

Towards a European research area

A response by the Royal Society to consultations issued by the European Commission, Directorate General for Research, and the UK Government, Office of Science and Technology.

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European Research is an important subject which the Royal Society has been interested in for some time, and we are pleased to input into the current consultations. We recently held a discussion meeting on this subject, the proceedings of which were published [*'Science funding: the European dimension'*, Royal Society 1998]. We were also pleased to input our ideas during the development of the European Commission's Framework Programme 5 [*Framework Programme 5*, Royal Society 1995].

Main recommendations

- European Research Programmes should concentrate on areas that clearly benefit from European-level collaboration. Such programmes should ensure international competitiveness in most major areas of research and innovation, and leadership in some.
- European Research Programmes must, like national programmes, have effective review mechanisms for proposals by high calibre scientists and adequate monitoring and evaluation of the output.
- Increased information exchange about national exchange programmes should complement the European Research Programmes and concentrate funding on maintaining and supporting a healthy European science base from which innovative research will develop.
- Many centres of excellence already exist in the European research community. The European Commission should place emphasis on facilitating collaboration, infrastructure and information exchange between such centres, in particular through the development and effective use of high-speed Internet links. A key step in the evolution of a European Research Area should be the early creation of a number of Europe-wide, world class research institutes 'without walls', based on high-bandwidth second-generation Internet links, and funded to a level that enables them to strive for world leadership in their domain.
- One of the most effective ways of developing a healthy research base is through mobility of high calibre researchers. The Commission, and national research programmes, should remove barriers to participation by non-nationals, both within and outside the European Union, and should investigate ways in which longer-term funding for young researchers can be provided.

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General points about 'A European Research Area'

A successful industrial base, increased quality of life and ways to solve both social and economic problems can all result from research in science, engineering and technology. In order to build up a healthy research base it is vital to invest in an educated and motivated workforce, concentrating on teaching and training of young researchers and support of research infrastructure.

We believe that the European Commission document correctly summarises the current situation, and problems, in the European Science Base. We also welcome the opportunity to comment on the Commission's proposals, and hope that this will be the first stage in a wide-ranging, two-way consultation process leading up to the development of the next European research programme.

Nevertheless, the document from the Commission omits to state explicitly the fact that European research is already vigorous and highly productive. It contributes not only to underpinning the economic health of the European Union, but also to developments of benefit to the individual citizens of the Community. What is needed for the future is a mechanism to develop European research even further. The emphasis in the Commission document seems to be on achieving parity with our competitors such as the US and Japan. We believe that this is a fundamental mistake. Rather, what is needed is to identify and build on those areas in which European scientists are most innovative, and in which we have the expertise and potential to become world leaders as the subject grows to ensure that such innovative and novel science can flourish. This requires investment in education, research, career structures and the generation of a culture in which the best brains enter and remain in science and which is attractive for financial investment.

Supporting and enhancing the science base

We support the view of the UK OST that European Research must have some 'European added-value'. It must not simply plug the gaps not covered by national programmes, nor should it replicate what is being funded at a national level, unless by doing so it can produce more than the sum of the national programmes. Nevertheless, we do not support the view that this added value can be accomplished simply by narrowing the scope and objectives of the European Framework Programmes. There are several existing pan-European collaborations (e.g. CERN, ILL, ESRF,¹ etc) and a host of successful EC Framework Programmes consisting of multiple projects. One reason to collaborate is that in certain areas experiments have reached such a scale that they cannot be contemplated by a single country. However, an equally valid reason is that world class scientists who are working in related topics benefit immensely from collaboration.

The two major outputs of the science and engineering base in Europe are knowledgeable people and new knowledge. A key goal for Europe (in terms of industry, research, and quality of life) is not just to train knowledgeable people for the knowledge economy, but to create an environment in which they will flourish, and hence aid retention of world-class individuals in Europe.

Although only 5.4% of total research spending in Europe, the Framework Programme spending represents a very large fraction of uncommitted, flexible funding (i.e. not tied to infrastructure or salaries as national funding is) and as such it should be able to make a very important difference if used well.

There is considerable scope for increased information exchange about national research programmes within the European Union. A more co-ordinated approach to research funding would help to avoid duplicated effort and hence contribute to the health of national research bases in turn complementing the European Research Programmes. In order to facilitate such co-ordination it will be necessary to open up national programmes to wider EU participation. Ways should also be investigated to increase access from non-EU countries such as the US and Japan, as well as Central and Eastern European countries, notwithstanding potential legal difficulties.

One of the fundamental problems with the European Framework Programmes to date has been the necessity to tie them to a short-term budget. This has resulted in programmes of a limited period, often followed by a complete change of emphasis of research priorities. Whilst we accept that short-term budgets are necessary, we do not think that this is at odds with the concept of long-term research strategy. It should be possible to maintain long-term research priorities and aims that may last for a number of Framework Programmes. Such long-term programmes are more likely to result in innovative, wealth creating initiatives than are short-term programmes with highly specific aims.

We welcome the initiative by the European Commission and the European Science Foundation (ESF) to hold a conference to consider European infrastructure for science and technology. In particular we welcome the increased co-operation between the Commission and ESF as indicative of a willingness to improve co-operation between the Commission and the large number of pan-European science and technology organisations. Lack of co-ordination and co-operation in the past has led to considerable overlap and duplication. We urge the Commission to view organisations such as CERN, ESRF, EMBL, EMBO, ILL, ESO, COST and ESA² as valuable sources of help in co-ordinating international peer review, or research collaboration.

We support the move by the European Commission towards facilitating trans-national programmes rather than attempting to manage them. Nevertheless, there must be robust procedures for evaluation and monitoring of research programmes funded at a European level. Current methods of obtaining suitable experts for peer review are not sufficient to obtain the high calibre scientists and technologists necessary to ensure that only the highest quality research proposals are accepted for funding. We recommend that national bodies, such as research funding agencies, are able to nominate peer reviewers for EC programmes. Current monitoring and evaluation procedures for European research programmes appear to be somewhat variable.

In some subject areas, there needs to be a review of the bureaucracy involved in applying for, and holding, European research funding. Some large research programmes involving several sites and numerous researchers currently require the employment of a full-time project co-ordinator to be successful.

There is a strong need for increased co-ordination regarding the use of large-scale research facilities. What is needed is a programme to ensure access to and maintenance of such facilities rather than central management of the facilities by the European commission. The current level of transnational access to large-scale facilities militates against the development and maintenance of such facilities as 'centres of excellence'. It is particularly important to consider the source of long-term funding for such facilities. We recommend that the European Commission works closely with the ESF to consider this issue since the organisation has considerable expertise in this area.

¹ CERN: European Organisation for Nuclear Research; ESRF: European Synchrotron Radiation Facility; ILL: Institut Laue-Langevin.

² ESA: European Space Agency; EMBO: European Molecular Biology Organisation; EMBL: European Molecular Biology Laboratory; ESO: European Southern Observatory; COST: European Cooperation in the field of Scientific and Technical Research

The consultation document from the European Commission has an immensely broad scope and we recommend that the Directorate General for Research focuses on what is achievable via the Framework Programme structure. Proposals to initiate a European dimension to the public understanding of science for example are likely to fail as they might not take into account national issues.

We do not agree with the UK OST's view that dissemination of results should be an integral part of the evaluation of Framework Programme research. Exchange of information between scientists via publication in peer reviewed journals happens without facilitation, and is a wholly separate issue from the exploitation of results.

Supporting excellence in science at European level

It is pointless to try to distinguish between basic and applied research when deciding which to fund – what is important is to encourage excellence in research and to facilitate an environment in which it can be effectively exploited.

Centres of Excellence – by which we mean places in which excellent research is carried out (either Universities or Research Institutes), already exist in Europe, and will develop and attract funding and collaborators without 'start-up' funding. What is needed is funding to facilitate collaborations with other centres of excellence both within and outside the EU.

Before we can concentrate on developing mechanisms to link Centres of Excellence together it is important to identify criteria by which such centres will be judged. These must be based on rigorous peer review by high calibre scientists

What is vital to facilitate the development of research collaborations, and the exchange of information, throughout Europe is the development of a high speed Internet link throughout the EU and the support of access to centres of excellence. We urge the European Commission to focus on this requirement and we support the recommendations of the ESF and the Academia Europaea ['High Bandwidth Computer-based Networking in Europe' ESF Policy Briefing Number 7 Feb 2000].

Encouraging innovation

A majority of the measures for encouraging innovation are outside the scope of the European research programme. What is needed for effective wealth creation from research is a suitable fiscal environment. We support the need for a review of tax incentives and other fiscal mechanisms for encouraging innovation, but we recognise that the responsibility for such measures lies with other Directorates within the European Commission than that responsible for research.

We also support the need for a simplification of the European patenting system, which is currently expensive, when compared with national systems such as that in the US. The vast majority of start-up companies need to identify and protect their intellectual property but may be discouraged from doing so by the costs involved. The Society urges the European Commission, and the UK Government, to press for harmonisation of intellectual property legislation in Europe, so that a patent may be lodged in only one EU country yet be recognised and enforceable in all. Subsequently a more broad-based global system should be developed. Some intellectual property is best protected by non-disclosure and confidentiality agreements (N/CDA). However, if they try to prove breaches of a N/CDA, small companies are always at the mercy of those with deeper pockets. There is no equivalent of the Legal Aid system for Small and Medium-sized Enterprises (SMEs). The Society recommends that the European Commission, and UK Government, investigate the idea of an 'Intellectual Property Legal Aid' scheme to support SMEs in cases arising from alleged breaches of N/CDAs.

Applied research will only grow from the highest quality basic research – it is not helpful to target specific problems and attempt to design research programmes to come up with the solution. The most innovative research has grown organically. It is also very difficult to try to carry out the application of research for wealth creation on a European scale. European research collaborations benefit basic research because of exchange of ideas and results, and sharing of expertise. One way in which innovation may be encouraged is to include mechanisms in EU funding schemes which allow responses to unexpected innovative research developments and discoveries.

Many areas that are likely to result in innovative developments in the future will also require a degree of transdisciplinarity. It is important to facilitate the exchange of ideas between researchers in different fields without being too prescriptive. Programmes which require a fixed representation from specific disciplines stifle innovative research, whereas successful programmes such as the ESF Networks and Research Conferences encourage co-operation and exchange of ideas.

There is also a need for explicit support for Small and Medium-sized Enterprises. An effective way to do this would be to develop a European equivalent of the US Small Business Innovation Research (SBIR) program and we recommend that the European Commission investigates this option.

Supporting the careers of scientists and technologists

We welcome the Commission's willingness to decrease barriers to participation in research programmes, and we urge national programmes to remove barriers to participation of non-nationals, not just EU citizens but also those of non-EU countries. It is also vital to concentrate on making Europe an attractive destination for non-EU researchers by removing economic and legislative barriers. The development of well-funded centres of excellence will by their nature attract the highest calibre researchers from all countries.

We recommend the formation of a Returning Fellowship programme to facilitate information exchange – Fellows would be funded to carry out 3 years research (perhaps a PhD) elsewhere, and then funded for a further 3 years in their home country. Such a programme would ensure that those gaining experience and training would return to their countries of origin to disseminate such knowledge, but would also provide longer term support than is currently available to young researchers.

A specific, but simple, measure that would benefit the careers of all researchers, but particularly women, would be to lift all age restrictions on fellowship programmes.

An important consideration in endeavouring to improve the careers of researchers is whether the salary in research is comparable to that in other sectors. Whilst this is clearly a national consideration, it is a crucial element to consider when reviewing mechanisms by which careers in science could be made more attractive.

In order to be able to take advantage of all the opportunities available in rapidly developing, interdisciplinary areas, it is vital that young researchers are given the training necessary to be able to work in an interdisciplinary environment.

Underpinning policy decisions with sound science

The Society has long advocated basing decisions on science policy on sound science, however we also recognise that science is not the only consideration when developing policy: there must also be mechanisms in place for taking into account public concerns.

We strongly support the guidelines developed by the UK Chief Scientific Advisor on the use of scientific advice in policy making ['The Use of Scientific Advice in Policy Making', Sir Robert May FRS

AC, Chief Scientific Advisor UK, 1997] and urge the European Commission to put measures in place to increase the transparency and openness with which European Science policy is developed.

Whilst we support the need for scientific research to underpin science policy, we do not see this as falling within the remit of the European Framework research programmes. The individual Directorates responsible for developing policy should also be responsible for commissioning research related to that policy, on a strict contractor/customer basis. Individual projects should then be put out to competitive tender with such exercises open to national centres of excellence in addition to multinational centres such as the Joint Research Centres. Projects of a sensitive political nature, such as the development of detection methods for BSE, for example, should be undertaken by centres such as the Joint Research Centres, which do not have specific national agendas, provided that they have the relevant expertise and facilities to conduct the research.

It is vital that the European Commission reviews the role and funding of the Joint Research Centres in the context of the provision of research to underpin policy decisions. Whilst we support the view that there may be specific areas of research which the JRC could conceivably carry out to support policy development, it is crucial that such projects are applied for on a competitive tender basis with the tender process being as transparent as possible. It is also crucial that the operating costs and complexity of the organisation are taken into account when considering its future role.

Since the European Science and Technology Assembly (ESTA) no longer exists there is a need for an independent source of high quality scientific advice for the European Commission. It is possible that the JRC could provide a role analogous to the role of a Chief Scientists Office in providing advice on issues of science policy and public policy for science for the Commission. However, such a role would be radically different to the one that the JRC carry out today and would require a different range of expertise and a re-organisation.

Specific priority areas for further research development

Future advances in science and technology are likely to require inter-disciplinary skills and applications. The following are some examples of areas in which there are likely to be rapid developments in the future:

(i) Manipulating atoms, molecules and macro-molecules. This covers 'Nanotechnology', 'Combinatorial Chemistry' and 'Functional Genomics'. Nanotechnology provides the ability to construct structures on a range of scales – starting at the atomic level. It is also a clear example of a field of research that developed as an 'added extra' or offshoot to another research programme. Like Combinatorial Chemistry it is a field which is still at the very early, pre-commercial stages of development, but it has immense potential for further development.

There is a huge opportunity to use the technology resulting from the sequencing of the human and other genomes to develop an increased understanding of life processes, as well as more specific applications in the medical, agricultural and pharmaceutical fields. Such research will require a range of different expertise from mathematics to biologists.

There are also related 'spin-off' technologies such as the developments in microscopy and opto-electronics in recent years which allow researchers to monitor developments from single molecule detection to whole organisms and to develop non-invasive diagnostic tools. Magnetic resonance Imaging, for example, is now a routine tool for medical use, a dramatic development which has occurred over the last decade.

(ii) Dealing with complex data

One of the most difficult challenges faced by the research community in many areas of work will be how to deal with the sheer volume and complexity of data generated by ongoing research such as the human genome programme, the Large Hadron Collider programme & Earth Observation Satellites. It will be essential to facilitate collaboration between computer developers and a range of disciplines who will require networks and super-computing power to process their results. The development of such computing power will result in the ability to predict the physical, chemical and biological environment – from life processes, to the fate of chemicals in the environment, to climate change, and has major implications for European-wide infrastructure.

(iii) Post-silicon computing

The silicon chip will begin to reach the limit of its development over the next decade after which it will be imperative to have alternative technologies in place. We note that the US is currently supporting a vast initiative in semiconductor development and it is important the EU identifies areas of European expertise in this area and encourages the necessary high quality fundamental research.

(iv) Micro to macro

Two of the most exciting, and far reaching, scientific advances over the past twenty five years have been: (a) molecular biology leading to the concept of molecular medicine; and (b) the development of a powerful Information Science and Engineering, building on the falling costs of electronics and increased bandwidth of communications. These have proceeded independently, with very little overlap. There is now a major opportunity to relate molecular explanations of disease processes to their anatomical and physiological expression as determined by medical image and signal processing. Europe has a world-class presence in these two scientific advances, and could achieve world leadership in their synthesis. This would breed a new kind of scientist at the frontier of biology/medicine and information science/engineering.

(v) Planetary science

The European Space Agency has been responsible for the development of a viable European Space Programme. In the next 10 years there will be a number of European, US and Japanese mission to Mars, including several 'landers' and return of soil samples to Earth. Given the current strong European position in Space technology, we consider that transnational programmes for data collection and interpretation of planetary samples are vital for the European scientific community to gain maximum benefit for its Space Programme. This area of science is one which also attracts a great deal of public interest and support.

(vi) Environment and health

The release of synthetic chemicals into the environment, the potential application of genetically modified organisms to agricultural practices, and long-term monitoring of climate change, are areas of vital interest for the health and well-being of EU citizens. The area of 'environment and health' is one which could benefit from collaboration between national research programmes and from international programmes such as European framework Programmes. Such collaboration should involve 'centres of excellence' identified as set out above.

Additional information

Additional copies of this response and other science policy publications are available from the Science Advice Section at the Royal Society (rebecca.bowden@royalsoc.ac.uk; tel: 020 7451 2588; fax: 020 7451 2692). All publications are also available on the Society's web page (www.royalsoc.ac.uk).