin -offs and socio -- economic impacts and the application form does not require these. Researcher B's project was "risky" -it might be successful and it might fail. This risk was clearly stated in the application and, nevertheless, the project received the award. The competition is severe, but once awarded, there is no further HFSP evaluation. Production of a scientific publication is required and this will be evaluated only by the scientific community. If it is poor, then it is liable to prejudice future award of HFSP funding. HFSP applicants receive results 6-7 months after the submission of an application. This allows scientists to start a project when they want, an idea can be tested remarkably quickly backed by adequate funding The budget is extremely flexible -researchers are given freedom on how to use the money, and if the budget is not used within the specified three years, the project can be extended by up to 12 months. There is also flexibility in relation to the purchase of equipment. (Interview B: recipient of Molecular Biology grant)

Two interviews also made it clear that HFSP was very helpful in bringing together large research teams:

There are significant advantages in drawing from an international pool of talent when one is constructing large research teams. Being able to draw on research collaborators from a broader basis than the national basis and get international post doc students increases the pool of talent that one is drawing from. This advantage is less pronounced though when dealing with small teams. (Interview C: anatomy scientist)

HFSP is basically 'fantastic' and the outcomes have certainly served to benefit European Science. One of the great virtues of the HFSP is its support for 'risky' science. In contrast, the EU is not very interested in this kind of science. Promotion of 'risky' science' is of enormous European benefit. Additionally, the manner in which the HFSP promotes larger networks between Japan, the US and the EU ensures that a whole series of wider institutional relations and research networks are established which are of immense long term benefit to European science. (Interview D; Molecular structure scientist)

The Project Review Process. There are two Review Committees: one for fellowships and one for research grants. Until 2001 the review committees were composed of 18 reviewers, 2 from each participating nation. They are composed of international scientists who are experts in relevant fields. Evaluators are independent and are free from any national political influence. After the HFSP decided to fuse Molecular Biology and Neurosciences into a single program, six supplementary reviewers were added to each Review Committee. These extra reviewers may be from any country, even from non-member countries. Evaluation for the research grants and fellowship applications is thereby now undertaken by 24 experts.

In the case of research grants, each full application is viewed by two experts from the Committee and by at least two external experts. External reviewers are chosen by the Directors of research grants from the HFSP database of mail reviewers, and from suggestions made by the applicants and the review committee members. Applicants are asked to suggest 6 referees which they find appropriate. The return rate of evaluation comments from experts being approximately 50%, applications are sent to 4-5 reviewers to obtain at least 2 written review comments. 3-4 weeks are accorded for external review. Assignment of applications to reviewer committee members is done by the Directors of the HFSP. It is Directors' task to choose appropriate reviewers for each application.

The selection procedure is simple. Until 2001, the HFSP received about 3-400 Research Grant applications per year. As a consequence of concern about the small size of grants and low success rate deterring excellent scientists from applying, HFSP introduced a two-tiered application process in 2001. A relatively small proportion of initial applicants are now invited to complete full applications, and the average size of grants to those selected to complete full applications is larger. More emphasis is being given to supporting interdisciplinary collaborations that represent new departures for the teams involved. (Wiesel, 2000).

External reviewers write comments, which are taken into account by the Review Committee members in their evaluation. The final recommendations are made by the Review Committee as a whole at the annual meeting. The Review Committees rank applications according to the scores given by its members and will recommend the projects to be awarded to the Council of Scientists, who formally make the decision on the selected applications. The final decision is then taken by the Board of Trustees taking into account the funds available.

In the case of Fellowships, the procedure is similar, but the evaluation is performed entirely by the Review Committee members without external reviewers. The Review Committees meet once a year for the evaluation. Scientists feel it their duty to participate and are honoured to be invited.

The evaluation meetings provide referees with excellent opportunities to broaden their perspectives -for example by getting a first look at leading edge science proposals - and discussing them with other high calibre scientists of various disciplines. The Secretary General and the Directors share responsibility for selecting appropriate people to appraise proposals. Review Committee members are appointed by the Council of Scientists, advised by the Secretary General and the Directors. Reviewers are given a one year contract, renewable for another three years.

Recommendations are made at the Review Committee meeting. Many experts taking part in the Committee are influential and charismatic. Ensuring that the meeting is well chaired is one of the key conditions for good evaluation. The chairman's most important responsibility is to prevent one powerful person from dominating the meeting. He must control and seek balance in discussion. The selection of Chairmen is critical, and it is essential that s/he understands HFSP policy. Chairmen are chosen carefully by the Council of Scientists on the basis of consultation with the Secretariat.

Selection of a research project in a rapidly evolving field needs to be carried out as quickly as possible. Applicants for Fellowship grants receive the result within seven months. However, in the case of Research Grants, it takes about a year from the submission of the letter of intent to the final decisions on awards. Recently the HFSP evaluation process was modified by setting up a two-step procedure to allow a stronger focus on applications fulfilling the aims of the Program, and to increase the success rate of those invited to submit a full application. Applicants send in a letter of intent to the HFSP website. If this is accepted, they can send in the formal proposal.

It was decided at the Council of Scientists and Board of Trustees meetings in March 2001 that Research Grants may not be renewed in order to avoid the Program become "a club" – always the same researchers receiving grants – and to ensure a reasonable distribution of HFSP's limited funds to obtain funding for the following year. These reports are examined by the Directors.

The First Annual HFSP Awardees Meeting was organized by the HFSP in Turin, in June 2001, in order that the awardees (of both Research Grants and Long-term Fellowships) can meet and exchange information. The objective of this meeting is to foster interaction among awardees and create opportunity for setting up new collaborations among participants from different fields. It offers excellent young scientists, who are potential future research grant awardees, an occasion to be well informed of the Research Grant Program in addition to entering into the "network" of worldwide top level scientists. Three days were devoted to oral presentations and sessions for discussing ongoing work with colleagues. Such a meeting contributed in creating a sense of community among awardees.

The evaluation concept has changed somewhat in the last ten years. The HFSP started by making great efforts to select good applications. Very little evaluation was undertaken at the end of research projects. The underlying understanding is that the research is very basic and the outcome can be judged only on scientific impact which is likely to come much later. The grants are only for three years. If the result proves to be of a low quality or inadequate, the awardees are not allowed to apply for another grant. (interviews).

POLICY

Issues related to the overall policy of the Program are addressed to the Council of Scientists and to the Board of Trustees. Formal decisions are made at Board of Trustees' meetings. For example, the Board of Trustees decided in March 2001 on the fusion of two programs (molecular biology and neuroscience) into a single, unified program (complex living organisms). This issue was discussed in detail by the Council of Scientists and their decision was ratified by the Board of Trustees. In practice, problems pertinent to the function of the organization are generally resolved at the local level.

Maintaining the interest of participating nations in the Program is one of the issues that concern the Board of Trustees. Issues such as finance and budget of the HFSP in the future concern each nation directly, while management issues are dealt with at the Strasbourg office. In order to deal with budget issues, each participating nation must send a representative to the Board of Trustees who has the authority to decide on relevant financial matters or who is at least in a position to negotiate with administration at home. A high priority for the Board of Trustees is to maintain commitment of countries to the Program. (interviews)

PERIODIC REVIEWS OF THE HFSP PROGRAM

An Intergovernmental Conference was held in Tokyo in 1992. The Conference recognised the achievements made in the initial phase of the Program and the desirability of continuing HFSP. It was decided to carry out a general review of the program of both scientific and organisational aspects. The review was carried out by an international panel of eminent scientists and by external, independent organisations specialising in scientific policy and evaluation and completed in 1996. The conclusions of the 1996 review were very positive and emphasized in particular that:

- HFSP grant holders find the Program a unique source of support for inter-continental interdisciplinary research;
- New collaborations vital to the execution of the research are created and continue after the project;
- The Fellowship Program is one of a number of outstanding programs;
- For both grants and fellowships, HFSP publications have citation performance well above the norm. (Joint Communiqué, 2002).

The 2001 review considered the impact of the Program on the career paths of grants holders and long-term fellows and assessed their scientific achievements through questionnaire survey and a bibliometric analysis. It reached very positive conclusions similar to those of the 1996 review. As far as university scientists are concerned, the grants program is unique. "It supports interdisciplinary, intercontinental research teams that are virtually impossible to create through other funding mechanisms. These collaborations are facilitated by the funding available for face-to-face meetings, travel and visits to other laboratories, and the flexibility of the program in allowing the funds to be used for many purposes. Much of the HFSP research would not have been done at all without the award" … Many grant holders believe that HFSP grants provide superior support to younger scientists….The fellowships have played a major role in encouraging interdisciplinarity and the flexibility of the program in allowing the funds to be used for many purposes. (KPMG et al 2001, pages 40 and 41)

HFSP grant holders regarded the Program as a unique source of support for intercontinental interdisciplinary research. 89% of grant holders were not aware of alternative sources of funding and nearly half (47%) could not have performed the research at all without HFSP support; a further 36% would have been unable to work with the same partners. New collaborations are created which continue after the project, thus building an intercontinental community of researchers. There was a general agreement (83% of grant holders) that their collaboration was either important or critical to the achievement of their own research. The Fellowships are not unique but are one of a number of élite schemes that together ensure that fellows who wish to work in the best laboratories in other countries are able to do so. Half the fellows were aware of other programs that could have supported their research and 44% thought that, without HFSP, they would definitely have secured a position in the host laboratory supported from another source. However, in the great majority of cases the superior terms offered by HFSP made it the first choice of fellows. Career benefits to fellows are evident, including maintenance of links with the host laboratories after they have moved on.

For both grants and fellowships, the top HFSP publications have a citation performance well above the norm**.** Citation rates for publications of grant holders and fellows are as much as 26% and 21% better, respectively, than citations of other papers in the same journals. Compared with other papers by the same authors, their citations were up to 88% and 109% better, respectively. Nevertheless, these findings have to be treated with some caution, insofar as research has shown that internationally co-authored papers are more highly cited than other papers. The enhanced citation of papers which arise from international collaborations might not be attributable entirely to the benefits of international collaboration, but could rather be because the individuals and institutes involved in the collaboration were an elite group which might have performed better than others even in the absence of international collaboration. HFSP Annual Report 2002/3; KPMG et al 2001, Wiesel, 2000, Luukkonen, et al, 1992)

DISTRIBUTION OF BENEFITS BETWEEN COUNTRIES

By 1997, while Japan was still contributing 80% of the total budget, Japanese scientists only received 7 per cent of the awards. Other countries, most notably the US, received far more in grants than they contributed. While Japan seemed to have a good case for seeking larger contributions form other participants, many participating countries considered that spending on their own national research programmes represented a better use of funds. (Nathan, 1997)

Over a 10 year period, 52% of fellows returned to work in their home country, 32% were still based in the host country (usually the USA) and 16% were in a third country. HFSP is concerned with the effects of its Fellowship programs in causing "Brain drains" -the emigration of a nation's most talented young scientists and engineers to a few highly-developed countries, particularly the US and is concerned with the high proportion of HFSP fellows who go to laboratories in the United States. Until recently, about 70 % of fellows choose to study in the United States. This is positive insofar as the U.S. is an international resource for basic science training, but about half of HFSP fellows studying in the U.S. stay in the U.S. after their fellowships are completed, primarily because of lack of career prospects and opportunities to interact with other scientists in their home countries. However, in the last two years, nearly 15 % fewer fellows chose to train in the U.S., and the number of U.S. students seeking training abroad has increased. (HFSP Annual Report 2002/3; KPMG et al 2001, Wiesel, 2000)

PRACTICAL APPLICATIONS OF HFSP RESEARCH AND INDUSTRIAL PARTICIPATION

HFSP primarily supports fundamental research and does not get involved in Intellectual Property Right (IPR) issues. So far there have been few practical applications. These have mainly related to instrumentation.

Examples include:

"New understanding of the disease process in the central nervous system is being applied to the study of patients with genetic diseases."

"This was a basic research project. Its importance relates to our understanding of diseases such as diabetes and oncogenicity".

"The aspect of our project, which is already commercialized, includes some monoclonal antibodies offered by several companies" (HFSP 2001)

CONCLUSIONS

Initially, like the IMS programme, HFSP was initiated by Japan to counter the perception in major Western countries -particularly the USA- that Japan was using basic science developed elsewhere in the world to support its industries which were becoming increasingly dominant in world markets. The *juste retour* sought by Japan in initiating the programme was originally alleviation of the perception that Japan was "free loading" on basic science mainly created in the West. Resentment of Japan, if unadddressed, could have resulted in retaliatory actions, e.g. erection of trade barriers -which could have led to severe consequences for Japanese industry. However, soon after HFSP was initiated, Japanese industry began to suffer severe damage to its international competitiveness. This virtually destroyed the original case for Japan to make contributions to HFSP which were disproportionate to the benefits it received directly from the programme. Accordingly, Japan has been struggling to reduce its contributions to HFSP, and its case for so doing is now generally recognised by other countries on grounds of *juste retour*.

HFSP is a distributed research programme designed and managed by scientists but with a central organisation in Strasbourg. It supports pure scientific research in life sciences. Unlike, IMS (see separate report), HFSP primarily supports fundamental research and does not get involved in Intellectual Property Right (IPR) issues.

HFSP grants scientists research funds and enhances mobility through long and short-term fellowship grants. It provides an opportunity to create networks among scientists of different continents. It also provides means for countries with small budgets for science to participate in leading edge research. The EC thus supplies means for smaller EU countries to participate in global research. HFSP provides access to international science and complementary competencies of high quality which would be difficult to find locally or regionally, and this is particularly important when it is necessary to create large teams of researchers to undertake high risk projects. For Europe, HFSP contributes to creating European S&T competencies in life sciences, and therefore is coherent with the EU's "competitiveness and cohesion/integration policy". HFSP provides an example of EU's external policy being complementary to its internal policy in strengthening the European science base. Taking part in the HFSP helps Europe to enhance its scientific profile on the international scene.

After some initial difficulties with excessively bureaucratic procedures, HFSP has developed into a program which appears to be administratively very sound and in many ways a "best practice" model for a peer reviewed scientific programme.

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The Human Genome Project (HGP)

INTRODUCTION

The Human Genome Project (HGP), the international research effort that determined the DNA sequence of the entire human genome started in 1990/1991 and was completed in April 2003. HGP was an international scientific "project" insofar as numerous organisations around the world worked collaboratively to work towards clear and explicit goals - the mapping and sequencing of the human genome. However, while it is convenient in some contexts to refer to "the HGP" as a project, never at any time during this period did the HGP become an international "organisation" with clear boundaries and centrally determined budgets and objectives.

In the USA contributors to the HGP included the National Institutes of Health (NIH), which began participation in the HGP in 1988 and created the National Human Genome Research Institute (NHGRI) in 1993; the U.S. Department of Energy (DOE), where discussions of the HGP began in 1984. Numerous universities throughout the United States were involved, as, at various times and to varying extents, were 16 centres in the USA, UK, China, France, Germany and Japan. The HGP also included efforts to characterize and sequence the entire genomes of several other organisms, many of which are used extensively in biological research.

The aims of the Human Genome project were to:

- identify all the 30,000 or so genes in human DNA;
- determine the sequences of the 3 billion chemical base pairs that make up human DNA;
- store this information in databases;
- improve tools for data analysis;
- transfer related technologies to the private sector and
- address the ethical legal and social issues that may arise.

(DOE website, November 2003)

In April 2003, scientists announced that they had sequenced the entire genetic code of a human being, to an accuracy of 99.999%.

THE CREATION OF THE HGP IN THE USA

In 1982, NIH in the USA formed GENBANK, a publicly accessible genetic sequence database. Scientists submit DNA sequence data to GENBANK and scientific researchers routinely retrieve and analyse the data in the archive.

Beginning in December 1984, the US Department of Energy (DOE) and National Institute of Health sponsored meetings to consider the feasibility and usefulness of mapping and sequencing the human genome. From 1985, several workshops took place in the US, at which scientists discussed the possibility of mapping and sequencing the human genome. Estimates that it might cost as much as $3 billion involve 300 people and take 20 years were bandied about. There were reservations in the scientific community, particularly about the danger of diverting biological research funding from traditional bottom-up modes which favoured small investigator-initiated research projects.

The US Congress became very enthusiastic and the momentum for a structured approach to the human genome became unstoppable. In 1987 The U.S. National Research Council (NRC) appointed a committee to consider proposals and its report was released in February 1988. It proposed a special project funded by the federal government to map, sequence and acquire increased understanding of the human genome.

The Congressional Office of Technology Assessment (OTA) prepared a report which laid out options for Congress to consider at House of Representative hearings. The central issue at those hearings was how to fully engage the NIH and the DOE in the human genome project without inviting internecine politics between them and disturbing their respective Congressional patrons. The US 'Human Genome Initiative' was launched in 1990/1 with a target of completion in fifteen years.

HGP ADMINISTRATION

At no stage was the Human Genome Project a centrally coordinated or funded international project. "HGP…has maintained an informal structure that has been adaptable, inclusive and task oriented, requiring no diplomatic-level international agreements or formal governing structure". (Wagner et al 2002)

HGP can only be regarded as a case of an international scientific research cooperation project insofar as scientific research institutions in several countries (but principally the USA and UK) cooperated together for the aim of securing specific scientific research goals. Some protocols and guidelines were developed to ensure coordination. HGP was able to work on this basis without central administration largely because each country funded its own research.

Organisation and Administration in the USA

Congress chose to maintain a dispersed funding base for the human genome project, with NIH and DOE as major players, but also with participation from the National Science Foundation (NSF), the United States Department of Agriculture (USDA), National Institutes of Standards and Technology (NIST) and the Department of Defense. This diversity increased the funding reservoir for the project, and it created a variety of funding mechanisms and constituencies. The NIH's National Human Genome Research Institute (NHGRI) although not initially designated an 'official' lead for the project, became the largest player and often led. NHGRI's Division of Extramural Research

(DER) supported and managed the role of NIH within genomic research. The DER set the scientific priorities for genomic research and oversaw the peer-reviewed research projects that address those research interests. The extramural research community and the National Advisory Council for Human Genome Research (NACHGR) advised the DER. In other areas, DOE took the federal lead, for example by encouraging DNA sequencing and some special mapping and instrumentation projects. (Burris et al, 1998; Balmer, 1996)

Organisation and administration in other countries

Plans for Human Genome projects developed in the 1980s in several European countries, as well as in the Soviet Union and Japan. A Japanese programme started in the early 1980s, and the need to keep up with Japan was a factor stimulating initiation of a programme in the USA. (Cook-Deegan, 1987, page 218). In 1991, a world-wide survey of genome mapping activities listed eight countries with established national genome projects (Denmark, France, Germany, Italy, the UK, Japan, the former USSR and the USA.) A further seven had made moves towards initiating national programmes (Australia the Netherlands, Canada, Chile, Sweden, Korea and New Zealand). International programmes had been started or proposed by the EC, UNESCO, and by Latin American and Nordic Countries. (Balmer, 1996a). The various projects shared a general aim of contributing to a complete map and sequence of the human genome. Laboratories lodged claims to sequence particular regions of the human genome. The human genome was produced as a mosaic of contributions from several laboratories which worked on the basis of consensus. Sharing and dividing genome sequencing into manageable bits was achieved with the help of maps of the human genome: the availability of genome maps facilitated the allocation of responsibilities between laboratories internationally. This informal mode of cooperation worked well until 1998, when competition from the private sector in the US resulted in concentration of human genome sequencing activities and decision-making in only five laboratories in two countries (see below).

National projects were organized in a variety of ways: In the United Kingdom and France, national projects were run by a single lead agency. In Denmark there was a single national centre. In Germany and Italy funds were dispensed to individual projects. During the middle 1990s, laboratories around the world began to form consortia, planning to sequence parts of the human genome in arrangements resembling the collaboration between the Sanger Centre and Washington University (see below).

The major funders, - NIH and DOE in the United States and the Wellcome Trust in the UK- oversaw coordination of the international HGP effort. Before HGP, the UK already had a molecular biology research record out of all proportion to the country's size, and was drawn into the earliest discussions of a coordinated international effort to sequence the human genome. The UK's Wellcome Trust, as the major HGP funder outside the United States, played an increasingly important role in co-ordinating work in the other scientific institutions outside the United States - in particular those in France, Germany

Japan and China. There were few conflicts over which chromosomes which institutions should work on.

The UK

Cooperation between the USA and UK in the mapping and sequencing of the roundworm led to a major expansion of human genome research efforts in the UK. UK Government funding, mainly through the Medical Research Council, was significant in funding the early stages of human genome research in the UK as was the US National Institutes of Health. But subsequently the Sanger Centre, which opened in 1993, was funded almost entirely by the Wellcome Trust. From the outset, its Director John Sulston organised sequencing as a transatlantic collaboration with Bob Waterston at Washington University in St. Louis. Contemporary observers hailed their cooperation as the flagship of the Human Genome Project. In due course, it became a model for its organisation. The Wellcome Trust initiated HGP as an (informal) international consortium of scientific institutions mainly funded by governments.

France

French laboratories carried out early pioneering work in human genome research. French researchers managed to secure government funds to concentrate on chromosome 14 and accounted for about 3% of world HGP efforts.

The Centre d'Etude du Polymorphism Human (CEPH) was established in 1984. Later that year CEPH organized the first international meeting of genetic mapping groups. CEPH aimed to participate in a coordinated worldwide effort to construct a primary human genetic map. CEPH together with collaborators in Utah, USA and a small private firm, worked together in a collaboration described as "a watershed in human genetics".

In 1991, CEPH and AFM created Généthon, a non-profit research institute, in order to provide tools for the scientific community to locate and clone disease determining genes. In 1992, Généthon's publication of physical and genetic maps of the human genome placed French genomics in the forefront of international competition. The success of genomics through CEPH led the public authorities to invest heavily in mapping and sequencing. CEPH was mostly state-funded but also supplemented with grants from the US National Institutes of Health, the Howard Hughes Medical Institute and national charities.

Germany

Initially, it seemed likely that Germany might play a major role in HGP. German scientists tried without success to persuade their government to agree to provide resources sufficient for a German laboratory to contribute about 7 per cent of HGP's output: the German government were reluctant to comply with HGP requirements that data should be in the public domain, free and accessible. In 1998, the German Government decided to phase out its contribution to HGP and concentrate on patentable applications.

Japan

Japanese researchers played a key role in sequencing chromosome 22 and also participated in sequencing chromosome 21. However, by 1999 Japanese scientists were complaining that their government was concentrating funding too heavily on post-sequencing research at the expense of genome sequencing. The government was concerned about Japan's limited sequencing capacity and shifted its sequencing into areas such as SNPs. Scientists were also concerned about the organisation of genome projects - as funding was the responsibility of five separate ministries. (Saegusa, 1999)

INTERNATIONAL COORDINATION

In 1988 a group of the world's leading scientists established the Human Genome Organization (HUGO) as a means of promoting international collaboration between **individual scientists** and minimising bureaucratisation of research. It was envisaged originally that through HUGO, scientists as scientists would have a major role in coordinating the international human genome effort.

- To assist with the coordination of research on the human genome and in particular to foster collaboration between scientists with a view to avoiding unnecessary competition or duplication of effort, and to coordinate this research with parallel studies in model organisms.
- To coordinate and to facilitate the exchange of data and biomaterials relevant to human genome research and through a training program, encourage the spreading of the related technologies.
- To encourage public debate and provide information and advice on the scientific, ethical, social, legal and commercial implications of human genome projects.

But HUGO never succeeded in playing important roles, such as setting policies for collaboration and trading data internationally, which were originally envisaged by its founders. In the event HUGO had very little influence and was not directly involved in shaping the HGP. HUGO failed to gain the support of the US government and Congress, failed to develop a good relationship with NIH and also failed to secure the financial support it would have needed to play a central role in HGP. It did, however, survive to convene international meetings on ethical, social and legal aspects of HGP.

In the late 1980s, there was worldwide concern that if the U.S. dominated human genome research, U.S. industry might achieve a dominant position on world markets for the commercial producers which would be derived eventually from the research. This concern was mirrored in the US, where there was concern that overseas competitors would gain advantage in terms of understanding diseases and being able to cure them through mapping and sequencing of the human genome. Although the NRC's funding recommendations focused on United States agencies, their report also called for a "major organized mechanism for international cooperation".

International coordination was achieved almost entirely through cooperation between organizations rather than through cooperation between individual scientists as envisaged by the proponents of HUGO. The NIH in the USA and the Wellcome Trust agreed that data should be in the public domain, free and accessible, and these principles were incorporated in guidelines established by NIH and DOE in 1992. But there were problems in getting these principles accepted internationally, especially in France, (Butler, 1999) Germany and Japan. The Wellcome Trust in the UK, the first organization to put significant resources into human genome sequencing, contacted NIH and DOE in the USA to organise the first "International Strategy Meetings on Human DNA Sequencing" in Bermuda in 1996. Participants in the 1996 meeting arrived with claims to sequence a particular region of the genome, and any competing claims were sorted out during the meeting. These claims were recorded on a website.

Subsequent Bermuda meetings were organised annually. The 1997 meeting affirmed the so-called "Bermuda principles". These concerned the rapid public release of genome sequence data without restrictions on use. Scientists present at the 1998 meeting agreed that HGP participants should release sequence data within 24 hours of its generation. International agreement was only secured after Germany had been threatened with expulsion from the consortium because of its government's reluctance to accept the Bermuda principles.

In 1998, as part of their efforts to accelerate progress and compete more effectively with Celera (see below), the five leading HGP institutes - four in the US, plus Sanger in the UK - which were given the name "G5" – effectively, if somewhat reluctantly, took over the role of overall coordination from the larger group of 16 institutions worldwide. G5 started to meet more frequently- four times a year rather than once- and communicated weekly by the use of conference calls. Each G5 centre was required to report on production over the previous week and predict its forthcoming production. (Sulston and Ferry, 2002)

FUNDING

U.S. Human Genome Project Funding			
($Millions)			
FY	**DOE**	**NIH***	**U.S. Total**
1988	10.7	17.2	27.9
1989	18.5	28.2	46.7
1990	27.2	59.5	86.7
1991	47.4	87.4	134.8
1992	59.4	104.8	164.2
1993	63.0	106.1	169.1
1994	63.3	127.0	190.3
1995	68.7	153.8	222.5
1996	73.9	169.3	243.2
1997	77.9	188.9	266.8
1998	85.5	218.3	303.8
1999	89.9	225.7	315.6
2000	88.9	271.7	360.6
2001	86.4	308.4	394.8
2002	90.1	346.7	434.3
2003 (Projected)	76.8	374.5	451.3
Note: These numbers do not include construction funds, which are a very small part of the budget.			

Source: DOE Website.

These figures are the only comprehensive figures available, but they exaggerate very considerably the total amount of funding devoted to human genome mapping and sequencing in the USA, as numerous associated activities are included (although private genome funding in the USA which exceeded federal funding between 1994 and 1998 is excluded from these figures) .

Although many other universities and centres in Europe, Japan and elsewhere participated, in the event the vast majority of the human genome was sequenced at four centers in the United States and at the Sanger Institute in the UK, the largest public-sector sequencing centre in the world which completed almost a third of the work.

The Sanger Institute was funded principally by the independent Wellcome Trust which saw HGP as an opportunity to assume a major, high-profile role that would improve its reputation and status worldwide. In 1992, Wellcome became the wealthiest medical research charity in the world. At that time its research budget was around £200 million per year (nearly $300 million), and over the following ten years it doubled. At some times during this period, nearly a third of Wellcome's budget was devoted to HGP. By 2001, Wellcome had spent about £120 million ($170 million) in total supporting the Sanger Centre.

Overall, probably about 60 per cent of the world's human genome mapping and sequencing work over the period 1991 to 2003 was completed in the USA. Before 1998, the UK only accounted for about 17 per cent, but this was doubled to about 33 per cent from 1998 onwards, when their funding from Wellcome was doubled. At that time, Sanger became the world's biggest institution in terms of sequence output. By 1998 it had become clear that other countries would remain minor players: perhaps nearly 90 per cent of HGP's total research expenditure worldwide was concentrated in the USA and the UK. (Smaglik, 2000, Burris et al 1998, Sulston and Ferry, 2002)

THE EFFECTS OF PRIVATE SECTOR COMPETITION ON HGP.

Craig Venter's private sector ventures stimulated the five principal HGP laboratories in the world, all in the USA and UK, to:

- seek and secure additional funding to counter Venter's claims that he could complete sequencing the human genome more quickly and efficiently;
- collaborate more closely together, accompanied by the exclusion of other international scientific research institutions from HGP decision making;
- invest heavily in expensive sophisticated automated sequencing machines, thus accelerating the transformation of HGP into a "Big Science" project. (Senker et al, 2000)

Until 1992 Craig Venter worked at the NIH, a core institution of the US HGP where he helped develop the Expressed Sequence Tag (EST) sequencing technique. (ESTs are gene fragments). Venter wanted to apply the method to the HGP whose research usually proceeded by identifying a function or disease, locating the gene responsible and then sequencing it. Venter's method identified the gene sequence first and was associated primarily with sequencing using high throughput sequencing machines, rather than functional analysis and mapping. His rationale was that patent protection was necessary to ensure that private firms invest in developing related products.

In 1992 Venter left the NIH when Healthcare Investment Corporation offered him $85m over ten years to start up a not-for-profit research organisation. Subsequently, Perkin-Elmer, the firm which made the sequencers used by most sequencing laboratories, become involved and put at least $300 million into Venter's activities.

In 1998 Venter announced that he had formed a private company which later became Celera Genomics. The central aim was to sequence the human genome by 2001, four years earlier than HGP's then scheduled completion date of 2005. Venter's press releases presented Celera as a more effective alternative to the publicly funded HGP: they claimed that they would sequence the human genome much more quickly and cheaply, that they would overtake the HGP at a fraction of the cost. But Venter planned to release data quarterly, rather than daily as was done by the public project, renewing concerns among public sector scientists.

Venter tried very hard to get the US Congress on his side. The Head of the US National Human Genome Research Institute said:
"The public project was portrayed as labouring with a clumsy, bureaucratic difficult to-implement strategy, and these fast-moving folks in the private sector were going to run circles around us with their fancy whole-genome shotgun approach. And that was really quite unjustified and hurtful." (Sulston and Ferry, 2002, page 184).

Venter's press statements gave the US HGP grounds for fearing that he would persuade the Congress that it was wasting money on the public HGP project. Venter's case gained support from the pervasive ideology of support for private enterprise in the US Congress. HGP was fighting for its life against the view that it was an expensive white elephant and needed a big independent vote of confidence.

At that time, the UK Sanger Institute accounted for one sixth of the project, but had prepared plans for doubling its output. These plans were presented to its funders Wellcome, on the grounds that Venter's activities made it essential for Sanger to have a strong presence to help to ensure that basic genomic data should be available to all scientists. The Wellcome governors were given to understand that Venter's activities amounted to privatization of basic genomic information and agreed to double Sanger's budget to counter this threat.

At the May 1998 annual symposium on genome mapping and sequencing at Cold Spring Harbor, the Wellcome Trust reaffirmed "its commitment to the international initative to produce a high quality, finished product which would be available for all to use". Venter had proposed to patent some sequences. Wellcome "was opposed to the patenting of basic genomic information and would be prepared to contest such patent applications in the courts". This announcement was aimed deliberately -and, in the event, successfully- at "putting pressure on the US National Institutes of Health to increase its backing for genome sequencing". (Sulston and Ferry, 2002, page 190).

A sub committee of the US Congress called a hearing to investigate how the launch of Venter's company would affect the federally funded Human Genome Project. After extensive consideration, the Congressional Committee agreed to continue supporting HGP's work and the Head of the National Human Genome Research Institute announced that The International Human Genome Sequencing Consortium* would produce a working draft by 2001 and complete the fully finished sequence by 2003.

The US equipment firm Perkin-Elmer (the world's largest manufacturer of automated sequencing machines) was heavily involved with Venter's company, eventually named Celera. Celera adopted a 'whole-genome shotgun' strategy, which relied on shattering the entire genome into tiny pieces, sequencing them en masse and then using sophisticated computer algorithms to put the pieces back together.

Wellcome/DOE/NIH increased their level of funding to compete with Celera's challenge, and the public HGP programme scaled up and brought forward its plans so that the 90% draft would be completed by mid-2000 and a full draft by 2003. (Sulston and Ferry, 2002)

Three years earlier in 1995, it had appeared that other countries were also likely to be major participants, particularly France, Germany and Japan. However, the announcement of the accelerated HGP timetable came as a shock to the international partners outside the G5- i.e. the smaller laboratories in the US and the centres in countries other than the USA and UK. So competition from Celera led to the marginalisation of all the international participants in HGP, with the exception of the four major laboratories in the US and Sanger in the UK. Sanger managed to avoid being left "out in the cold" with the rest of the non-US groups simply by being big. (Sulston and Ferry, 2002)

Originally HGP intended to produce finished sequences chromosome by chromosome. However, in order to compete with Celera, the largest HGP members adopted the Celera “shotgun" approach and individual laboratories bought large numbers of advanced sequencing machines which cost $300,000 each. Competitive pressure from Celera combined with technological advances in sequencing and computing were factors in accelerating HGP progress. In the year after Celera was launched (1999), the principal supplier of advanced sequencing machines, Perkin- Elmer, reported sales of over $1 billion of sequencing machines. HGP had truly become "Big Science". (de Solla Price 1963)

Committees of the US Congress pressed NIH and DOE to collaborate with Celera.

In June 2000, Venter - and the publicly funded International Human Genome Project (HGP) which, in the US, was led by Francis Collins, director of the National Human Genome Research Institute, buried their differences in a celebration and were praised by Bill Clinton, the US President, and Tony Blair, the UK Prime Minister. A joint statement by Clinton and Blair confirmed that there would be wide distribution of raw fundamental sequence data to encourage private investment in gene-based technologies so as to turn information into useful medical products as soon as possible. (Macilwain, 2000).

There were also celebrations amongst members of the so called "International HGP consortium*" in London, Paris, Tokyo and Bonn. The race to obtain a draft sequence of the human genome was declared an honourable draw: the HGP had compiled a 'working draft' of the human genome and Celera had achieved a 'first assembly' of a complete genome. Nevertheless, cooperation by no means entirely superseded competition and, at times, the links between partners were fragile. (MacIlwain, 2000) However, "In many senses, the production of the draft genomic sequences represents the accomplishment of shared scientific goals, as it provided the bases both for refining and completing the sequence, and for further investigation of gene location and function" (Ankeny 2003). Celera Genomics and the Human Genome Project continued to produce somewhat different versions of the human genetic code, raising questions about the extent of comparability between the results achieved through the different procedures and measures used to process the data. After 1998, there appears to have been some convergence between Celera and the HGP in terms of both methodology and results: they adopted significant elements of both scientific results and scientific strategy from each other. Celera assimilated and continued to assimilate data from public databases into its own assemblies -a high proportion of their sequence map was derived from HGP's map. But HGP assembled its draft with significant help from end-pair data, the principal and original assembly method of Celera, and continued to rely on this method to identify assembly problems. (Bostanci, 2003a; Bostanci, 2004, Brown, and Rappert, 2000, pages 449 -451)

HGP ACHIEVEMENTS

HGP achievements are very difficult to evaluate. (McIlwain 2000). It has been asserted that the results of the Human Genome Project will be used to develop vital tools for use in medical research, that it will be used to develop drugs and diagnostic tests for predisposition to certain conditions such as breast cancer, heart disease and diabetes, together with therapies with which to treat them. Indeed the Human Genome Project "is considered by many to be the most significant organized scientific effort ever undertaken by humankind" (Collins et al, 1999).

But disease has a multiplicity of causes and the potential for genomic data to help in the development of new drugs is uncertain. Genomic information may not be as useful as claimed by its protagonists because susceptibility to disease is caused by a complex amalgam of genetic mutations and environmental factors. (Senker 2000, Hodgson, 2000, Nightingale, 1999) Even genetically "simple" diseases can be very heterogeneous in their origin. Sequencing studies of the gene that codes for a critical protein in blood clotting has shown that haemophiliacs differ from people whose blood clots normally by any one of 208 different DNA variations, all in the same gene. These differences occur in every part of the gene.

“We all carry one copy, inherited from one parent, of mutations that would result in genetic diseases if we had inherited two copies". No one is free of these, so the standard genome which has now been mapped and sequenced, inevitably includes some unknown sequences which code for defective proteins. Because there is no single, standard "normal" DNA sequence that we all share, observed sequence differences between sick and well people, cannot, in themselves, reveal the genetic cause of disorder. At the least, we would need the sequences of many sick and many well people to look for common differences between sick and well. But if many diseases are like haemophilia, common differences may not be found. (Lewontin, 1992).

The problem of telling a coherent causal story, and then designing a therapy based on knowledge of the DNA sequence, is that all the functions of the different nucleotides in a gene are not known, nor how the specific context in which a nucleotide appears may affect the way in which the cell machinery interprets them, nor is there any but the most rudimentary understanding of how a whole functioning organism is put together from its protein bits and pieces.

The DNA sequence that has now been mapped and sequenced is a mosaic of some hypothetical average person. The DNA of every human being differs from the DNA of every other human being by about 0.1%, or 3 million nucleotides - so a similar quantitative difference exists between the DNA that each person derives from their mother and their father. These differences are single nucleotide polymorphisms (SNPs). While most SNPs may not have any effect, some could cause subtle differences which could influence susceptibility to heart disease or drug responses. This problem is being tackled through the development of SNP databases. SNPs are of considerable interest to pharmaceutical companies which aim to use SNP maps for purposes such as achieving better understanding of the genetic factors involved in adverse drug responses and development of drugs tailor-made for groups of patients according to their genetic profiles.

In May 1998, Celera announced that a SNP database would be one of its flagship products, and other commercial operations responded by launching their own SNP initiatives. Glaxo Wellcome plc was concerned that it would be wasteful for each major pharmaceutical company to set up its own SNP database and initiated discussions with other pharmaceutical companies about a joint initiative. The Wellcome Trust offered resources in terms of cash and the Sanger Institute's sequencers. It was difficult to get pharmaceutical companies to agree to work together and it was necessary to ensure that the arrangements were compliant with US anti-trust laws. Accordingly, a non-profit making SNP Consortium was launched in April 1999 with a budget of $14 million from the Wellcome Trust Glaxo and $3 million from each of ten major pharmaceutical firms. The consortium commissioned the Sanger Centre in the UK and two major US sequencing laboratories to find 300,000 SNPs by 2001. This SNP database was designed as a 'pre-competitive' development to comply with the provisions of US anti-trust laws. The Sanger Institute was motivated to participate in this venture by the funding that it brought in and, as the SNP database was to be free and publicly accessible, because it supported the Sanger and Wellcome commitment to open and free knowledge transfer. (Sulston and Ferry 2002)

Francis Collins et al (2003) articulated "A vision for the future of genomics research". The authors write on behalf of the US National Human Genome Research Institute and their vision is endorsed by the National Advisory Council for Human Genome Research and is therefore likely to be politically powerful. They admit that "deciphering the role of genes in human health and disease is a formidable problem for many reasons". However, they suggest that this problem can be solved and propose numerous projects to meet these objectives.

Most developments relating to genomics and health biotechnology are undertaken in developed countries with the aim of diagnosing and treating disease prevalent in those countries, rather than those prevalent in developing countries. Even if developments in genomics and health biotechnology succeed to some extent in improving disease diagnosis and treatment, these benefits are likely to have little effect on improving health in developing countries: there could be a "genomics divide" analogous to the digital divide between developed and developing countries. (Singer and Daar 2001) There is a danger of conflict developing between advanced industrial nations and developing countries in relation to genomics research analogous to current conflicts in relation to world trade policy.

ANALYSIS

A full analysis of the organisation, administration and international collaboration involved in the HGP "project" would require a massive research study. It has been emphasised that there never was a formal international HGP organisation and full analysis would require detailed study of the numerous laboratories which participated in this international effort, as well as of how each country funded and organised its own research. Indeed, it may not be entirely inaccurate to view HGP as a sort of "concerted action project".

All that can be attempted here is a brief outline of some of the principal features of this enormously complex “project", which achieved its principal objectives in 2003 -earlier than planned or anticipated. This was partly because HGP activities were spurred by competition from the private sector, principally in the US; and that, in the event, this competition increased the funding available in the UK and US for pursuing HGP objectives.

From 1998, when the US Congress agreed to increase public funding of the HGP, funding and decision-making became dominated by four publicly funded research laboratories in the USA and a UK laboratory financed by the world's largest medical research charity. As HGP activities expanded rapidly after 1998, primarily in the USA and UK, elaborate, complicated and very expensive machines and techniques were developed and used, large numbers of people were employed and HGP developed into a project best classified as "Big Science"- the first 'big’ biological science project. (Sulston and Ferry, 2002)

Initially, leading individual scientists attempted to secure international research cooperation by establishing the Human Genome Organisation (HUGO) with the aim of coordinating the international human genome effort and minimising bureaucratisation. It was envisaged originally that through HUGO, scientists as individuals would have a major role in coordinating the international human genome effort. But HUGO failed to gain sufficient support. International coordination was achieved almost entirely through cooperation between organizations rather than through cooperation between individual scientists, as had been envisaged by the proponents of HUGO. The NIH and DOE in the USA and the Wellcome Trust in the UK agreed that data should be in the public domain, free and accessible and these principles were incorporated in guidelines established in 1992. But there were problems in getting these principles accepted internationally, especially in France, Germany and Japan, and this was a factor in the subsequent domination of HGP by the USA and UK. (Sulston and Ferry, 2002)

HGP lacked some of the usual characteristics of an "international scientific project", insofar as there was never any central administration responsible for coordination and/or funding. Moreover, after 1998, the competitive threat from Celera had the effect of changing HGP into predominantly cooperation between laboratories in two countries, - the US and UK - as opposed to international cooperation between a large group of countries.

"Many pharmaceutical firms have found it to be in their interest to cooperate on a formal basis with the HGP…The SNP Consortium is one… example of where public-private alliances have opportunistically formed to protect what might otherwise be seen to be competing interests… this lies in the protection of market share threatened by the sequencing industry" (Brown and Rappert, 2000, page 449; Sulston and Ferry, 2003, pages 224-226). Relationships between public and private in terms of the appropriation of knowledge will continue to be of vital importance: SNP developments put such issues into sharp focus. While there is general agreement, for example, that it is reasonable for genetic tests to be patented by firms, it is likely that conflicts over the appropriation of knowledge and relations between public and private arenas will recur in many contexts. The distinction between public and private is not always clear, nor are the grounds for public investment in research.

NOTE

*"The International Human Genome Sequencing Consortium" was created for public relations purposes, primarily to compete with Venter for the attention of the US Congress. (Sulston, & Ferry, 2002, page 260.) The development of the organisation of international HGP scientific effort is outlined in the main body of this text.

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Intelligent Manufacturing Systems (IMS)

BACKGROUND

"In 1950, Japan was not a major economic power". But thirty years later, like many other commentators, Bowonder and Miyake, (1994, page 70) were referring to "The Japanese economic miracle." From the 1970s to the 1990s, Japan experienced considerable competitive success in global markets for manufactured products, partly because Japan was the world leader in manufacturing technology and automation. Japan's technological advance was due to intense efforts to import and assimilate technology, (Freeman, 1987). Japan's manufacturing strength, international competitiveness and technological capability were closely related. Between 1970 and 1980 the share of manufactured goods in Japan's total exports rose to over 80%, and reached 90% by 1990- at a time when the comparable percentages for the UK and the USA were barely over 70%, and when the only major European countries with over 80% were West Germany and Sweden. At that time, Japan was ahead of Europe in fields such as numerically controlled machine tools and robotics, while Europe was ahead of Japan in pharmaceuticals and computer software. (Bowonder and Miyake, 1994). In the late 1980s, there was growing pressure from other countries, aware of Japan's manufacturing dominance, which caused them to put pressure on Japan to contribute to global science and technology. Japan responded by looking for ways of launching international programs in science and technology, and both IMS and HFSP represented Japan's response to those pressures (see also HFSP report).

It was suggested that three linked groups of factors were largely responsible for Japanese international competitive success in manufacturing in this period:

- The development of high quality, high performance products which were inherently cheap to produce;
- Their success in devising technically advanced production methods which helped to ensure that their products consistently attained the potential high standard of quality and reliability inherent in their design, and
- Their development of purchasing and production techniques and working practices which placed high priority on quality, but also permitted very high rates of production and low production costs.(Senker, 1986)

In 1974 , an 'unmanned metal working factory' was planned which would have a control crew of ten, in contrast to the normal complement of between 700 and 800 workers for a plant with comparable output. Very considerable progress was made towards such goals. Fujitsu Fanuc was the first to construct a complete factory along these lines. Their plant had 29 cell-like work stations, seven of which were equipped with robots and 22 with automatic pallet changers. Work Stations were connected by unmanned vehicles guided by electromagnetic and optical methods. (Hatvany et al 1985).

The Japanese Ministry of International Trade and Industry (MITI) played an important role in the development of Japanese international competitiveness and manufacturing technology (as it was to do later in guiding and supporting IMS). MITI protected Japanese industries from overseas competition in the early stages of their development and "prodded" industries to reduce capacity when they ceased to grow. (Senker, 1986.) "Administrative guidance by MITI involves no coercion of private firms…. There are no legal sanctions against firms which fail to act in accordance with the administrative guidance…. To ensure that administrative guidance is effective, MITI has a system for gathering relevant information from within and outside Japan and using it to decide policies which are likely to produce maximum benefit for the nation." (Bowonder and Miyake, 1994, page 64) MITI's policies could be perceived as being designed "to accelerate market forces and bring about more stable competition among a few relatively low cost producers". (Magaziner and Hout, 1980)

HISTORY

In 1989 a meeting was held in Japan, chaired by Prof. Yoshikawa, to bring together industrialists to discuss future visions of manufacturing. The idea of taking an initiative in manufacturing technology was raised and MITI drafted an R&D proposal. Their report was submitted in October 1989 and the idea of an IMS programme quickly won political support in Japan. MITI agreed to provide financial support.

A delegation headed by Prof Yoshikawa was organized and sent to several countries. It met with manufacturing technology related NGOs and the Society of Manufacturing Engineers in the US and with the EC in Europe. Its mission was to prepare the ground for discussions to explore the prospects of cooperation with international partners on scientific research related to manufacturing upstream from commercial application. The idea was presented as promoting direct collaboration; researcher to researcher. The carrot of Japanese funding was dangled. The motivation presented was of 'good global citizenship' by sharing and cooperating. It was implied that this would help to overcome the trade-related strains over Japanese "unfair practices" of the late 1980s. In addition to universities and companies, the Japanese delegation approached various government ministries, concentrating on the most advanced industrial regions of Europe.

In the late 1980s there was an atmosphere of distrust of Japanese motives in Europe. This manifested itself in feelings that the Japanese IMS delegation could be part of a plot to further erode European and American competitiveness by building Japanese industrial/manufacturing dominance and plundering European scientific talent. Moreover, there were also deep suspicions in the USA of R&D cooperation between European states: the European Commission was holding informal meetings with the US on international cooperation in R&D to assuage US fears over the Framework Programme and European protectionism. Accordingly, the Japanese delegation often received a cool welcome in official circles in both Europe and the US.

However, a senior EC official who was approached, thought that, in spite of all the distrust, it would be best to receive the Japanese delegation to prepare the ground for a possible coordinated European response. She thought that "we might actually learn something" from the Japanese; let's see what they have to offer".

It quickly became apparent that the Japanese approach to Europe was, in effect, an MITI delegation led by a charismatic professor. Accordingly DG XIII called in DG I as a matter of protocol. EC officials were aware that the Japanese delegation was also visiting the US. In fact they were less successful there in finding potential academic partners and in general were unsuccessful in setting up meetings with Federal authorities. EC officials realised that in order to get European support for IMS, and to make the whole thing work through a reciprocal, balanced structure, it was necessary to have full US participation. Accordingly, EC officials made unofficial enquiries in NIST, NSF and DARPA, to find out what was happening in the US.

The first version of the IMS presented by the Japanese suggested a 100% Japanese government-aided and financed international program. It also suggested construction of an international research center, a core organization which would co-ordinate existing technologies rather than concentrating on developing new technologies

The European Commission hosted the first international meeting to discuss IMS.- officially trilateral CEC/Japan/US, with Australia, Canada, EFTA and Switzerland present as observers. This was the meeting at which the main issues and programme architecture were discussed and basic principles of balance, reciprocity and equality were established. The meeting agreed that a common IPR framework would be mandatory. (see below).

The European Community "had a treaty, negotiated with a mandate from all twelve Member States." But this was conditional upon a unanimously positive evaluation of a pilot, feasibility stage. This is one reason why such a long time was necessary from the delegation's first approach in 1989 to the EC's official involvement after 1995.

Then suddenly, Japan unilaterally issued a Call for Proposals, sending notices to research institutions throughout Europe and the USA. MITI went round to the national ministries again in the France, the UK and elsewhere in Europe. A senior EC official reacted strongly by declaring that this was incompatible with the European Community's "blessing" achieved with so much painstaking negotiation with the Council of Ministers, and told the Japanese in no uncertain terms that this would upset the Member States. She demanded that Japan revoke the Call, but by then proposals were being prepared and coming in to MITI.

Then, "the Japanese …physically carried all the European proposals to Brussels and handed them over to the Commission, unbidden. This demonstrated convincingly that the Japanese were acting in good faith. The Japanese "promised to hold their horses so long as Europe got its skates on". They stuck to their promise, the Europeans ‘got their skates on’ and, although it might all have collapsed, the IMS feasibility stage could get started. (interviews).

Following the feasibility study, the Governments of Australia, Canada, Japan and the

USA agreed to establish the IMS Program and in 1995 IMS was incorporated in Canada to manage and guide operations. Subsequently, Switzerland and the European Union joined and an application from Korea was in the final stages of approval in 2000. (Mid-Term Review Panel, 2000, 2.1)

IMS is embedded in ESPRIT (primarily) but also in other parts of the "Competitive and Sustainable Growth" strand of the Framework Programme. The European Commission provides the Regional Secretariat for the European Union and Norway (and presumably Israel and Iceland, as full members of the Framework Programme). European participation requires proposals to fulfil the requirements of both the Framework Programme (including having specifically European objectives according to the priorities identified in the FWP) and IMS. IMS is thus fully integrated into European research policy, which in turn relates to other policies of the EU. It is a unique and exceptional form of global-scale cooperation within the Framework Programme. (interview)

OBJECTIVES

The IMS initiative was established to encourage global cooperation in the development of manufacturing technologies and systems to allow manufacturing firms and nations to move ahead rapidly in a global environment while maintaining their competitive edge. The vision of IMS was for a global system of industrial cooperation and technology sharing to the general benefit of mankind and the particular benefit of partners involved in cooperative projects. The IMS initiative provides a framework for large and small companies to work together to mutual advantage. A key aspect of that framework is the protection and use of intellectual property brought to and generated from a cooperative project (Mid-Term Review Panel, 2000:2.1)

"The Intelligent Manufacturing Systems Initiative assists and encourages the formation of international research consortia to address industrial manufacturing and organisational challenges in the 21st century. IMS provides a framework for industry and academia to co-operate throughout the full innovation cycle, to identify partners world-wide. It offers broad-based technology trials and benchmarking, involving a world-wide user community, ensuring general applicability of the technology developed and providing a better understanding of global markets through improved market intelligence." (Cordis, 2003)

Nine objectives were stated for the IMS Program in its original Terms of Reference.
These were to:
• enable greater sophistication in manufacturing operations;
• improve the global environment;
• improve the efficiency with which renewable and non-renewable resources
Are used;
• create new products and conditions which significantly improve the quality of life for users;

• improve the quality of the manufacturing environment;

• develop a recognised and respected discipline of manufacturing that will encourage the transfer of knowledge to future generations;

• respond effectively to the globalisation of manufacturing;

• enlarge and open markets around the world;

• dissemination, understanding, and application of consistent guidelines, provisions and model agreements that respect IPR of participants and project consortium partners.

Subsequently, through the development of a Strategic Plan, five types of desired outcome were identified. These were:

1. Increased resource commitment to IMS.
2. Effective and broad diffusion of manufacturing technology.
3. Enhanced standing of manufacturing as a profession.
4. Active globalisation of manufacturing operations and recognition of the role of IMS in globalisation.
5. Effective and efficient management of IMS.

As a further guide to the Program, and in particular project applicants, five technical themes and associated sub-themes were developed:

1. Total product life cycle issues

• future general models of manufacturing systems;

• intelligent communication network systems for information processes in manufacturing;

• environment protection, minimum use of energy and materials;

• recyclability and refurbishment;

• economic justification methods.

2. Process issues

• clean manufacturing processes that can minimise effects on the environment;

• minimum consumption of energy;

• technology innovation in manufacturing processes;

• improvements in the flexibility and autonomy of processing modules;

• improvement in interaction or harmony among various components and functions of manufacturing.

3. Strategy/Planning/Design tools

4. Human/Organisation/Social issues

• improved image of engineering; (this last phrase sounds strange)

• improved manufacturing workforce education/training;

• autonomous offshore plants;

• corporate technical memory;

• appropriate performance measures for new paradigms.

5. Virtual Extended Enterprise issues

The variety and breadth of these objectives and goals posed a considerable challenge to the assessment of IMS performance (Mid-Term Review Panel, 2000: 2.3); moreover the five technical themes seem to have had little effect on either proposal formulation or approval. (Mid-Term Review Panel, 2000: 3.2.)

CONTRIBUTORS

The first version of the IMS presented by the Japanese suggested a 100% Japanese government-aided and financed international program. The IMS proposal originally focused on the mainstream manufacturing regions of Europe, Japan and the US. The European Commission hosted the first international meeting to discuss IMS. IMS was initially trilateral -European Commission., Japan and the U.S., but representatives of Australia, Canada, EFTA and Switzerland were at the first meeting as observers. At an early stage, it was agreed that the inclusion of a small group of (then) EFTA countries, and Australia and Canada, would provide a broader perspective, particularly with regard to the engagement of SMEs.

From 1992 to 1994, nearly 100 leading firms in these regions, including Toshiba, BICC, Daimler Benz, Transtec, BHP, Inco, Nestle, ICI, BAE, Rockwell International and many smaller firms, worked with governments and research groups in a feasibility study. The study was designed to test the practical benefits of working together to address common problems while retaining or enhancing their own market positions. It was, in fact, a giant experiment in the possibilities of multi-lateral cooperation. In 1994, participants in the feasibility study recommended the establishment of an industry-led framework for international R&D cooperation.

By 2000, the EU (123) and Japan (100) had provided by far the largest number of partners. They were followed by the US (50), Australia (20), Canada (18) and Switzerland (13). This broadly reflects the financial contributions to projects from each Region: Japan contributed 38% of these funds and the EU 36%, followed by the US with about 15%.(Mid-Term Review Panel, 2000: 3.2)

POLICY - INTELLECTUAL PROPERTY RIGHT

In early meetings in Brussels within the European Commission it was decided that an IPR regime should be developed internationally with all countries involved.

They had to arrive quickly at an IPR regime to test in the feasibility phase, as well as to establish a refined IPR regime for the full-scale programme. This was done with the aid of an "International IPR Committee" - IIPRC. They adapted the IPR regime from the Framework 3 model contract -- the IMS rules were essentially a stripped-down version of what was available under FP3. However, the FP3 IPR rules, which deal with connectivity between projects in full-scale programmes, were too complicated. Also, there were rules about eligible costs (for IPR protection) that were not considered relevant in the global context.

A European committee was set up, consisting mainly of industrialists who had previously been involved in developing the FP3 rules. They had considerable prior experience and had already been involved in discussions on IMS, through the European Commission and at national and corporate level. The Committee understood completely that IPR rules should cover this and ensured that the IMS and FP rules were compatible from the very outset.

The European committee also took into account the need for compatibility with normal Science and Technology agreements with third countries. At that time, there was a section within DG13 which was concerned with international cooperation and provided support.

The European IPR Committee created a document (the "IP Annex") in mid 1992. The IMS Technical Committee was meeting in Stuttgart around the same time and there was intensive discussion between the two committees and the Steering Committee, which oversaw the activities of both subsidiary committees. This European document was used for the Call for Proposals later that same year (November) in the USA.

Europeans were most concerned to ensure that exploitation could not be blocked. They wanted there to be an obligation to share background IPRs if exploitation opportunities emerged in the course of the project that required their use – as was the case in the Framework Programme. In contrast, the US participants were more concerned about protecting IPR and preferred background IPRs not to be available automatically, but only by agreement. A compromise was reached at a subsequent meeting.

The IIPRC took into account the experience of the feasibility study and discussed how to apply it to full-scale cooperation. All the principles from the feasibility study) were taken forward for the full-scale programme. However, there were a number of issues at the time and a number of points had to be clarified. For example, the US requested exclusivity on IPRs owned by universities so that they could not be commercialised, on the basis that universities had already given rights to a third party.

Under Japanese law at the time, universities were required to ask for a fee which they were unable to waive. It was important to allow not-for-profit organisations to participate, provided that associated fees were small and consistent. It took a long time to negotiate this. It was not only very important to clear the way for Japanese academic participation, but also to establish the basic principle so that all could live with the outcome. This part of the IPRs was negotiated at the very end of the feasibility phase. Further relatively minor issues were resolved subsequently.

The outcome of the IPR negotiations resulted in a robust, enabling regime that allowed participation by several different types of partners in all regions. The IMS provides excellent guidelines for Intellectual Property Rights issues. About 90% of the IPR rules have been clearly defined in the program. Only the remaining 10% was left to the participants to resolve. This avoided substantial conflicts over IPR and has been a significant strength of the program. (Interviews and with a senior EC official)

OPERATIONS

The core of IMS is the portfolio of projects endorsed under agreed processes and criteria. As of early 2000, sixteen projects had been endorsed and were underway, involving a commitment of US$194 million and involvement of over 350 firms and research groups across the IMS regions. The projects range from highly specific activities, such as the development and processing of intelligent composite materials, through to long-term investigation of strategic issues confronting global manufacturing in the twenty-first century. Areas such as human, organisational and social issues have been neglected. (Mid-Term Review Panel, 2000, 2.2 and 3.2)

ADMINISTRATION

The executive decision-making body is the ISC, which meets bi-annually.

Its membership is currently a maximum of twelve, but with the inclusion of Regional observers, project partners etc, meetings have commonly included more than 50 participants. This has undoubtedly made it difficult for the ISC to operate efficiently.

The approval process is complex and lengthy. The time between submission of an abstract and proposal endorsement should not exceed five months, but has often been a year and sometimes longer. This arises from elaborate requirements, e.g. for all proposals to obtain approval from all regions regardless of whether there is a partner from that region. (Mid-Term Review Panel, 2000, 3.2). An interviewee pointed out that the IMS system is extremely cumbersome and complicated. IMS started with a central fund, but became a collection of regional programmes. Applicants apply in their own countries and a project is evaluated according to each country's criteria. Moreover, each participating country has its own research fund[150]. As a consequence, there is a lack of synchronisation of funding - one partner may receive the go-ahead from its own government but the project is delayed while other partners go through their own application processes. Each region has a different system. Funding schemes and timeframes are different between regions. In addition, each region requires different documentation. Numerous discussions within the partnership and between the partnership and IMS bodies are needed to prepare an international proposal which presents a work program, identifies responsibilities, specifies property rights and decision mechanisms, showing a budget and a schedule. Europeans have to submit documents to the EC as well as to the IMS. If either does not

[150] This is the reason why it has not proved possible to provide data on IMS total expenditure.

approve the project, it is rejected. The decision making process is long and painful for applicants.

The Terms of Reference for the IMS state that the "ISC will reach decisions by consensus of its members". This has been taken to mean unanimous consensus. While this may seem an appropriately cautious approach to managing the considerable challenge of a multi-lateral program, it has provided a considerable barrier to speedy decision-making (Mid-Term Review Panel, 2000: 4.2).

The principle of shifting the location of the IMS Inter-Regional Secretariat every 2 to 3 years in practice up to 2000, designed to ensure acknowledgment of the multi-lateral nature of the IMS Program, apparently contributed little to this objective, and was highly wasteful and inefficient. The potential of Internet-based communications further weakens the case for shifting physical location. (Mid-Term Review Panel, 2000, 4.3) The monitoring and evaluation processes for projects, and the overall program, have been inadequate. Such processes have now been changed to recognised best practice, but they were not established at the beginning of IMS and no budget has been provided for developing, assisting and selling the process. (Mid-Term Review Panel, 2000, 5.5).

CONCLUSIONS

IMS has not made significant achievements in relation to some of its somewhat grandiose official goals, for example making contributions to "improving the global environment" or "the efficiency with which renewable and non-renewable resources are used"; or to "effective, equitable and beneficial global cooperation in manufacturing R&D" or "to enlarge and open markets around the world" . or in relation to the goals of some of its participants such as: "It is expected that the key breakthrough technology to solve current problems of the manufacturing sector will be an autonomous distributed manufacturing system assisted by advanced IT, which will be realised by the IMS.". (Mid-Term Review Panel, 2000:3 and 3.1). Despite the fact that the projects are industry-led, performance is biased towards research, with insufficient orientation towards commercial outcomes. By 2000, only ten patent applications had been lodged and two granted. No copyright or licensing agreements had been reported. In contrast, there had been 203 presentations and 119 publications.

These results may to some extent be a reflection of the early stages of many projects. However, it is widely believed that the IMS IPR Provisions "are the most significant and successful aspects of the IMS Program", and this may be a considerable achievement, although some people associated with the program pointed out that the IPR provisions had not yet been severely tested. The Panel also pointed out that the number of project participants, the extent of their interaction, and the generally positive comments of participants about their experience, provided prima facie evidence of substantially increased and valuable international cooperation in manufacturing R&D. Cooperation extended to both large and small companies, users and suppliers, universities and research institutes, and, to a limited extent, to governments.

Some small progress has also been made through an IMS project to develop a model curriculum for an undergraduate degree in Manufacturing Management, and to trial it in one institution in each region. This represents only a modest contribution to the central objectives of the "advancement of manufacturing professionalism worldwide" and "developing a globally recognised, respected and relevant discipline" (Mid-Term Review Panel, 2000:3.1). The continuing evolution of appropriate technology development projects, and most importantly, application and diffusion of their findings and outputs, offers the possibility of a significant contribution to the objective of greater sophistication in manufacturing operations.

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The Intergovernmental Panel on Climate Change (IPCC)

INTRODUCTION

The IPCC differs sharply from the other three case studies. HGP, IMS and HFSP all relate to projects or programs in which scientists from several countries carry out scientific research. The IPCC is an international organisation in which scientists use the results of scientific research in several countries to provide the basis for policy advice. Skodvin (2000, pages 96- 98) for example considers the IPCC as an *intergovernmental* mechanism with the role of undertaking "internationally coordinated scientific assessments of climate change". Similarly Siebenhüner (2003) describes the IPCC as an international environmental "scientific assessment body". He suggests that "scientific assessments could be understood as social processes which help to translate expert knowledge into policy-related forms of knowledge that exert some form of influence on actual decision-making process".

In the late 1950s, scientists, particularly in the USA, Germany and Sweden, were engaging in debates about climate change. By 1961, Charles Keeling had proved that carbon dioxide concentration in the atmosphere had been increasing. During the 1960s, the International Council of Scientific Unions and the World Meteorological Organization (WMO) established the Global Atmospheric Research Programme (GARP). GARP's goals were to develop numerical global circulation models to simulate the present climate and the behaviour of the atmosphere in long time scales as 'a natural first step in attempts to predict what happens to the atmosphere as a result of man's activities'. (Halopainen, 1972)

The first International Conference on Environmental Futures was held in 1971 in Finland. Bryson, a climatologist, presented a keynote paper which considered the cooling role of aerosols in climate and threats to the ozone layer. In discussion, he admitted to a ”sneaking suspicion that demands for more monitoring were 'mostly for the care and feeding of big computers' rather than the welfare of man” (Bryson, 1972). Bryson feared that atmospheric dust could cause global cooling. Global cooling was more of a concern than global warming at that time, because global temperatures had declined since the 1940s, and some scientists were warning that the onset of the next ice age could be imminent

The work of Mann et al (e.g. 1998) forms an important basis for IPCC's work. This shows a weak declining temperature trend from 1000 to 1900, possibly caused by the trend towards a new ice age, followed by a rapid temperature increase in the twentieth century. On this basis, IPCC concludes that the twentieth century was the warmest century, the 1990s the warmest decade and 1998 the warmest year in the last thousand years. It is generally agreed that the years 1400 to 1900 were colder than the twentieth century: indeed this period of history has been referred to as a "Little Ice Age". This period was preceded by a significantly warmer "Medieval Warm Period". If temperature increases occur, and sea levels also increase as fast as IPCC envisages, both could be important and seriously damaging.

According to a leading IPCC spokesman, "It has been known for well over 100 years that the presence in the atmosphere of gases such as carbon dioxide leads to a warming of the earth's surface." In the 1980s, "it began to be generally recognised that human activities involving the burning of fossil fuels (coal, oil and gas) was resulting in a large increase in atmospheric carbon dioxide and a probable doubling of its pre-industrial concentration before the end of the 21st century. The possibility of serious consequences to the world's climate was increasingly raised by scientists and those with environmental concern." (Houghton, 2001, p3)

THE CREATION OF THE IPCC

The UN Conference on Human Development in Stockholm in 1972 was the starting point for international efforts to understand climate variations and the possible problem of human-induced climate change. (Skodvin, 2000, page 97). In 1979, there was a World Climate Conference in Geneva and the World Climate Programme (WCP) was launched. A series of Workshops were then organised under the auspices of the World Meteorological Organization (WMP), the United Nations Environment Programme (UNEP) and the International Council of Scientific Unions (ICSU) held in Villach

A small group of environmental scientists and research managers in organisations independent of governments participated in the 1985 Villach Conference. This conference was dominated by climate modellers from scientific institutions - particularly from the International Institute for Applied Systems Analysis and from Harvard University. The conference concluded that a rise of global mean temperature could occur in the first half of the twenty-first century which was greater than any such rise in the whole history of humankind. Nearly all of the conference participants were scientists from non-government institutions using modelling techniques who were broadly in agreement with this and had already defined desirable responses to the global climate threat as part of sustainable development strategies before the conference. The conference recommended that science-based emission or concentration targets should be worked out to limit the rate of change of global mean temperature to a specified maximum. The Villach conference organisers initiated the Advisory Group on Greenhouse Gases (AGGC) in 1986 under the joint sponsorship of WMO, UNEP and ICSU. The energy chapter of the Brundtland Report published in 1987 was written by Professor Gordon Goodman, a prominent member of AGGG. It concluded that 'a low energy path is the best way towards a sustainable future… nations have the opportunity to produce the same level of energy services with as little as half the primary supply currently consumed.'

AGGG members organised the 1988 Conference on “The Changing Atmosphere: Implications for Global Security” in Toronto, Canada which called for 20 percent reductions in CO2 emissions. AGGC prepared the Meeting of Legal and Policy Experts in February 1989 in Ottawa which recommended an "Umbrella" consortium to protect the atmosphere.

AGGG's recommendations contributed to pressure on governments in several countries to set up an intergovernmental body to deal with issues related to global warming. The US State Department wanted scientific assessment to be in the hands of government not 'free wheeling academics.' So it used its influence on the Executive Committee of WMO to initiate the establishment of IPCC jointly by WMO and UNEP in 1988 as a scientific advisory body to replace AGGG in its roles of writing reports and creating consensus amongst scientific institutions. In contrast to AGGG, IPCC was designed as an intergovernmental organisation that is basically scientific in its membership but involves governmental participation in the process of approval of the major conclusions: governments own the whole process and the final documents.

IPCC was established to consider the problem of potential global climate change, and its aim is to "assess on a comprehensive, objective, open and transparent basis the scientific, technical and socio-economic information relevant to understanding the scientific basis of risk of human-induced climate change, its potential impacts and options for adaptation and mitigation".

While AGGG was dominated by scientists from non-governmental institutions, IPCC's Panel was dominated by scientists employed by government scientific research institutions. AGGG was gradually replaced by the IPCC and last met in 1990. The IPCC's Panel set up three Working Groups:

- WG1 to assess available scientific information on climate change, based in the UK;
- WG2 to assess environmental and socio-economic consequences of climate change, based in the USSR and Australia;
- WG3 to formulate "realistic response strategies for the management of the climate change issue" based in the USA.

A fourth Working Group had been proposed to deal with problems facing developing countries, but was never started. This is interesting in the light of the fact that the Brundtland Report (1987), published the year before the IPCC was set up, had perceived the climate change threat as creating the opportunity to succeed in bringing developing and developed countries together for the benefit of developing countries, thus replacing the North-South dialogue of the 1970s which had failed. The North-South dialogue of the 1970s had been designed to secure significant wealth transfers between rich developed countries and poor developing countries. The problem of global warming was perceived to have been caused by the developed countries which had undergone industrial revolutions and had burned large amounts of fossil fuel. But the consequences in terms, for example, of rising sea levels were most harmful to developing countries. (Boehmer-Christiansen, and Kellow, 2002, pages 124-132)

THE IPCC'S OBJECTIVES

The ultimate aim of the IPCC is to produce "policy relevant" and not "policy prescriptive" materials. IPCC does not provide possible solutions to climate change problems. It is of the utmost importance to the IPCC to produce scientifically rigorous documents: there is a long process of evaluation of Reports, in which numerous intensive debates take place and the scientists claim that a good equilibrium of scientific and political perspectives is established through consensus during the process.

The IPCC provides scientific, technical and socio-economic advice to the world community through its periodic assessment reports on the state of knowledge of causes of climate change, its potential impacts and options for response strategies. IPCC Assessment Reports are very widely used as a basis for governmental research and negotiations in relation to global warming issues. They help the EC to establish a European consensus on the climate change issue. The IPCC is a crucial source of information on climate change for the United Nations Framework Convention on Climate Change, which includes the international negotiations before and after the Kyoto Protocol. At five-year intervals it publishes comprehensive progress reports on the state of climate change science, the latest of which appeared in 2001. It also prepares Special Reports or Technical Papers on specific issues in response to requests from the COP (Conference of the Parties). The Panel's work on methodologies has also played a major part in the process of developing common guidelines for Parties to compile their inventories of greenhouse gases.

The IPCC's mission is clearly defined. Its role is to collate data on global warming and analyze their social and economic implications. Its major activity is the preparation of comprehensive reports designed to assess the scientific, technical and socio-economic information relevant for the understanding of the risk of human-induced climate change It does not generally carry out research nor does it monitor climate related data or other relevant parameters and bases its assessments mainly on peer reviewed and published scientific/technical literature. However, if researchers judge it necessary to advance their understanding on a subject, research may be conducted during the preparation of reports. The objective is to produce "policy relevant" documents, which are not "policy prescriptive". This indicates how far the IPCC can go, and provides limits at which the work must stop. This clear framework is regarded as an important element in producing a good outcome; valuable to various users. (WMO and UNEP, 2003)

IPCC claims that its views reflect the principal views of the whole scientific community and also convey the degree of variability around that average view. It claims the support of the best scientists. Its main concern is global warming and the predicted warming is based on the so-called greenhouse effect. Greenhouse gases, which include water vapour, carbon dioxide CO2, methane, CFC gases and ozone, can reflect or trap heat. Human activities have increased the quantities of greenhouse gases in the atmosphere, in particular CO2: about 80 percent of the extra CO2 arises from the combustion of oil, gas and coal, and the remainder mainly from deforestation and other land changes in the tropics. The IPCC's analysis relies on the proposition that the extra heat reflection back to the earth created by these human activities (the so called anthropogenic greenhouse effect) will lead to increases in temperatures on earth.

ADMINISTRATION AND FINANCE OF THE IPCC

The IPCC is managed by the IPCC Secretariat, which is hosted by WMO in Geneva and supported by UNEP and WMO. In addition, each Working Group and the Task Force has a Technical Support Unit (TSU). TSUs are supported by the government of the developed country co-chair of that Working Group or Task Force and hosted by a research institution in that country. A number of other institutions provide in kind support for IPCC activities.

There is a Panel which meets in plenary sessions about once a year. The Panel decides on the IPCC structure, its principles and procedures, the work programme and budget, and it elects the IPCC Chair and the Bureau. It also agrees on the mandates and work plans of the working groups, the scope and outline of reports, and accepts, approves and adopts IPCC reports. Panel sessions are generally attended by hundreds of participants.

The IPCC Bureau consists of the IPCC Chair, the three IPCC Vice-Chairs, the Co-Chairs and Vice-Chairs of the three working groups and the Co-Chairs of the Task Force on Inventories. The Bureau must have a balanced geographic representation of members with appropriate scientific and technical qualifications. The IPCC, the Bureau and the Chair are supported by a small IPCC Secretariat located in Geneva.

The IPCC is organized into three working groups and a task force on national greenhouse gas inventories. Each working group has two co-chairs (one from the developed and one from the developing world) and a technical support unit.

Working Group I assesses the scientific aspects of the climate system and of climate change.

Working Group II addresses the vulnerability of human and natural systems to climate change, the negative and positive consequences of climate change, and options for adapting to them.

Working Group III assesses options for limiting greenhouse gas emissions and otherwise mitigating climate change, and economic issues

The IPCC has undergone several changes in regard to the internal structures and procedures, the Panel established a special Task Force on the IPCC Structure that reported in 1992. The Task Force prepared a report that led to the adoption of a four-page document about new rules of procedure.

The IPCC administration consists of a small number of administrators and secretaries, with the vast majority of participants being employed in organisations other than IPCC which also pay their travel expenses. The IPCC pays travel costs for many experts from developing countries and from countries with economies in transition. These are financed through voluntary contributions from governments as well as to a small extent from the UNFCCC. The IPCC's two parent organizations, WMO and UNEP, provide staff and financial support.

At first glance the organisational structure of the IPCC seems fairly complicated. But a closer look shows the organisation to be rather lean. The IPCC Bureau consists of five vice-chairs plus the co-chairs and vice-chairs of the working groups. The work of the working groups is coordinated and administered by individual TSUs that are mainly located in industrialised countries from which they obtain their funding. The Bureau prepares papers on decisions to be taken at the plenary sessions, which are attended by government officials from the member countries of UNEP and WMO. At these regular annual meetings, the Panel accepts and approves IPCC reports, decides on work plans, the structure and outlines of reports, the IPCC rules of procedure, and the budget. It also elects the chairperson and the Bureau. It is the responsibility of the co-chairs of the working groups to select the lead authors of the chapters based on government nominations and to coordinate their work. (Siebenhüner, 2002)

Bearing in mind that the IPCC does not undertake research, but only scientific assessment based on research throughout the world, its costs are relatively modest. IPCC Reports draw extensively on scientific work related to meteorology, climate change etc, financed by individual governments and, of course, the costs of this scientific work greatly exceeds IPCC's centrally budgeted costs. Most costs included in the IPCC's central budgets are incurred in relation to meetings and contributions to the costs of experts from developing countries and economies in transition which are paid by IPCC. It is impossible to be precise about IPCC's total costs, insofar as the IPCC's central budget does not include resources contributed by governments, most notably by Japan, the Netherlands, the UK and the USA, to the support of Technical Support Units; nor does IPCC pay travel costs of experts from developed countries who attend meetings.

Subject to all these caveats, some idea of the order of magnitude of IPCC's central costs can be given by the IPCC's budget of just under 35 million sw.fr. (22 million euros) for the five years 2003-2007, i.e. an average of about 4.5 million euros per annum. (IPCC 2003)

THE IPCC'S OUTPUT

The IPCC has produced three major multi-volume Assessment Reports in 1990, 1995 and 2001 and a number of special reports and technical papers as well as supporting materials, such as guidelines and documentary materials. Each Assessment Report includes Summaries for Policymakers. These summaries are intended to reflect the state-of-the-art understanding of the subject matter and are written with the aim of being comprehensible to the non-specialist.

The IPCC's claims that its First Assessment Report in 1990 confirmed the scientific basis for concern about climate change and had a powerful effect on the general public. It provided the basis on which governments established the Intergovernmental Negotiating Committee, which adopted the UN Framework Convention on Climate Change in 1992.

The Second Assessment Report was adopted in 1995 and published in April 1996. It contributed to the negotiations that led to the adoption of the Kyoto Protocol in 1997. The IPCC also prepares Special Reports, Technical Papers and Methodology Guidelines. It also carries out work on greenhouse gas inventory-related methodologies and practices. IPCC Guidelines for National Greenhouse Gas Inventories were prepared so that the Parties to the United Nations Framework Convention on Climate Change can use comparable methodologies when calculating their greenhouse gas emissions and removals. The first Guidelines were prepared in close collaboration with the Organization for Economic Cooperation and Development (OECD) and the International Energy Agency (IEA) in 1994 and adopted by the Conference of the Parties in 1995 as guidelines for the preparation of national communications by developed countries.

Since then, the IPCC has published inventory-related methodologies and guidance papers including IPCC Guidelines for National Greenhouse Gas Inventories (1996) and Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (2000).

WRITING IPCC REPORTS

IPCC authors are nominated by governments and by international organizations. They come from universities, research centres, business and environmental associations as well as other organizations in about 120 countries. Through this worldwide network, the IPCC seeks to represent all geographic regions and to reflect a diverse range of scientific, technical and socio-economic views and expertise.

The IPCC usually starts a new assessment by developing a general outline, often during a "scoping" meeting of experts. Policymakers and other users of IPCC reports are consulted with the aim of identifying the key policy-relevant issues. Each working group elaborates and approves the outline for the chapters that it will contribute and teams of lead authors are assembled for each chapter by the working group bureaus. The aim is for every chapter team to represent a range of prevailing scientific-technical viewpoints and expertise and to ensure appropriate representation of experts from developing and developed countries as well as countries with economies in transition.

The lead authors write a first draft based mostly on peer-reviewed literature, making sure to include literature published in languages other than English. They also consider the most recent scientific findings and reports from national academies of sciences, industry and United Nations bodies. Expert meetings and workshops are held to gather more information in areas where peer-reviewed literature is sparse or unavailable. Diverging viewpoints that authors consider to be scientifically sound are clearly identified in the draft text. The authors work closely together as a team. The lead authors may enlist contributing authors to assist with the work.

THE REVIEW PROCESS

Reports pass through a review process, with the aim of ensuring that they are credible, transparent and objective. Drafts of each chapter are circulated to specialists with significant expertise and publications in the field. The reviewers are asked to comment on the completeness and objectivity of the scientific and technical content. Lead authors in collaboration with contributors then produce revised drafts. These drafts are distributed for government technical review, to all authors and to expert reviewers

In the first assessment each chapter had been reviewed by two or three experts and government officials simultaneously and no precise formal rules on the issue had been available. New Rules were introduced after a review in 1992 to ensure scientific quality and credibility to both the scientific and the political community. The review process in the second assessment was much more refined. (Siebenhüner, 2002)

SUMMARIES FOR POLICYMAKERS

The final drafts, taking into account expert and government comments, go back to the appropriate working group for final acceptance of their content. Co-chairs of the working groups are responsible for producing summaries for Policymakers and Special Reports. These should be consistent with the full scientific and technical assessment and are submitted for expert and government review. They are then approved by the working group with the concurrence of the lead authors, to ensure that they are consistent with the underlying scientific-technical report. Review editors aim to ensure that report provides balanced assessment. Finally, the Summaries for Policymakers are formally accepted by the entire IPCC. Conclusions drawn by IPCC Working Groups or Task Forces become official IPCC views when they are accepted by the Panel in a plenary meeting.

PARTICIPATING SCIENTISTS' VIEWS ON THE STRENGTHS OF THE IPCC
(Source: interviews)

The IPCC as a model of international cooperation

The scientists involved feel the necessity for raising the global issue of disaster likely to result from global warming. Such issues are increasingly prominent and involve many fields of science, including health, agriculture, food, and the environment. The scientists feel that it is part of their mission to be conscious of the problem and to alert politicians as well as the public. Dialogue between the society and scientists is a paramount necessity in an era in which scientists feel that increasingly issues need global solutions. Such dialogue takes time to establish; it requires long term commitment. The scientists involved believe that the IPCC is one of the methods of accomplishing such dialogue to construct consensus among differing nations. The IPCC is thought to provide a remarkable platform on which the knowledge of scientists and policymakers can be integrated.

IPCC has simple but clear objectives. It is to consolidate the best knowledge to provide landmark top quality scientific documents for discussion. Such a simple mechanism is one of the important elements in this successful international program. IPCC opponents claim that it mixes science and politics. But the scientists claim that if scientists' statements are judged to be particularly leaning towards, or defending, certain political views, the elaborate review process (including 400 experts and reviewers in one Working Group) will check to see that such sentences will be revised. The scientists claim that this system works extremely well and eliminates prejudiced and unfounded views.

The scientists believe that IPCC is an exemplary model for programmes that aim to assess the present status of science in a given field. It gives a good picture of what is happening in that field, and where we stand in the evolution of the field. They believe that the IPCC methodology can be widely applied to programmes that assess global issues such as health, bio-ethics, agriculture, safety, etc.

Researchers' motivations for IPCC participation

Researchers' are motivated to participate in the IPCC's activities because of the opportunities they provide to meet with worldwide experts and participate in interesting scientific discussions. Debates on controversial issues are not only stimulating, but also create stronger ties between scientists. At laboratory-level, participation in the IPCC is regarded as vital. Whether a laboratory participates in IPCC activities or not is seen as an important indicator of its international status. The scientists interviewed claim that they produce reports independently of political influence. The Reports undergo various reviews and comments are sent back to scientists for scrutiny. Most comments are taken into account and texts are modified, but scientists do not perceive that they are subjected to political pressure. They consider that their independence as scientists is totally respected during the write up of Reports.

Communications between scientists and policymakers

The programme has successfully built an effective communication system between scientists and decision makers. The dialogue between decision-makers and scientists in the programme is remarkable and is seen as one of the major benefits of participating in the IPCC. During the preparation of Reports, scientists, experts, authors and reviewers communicate freely and consult each other's work whenever necessary. They know each other and can easily ask for further information or supplementary explanation.

The consensus building process

The strength of the IPCC is that reports must be endorsed by all the experts; a consensus must be constructed. In order to construct such consensus, the reports must be established on solid scientific ground. A good outcome cannot be obtained unless it is based on scientific arguments. The statements are carefully noted and reviewed by experts. If consensus cannot be reached, the points of disagreement will be clearly stated in a note.

One of the remarkable features of the IPCC is that it provides a mechanism for securing consensus amongst leading scientists and many governments (of all the members of the

WMO and the UNEP) on the climate change issue. The quality of Chairmen of Working Groups is thought to play an important role in producing such excellent results. The scientists interviewed believe that Robert Watson was an excellent leader and contributed enormously to the efficiency of the Programme .

Participation of outstanding scientists

The IPCC claims to involve the best scientists in the world. As a consequence of rigorous selection of authors and reviewers, few participants doubt that the quality of IPCC outcomes is high. Their Reports become an authority ("a bible") for those who seek solid scientific arguments in relation to climate change issues.

The evaluation process

Evaluation is conducted repeatedly during the production of Reports. Numerous governmental experts comment on the draft, comments are re-examined by scientists; governments provide their view regarding the IPCC operation, scientist's debate intensively throughout the production process.

Diversity of participants

Participation of developing countries is also substantial in the IPCC activity. It is encouraged and a large proportion of the IPCC budget is used for trips of experts from developing countries to take a part in the IPCC meetings. Their views on the global warming problem enrich the Reports and widen the perspective of the overall outcomes than when the Reports are only elaborated by the developed nations alone.

Authors selected for the IPCC task are scientists of high calibre, who can take into account both scientific and political considerations. It is their quality that guarantees excellent outcomes. Nevertheless, if there is a doubt about the quality of selected authors, the Bureau will immediately provide supplementary authors to strengthen the team, thus providing means to secure quality.

COMMENTS ON THE IPCC REPORTING AND REVIEW PROCESSES

The role of IPCC is to gather and assess the findings of current research. Reports are approved by the IPCC Bureau, but then have to be approved line by line by civil servants responsible for policy research in individual governments. In order to be capable of reviewing these reports, civil servants need access to the results of model based climate research the principal type of climate research utilised by IPCC's reports. In effect, this confines influence on IPCC reports to the countries in which this research is carried out, i.e. the developed countries. While large numbers of scientists from developing countries attend IPCC meetings, it has been suggested that their influence on IPCC's findings is relatively small. (Boehmer Christiansen and Kellow, 2002, page 133).

The whole process of preparing the chapters and the first round of peer review is carried out by scientists. IPCC assessments take place within the scientific core of the WGs. In WGI, the scientific core "Is well protected against politically motivated influence. WGI enjoys a high level of autonomy guided by the norms and standards of science, and with no systematic government control" (Skodvin, pages 143 and 144).

Government comments are called for in the second round of review when their comments are being solicited and they have a major role in the approval of the Summary for Policymakers and the Synthesis Report. (Siebenhüner, 2002). The main participants in WGI plenaries are government officials and scientists funded by governments (Skodvin, pages 143 and 144). The following example suggests that when the scientists' views differ from governments - by whom most scientists involved in IPCC are employed - the views of government may sometimes prevail.

The Policy Maker's Summary of the IPCC Second Assessment Report in 1995 (SAR) claimed that "The balance of evidence suggests a discernible human influence on global climate", suggesting that global warming mainly resulted from the result of changes in the composition of the atmosphere brought about by the combustion of fossil fuels ('radiative forcing'). This statement is stronger than the evidence given in Chapter 8 of the full IPCC report, as follows: "While there is already initial evidence for the existence of an anthropogenic climate signal, it is likely (if the model predictions are correct) that this signal will emerge more and more convincingly with time". And "The body of statistical evidence in Chapter 8 now points towards a discernible human influence on global climate". One of the lead authors of chapter 8, Benjamin Santer was accused by representatives of the fossil fuel industry and others of deleting the following passages without authorization: "no study to date has positively attributed all or part of that 0.6 degrees C rise in average global temperature during the past 100 years to anthropogenic causes. Nor has any study quantified the magnitude of a greenhouse-gas effect or aerosol effect in the observed data -an issue that is of primary relevance to policymakers." But IPCC rules permit such changes. What apparently happened was that the text of the Summary for Policy-Makers had been formally approved line-by-line by the Working Group and accepted by the IPCC and Governments. "As an agreed document, the Summary could not be modified. So the text of Chapter 8 -the detailed discussion of the science- was amended instead". (Boehmer-Christiansen and Kellow, 2002, pages 149 153).

Before 1992, WGIII's role was to formulate response strategies to human-induced climate change. It became dominated by policymakers and negotiators and scientific peer review did not apply. The work of WGIII could not be clearly identified with the work of a coherent and well-organised scientific community. There was some uncertainty whether their work could be evaluated as political or scientific. It decided to develop global emission scenarios by a top down approach which assumed the equivalent of a CO2 doubling from pre-industrial levels by particular years in the future. These scenarios were strongly criticised from within the IPCC. As a consequence of these problems, and in accordance with the recommendations of the IPCC Task Force on IPCC Structure, the task of developing emission scenarios was transferred to WG1. WGII was reformulated to become the assessment of response options. As Skodvin states "The mandate of the new WGIII lies within the sphere of socio-economics. And he points out that "Economics is, however, more closely linked to value judgments than natural science and this may, in itself, lead to confrontations between scientists and policymakers". As an illustration, Skodvin reviews the controversy over the value of "a statistical life" which took place in relation to the Second Assessment Report in 1995 - in which "a cash value of $1.5 million was assigned to statistical life in OECD countries as opposed to $150,000 in developing countries". As Skodvin suggests "Attributing a monetary value to statistical lives is controversial even among economists." (Skodvin, 2000 pages 120 -123).

UNCERTAINTIES INHERENT IN FORECASTING CLIMATIC CHANGE

By the late 1990s, the IPCC's global warming hypothesis had generated a consensus of scientific opinion that is now rarely challenged at the political level, especially in Europe. Central IPCC claims are: that global warming is man-made, that this will harm the planet in coming decades, and that warming is 'discernible'. These claims involve the assumptions that climate is predictable, that anthropogenic warming can be distinguished from natural change, and that the available models are good enough for policy purposes. The IPCC's scientific consensus is that global warming is an established man-made trend based on excessive emission of greenhouse gases - primarily carbon dioxide - and that if this trend is not reversed it will result in serious harm to the planet. If temperature increases occur, and sea levels also increase as fast as IPCC envisages, both could be important and seriously damaging

Skodvin (2000: pages 96-98) emphasises that "the problem of a human-induced climate change is characterised by significant scientific uncertainty with respect to demonstrating that an observed climate change is statistically unusual (detection), establishing causeand effect relations (attribution) and, not least, projecting future change." He lists some of the sources of significant uncertainty, including estimates of future emissions, (including sources and sinks) of greenhouse gases, aerosols and aerosol precursors; feedbacks associated with clouds, oceans, sea ice and vegetation, and representation of such variables in models; collection of long-term observations of solar output, atmospheric energy balance cycles and ocean characteristics.

The earth's climate is the consequence of complex interactions in an incredibly complex system. It is basically controlled by the Earth's exchange of energy with the sun and outer space. The calculations comprise five important elements: the atmosphere; the oceans; the land surface; the ice sheets and the earth's biosphere. The interaction between these five basic elements is enormously complicated and very little is yet known about some crucial interactions. The IPCC's Working Group 1 climate predictions are based on computer model simulations on supercomputers with Atmosphere-Ocean General Circulation Models (AOGCMs). The result of simulations depends entirely on the parameters and algorithms with which the computer is fed. The members of WG1 are principally meteorologists and atmospheric physicists who, together with computer and modelling experts, collect and process vast amounts of data secured from observation.

But members are drawn from a narrow range of scientists and do not include solar physicists, paleogeologists, oceanographers or biologists Similarly, the peer review process embodied in the workings of Working Group 1 is also confined to people working in the same narrow range of disciplines.

There is general consensus in the whole scientific community concerned with such problems that there is likely to be some warming as a result of man made CO_2. But the size of this effect is extremely difficult to predict. Modeling the cooling effects of particles, fitting the water vapour feedback and handling clouds all involve very difficult problems. For example the IPCC's 1996 report pointed out that when GCMs were used to simulate climates in the previous century, most produced results showing much greater global warming than had occurred in fact. This could be because the global warming due to CO_2 was reduced by the cooling effect arising from particles - from sources such as fossil fuel burning or volcanoes - reflecting solar energy back. The IPCC have attempted to include such effects in more recent models, but the cooling effects of particles are very difficult to estimate and very uncertain. It seems likely that both greenhouse gases and the sun affect the temperature of the earth, but IPCC reports mention solar influences only briefly.

Human activities are increasing atmospheric concentrations of CO_2 to some extent: temperatures have increased 0.6 degrees in the past century and some of this is most probably due to the anthropogenic greenhouse effect. Professor Richard Lindzen of MIT has been very critical of the IPCC consensus, as was Singer. Lindzen argued that the IPCC's first assessment report relied too heavily on large models whose conclusions were mainly verified by comparing the output of one model with another. He suggested that models tend to agree more with each other than with the phenomena which they are used to assess. Nobody knows whether climate changes are related to CO_2, or if climate changes and CO_2 concentrations are related, how they are related. The General Circulation Models (GCMs) used to predict future climate increases are not able to account for the natural fluctuations of climate. Even the most sophisticated GCMs, using coupled atmosphere-ocean computer models, are as yet unable to predict the El Nino Southern Oscillation (ENSO), the North Atlantic Oscillation (NAO) and other quasi - periodic variations of climate (Singer, 2001 pages 12 -17). The IPCC's models are complicated, but far from complicated enough to capture all the essential aspects of the global climate.

Paleo-geology is not included in the IPCC's work. The retrieval and analysis of a long ice core from Antarctica provided a 150,000 year history of both surface air temperature and atmospheric CO_2 concentration. This showed close relationships between these variables and led some scientists to claim that "those observations actually *proved* that anthropogenic CO_2 emissions were responsible for 20th-century global warming. But Idso, Idso and Idso (2003) adduce evidence from several studies which fail to support this thesis.

THE INFLUENCE OF THE IPCC ON INTERNATIONAL CLIMATE POLICY

The following brief account demonstrates the profound influence of IPCC reports in international climate negotiations.

During the 1980s, governments grew more aware of climate issues. In 1988 the United Nations General Assembly adopted resolution 43/53 urging the ‘Protection of global climate for present and future generations of mankind.’ In 1990 the IPCC issued its First Assessment Report, which "confirmed that the threat of climate change was real". The Second World Climate Conference later that year called for the creation of a global treaty. The Intergovernmental Negotiating Committee (INC) first met in February 1991 and its government representatives adopted the United Nations Framework Convention on Climate Change (UNFCC). At the Rio de Janeiro United Nations Conference on Environment and Development (Earth Summit) of June 1992, the new Convention was opened for signature. The commitments involved by the 155 signatories were very considerable. The principles involved included a requirement for the parties to protect against climate change on the basis of equity and the 'common but differentiated' responsibilities of parties and their respective capacities. It entered into force on 21 March 1994. Since it entered into force, Parties to the Convention have met annually at the Conference of the Parties, known as the COP. The Convention outlining legally binding commitments was adopted at COP 3 in Kyoto, Japan, in 1997 (the Kyoto Protocol). This outlined rules and required a separate, formal process of signature and ratification by national governments before it could enter into force. However, in March 2001, President George W Bush announced the USA's withdrawal from the Kyoto Protocol for several reasons -because it exempted major countries such as China and India from compliance, because of incomplete scientific knowledge about the causes of and solutions to climate change problems and because it would cause serious damage to the US economy. (Boehmer-Christiansen and Kellow, 2002 page 80).

A third report from the IPCC "improved the climate for negotiations by offering the most compelling evidence to date of a warming world." At COP 7, negotiators built on the Bonn Agreements by adopting a comprehensive package of decisions – known as the Marrakesh Accords – containing more detailed rules for the Kyoto Protocol.

THE CLIMATE CHANGE CONVENTION THE IPCC AND THE KYOTO PROTOCOL 1979 -2002

1979	1988	1990	1991	1992	1994	1995	1997
First World Climate Conference (WCC)	IPCC established	-IPCC and second WCC call for global treaty on climate change. -September, United Nations General Assembly negotiations on a framework convention	First meeting of the INC	May, INC adopts UNFCCC text June, Convention opened for signature at Earth Summit in Rio	March, Convention enters into force	March and April, COP 1 (Berlin, Germany) March and April, Berlin Mandate	December, COP 3 (Kyoto, Japan) Kyoto Protocol adopted

1998	**2000**	**2001***	**2001**	**2001**	**2002**	**2002**
November, COP 4 (Buenos Aires, Argentina) Buenos Aires Plan of Action	November, COP 6 (The Hague, Netherlands) Talks based on the Plan break down	March USA withdraws from Kyoto Protocol. Subsequent negotiations to meet US requirements fail.	April, IPCC Third Assessment Report. July, COP 6 resumes July, Bonn Agreements	October and November COP 7 (Marrakesh, Morocco) Marrakesh Accords	August and September Progress since 1992 reviewed at World Summit on Sustainable Development	October and November COP 8 (New Delhi, India) Delhi Declaration

Source: UNFCCC (2003)Caring for climate: A Guide to the Climate Change Convention and the Kyoto Protocol, Climate Change Secretariat (UNFCCC)Bonn, Germany.
Column inserted marked by*(derived from Boehmer-Christiansen and Kellow, 2002 page 80-81)

EC INVOLVEMENT IN THE KYOTO PROCESS

EC participation in the Kyoto Process probably represents the most significant example so far of a close relationship between international scientific cooperation and EU internal and foreign policies. Skodvin (2000: page 199- 200) suggests that "Being the only supranational entity with legally constituted policy sovereignty over its member countries, the EC is particularly well suited for concerted environmental action." The 1990 Maastricht Treaty implied a shift in environmental policy away from Member States, who share a common interest in participating in an entity recognized as a global power in international agreements, although there has been some resistance to this EC role from some Member States who wish to guard their sovereignty.

Since the beginning, the EC played a leading role in the drive for international regulatory policies to reduce GHG emissions. In 1990, the EC committed itself formally to stabilise the EU's emissions as a whole at 1990 levels by 2000. The EC attempted to create a coherent policy to achieve this goal mainly through the proposal for an EC carbon-energy tax, but this failed largely due to strong industrial opposition and EC internal conflicts over the distribution of emissions reductions. However, starting with the 1992 Framework Convention on Climate Change (FCCC: the Rio Earth Summit), the EC has achieved some success in achieving its policy objectives, and is continuing to work towards Kyoto objectives despite the Kyoto Process becoming stalled as a consequence of US withdrawal in 2001.

The EC played a major role in the negotiations leading to the Kyoto Protocol in several ways, including selection of 1990 as a base year. This was generally advantageous to EU member states, particularly to Germany and the UK: the selection of 1990 as the baseline portrayed current emitters other than EU member states as disproportionately responsible for the emission problem, and exempted them from the 'historical debt' resulting from their past emissions.

Developed countries and 'economies in transition' were to be required to stabilise their CHG emissions at 1990 levels by 2000. The EC achieved a highly significant role in the negotiations by securing the right to have a single European reduction target within which targets for Member States could be differentiated (the so called 'European Bubble' or Burden Sharing Agreement). Moreover, the EC was made responsible by non-EU signatories for ensuring its Member States' compliance under the terms of the EU Bubble. In these and in several other ways, the EC expanded its competence in energy policy, one of its long-term policy objectives. It also secured the high moral ground by proposing the largest reduction target of all developed countries and took advantage of this position to criticise others as not being such good global citizens.

In March 1997, the Member States of the EC agreed to a negotiating position to reduce total EC emissions of the three major CHGs (CO_2, CH_4 and N_2O) by 15% by 2010 from 1990 levels. The EC secured this agreement by development of an approach which involved a complex analysis of emissions by industrial sectors in each country, followed by complex and difficult negotiations with Member States. The European Climate Change Programme (ECCP) was established in June 2000 with the aim of identifying the most cost effective measures required to meet Kyoto targets.

In March 2001, President George W Bush announced the USA's withdrawal from the Kyoto Protocol. There were numerous protests by prominent European politicians, including the German Chancellor Schroeder and the EC and EU Presidents -Romano Prodi and Goran Persson. Persson wrote to Bush that Kyoto was an integral part of EU-US relations. Environmental groups organized boycotts against US oil companies who were perceived as being heavily involved in the US decision, but the EU refused to consider trade sanctions against the US. The EU held high-level talks with the USA with a view to renegotiating Kyoto to meet the USA's requirements, but failed to secure an acceptable compromise. (Boehmer-Christiansen,, and Kellow, 2002 page 51-59,80-81).

Following the US withdrawal, the EU ratified the Kyoto Protocol on 31 May 2002, committing itself to reducing its greenhouse gas emissions by 8% in 2008-2012 compared with 1990 levels. Measures adopted have included the Commission's Directive on Greenhouse Gas Emission Trading which entered into force in October 2003. Other measures involve improving energy performance of buildings, for promoting the generation of electricity from renewable energy sources for promoting co-production of heat and power and for reducing greenhouse gases from transport; including measures on fuel taxation. In relation to transport, measures have been adopted towards the objective of shifting from road and air transport to rail, water and from private to public passenger transport. It is anticipated that the overhaul of the Common Agricultural Policy (CAP) agreed in 2003 will lead to emissions reduction in agriculture. (EC2003b, EC 2003a)

CONCLUSIONS

The IPCC owes its origins to an international group of scientists who felt the necessity of raising the global issue of disaster likely to result from global warming. While the IPCC was constituted as and remains an Intergovernmental body rather than a scientific body, the scientists currently involved believe that it fulfils this role admirably. Indeed, they point out that such issues are increasingly important and that it could be advisable to establish comparable institutions to involve many fields of science, including health, agriculture, food and the environment. They believe that it is part of their mission as scientists to be conscious of such problems and to alert politicians as well as the public to possible dangers; that increasingly such issues need global solutions, and that the IPCC provides a "best practice method" for securing consensus among differing nations.

Participating scientists make it clear that the processes of report writing and peer review, together with the way that the IPCC is administered as, in general, best practice- with a few minor reservations.

A central problem is, however, that climatology is essentially multi-disciplinary. The central scientific problems addressed by the IPCC include the existence, nature and extent of global warming. The measurement of global temperatures over time is by no means unproblematic, and understanding the numerous variables and relationships which combine to cause variations in global temperature is an exceedingly complex problem, which, essentially, the participating IPCC scientists aim to solve by the use of enormously powerful computers and computer programs. But several scientists from other climate-related disciplines do not accept that the IPCC methodologies are the best or only way of tackling the problems. This lack of "inclusiveness" - if it may be so described - represents a limitation on the value of IPCC's work. How serious a limitation is a matter of intense controversy.

The IPCC's findings have had a profound influence on international negotiations in relation to climate change and on EU environmental policy. As the IPCC scientists themselves suggest, it is likely that the requirement for international scientific assessment will grow, and it is probable that the EC amongst others will seek to establish and participate in furthering such initiatives. This case study has indicated that, in several respects, the internal operations of the IPCC represent very good practice. But it has raised the issue of "inclusiveness" in terms of scientific discipline, which may also well apply to other cases where there are future requirements for scientific assessment.

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APPENDIX 5 - LIST OF ACRONYMS AND ABBREVIATIONS USED IN THE REPORT

AGGG- Advisory Group on Greenhouse Gasses
AOGCM- Atmosphere-Ocean General Circulation Models
CAP- Common Agricultural Policy
CEEC- Central and Eastern European Countries
CEPH- Centre d'Étude du Polymorphisme Humain
CERN- Centre Européen de Recherche Nucledaire
CFCs- Chlorofluorocarbons
CFSP- Common Foreign Policy
COP- Conference of the Parties
COST- Cooperation Scientifique et Téchnique
CREST- Comité de la Recherche Scientifique et Technique
DC- Developing Countries
DER- Division of Extramural Research (NHGRI)
DG- Directorate-General
DOE- U.S. Department of Energy
EAB- ESPRIT Advisory Board
EC- European Commission
ECCP- European Climate Change Programme
ECSC- European Coal and Steel Community
EEC- European Economic Community
EFDA- European Fusion Development Agreement
EFDA- European Fusion Development Agreement
EFTA- European Free Trade Association
EIRO- European International Organisations
ELDO- European Launcher Development Organisation
EMBL- European Molecular Biology Laboratory
EMBO- European Molecular Biology Organisation
EMC- ESPRIT Management Committee
ENSO- El Niño Southern Oscillation
ERA- European Research Area
ESA- European Space Agency
ESO- European Southern Observatory
ESPRIT- European Strategic Programme for R&D in Information Technology
ESRO- European Space Research Organisation
EU- European Union
EURAB- European Research Advisory Board
EURATOM- European Atomic Energy Community
FCCC- Framework Convention on Climate Change
FP- Framework Programme
GARP- Global Atmospheric Research Programme
GCM- General Circulation Model
GHG- Greenhouse Gas
HFSP- Human Frontiers Science Programme

HGP- Human Genome Project
HUGO- Human Genome Organisation
ICSU- International Councils of Scientific Unions
ICTs- Information and Communication Technologies
IEA- International Energy Agency
ILL- Institut Laue-Langevin
IMS- Intelligent Manufacturing Systems
INC- Intergovernmental Negotiating Committee
INCO- International Cooperation Programme of the European Framework Programmes
INTAS- International Association formed by the European Community, European Union's Member States and other countries to preserve and promote the scientific potential of the NIS through East-West Scientific co-operation
IP- Integrated Project
IPCC- Intergovernmental Panel on Climate Change
IPR- Intellectual Property Rights
IST- Information Society Technologies
ITTF- Information Technology Task Force
MITI- Ministry for International Trade and Industry (Japan)
MSP- Management Supporting Parties (HFSP)
NACHGR- National Advisory Council for Human Genome Research (U.S.)
NAO- North Atlantic Oscillation
NGO- Non-Governmental Organisation
NHGRI- National Human Genome Research Institute
NIH- National Institutes of Health (U.S.)
NIS- Newly Independent States
NIST- National Institutes of Standards and Technology (U.S.)
NoE- Networks of Excellence
NRC- U.S. National Research Council
OECD- Organisation for Economic Cooperation and Development
OTA- U.S. Office of Technology Assessment
PREST- Politique de la Recherche Scientifique et Technique
R&D- Research and Development
RACE- R&D in Advanced Communications Technologies in Europe
RTD- Research and Technological Development
SDI- Strategic Defence Initiative
SEA- Single European Act
SG- Secretary General (HFSP)
SNP- Single Nucleotide Polymorphisms
TSU- Technical Support Unit
UNEP- United Nations Environmental Programme
UNFCCC- United Nations Framework Convention on Climate Change
USDA- U.S. Department of Agriculture
USSR- Union of Soviet Socialist Republics
WCP- World Climate Programme
WG- Working Group
WMO- World Meteorological Organisation

APPENDIX 6 - FINAL STATUS OF GLOSPERA DELIVERABLES

Deliverable	Status		
	Completed	Partially Completed	Abandoned
Workpackage 1			
Report on the activities of the Network to be included in Interim Report	√		
Workpackage 2			
Interim Report	√		
Ideas for incorporation of European S&T expertise into external relations policy design in Europe	√		
Workpackage 3			
Ideas on optimising benefits to ERA from international research cooperation	√		
Workshop report	√		
Workpackage 4			
Synthesis of the results of the concerted action and pooling of data on the 4 case studies	√		
Workpackage 5			
Clear conclusions about the options for policy design for ERA within the context of globalising research systems	√		
Practical assessments of how European S&T expertise may contribute to the design of European external relations policy		√	
Final project report	√		
Workpackage 6			
Advisor's report		√	