European Research Council
Scientific Council

Scientific Council of the ERC:
Relaunching the European Research Area (ERA)

1. Introduction

The Scientific Council of the ERC was asked by Commissioner J. Potočnik to contribute ideas towards the re-launching of the European Research Area, specifically as related to the Commission's Green Paper. We are pleased to do so. Rather than attempting a point-by-point analysis and response to the Paper, we will address key requirements for the future development of the ERA, especially from the perspective of fundamental research given the special role of the ERC in this respect.

We begin with analytical sections, briefly assessing a series of topics related to research and knowledge generation in Europe, on which we have considerable collective expertise, in part from our one-year experience in constructing the ERC, a major European initiative that we describe in some detail. From this we proceed to a series of recommendations, cutting across the themes identified in the Green Paper.

2. Frontier Research and the ERC: Central features of ERC

a) Frontier Research: a key requirement for competitiveness

With the ERC and more broadly the 7th framework programme, the EU has begun seriously to promote frontier research as a key aspect of competitiveness in a knowledge society. This necessary development, long advocated by the scientific community, is of course strongly endorsed by the ERC Scientific Council. However, it should not escape our attention that Europe is not alone in pursuing the knowledge society as a platform for competing effectively in the coming decades. Despite some recent problems, the competitiveness of the US research system and its funding remains formidable. The emerging giant economies of China and India as well as several other Asian and Australasian countries (Japan, S.Korea, Taiwan, Singapore, Australia) are moving rapidly ahead, in the same direction. Europe needs to act on several fronts to follow up the ERC initiative.

It is commonly argued that the major problem for research in Europe is fragmentation of efforts. Fragmentation is indeed an important problem, but it goes hand in hand with inadequacy of overall resources, due to vast disparities in R&D investment levels across the countries of Europe. According to the Commission's "Key Figures 2007 on Science, Technology and Innovation", total (public and private) national R&D expenditure on Civil R&D (GERD) in the EU varied tenfold, between 0.39 and 3.86% of GDP in 2005, the average being only 1.84% of GDP. The comparable R&D funding levels in the USA, Japan and S. Korea are currently 2.67%, 3.17% and 2.99%, respectively.* The significant funding of the ERC (an average of 1.073 billion per year for 7 years) pales in comparison to the current annual budgets of the NSF (ca. € 4.4 billion) and the NIH (ca. € 17.3 billion).

* Of course these figures underestimate the gap, as the exceptionally large military research expenditures in the US (many of which have civil spin-offs) are not included.

It would be a cruel deception to argue that we are now poised to achieve the professed goal of our becoming the most dynamic knowledge economy in the world. Much more remains to be achieved rapidly. Europe's recent investments are (still) insufficient, and fragmentation calls for the development of new synergies and other innovative initiatives. We must continue to ramp up private and public research investments, provide the necessary research infrastructures, extensively reform the education sector (in particular the university systems) and facilitate Masters-level, doctoral and postdoctoral training.

b) The ERC – a logical but revolutionary step for the EU

The European Research Council (ERC) is a recent but vital instrument for the construction of ERA as a vibrant common market for knowledge creation and utilization. Our central mission is to promote frontier research in Europe, with excellence as the sole criterion and without regard to nationality. Therefore, the establishment of the ERC through the FP7 Ideas Programme by co-decision of the EU institutions is a logical but also revolutionary step in European integration. It is logical because extending the scope of ERA to frontier research continues the EU's signature process of abolishing artificial barriers, so as to improve performance and productivity. It is revolutionary in three key respects. The ERC operates according to independent scientific governance, being managed autonomously from the Commission under the leadership of a distinguished, 22-member Scientific Council; it redefines the concept of European added value, in terms of Europe-wide competition rather than only trans-national actions; and instead of focusing on redistribution, it is a pure and bold excellence initiative, recognising that excellence begets excellence.

In creating the ERC, the EU acknowledged a cardinal principle that the scientific community well understands: competition on the sole criterion of excellence, independent of political considerations, is the surest way to release human creativity and thus to promote fundamental advances at the frontier of knowledge. By beginning overdue changes in the European legislation and establishing new structures to allow this shift, creation of the ERC has liberated thinking on how the Community research funding system should operate. In doing so, it is opening up new avenues for the development of the relaunched ERA.

The Scientific Council has designed the ERC's funding schemes to promote research excellence in all fields of knowledge and scholarship, and to secure the corresponding human capital, by both retaining in Europe and progressively recruiting from overseas some of the top research talent of both the current and the next generation. Therefore, there are no restrictions on the nationality of the Principal Investigators to be funded by the ERC, although the core part of the research must be based in Europe. To support "brain circulation" while preventing brain drain, we aim to improve conditions in the research sector, thus encouraging young Europeans to enter a scientific career, European top talent to repatriate, and top non-European research talent to move to or remain in Europe. It is well recognized that immigration and retention of scientists from across the world has been an important source of the competitiveness of the United States in the post-WWII decades. Thus, one of the aims of the already launched Starting Independent Researcher Grant ("Starting Grant") scheme of the ERC is to retain in or recruit to Europe highly talented young investigators. The forthcoming "Advanced Grant" scheme has a similar aim for scientists of any age; it will be launched next year, for projects led by top established investigators currently working

in Europe, or overseas but committed to emigrate and work in a supportive host institution in Europe.

In particular, the ERC is convinced that the prospects for young investigators are critical for the competitiveness of Europe in the world-wide search for research talent. In all of Europe we must support young scientists and scholars with an attractive package as they begin and/or consolidate their independent research programme and group. They require good career prospects and structures. They must have the opportunity to develop their own ideas and research projects; to recruit their co-workers freely; and to publish independently. Given the critical role of young scientists and their relative neglect in Europe, the ERC decided to devote its entire budget to them in the first year of ERC operation, and at least one third of its subsequent budgets which are scheduled to progressively increase.

It is envisaged that these two funding streams, operating on a "bottom-up" basis, will be the core of the ERC's operations, at least initially. They will provide flexible-to-manage research funds for ground-breaking, high-risk research in all scientific domains, including research of a multi- and inter-disciplinary nature. ERC grant proposals will be evaluated by peer review panels solely on the basis of quality. Initially twenty panels consisting of selected European and non-European scientists have been appointed by the ScC to evaluate Starting Grant proposals. The panel structure will be fine-tuned in light of the response to the first call, thus ensuring optimal coverage of future Starting and Advanced Grant proposals. Panels cover all scientific areas and are structured in a way that encourages and facilitates evaluation of inter-disciplinary proposals (see http://erc.europa.eu/pdf/erc_guide-for-applicants_stg.pdf).

It was clearly recognised even before the ERC's current budget was fixed, that the average of just over €1 bn per year from 2007 to 2013, while impressive for a new agency, would certainly be inadequate to achieve its full potential. This is already demonstrated by the vast demand for grants arising from the first ERC call for proposals, where only approximately 3% of proposals submitted can be funded. A phenomenal number of applications (9167) were submitted, from throughout Europe but also several hundred from the rest of the world. The box at the end of this section summarizes the numbers of applications by provenance and intended institutional location; clearly, all parts of Europe responded with enthusiasm to the ERC, in terms of current residence of the applicants and location of their intended institutions. Countries are clustered by accession to the EU or association with FP7, thus reflecting the process of European integration. After adjustment for population size, it appears that the earlier the EU accession date, the greater the interest of both individuals and institutions. Thus it can be expected that, over time, the new candidate, associated or member states will converge towards the involvement level of the other member states.

At the 1st stage of evaluation, 559 of the 9167 applicants were selected to submit a full application for the 2nd stage. It is intriguing that, even at this early stage it appears that the ERC will help attract and retain in Europe a not insignificant number of highly qualified scientists. Thus of the 559 impressive semi-finalists, 20 are applying to come to Europe: one is an intended American immigrant and 19 are overseas† Europeans intending to repatriate to Europe, not necessarily to their native country; 18 are from the U.S. and one from Japan. Furthermore, 36 additional semi-finalists are non

† This term is used to refer to scientists who are currently not residing in any EU member state, associated or candidate country

Europeans currently residing in Europe and applying to remain here: 12 of them are nationals of the U.S., 4 each of Japan, China and Australia, 3 of Canada, 2 of Russia and 7 of other countries.

The ERC is committed to present transparently, in full detail, the statistics when the 2nd stage applications are evaluated by the panels and awards are made. The results will undoubtedly be valuable for Europe's scientific communities in different fields, and for the national/regional communities and policy makers to consider appropriate reforms. Currently it appears that the success of the ERC will justify substantial expansion of its scope and budget, in the next Framework Programme if not before.

Starting Grants First Call:
Applications clustered by the country's EU accession date or other status

Cluster	PI residence	Host Institution location
EEC6: BE, DE, FR, IT, LU, NL	**44.8**	**46.2**
Next 9 of EU15: AT, DK, EL, ES, FI, IE, PT, SE, UK	**35.5**	**37.2**
Next 12 of EU27: BG, CY, CZ, EE, HU, LT, LV, MT, PL, RO, SI, SK	**8.6**	**8.8**
7 EU-associated or candidate: CH, HR, IL, IS, NO, RS, TR	**7.9**	**7.8**
6 Overseas highly developed: AU, CA, JP, NZ, TW, USA	**2.8**	**0**
AL, AR, BR, BF, CN, EG, IN, IR, KH, ME, MX, SN, TN, RU, SG, UA, UZ, ZA, ZW	**0.4**	**0**
	100	**100**

3. Additional priorities for ERA

We are not proposing that additional research funding should be directed exclusively to frontier research and the ERC. There is also considerable scope for complementary research-related goals as summarised below. A broad improvement of the financial base of the ERA should be sought, to fill the gaps and level out the imbalances within the ERA. Much of this responsibility lies with member states and with other initiatives of the EU. However, in light of the conflicting priorities facing policy makers in the less wealthy member states, "central" competitive initiatives like the ERC have a very important place in identifying and supporting human talent. When properly cultivated, talent is a well-distributed "natural resource".

Competition should be fair in order to be effective, with similar starting conditions for every party involved. The key problem here is the imbalance between different Member or Associated States in salaries for researchers as well as national support for fundamental research and for research infrastructure. The countries themselves are responsible for rectifying such imbalances. Otherwise, the unintentional effect could be that the ERC's strategy of attracting the best researchers to work in the EU will unintentionally contribute to growing disparities. For example, world class researchers

will not be able to accept the financial conditions offered at the local level in several member states, including some of the wealthier ones.

a) Autonomy of the ERC and beyond

Autonomy and independent scientific governance were emphasized in the ERC legislation, as requirements that would be guaranteed by the European Commission. The ERC has been able to establish new benchmarks of good practice precisely because the strategic direction and responsibility for the management of its operations was entrusted to a Scientific Council derived from the research community and selected by an independent Identification Committee. The Council's autonomy is legally guaranteed by FP7. However, there is still some way to go before the ERC operates with the appropriate autonomy. Some of our recommendations (below and in sections 6a and 6b) reflect the need to work quickly to establish in practice bold, innovative solutions to this essential requirement.

Operational autonomy is well-established in the US research system (despite occasional interventions by Congress to fund directly "pet projects"). At EU level, it is foreseen that the early experience of the ERC will be taken as the basis for revising and adapting its structure as necessary, after an agreed mid-term review. An autonomous, well-functioning ERC could provide a model for other Commission linked (but autonomous), flexible and responsive European Agencies. Indeed, a separate agency to deal with European infrastructures has been suggested recently by others, and should be considered seriously (see section 2b).

An autonomous ERC would also provide a model for those national agencies that are insufficiently independent, because of the reflex over-emphasis on statist solutions in parts of Europe. Indeed, the side-effects of the ERC and its synergy with national best practice are beginning to be felt. Some member states that did not have autonomous Research Councils have started to create them de novo, or have initiated the process of making them autonomous from existing government ministries. An example is Spain: the recent obvious success of the Catalonia region in recruiting internationally top quality scientists with private sector contracts and allowing them to join a local institution of their choice, is beginning to be emulated, both in other Spanish regions and at the national level. It can be expected that such structural reforms will improve the quality of research in additional member states, and thus raise their competitiveness in the ERA.

b) Infrastructures: A key requirement for world-class research and innovation

Infrastructures, whether single-sited or distributed large facilities and electronic databases, are essential requirements for frontier research in practically all fields of knowledge. In the post-WWII period, European research greatly benefited from, and often became world-leading, because of visionary initiatives of the scientific community, culminating in the creation of European Intergovernmental Research Organizations (EIRO's) such as CERN, ESO, EMBL and the other members of EIROforum. Whilst most of the funding for EIROs is provided by *ad hoc* groups of member states, the European Commission has made an increasingly important contribution in this sector: for example by making EIRO scientists eligible for support in FP6 and FP7; by becoming a significant funder of the essential infrastructures of the European Bioinformatics Institute (a component of EMBL); by establishing a well-appreciated programme that provides broad access to numerous existing infrastructures and

supports their upgrades and their networking; and finally by playing a major role in funding and locating in Europe ITER, the new global infrastructure for research towards energy production based on controlled nuclear fusion. The Capacities Programme of FP7 continues in this positive direction, although it is clearly underfunded. In the mid-term review of the financial perspectives it will be important to address infrastructures as a key issue, and also to verify whether central requirements of the scientific community such as broad access to infrastructures are adequately served.

A new, positive feature of the infrastructure landscape is the creation of the European Science Forum for Research Infrastructure (ESFRI). Currently it consists of individual Member State representatives assisted by EC staff. Unfortunately, the scope of EU participation has been kept low. In 2006 ESFRI adapted an initial Roadmap based on the outcome of deliberations within its Working Groups, assisted by scientific experts and advisors. It encompasses 35 projects for new or major upgrades of existing infrastructures, and it was well received. It has been suggested in the ERA Green Paper that structural funds be used selectively to fund new or substantially upgraded pan-European infrastructures, and others have proposed the creation of an ERC-like agency that would ensure the primacy of scientific considerations. The ERC strongly supports both of these proposals. A well-considered amalgam of MS and EC commitments to projects endorsed by a leading scientific expert committee, reflecting the scientific community, would build upon the highly successful intergovernmental model for large infrastructures; it would create an exciting new MS/EC partnership that retains the intergovernmental tradition of top quality, science-driven, autonomous governance and flexible operation, while benefiting from and further reinforcing the cooperation between MS and EC in the context of ERA.

The ERC strongly endorses the current broad concept of major infrastructures, which is not limited to the classical (and still very important) large centres for frontier research in the physical sciences, but now also encompasses the comparably important infrastructural requirements of the biological, biomedical, environmental and social sciences.

Whilst a variety of small or medium size infrastructures are properly the responsibility of individual EC Member States, the importance of infrastructures for frontier research and their enabling effects on the regional as well as European scientific community, institutions and industry, strongly argue in favour of a well distributed set of major infrastructures in Europe. The Green Paper includes recommendations on how to increase the synergy between different funding sources, especially how to harmonise FP7 and the Structural Funds. The use of these funds is a national responsibility, but not all governments attach appropriate importance to research infrastructures (and to R&D in general). The ERC recommends that the EC services use all the powers available to them through the negotiating procedures and regulatory provisions (including a lower mandatory recipient contribution), to emphasize the significance of a balanced spectrum of European research infrastructures. A bi-annual review of the national reports on the implementation of the Lisbon strategy in connection with the objectives of the European Research Area is also recommended, with the aim to introduce appropriate corrective measures on EC level. The assessment of this review should involve in addition to an ESFRI or ERC-like type of Infrastructure Agency, the Directorates of the EC involved in R&D and in infrastructure.

c) Open access to scientific information

Scientific research is generating vast, ever increasing information, including primary data, data structured and integrated into databases, and scientific publications. Additionally, at least in the exploding field of Life Sciences, accessible repositories for materials and research tools are already a necessity rather than an option. In the age of the Internet, free and efficient access to information, even in the form of original data, will be the key for sustained progress. To achieve this, significant investment is required to establish repositories for data, publications and materials where needed, or to upgrade and maintain existing repositories. Sustained investment is mandatory to secure curation of very large data sets, such as genomic and related biological information, and to guarantee open, efficient accessibility to it. Open access to publications and more generally processed data (information) is a concept already strongly supported by the scientific community. The ERC is on record with a recommendation that the outcome of research it supports be published in print or electronic publications, and be freely accessible as soon as possible, preferably no later than 6 months from publication.

The importance of additional access to unprocessed data is now beginning to be widely understood: it allows fresh analysis and utilisation beyond what the originator of the data had in mind. A number of repository resources for data and material exist in Europe, but suffer from lack of sustained support, simply because there have been no instruments in the European Framework Programmes for funding infrastructures of this kind.

The EU should also encourage the ongoing efforts to support and, where appropriate, to enforce open access to scientific information, while not endangering long trusted peer review systems based on scientific integrity and the quality of scientific publications. Critical for such systems are high quality and affordable journals, including those that are published by scientific societies and thus recycle publication profits to support scientific activities. A prerequisite for this policy is the existence of reliable, freely accessible repositories for scientific publications. While the physical sciences, mathematics and computer science have the worldwide, US-based and federally-funded arXiv Internet preprint library, the biomedical and life sciences currently rely mostly on the US-based and federally-funded Pub Med Central which has a mirror at the Hinxton (UK) Genome Campus. Ideally, such infrastructures should encompass not only preprints but also the final publications in an Internet-accessible, searchable format, connected to repositories that allow access to and free utilization of primary data for further research, per the previous paragraph. Europe can and should pioneer development of similar repositories in all fields, including the humanities and social sciences. Filling these deficits and building upon new opportunities should be a major objective of ERA, towards optimal utilization of scientific data and information that has been secured by public investment, to the benefit of both science and society.

It should be noted that the ERC is currently refining its policies concerning open access and intends to contribute actively to the ongoing debate and to developments in this important area.

d) The imperative of structural change in Europe's advanced training and research systems

Creation of the ERC reflects an important shift in emphasis that is at the heart of the Green Paper. The traditional role of Community research policy - to reinforce and "join up" national research efforts – has been supplemented by a concern to promote major structural reforms in Europe's research system, and thus to ratchet up the quality and efficiency of European research as the foundation stone of a more ambitious innovation policy. This vision intersects with the recognition that, despite the existence of high-quality research-oriented universities in Europe, our overall tertiary education and advanced training system, including Masters, doctoral as well as postdoctoral training, is not as well-performing as it should be. OECD data from 1981-2003 show a persistent gap in the EU vs. USA in total researchers per thousand labor force. Prof. Manuel Heitor (Centre for Innovation, Technology and Policy Research, IST Lisbon) estimates that Europe needs to train and secure more than 500,000 researchers to deliver on the Lisbon targets (personal communication). Women and scientific immigrants are the most obvious potential source for increasing human resources for science and technology in Europe.

European universities vary widely in quality. In the aftermath of the catastrophic WWII, a new challenge has emerged: the overwhelming expansion in access to higher education has not been accompanied by commensurate growth in resources or sufficient internal reform. The Bologna process, an important reform promoted by the European Universities Association, promises convergence towards greater coherence between national systems and their performance targets. Convergence should facilitate performance comparisons and valuable exchanges of students and academic staff, following up on the highly appreciated Erasmus programme of the EU, which has enriched learning and fostered European identity in a critical age group. However, convergence is not a substitute for straightforward improvements. The resource gap in public higher education, which resulted from a vast increase in enrolment, needs to be addressed either from state budgets or from alternatives such as those that sustain American higher education:

- tax-exempt bond issues.
- private philanthropy facilitated by relevant changes in the tax code.
- tuition charges coupled with student loans and scholarship schemes, both performance-based and income-dependent.

Improved finances will need to be tightly linked to performance and to firm programmatic commitments. In this respect, the Research Assessment Exercise in the UK and the Excellence Initiative in Germany are valuable models. Teaching quality also needs to be continuously assessed and its excellence rewarded.

While indirect costs of sponsored research should be reimbursed, the full economic cost model for research as practiced in UK universities is somewhat problematical, as it conceptually undermines the inherent research and scholarship mission of the universities. Excellence in knowledge creation and transmission is surely more important a part of the universities' mission than entrepreneurship, and should be directly rewarded by corresponding basic funding, rather than by overly relying on reimbursement of indirect costs of research. Assessment-based teaching and research rewards will also enhance institutional accountability.

Last but not least, in a period of revolutionary advances worldwide in many areas of research, the traditional departmental barriers need to be reconsidered, and a strong focus on interdisciplinarity promoted. University reform should have a strong intellectual as well as organisational and financial content.

e) Complementarity and synergy in research systems

As the ERA matures, it will be necessary to ensure that actions at different levels –in particular the EU, national and regional levels – are mutually reinforcing and synergistic. It might be argued that, in a reversal of past policy, fundamental research and infrastructures should be exclusively supported by the EU via the ERC and ERC-like agencies; and that Member-State and regional funding should be reserved for industry-related applied research; or that the reverse alternative should be considered, with the member states funding basic research and infrastructures and the EU limited to industrial research. We consider both of these "compartmentation" alternatives unwise, and instead advocate complementarity through partial overlap, to create synergy rather than duplication. Some of the many possible arguments are as follows:

- Industrial research greatly benefits from proximity and interaction with fundamental research, and vice-versa. Their direct interaction is desirable, as shown by the relocation of much of the in-house research of European pharmaceutical companies to the best fundamental life sciences research centres in the USA: in the Boston, San Francisco Bay and San Diego regions, practically adjacent to research buildings of corresponding leading American Universities and research centres. Frequently, industry/academia agreements allow direct collaborations between scientists who can meet easily in each other's building. Career changes of scientists between these domains are encouraged and fruitful. Europe should aim at closer interaction between industry and academia, not their separation.

- Much basic research is conducted in Universities and Research Centres, and often directly relates to postgraduate and postdoctoral training. If that research were entirely dependent on funding from Brussels, this would strongly undermine the European excellence initiative of the ERC by claims for "juste retour" that would become necessary for training the new scientists in each member state.

- Orienting EU support almost exclusively to industry was tried early on and failed. It highlighted the problems of industry over-reliance on public funds for its research in a free-market system, and it also cemented great disparities between member states' funding for fundamental research, to the detriment of Europe as a whole.

4. Toward a new European research policy

The four arms of the EU science funding instruments in FP7 have introduced a high level of clarity in what the EU programmes intend to deliver and a very good basis for their complementarity: The ERC/Ideas Programme for frontier research, Co-operation Programme for collaborative networks (both basic and more applied), the People Programme for training, and Capacities - including ESFRI - for analysing infrastructure needs. However, the Scientific Council's experience would suggest a number of improvements. In particular:

a) ***Post-doctoral support:*** It is unfortunate that the People programme does not contain a conventional postdoctoral fellowships scheme. Postdoctoral mobility and training, particularly in a new environment (preferentially but not necessarily in a new country) is practically an essential part of a scientific career in many fields.

b) ***Mobility:*** The need to remove barriers to mobility and to assure a free job market for scientists in Europe is stressed in the ERA document, and mention is made of "linguistic barriers" but this is not developed further. Europe's many languages are a cultural wealth rather than a problem in themselves. However, most of the researchers in Europe work within universities and have to teach; many European countries still demand that ALL teaching should be in the local language, even at the postgraduate level. Linguistic barriers sometimes are also imposed in research institutions. This is a very efficient way to prevent any recruitment from abroad! Since in the time of the Internet all young people of Europe are becoming fluent in English, it would not be difficult to solve this problem. We understand (and share) the sensitivity concerning preservation of national and local languages. However, some entrepreneurial countries and regions (Denmark, the Flanders region of Belgium) have chosen to adopt English as the language of instruction at the postgraduate level of education and training.

c) ***Networks and Communities-of-Excellence:*** Much of the framework programme's activities, and now those of the planned European Institute for Technology, aim at establishing networks that are virtual Poles-of-Excellence. The Green Paper states that entities work best if they are not too large. We agree with this statement broadly and suggest that Framework Programme collaborations should normally be formed between 5-10 partners, rather than the more than 20 that was customary in FP6. Mindful of the importance of flexibility, and aware of the exceptional success of certain FP6 NOEs that included both research coordination/cooperation and international postgraduate training programmes, we recommend that the possibility of very large NOEs is retained for such special cases as needed.

d) ***Simplification:*** For the Framework Programmes to better fulfil their potentially crucial role in structuring and funding European science, there is an obvious need for greater emphasis on the actual science to be performed. If network funding is exclusively for meetings, it loses its attraction and the opportunity to cement truly collaborative research communities. Additionally, it is essential to simplify: the application procedures; the negotiation process; the conditions for small companies to participate; and the reporting procedures. The Scientific Council has made intense efforts to develop appropriate conditions for the ERC and we hope these will prove useful as models to be applied, when appropriate, to other parts of FP7. Thus far, participation in several activities of Framework Programmes has been so complicated that many excellent scientists opt not to apply. This represents a lost opportunity for European science.

e) ***Institutional competition and cooperation:*** The post-WWII European culture fosters cooperation, which is especially valuable when leavened with healthy competition. Just as it is good to have universities compete in attracting the best researchers, it is also valuable to assure a degree of institutional competition within the European research system. Excessive fragmentation and unbridled competition undermine success by preventing assembly of critical mass, but

competition - between different parts of the Framework Programme, Member States and Foundations - reveals inadequacies and forces the system to correct itself.

On one hand, the ERC draws freely from the invaluable knowledge and expertise that has accumulated in Community and national (European) funding programmes, as well as from those outside Europe. On the other, the ERC's independent scientific governance helps to inject a more critical perspective and new ideas which can diffuse to other programmes and activities. It can contribute indirectly to a better coordination of research programmes and priority setting of funding agencies in Member States and Associated Countries by setting new standards of scientific excellence in frontier research, and in testing evaluation procedures which may diffuse throughout the ERA.

The coexistence of a Pan-European funding Council along with corresponding national institutions creates a unique situation for Europe which must be developed into an asset. Interestingly, the higher the performance of the National Research Councils the more it seems they are willing to develop cooperative programmes on a bi- or multilateral level, thus also enhancing their ability to complement activities of the ERC itself. It is a welcome development that some national research agencies have already begun to consider grant schemes that build on the ERC Starting Grant competition.

5. The contribution of frontier research to innovation

Innovation is not sufficiently addressed in the Green Paper but is evidently an important issue for ERA. While the ERC's role in promoting frontier research does not include a specific task to foster innovation, there is a clear link between frontier research and innovation. Although innovation is not driven by the "linear model" from research to application, frontier research is one of the essential drivers of the innovation process. Progress is more and more related to discoveries from frontier research which in the short or long term may be transferred into new industries. These may not necessarily be created where the specific research was done, but where there is an adaptive environment, including both knowledge creation at the frontier and experience in its translation to enterprises.

Scientists and engineers trained close to the borders of our knowledge are a precious resource, as they develop a flexible attitude which is essential for innovation. This requires strong knowledge centres, with research groups that attract and cultivate talent and utilize it to create advanced research of great potential. Industry will gather around such centres to get the best people and to look over the horizon with the best investigators. ERC will play an important role in creating this type of environment. However, ERA should also focus investments to develop cutting-edge infrastructure and instrumentation for frontier research. In several fields (biotechnology and materials science - nanotechnologies), breakthroughs are often related to progress in new characterization or measurement methods, or in novel instrumentation.

The US is good at involving industry in strategic research according to the conditions of industry, at the same time promoting ambitious basic research within the topic and linking it to good mechanisms for creating spin-off companies from universities. Broadly conceived mission-oriented research is a prominent feature of corresponding agencies

(NIH, DOE, DARPA). Mission-oriented research at the European level may be carried out by the JTIs (Joint Technology Initiatives) or by EIT. However, if the mission is not market driven, there is a risk of "fashionable research" or "non-applicable applied research" leading to little innovation. The mission-oriented research must be focused, and therefore it must be balanced by free "bottom-up" research as promoted by ERC: by research with the courage to go in new ways and thereby (on the short or long term) create a new basis for innovation.

Regions not investing in basic and frontier research will lose in innovation mainly because they will neither develop nor attract the necessary talent. Regions investing in frontier research may win, provided they master the balance between the bottom-up and the mission-oriented approaches: provided they cultivate the synergies in the triangle education-research-innovation, and forge mutually respectful links between universities, industry, policymakers and other stakeholders in the complex innovation process. We have a lot to learn throughout the EU. ERA sets the stage for steps in the right direction.

It is also worth recalling that the success of the US industry in high-tech domains is further sustained by the following facts:

- Intellectual property rules are well established and streamlined (unlike the still-pending European Patent);
- New findings from research labs are brought faster to R&D;
- People trained in frontier research have a more flexible mental attitude in respect of innovation, which can provide a winning advantage;
- There is a high level of mobility of researchers between frontier research labs, R&D labs, industrial labs and vice-versa
- There are safeguards rather than separation between the academic world and the industrial world, as opposed to the situation in many EU countries.

6. Coda: Some requirements for the further development of the ERA

We believe that the Green Paper has taken the debate on the future of the ERA in the right direction. The analysis above provides support for this belief, but also highlights additional needs such as those required for the development of frontier research in Europe. These requirements are summarized here in the form of brief recommendations.

a) Implement fully and properly an autonomous ERC according to the established legislation

The ERC already is moving forward to become one of the leading funding agencies in the world. However, much as its autonomy has been guaranteed by the Commission and endorsed by the Parliament and the European Council, it is far from being fully realized. The outcome of the current efforts to establish an ERC-specific Executive Agency with the appropriate flexibility, openness and autonomy from the Commission will determine to a major extent the ultimate success of the ERC. If the present model does not permit the distance from political and bureaucratic influences, as is required for the ERC to continue to be a driving force for quality within the ERA, another long term solution will have to be agreed following the mid-term ERC review.

b) Extend the principles of autonomous management and governance to other areas

Autonomy and independence of research and scholarship are crucial conditions for credibility in science and to its contribution to society's well-being. The experience of the ERC as a revolutionary new development should not only be used to optimise its own structures and operating methods for the long term, but ideally will also feed into the further development of EU research programmes more generally.

c) Increase research resources in Europe

In summary, it is imperative that the 3% Lisbon goal is approached rapidly and at all costs, in particular by those member states whose R&D expenditures are still far below the EU average of 1.84% of GDP. Without a radical improvement of the financial base of the ERA, most other efforts are likely to only broaden the gaps and differences within the ERA instead of levelling them out.

The ERC's budget, although large for a newly-established agency, is insufficient. If this first phase is successful, and following on from the approximately € 1.7 bn yearly budget assigned to the ERC for the year 2013, its starting annual budget in the next framework programme should be approximately doubled and continue to grow thereafter.

A major effort should be made to channel structural funds selectively into infrastructure for research and in parallel, there should be a significantly larger investment by the European Commission in critical research infrastructures, including joint national/EC investment towards implementation of successive, science-driven infrastructure Roadmaps.

Research excellence should be THE goal everywhere when science funding is concerned. However, enhancing the potential of currently 'scientifically weaker' states (including some new member states, for obvious historical reasons) needs to be addressed urgently, through EU structural funding and national or regional investments. This applies to infrastructures, and to research projects and personnel funding, including increases in remuneration levels. Permanent acceptance of great differences in salaries or honoraria paid from EU grants would contribute to a damaging internal brain drain in the EU research sector.

d) Improve the efficiency and complementarity of European research and training schemes and promote their synergies with robust national programmes

- A well functioning postdoctoral training programme is one of the reasons why science in the US has flourished in the last 50 years. The EC needs to either take direct responsibility for ensuring an excellence-based postdoctoral fellowship programme, without the rigid mobility requirements of the People programme, or support the very successful programmes run by other European organisations, e.g. EMBO (obviously similar organizations would need to be identified or established for all scientific domains). This should not, however, lead to an "EU status" that blurs the distinction between postdoctoral fellows (or even PhD students in advanced training) vs. independent investigators. Considering that the Erasmus programme is a huge success, a simple way to strengthen the ERA would be to create a similar programme, but for PhD students. Some carefully crafted thematic

programmes that provide PhD stipends are already funded by the EU in certain NOEs, and such best practice could be extended and disseminated. Supervision from two or more mentors in different countries should also be encouraged, to foster exchanges in the research community and enrich advanced training across Europe.

- Simplification should be pursued for all parts of the framework programme, in application procedures (with more focus on the actual science to be performed), in the negotiation and reporting procedures, and in the conditions for small companies to participate. A "market for best practice" should be encouraged within the various parts of the framework programme, to allow the procedures developed by the ERC to diffuse into other programmes, and vice versa.

- The language issue in research should be addressed, without any suggestion of "harmonization from above". The unprecedented level of internationalization of the ERC's peer-review system may induce national agencies to broaden the base of their reviewers accordingly and introduce English as the standard language for applications.

e) Improve the connections between frontier research and innovation

Successful translation cannot rely on "end-of-pipe" solutions. As the Scientific Council has emphasised in its observations on the proposed European Institute for Technology, the crucial requirement – as shown by the graduate schools in the US – is to irrigate industry and R&D labs with students well trained in basic research laboratories, and to facilitate the study of business-related frontier research problems. PhD theses involving both a basic research institution and an industrial lab could also be supported at the EU level. This would convey a strong message to all Europeans: frontier research can shape the future.

- Assure the free circulation of researchers: Following Council Directive 2005/71/EC, the EU should issue a more comprehensive Directive on the free circulation of researchers, which in addition to special procedures for visas, includes work permissions for spouses/partners, and other work-related and family-friendly measures. This is a case in which the entire ERA must become a hospitable and attractive space for researchers and their families to work and live in. Transferring social security entitlements of researchers across national borders would not be easy, but would have catalytic effects in promoting development of science, and should be seriously explored.

- Establish timescales and indicators for the future development of the ERA: Many in Europe agree about where to go, but also feel that – as is the case of the Lisbon strategy – forward movement is much too slow. We would suggest that explicit ERA targets and timing to achieve them be set.