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**COMMUNICATION FROM THE COMMISSION**

**EUROPE AND BASIC RESEARCH**

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## 1. INTRODUCTION

An important debate is taking place in Europe today on the subject of basic research, the issues involved and the best way of dealing with them at a European level.

The debate is taking place against the background of the emerging knowledge-based economy and society; within the framework of the project to create a European Research Area, which has hitherto not explicitly taken account of the issue of basic research; and together with the target set by the EU of increasing its overall research effort to 3% of GDP by 2010.

During the years immediately after the Second World War, when research policies originated and developed in Europe and the USA, the emphasis was on basic research.

This is well illustrated by what Vannevar Bush, President Roosevelt's scientific adviser, wrote in 1945 in his famous report "Science: the Endless Frontier": "*Scientific progress on a broad front results from the free play of free intellects, working on subjects of their own choice, in the manner dictated by their curiosity for exploration of the unknown*".

During the decades which followed and in view of the importance of science for industrial competitiveness and its role in meeting social needs, this emphasis, and with it public funding, gradually shifted towards applied research and technological and industrial development.

Today, the general value of increasing knowledge and the importance of basic research for economic and social development, tend to be fully recognised again.

The debate on basic research has so far essentially taken place within the scientific community, in the form of thinking about the need for a "Basic Research Fund" and a "European Research Council".

During the last few months, various personalities, organisations and bodies have expressed their views on this issue.

In this respect, particular mention can be made of: a group of 45 European Nobel Prize winners; the European Science Foundation (ESF) and the EuroHORCS association of Directors and Presidents of National Research Councils; the Eurosciences association and Academia Europeae, the EURAB Group of advisors for Commission research; and an ad hoc Group of individuals (ERCEG),<sup>1</sup> which was set up during the Danish EU Presidency following a conference on a "European Research Council", held in Copenhagen on 7 and 8 October 2002.<sup>2</sup>

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<sup>1</sup> EuroHORCSs: European Heads of Research Councils; EURAB: European Research Advisory Board; ERCEG: The European Research Council Expert Group, chaired by Professor Federico Mayor.

<sup>2</sup> On 15 December 2003, the Danish Research Minister sent his European counterparts this group's final report, which calls for the setting up of a European basic research fund, principally financed through new resources, by the Union's Research Framework Programme, and operating through a European Research Council.

This debate is now ready to be brought to the political level. The European Parliament gave a signal along these lines in its Resolution<sup>3</sup> on the Communication from the Commission “Investing in research: an action plan for Europe”,<sup>4</sup> which calls for greater support from European research policy for basic research, through the setting-up of a “European Research Council”.

By presenting this Communication on basic research, the Commission wishes both to contribute to this debate and to help launch discussion at the political level. The Commission is responding in particular to the request made to it during the Competitiveness Council on 22 September 2003 to present its views on this subject.

In this context, the objectives of this Communication are three-fold:

- To make a broad analysis of the basic research situation in Europe and at a European level, through highlighting the related issues, as well as the European strengths and weaknesses in this field;
- To prompt thinking and discussion by clarifying matters and providing details and further information about various points raised during the debate;
- To put forward suggestions for avenues which should be explored to strengthen European performance in the field of basic research and to give it the resources to play the full part it must within the European Research Area.

## **2. BASIC RESEARCH AND ITS IMPACT**

### **2.1. What basic research is**

There have been very many attempts to define the concept of basic research, and this type of research has been characterised in many ways, often in a combined manner: by reference to its ultimate purpose (research carried out with the sole aim of increasing knowledge); its distance from application (research on the basic aspects of phenomena); or the time frame in which it is situated (research in a long-term perspective).

It has been pointed out that, in the research system known as “technoscience”, research is always carried out with a view to potential applications, and all research is performed “in an applications context”.<sup>5</sup> With very few exceptions, no research activity is carried out with the sole purpose of increasing knowledge.

The context of research and its funding, like that of research policy, has indeed evolved. However, this evolution does not in any way affect the distinction which in any case its theoretical sense retains, and a good part of its operational scope.

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<sup>3</sup> Resolution of the European Parliament P5-TA-PROV (2003) 0495 of 18.11.2003.

<sup>4</sup> COM (2003) 226, 4.6.2003.

<sup>5</sup> For example, see the work of the scientific sociologists Michael Gibbons, Helga Nowotny, Michel Callon, John Ziman, etc, e.g. the collective work: “The New Production of Knowledge”.

While there is no strict, unanimously accepted definition of what constitutes basic research, in practice one can identify and distinguish from other types of research, those which are carried out with no direct link to a given application and, if not exclusively, in any case and above all with the objective of progressing knowledge.

## **2.2. An impact on several levels**

When one looks at what has happened to major discoveries, and considers the realities of our everyday environment, it can be seen that nearly all technologies, products and achievements which have led to economic and commercial success and/or concrete improvements to the quality of life are based on basic research as indicated above.

The discovery of X-rays and nuclear magnetic resonance has led to very many applications in the field of medical diagnosis and the study of materials. Work on the principle of stimulated coherent radiation, lasers, in the 1960s has found numerous outlets in industry and medicine. Increased knowledge in the physics of semi-conductors allowed the development of transistors, thus integrated circuits and then microprocessors, the basis of electronics; and in informatics, the sophisticated software which controls user-friendly interfaces and calculation systems is based on mathematical algorithms which were developed in a very theoretical manner.

In the field of the life sciences and technologies, one can mention the example of the discovery of restriction enzymes, which have provided biotechnology with a universal tool in the form of “molecular scissors”. While, by definition, the empirical and clinical approach continues to play a determining role in this field, we also know how much recent successes in medical and pharmaceutical research and progress in the health sector, are due to breakthroughs in molecular biology and immunology. We know too that further progress can be expected in this area from work often of a very basic nature in the field of genomics and the neurosciences.

Environmental management and sustainable development are also largely the result of basic research in climatology, oceanography, atmospheric physics, etc.

As can be seen from the shortening of the average time span between a discovery and the applications derived from it, basic research sometimes quickly turns into concrete results and commercial products.

But sometimes work which remains unexploited for a long period of time finds a practical use long after being carried out: take the maths theory of fractors, which started to be used in synthetic imaging systems years after it was developed. Often, the applications to which the work gives rise were totally unforeseen, and are in fields far removed from the field in which the work was carried out.

Even if these applications represent the most visible and substantial part, the economic impact of basic research does not weaken the potential direct and indirect benefits which society can expect from this type of research, and represents only the most important form taken by these applications.

Alongside this, mention should also be made of the key role of basic research in the training of researchers. For a researcher, the only way to acquire knowledge and mastery of the techniques in his or her field is by carrying out research of this type. By conducting research in university laboratories which is at the leading edge of knowledge, researchers acquire skills and capabilities which they will use throughout their careers, in the particular field concerned or in the field of applied research. In this respect and for this reason, basic research is likely to remain a central feature of the activities and tasks undertaken by universities and, along with teaching, the performance of such research is the reason why they exist<sup>6</sup>.

More generally, what most distinguishes universities from other educational establishments is that they enable everyone to undertake knowledge-based training through research. The importance of basic research will be stressed from this angle too.<sup>7</sup>

In general terms, support for basic research has also been traditionally regarded as one of the tasks of the public authorities. This kind of support is more necessary than ever today because of:

- The indirect, but undeniable, impact of basic research on economic competitiveness, growth and, more generally, well-being;
- The growing cost of basic research due in particular to the cost of the instruments, equipment and infrastructure needed (in fields, for example, such as nanotechnologies), as well as the complexity of the matters with which basic research is concerned, which increasingly demand an interdisciplinary approach, the cost of which the private sector is reluctant to bear considering the very indirect nature of any expected financial return;
- The value of knowledge as “public property”, which means that, in principle, there must be free access to it, this being easier to guarantee if there is public funding<sup>8</sup>.

For reasons which will be explained below, there would seem to be a need for this public support to be given at a European level.

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<sup>6</sup> See the Communication from the Commission "The role of the universities in the Europe of knowledge" (COM (2003) 58, 05.02.2003).

<sup>7</sup> A Conference organised by the Commission will be held in Liège from 25 to 28 April 2004 on the subject of university research, in particular its links to education, and the issues related to a knowledge-based Europe.

<sup>8</sup> The question of intellectual property rights and their links to basic research is a complex one. Firstly, under patent law, neither scientific discoveries nor theories are patentable. Only inventions can be patented. However, a grey area is known to exist, and the problem has arisen, for example, in the context of genome analysis as regards DNA sequencing. The early publication of a discovery may also ruin the chances of protecting and exploiting the results in the form of a patentable product or process. In the USA, the “grace period”, which enables a researcher to publish for a period of one year before patenting, increases the tension between the need to publish the results and the need to protect them. The “grace period” concept does not exist in Europe where patent law is based on a different principle (“first to file”, rather than “first to invent”). To reconcile the somewhat contradictory requirements of free access to knowledge and its exploitation, action is needed at several levels, in particular the development by universities of a sound knowledge management policy, and the establishment of a clear and fair international framework.

### 3. THE SITUATION WORLDWIDE AND IN EUROPE

#### 3.1. The USA

In the USA, basic research is mainly carried out by universities, which form the heart of the country's research system, more precisely by the 150 research universities which give the USA its international reputation, where talents and resources are concentrated, and which attract most of the private and public funding available.

Basic research in the USA is largely financed by the major federal research support agencies. First and foremost, there is the National Science Foundation (NSF), set up in the wake of the famous Vannevar Bush report, which supports research in a large range of fields.

It is also financed, to some extent, by the National Institutes of Health (NIH) in the field of medical research, some of the activities of which are quite basic in nature. Lastly, there is the Defence Advanced Research Projects Agency (DARPA), the research agency of the Department of Defence, which supports research in a very large number of fields, both directly but often also quite indirectly linked to military needs (research for defence purposes, "dual use" research and research where there is a potential security interest).<sup>9</sup>

Most of this government support is given in the form of "individual grants" for specific projects, awarded to a named researcher, but in reality it serves to pay, apart from this researcher (the "principle investigator"), the young "Post Docs" working on the project and the technicians assisting them, as well as to cover the cost of the material and equipment needed for the project.

These projects are examined in the framework of a "peer review" system. It is often stressed that one of the strengths of the US research system is that excellence is stimulated through the competition for federal funding between university teams across the country as a whole.

In the USA, basic research also receives substantial support from the private sector. Private philanthropic foundations more especially play an important part in this. Their capital is derived from industry funding, but also to a non negligible extent from individual donations. Some undertakings also carry out a significant amount of very basic research "intra muros" in their own research centres. Well known examples are: a few years ago, the Bell laboratories; today, the research centres of IBM and Microsoft.

Along with its strengths, the US system also has its weaknesses, notably the precarious situation of many researchers who are permanently trying to find funding. It has its limits also. For some time now, the US federal research agencies have been tending to introduce financial support mechanisms based on the principle of collaboration, along the lines of what exists in the European Union's programmes.

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<sup>9</sup> Research in the field of particle physics is not financed by an agency, but directly by the Department of Energy (DoE).

On the whole, however, it is clear that a number of conditions are met in the USA which are favourable to both the development of basic research and the exploitation of the results by industry: the attachment of great importance to university research, a climate which stimulates cooperation between universities and industry- and businesses being much more ready to finance basic research in universities; strong competition between teams at the national level; agencies with a mandate for basic research, specialised, but in part also in healthy competition with each other, etc.

### **3.2. In Japan**

For a long time, Japan was almost absent from the international basic research arena and was confined to acquiring and adapting technologies which had been developed elsewhere, but it has come to the fore during the last few years due to the considerable increase in its efforts in this field.

Although it has not yet enabled the country to rise to the level of the other scientific powers, this increased effort is starting to bear fruit and to produce concrete results, as witnessed in particular by the spectacular rise in the number of Japanese Nobel Prize winners: 4 Nobel Prizes for science over the last four years, whilst the country could only boast of 3 prizes since the award was created.

### **3.3. Europe**

In Europe, most basic research is carried out in universities. It is financed partly through their basic grants and partly from outside sources, most of them governmental but some of them private.

Even if this type of research is the traditional field of activity of universities, it is not confined only to universities. In many European countries, the part played today by the major national research organisations is considerable, and a large part of their activities are precisely in the field of basic research.

This is the case, for example, with the CNRS in France, the CSIC in Spain, the CNR in Italy, the Max Planck Institute in Germany, etc. In these types of organisation, basic research is most frequently funded by fixed grants allocated annually to various laboratories or institutes, or in the framework of multiannual, sometimes thematic programmes. In some cases, however, projects are funded through outside sources, private or even public in the form of “competitive” funding at European or national level.

In several European countries, there are actually agencies which fund research, more especially basic research, in universities but also in research organisations: the Research Councils in the United Kingdom, the Deutsche Forschungsgemeinschaft in Germany, the Vetenskapsradet in Sweden, the NWO in the Netherlands, the FNRS in Belgium, etc. These operate largely by giving grants for projects carried out by individual teams similar to those seen in the USA.

In Europe, the private sector is relatively inactive in the field of basic research. Few companies have strong research capabilities in this field, and their activities generally tend to focus on applied research and development activities. Moreover, the funding of research through foundations is still limited.



Unlike in the USA where the private sector has always defended the idea of the need for sizeable public funding of basic research,<sup>10</sup> European industry has for a long time advocated giving priority to public funding for applied research, in particular for research carried out by companies themselves. Today, the importance of basic research for economic competitiveness is starting to be recognised more and more in Europe, including by organisations which represent the business world, such as the European Round Table of Industrialists.

### **3.4. Strengths and weaknesses**

It is not easy to quantify the respective efforts of the USA and Europe in terms of basic research and the difference between these efforts. Given the differences in how basic research is defined from one system and one country to another, the unstable nature of the nomenclature used for compiling statistics, as well as the very limited data available, especially for Europe, it is difficult to come up with figures that do not need to be treated with caution.

In overall terms, the level of US and European efforts seems to be more or less comparable. It is in terms of results and performance that the difference is greatest. The conventional indicators of the performance of research systems are the number of articles published in international journals, and the number of references to these articles.

In terms of publications, Europe is in the lead with 41.3% of the world total compared with 31.4% for the USA. In terms of number of references, regarded as the best indicator of the quality of research, Europe is however behind the USA in most disciplines: about one-third more references are to US researchers.

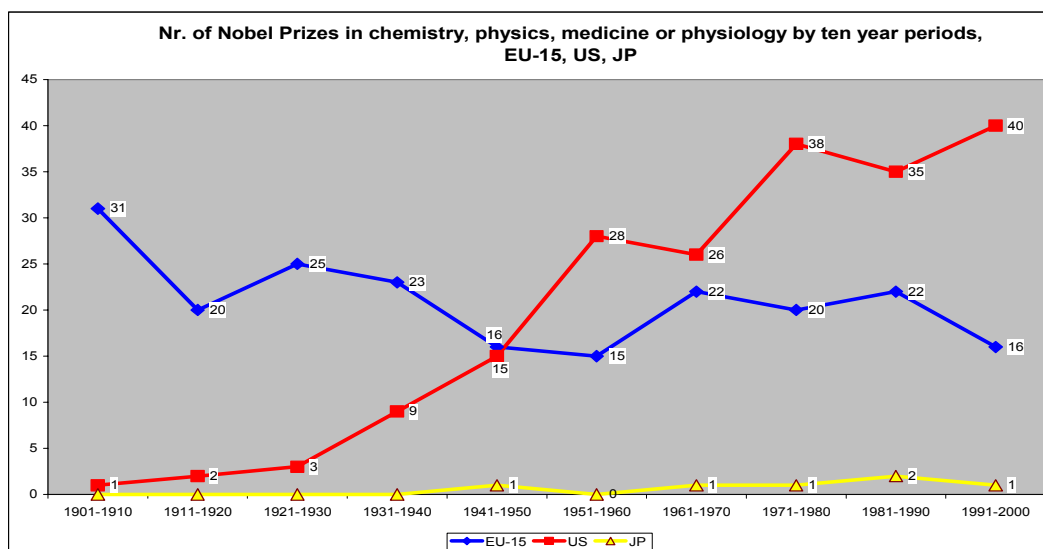
A field-by-field analysis shows the gap is generally wider in the fields of basic research where an increase in knowledge is likely to have a particularly marked effect on competitiveness. While it is relatively small in fields such as the earth sciences, mathematics and agricultural research, the gap widens in physics and medicine, and is particularly marked in chemistry and the basic life sciences. In the computer sciences, Israel and the USA clearly dominate world production.

This difference in performance is confirmed by the number of Nobel Prize winners in Physiology/Medicine, Physics and Chemistry: between 1980 and 2003, there were 68 in Europe, against 154 in the USA, with the gap widening over the years. As is often emphasised, a large number of US winners were actually born or trained in Europe.<sup>11</sup>

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<sup>10</sup> See the report "America's Basic Research: Prosperity Through Discovery" of the Committee for Economic Development, which includes representatives of the major industrial groups.

<sup>11</sup> For the Fields Medal, the "Nobel Prize in Mathematics" which is awarded every four years, the figures for the same period are as follows: 9 Europeans (including 1 working in the USA); 5 Americans; 4 Russians (including 2 working in the USA and 1 in Europe); 1 Japanese; 1 New Zealander (working in the USA). In other words, a total of 9 researchers working in Europe and 9 working in the USA.



The difference appears to be linked to the distinct manner in which research in general, and basic research in particular, is organised and how it operates on the two sides of the Atlantic.

In the field of research, and basic research in particular, Europe has undeniable strengths: the quality of the European training system; the very high standard of a large number of university teams; the existence of centres of excellence in practically all fields; the strength of the traditions of basic research which often exist in the countries acceding to the Union. But it also has a number of weaknesses.

In this regard, the first thing which should be mentioned is the lack of sufficient competition at European level, since teams and researchers are largely exposed only to competition within their own countries. By exposing researchers, teams and institutions in different countries to the ideas and dynamism of their greatest counterparts elsewhere in Europe, the establishment of genuine competition on a continental scale would undoubtedly stimulate the creativity and excellence of basic research in Europe.

The fact that Europe is split into a number of different countries, trivial but with several major consequences, also has an impact in other respects:

- The lack of cooperation and coordination of activities due to the compartmentalisation of national programmes and support systems;
- The lack in some cases of a critical mass of projects due to the small number and limited size of centres of excellence.

In terms of results, Europe in overall terms offers a less attractive environment for researchers: researchers from third countries but also European researchers, which Europe trains in number and at a high level, but who often choose to pursue their career in the USA.

Due to their intrinsic nature, these structural weaknesses need to be tackled and dealt with at a European level.

#### 4. BASIC RESEARCH AT EU LEVEL

In Europe, most basic research is carried out and funded at national level.<sup>12</sup> One of the reasons for this is that it is largely performed by universities, thus in the framework of the national education systems.

For a long time, the predominant feeling among the Member States has also been that this type of research by definition falls within the sphere of national competence and that, in view of the objectives of EU research policy, the European Union should confine itself to supporting applied research and technological development.

Here too, the perception has changed over the years due to an awareness of the realities about the knowledge-based economy and an understanding of the importance of advances in scientific knowledge and research, including basic research, for achieving the economic and social goals of the Union.

A substantial amount of basic research is however carried out at a European level, in the framework of the activities of several intergovernmental organisations, but also those of the European Union.

Historically the first scientific cooperation initiatives in Europe were indeed launched in the area of basic research with the setting up of CERN in the field of high-energy physics in the 1950s, the ESO (astronomy) in the 1960s, and the EMBO and the EMBL (molecular biology),<sup>13</sup> all of which are organisations that continue to play a very important role in basic research in Europe today.

The research activities carried out within the networks and projects of the European Science Foundation (ESF), a non-specialised organisation set up in the 1970s, also often concern quite basic research topics.

This is also the case with activities conducted under the Union's Research Framework Programme, which includes a certain amount of basic research in the form of specific activities or certain aspects of the research activities of major programmes.

##### Basic research in the Framework Programme

Basic research activities can be found in the following parts of the 6<sup>th</sup> Framework Programme:

- "Marie Curie" actions to support the training, mobility and careers of researchers; these activities are open to all scientific fields, including theoretical research (theoretical physics, cosmology, mathematics);
- Support for access to research infrastructures and their exploitation (particle accelerators, astronomical observatories, etc.);

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<sup>12</sup> To some extent at regional level in cases where, and subject to the limits within which, the regions, which generally tend to focus their efforts on technological development and innovation, provide funding for universities and the research activities which they carry out.

<sup>13</sup> CERN: European Organisation for Nuclear Research; ESO: European Southern Observatory; EMBO: European Molecular Biology Organisation; EMBL: European Molecular Biology Laboratory.

- The NEST activity to provide specific support for research “at the frontiers of knowledge” (€215 million), which is open to proposals for “visionary” research, throughout the field of science and technology, with the emphasis on interdisciplinary research;
- To some extent, the “thematic priorities”, with work in particular in the field of nanosciences and the physics of materials; some research on molecular biology and the basic mechanisms of genetics and genomics; the FET (future and emerging technologies) action to support new scientific and technological disciplines relating to the information technologies.<sup>14</sup>

Taken as a whole, however, the support provided by the Framework Programme for basic research seems limited. The resources explicitly devoted to it are not very great, and the general perspective of the programmes is still very much dominated by knowledge-application objectives. Above all, the range of research support modes remains limited, without there being, more especially, a support system for individual teams of a significant size.<sup>15</sup> In total, the Framework Programme does, however, seem to provide an appropriate basis for action on a greater scale, to be conducted with additional resources.

## 5. THE PROSPECTS

Along with its assets, Europe, as has been shown, suffers from a number of weaknesses as far as basic research is concerned. These are largely due to the compartmentalised nature of the national research systems, and above all the lack of sufficient competition between researchers, teams and individual projects at a European level.

Since these weaknesses vary in nature, they will not be overcome and the challenges associated with overcoming them will not be met unless resources, approaches and instruments are combined. There is no single formula which will allow all of the problems to be solved at the same time.

To enable Europe to extract the maximum benefit from its scientific potential and intellectual resources, to serve the economy and European society, action must be taken at several levels.

### 5.1. A new support mechanism at European level

First and foremost, there seems to be a need to introduce an European level support mechanism for individual teams’ research projects, modelled on the “individual grants” given by the NSF.

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<sup>14</sup> In this respect, it should be noted that all research projects supported by the Union are evaluated by means of a procedure involving panels of independent experts based on the principle of “peer review”, with rules and operating conditions very similar to those applied, for example, by the NSF.

<sup>15</sup> A support scheme for individual teams operates on a limited scale within the framework of the Marie Curie actions (Marie Curie Excellence Grants): €120 million in total, for support for a period of four years for teams set up around one researcher. Outside of the Union framework, there is the European Young Investigator (EURYI) scheme set up by Eurohorcs Association, which has a comparable budget of €25 million a year.

During the discussion on basic research and on a European Research Council, such a support mechanism was repeatedly put forward as a major and desirable innovation. It seems quite natural in the context of the European Research Area.

Such a mechanism would in fact make it possible to combat the effects produced by the compartmentalised nature of the national systems. By stimulating competition and encouraging innovation as well as experimentation in ideas and new approaches, including interdisciplinary ones, it would stimulate creativity, excellence and innovation by exploiting a form of European added value other than that produced by cooperation and networking: the added value which comes from competition at EU level.

The principle of stimulating through competition is currently exploited in the Framework Programme, though only at the level of projects and networks. Indeed, it should not be forgotten that proposals for projects and networks submitted in response to calls for proposals are presented and evaluated in a competitive context and only the best ones are adopted, within the limits of available resources.

Support mechanisms in keeping with the particular type of basic research concerned should be defined, in particular with recourse to topics and work programmes that are more open and less binding than in the case of targeted research.

The importance of this mechanism is not in principle limited to basic research. In the case of applied research too, support for individual teams' projects could and must be envisaged. In fact, in the USA, most of the funding given by the NIH, where many of the activities carried out are applied research, is awarded in the form of "individual grants".

Given that, according to the scientific community itself, it is difficult to establish strict, universal criteria for distinguishing between basic research and applied research, such a mechanism would therefore actually benefit from being applied throughout the scientific and technological field.

To be able to implement this new activity and achieve a sufficient impact without endangering other activities which support research at European and national levels, a significant volume of fresh funding should be provided for in the Union's research budget.

Converging on this point with the recommendations of the "Mayor Group", the Commission plans to propose making the introduction of such a mechanism, as well as increased support for basic research, one of the main themes of the Union's future action in the field of research.

## **5.2. Other activities**

While the introduction of such a new funding mechanism is necessary and will be useful, it will not be enough to resolve all of the problems affecting Europe in the field of basic research.

Other activities must be launched in combination, and those already in progress today must be continued and strengthened, in line with the other major lines of future EU action in the field of research, as envisaged by the Commission. To provide basic research with the resources it needs to achieve its rightful position in the European Research Area, it is in particular essential to:

- Strengthen European support for research infrastructures, and support the creation of centres of excellence in the enlarged Union, through a combination of national and European, public and private funding;
- Increase support for the development of human resources, researcher training and the development of careers in science;<sup>16</sup>
- Support collaboration and networking: in some cases, the mechanism which best meets the needs for a particular basic research topic is that of a collaborative project or a network. The possibility of making use of such a mechanism, as is done in particular today in the case of networks of excellence under the 6th Framework Programme, must continue to be ensured.
- Improve the coordination of national activities, policies and programmes in the field of basic research: the tools for this purpose exist at a Community level, in the form of the ERA-NET scheme and Article 169 of the Treaty.

At the same time, as a supplement and in the framework of the Action Plan towards the "3%" objective, action is needed to boost the financial support given to basic research in Europe, in particular funding by the private sector through foundations.

## **6. THE NEXT STEPS**

This Communication provides a basis for debate at the political level, more especially within the Union institutions.

The next steps in this debate, the follow-up and the translation of its conclusions into concrete proposals for action should be as follows:

- First quarter of 2004:
  - A broad debate on this Communication within the scientific community and groups concerned, in conjunction with the reflections on a "European Research Council";
  - A debate at the political level within the Council and the European Parliament on the basis of this Communication;
- Second quarter of 2004: presentation by the Commission of a Communication setting out proposals for the operational translation of the conclusions of the debate on basic research in the form of mechanisms to be implemented at a European level.
- Second half of the year: a political debate on the second Communication from the Commission, with a view to the establishment of a Commission proposal for the 7th Framework Programme.

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<sup>16</sup> See the Communication from the Commission "Researchers in the European Research Area: one profession, multiple careers" (COM (2003) 436, 18.7.2003).