White Paper

High-level round table on the

ADDED VALUE OF EXCELLENCE IN EUROPEAN RESEARCH

6 – 7 March 2017 · Brussels

Content

Foreword to the White Paper

„Added value of excellence in European research“

More than ever, it is essential to support excellence in research throughout Europe in order to meet society's high expectations with regard to the challenges it faces, now and in the future. The excellence of the research conducted in universities and research organizations is a prerequisite for breakthrough innovation, competitiveness, productivity and prosperity throughout Europe.

To highlight the urgent need to take the excellence of research into account at all levels of the academic and socioeconomic sectors, the presidents of the CNRS and Max Planck Society have brought together, on March 6th and 7th 2017 in Brussels, the presidents and senior representatives of major European universities, academies, and prestigious research organizations, alongside representatives from industrial companies. A debate was organized, enabling each participant to emphasize the various aspects of scientific excellence and its added value for the European continent.

A joint declaration was drafted at the end of the round table, and the present White Paper features the contributions of each of the participants to the debate.

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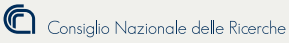
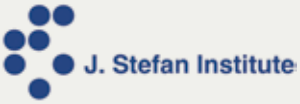
Major European science organisations, universities and academies together with prominent enterprises developed a common position on added value of excellence during a high-level round table on 6 and 7 March 2017 in Brussels.

The signatories of the declaration:





Added value of excellence in European research

DECLARATION

Europe is built on a reliable basis of common values and traditions and Europe's success in the future will extensively depend on its knowledge base. Essential to realizing this future are Europe's major strengths in research: its cutting-edge and diverse science and innovation landscape, its world-class science and research institutions, both public and private.

European institutions have achieved tremendous progress towards the open circulation of researchers and ideas, though some gaps remain which should be closed, and they have succeeded in generating a European research identity in the framework of the European Research Area (ERA). This Research Area has to be strengthened in light of the political challenges Europe is facing today in order to secure sustainable economic growth and employment built on the achievements of excellent research.

Major European science organizations and universities together with prominent industrial enterprises convened at a high-level round table organized by the CNRS and the MPG in Brussels on 6 and 7 March 2017, have developed the following common positions:

- Centres of excellence must be strengthened all over the continent to safeguard the outstanding position of European science and Europe's capacity for innovation.

- Europe should less focus on gradual improvements of existing technologies but rather on fundamentally new ideas and disruptive innovation within "ecosystems" which – by means of EU-funding – drive excellence, optimally link academic and industrial research institutions and support the efficient transformation of excellent scientific knowledge into innovative products and solutions thus generating economic wealth on which tomorrow's research funding ultimately depend.

- High priority should be given to cultivate new generations of scientists and to nurture the brightest and most creative minds, stimulating them to conduct cutting-edge research within a context of autonomy and academic freedom and to attract them by providing world-class research infrastructures.

- It should be reaffirmed that research including the social sciences and the humanities are essential to solve grand and global challenges. European higher education institutions and research performing organizations must be recognized as critically important and legitimate actors for the development of new knowledge.

- Global competition demands that research funding – at national and European level – be driven exclusively by scientific excellence, and that the European Framework Programmes be continued with a larger budget. EU funding must not compensate any shortage of national investments in R&D, nor should it divert European countries from reaffirming their strong commitment to reaching the 3% GDP-goal.

- To enable excellent science and thus to create new types of jobs suited to a changing world and to pave the way to sustainable growth, EU funding should aim at:
  - Establishing a critical mass of creative (young) researchers across the whole continent,
  - guaranteeing open access to knowledge and to excellent cutting-edge research infrastructures as well as supporting international cooperation and the unhampered circulation of scientists,
  - ensuring the continued strength of the European Research Council (ERC) which has become a global benchmark and the strongest driver for research excellence in Europe, and
  - providing funding schemes based on thematically open calls for "frontier research" collaborative projects responding to a clear need for long-term and fundamental non-market oriented research, in conjunction with state-of-the art transparent international evaluation procedures.

Brussels, 7 March 2017

Jean-Pierre Bourguignon
President
European Research Council, ERC
(Belgium)

Frontier research as key driver

For over 200 years economists have been studying the classical factors of production: land, labour, and capital. But, starting with Robert SOLOW (who won a Nobel Prize for this work), economists in the 1960s and 70s came to realise that at most half of the historical growth could be explained by known factors. The rest could only be explained by positing a new factor of production: technological progress.

Nobody now disputes this claim. The issue is therefore how best to support technological progress. And here again there is a high level of consensus. Firstly, it is accepted that technological progress requires both basic and curiosity-driven research and applied research, i.e. frontier research. Secondly, it is accepted that governments need to fund basic research. That is, because the applications of such research cannot be foreseen, there is possibly a long time lag between fundamental discoveries and their exploitation.

And again very few now dispute this form of "division of labour". According to the OECD's latest innovation strategy from 2015, *"public investment in scientific research is widely recognised as an essential feature of effective national innovation systems. Public research plays a key role in innovation systems by providing new knowledge and pushing the knowledge frontier. Universities and public research institutions often undertake longer-term, higher-risk research and complement the activities of the private sector. Although the volume of public R&D is less than 30% of the total OECD R&D, universities and PRIs perform more than three-quarters of total basic research."*

So why then do we in the basic research community feel that we are under constant pressure to justify our activities and our budgets? I believe that there are two related reasons.

The first reason is that, even if the importance of basic research for technological progress is understood, the way science relates to it and to economic growth is inherently complex and still poorly understood. One misunderstanding may arise from the many successes of the past. As people have seen a sustained stream of findings, technologies and innovations appear decade after decade, a number of people have come to think of it as an easy and, in the end, predictable process. Non-scientists could therefore grow impatient and imagine they can order whatever "innovations" they might like, as if from a menu.

But of course we know that science does not and cannot work that way. All technologies harness natural phenomena. These phenomena exist in the world regardless of our desires. We did not decide one day that better means of communication were needed and then somebody →

discovered electromagnetic waves. They were found by Heinrich HERTZ who emphasised the beauty of physics and who based his work on the theoretical considerations of Maxwell. The basic circuits used in computers were not found by people who wanted to build computers. They were discovered in the 1930s by physicists dealing with the counting of nuclear particles, their topic of interest. In 2012 one of the first to recognise the significance of CRISPR, which allows a totally new approach to genetic engineering, was Jennifer DOUDNA, who began to work in this area because she thought the chemistry might be "cool".

So my second reason is that we scientists need to do a better job of explaining how science works. Sometimes we too easily say, *"leave it to us, just give us more money and great things will happen"*. If we do this, then we ourselves are contributing to the impression that science is easy and predictable.

We need to be clear that basic research is essentially trying to understand how things work, which can in some circumstances lead to identify new phenomena, i.e. phenomena nobody has ever come across. We need to be honest that not every project or research programme will deliver a "breakthrough" in our knowledge. There is indeed no linear process by which scientists make discoveries that are then harnessed through a complex chain of actions.

Further, the channels through which basic research feeds into the economy are many and diverse. It is not just about the occasional breakthroughs. Fundamentally, basic research increases the stock of useful knowledge, both codified (e.g. in terms of publications) and tacit (skills, knowhow and experience), trains skilled graduates and researchers in solving complex problems, produces new scientific instruments and methodologies, creates international peer networks which transmit the latest knowledge and can even raise new questions about societal values and choices. A strong science base allows countries to be at the forefront of knowledge creation because, without this knowledge, individuals, firms or countries lack the absorption capacity to identify and assimilate potentially exploitable knowledge created elsewhere. And of course we could say much more on the interactions between basic research, technological progress and economic growth.

In summary, I do not believe that a tough selection aiming for excellence is enough in itself to guarantee the "impact" of any particular scientific project. Claiming that would mean that we get into the game of trying to demonstrate the unknowable a *priori*. It is our fundamental duty to try and educate policy makers as to why this is impossible. A worse illusion would be to only fund an elite group of researchers.

In a nutshell, the best bets are made when scientists are pushed to their boundaries, when they submit proposals, and the most competent evaluators confronted with these challenging projects, while pressing them to take risk, that the best bets are made. This is precisely what the European Research Council is about.

We must not forget that the most essential constituents of the research system are the researchers themselves, the human beings who make all this exist and work. In consequence it is very clear that the system must provide them with a decent career path, as nobody would enter a demanding working environment without being given some assurance that there is a chance to advance and be rewarded.

If these basic conditions are not met, we should not be surprised that the best researchers simply leave Europe to carry out their dreams elsewhere or leave research altogether. Any country, region or institution that wants to improve its capacity to deliver the best research needs to get these conditions right, and Europe would benefit greatly by providing the right platforms to share best practices. In particular, together we need to plot out a sustainable career path for talented young researchers across Europe.

Jean Chambaz
President
University Pierre et Marie Curie, UPMC
(France)

Ensuring quality research in universities

Hubert Curien, a famous scientist and former French Minister of Research, used to talk about "Applied Research with No Application" or ARNA. The minister created this term for poor quality research that hid behind the concept of "applying" research. His point was that it's not a question of "basic" or "applied" – it's just a question of quality research. So when we talk about "excellence", we need to be clear about what that really means. There are established performance metrics for research, be they publications, awards, or more recently a number of university rankings, but at the end of the day, what really counts is our ability to advance knowledge and to find and apply real-world solutions. For this, we need to have manpower, innovation and impact.

Universities as integrators for the economic development and social integration in Europe

Research universities are where frontier research creates new knowledge, where future leaders of the economy and the society develop their critical thinking and creativity through research-based education. Universities are also where both researchers and graduates are encouraged to transform their ideas into innovation and to transfer them into economy. As demonstrated by the Biggar study commissioned by LERU, universities represent a major lever for the economic and social development of Europe.

One of the primary ways that universities support research quality is by encouraging students to invest in a career in science. Our society needs experts who have in-depth scientific knowledge in one or even two domains as well as an understanding of the larger context. Therefore, research universities have started to ensure that students are exposed to a broader range of disciplines. This includes project-based learning and the development of research capabilities in young scientists-in-training, in bachelors, masters and doctoral programs.

A recognized method to encourage research innovation is to support communication and collaboration across disciplines, communities and institutions. Comprehensive universities are particularly able to provide support for interdisciplinary research within the institution and with local and international partners.

Creating an innovation-friendly ecosystem

Let's look at the innovation and impact of this approach. For example, University-Hospital Institutes bring together a broader range of expertise and skills, including researchers, medical doctors and caregivers, as well as students, to jumpstart translational medicine and improve patient care and student education. The Vision Institute works closely with industry and combines research, patient care and technology transfer. The Institute has a solid track record of launching start-ups. For example, Pixium Vision, specialized in bionic vision, is currently running multi-center clinical trials on its latest systems.

An innovation-friendly ecosystem also needs effective, end-to-end technology transfer. This means establishing a continuum of instruments to support researchers by covering technology maturing, start-up incubation, and venture capital. This approach has been effective, for example, with CAILABS, a start-up from the Kastler-Brossel Laboratory. Quantum physicists at this Nobel-winning lab developed a quantum optics tool, which when applied to fiber optics can transport data 400 times faster than conventional methods. →

Not surprisingly, the best research labs are also those with the highest social, health or economic impact.

The EIC should contribute by recognizing excellence in innovation ecosystems built by universities and their socio-economic partners within the region.

The fundamentals of university support

To meet society's challenges, we should therefore keep a few principles in mind. Quality research will always be founded on deep, fundamental questions. But today we must ensure both a critical mass and a critical diversity of researchers. This means building trans disciplinary teams of top-notch researchers that can tackle broad, complex issues and bring about paradigm shifts. And while an overall research strategy is essential for maximum efficiency, the research project proposals must come organically from the bottom-up.

And finally, let's remember that we can't schedule inspiration, so we should make sure our basic research funding is for the long-term.

Philippe Chomaz

Executive Scientific Director,
Direction of Fundamental Research
French Alternative Energies and Atomic Energy Commission, CEA
(France)

A global perspective: from ultimate research tools needed to perform disruptive research to concrete actions on key challenges

Part 1: two value chains: understanding the world and addressing key human issues

Research is a systematic investigative process performed to increase or update current knowledge by discovering new facts or relations between facts.The question of research added value calls for identifying the *value chains* requiring research and their final *deliverables*, i.e. the actual goals motivating research activities. Excellence is then the expected performance to achieve these goals.

Expected performance levels: breakthroughs having an impact on challenges

Since the dawn of humanity, mankind has sought to understand and master the world to overcome the challenges of its own existence and destiny. Curiosity and necessity, making discoveries and acting on vital issues, both require knowledge breakthrough, i.e. fundamental research, and excellence in research means having an impact on cognitive and societal challenges.

Connection to a knowledge-based economy: the market dimension of challenges

Addressing challenges includes a market dimension since it may require innovative services and products. For example, CEA fields – science, security, energy, health, environment and ICT – are key challenges and large markets. However, the performance assessment should not be reduced to the economic dimension since a market is not always linked to a challenge, and some innovations are more incremental than disruptive. Challenges should remain the "compass" for excellence in research.

Need to reconstruct the research value chains based on cognitive and societal challenges

For decades, the global tendency has been to slicing up the value chains into smaller tasks with the idea to optimise each activity separately. Research was separated from engineering, divided into "basic" and "applied", and split in disciplines. It is now time to reconstruct the global value chain, thus reinforcing the continuum from basic research to innovation, and from innovation to concrete actions on key issues. It is time to focus on challenges and to analyse the excellence of research not only per se, but through the impact of the global value chain on cognitive and societal challenges.

Part 2: ultimate tools and outstanding staff – the necessary inputs for excellence in research

To have a complete view of the research-based value chains, let us now consider research needs.

Strong interdisciplinary teams including researchers, engineers and technicians to address issues

Highly skilled researchers are obviously needed to achieve excellence. Yet this is not enough. Addressing challenges requires multidisciplinary approaches joining research and engineering forces in important projects. Therefore, it is a key issue to recruit and train researchers, engineers, technicians and managers, and to maintain them at the forefront of science, technology and project management.

Ultimate research tools for excellence in research

Ultimate tools are required to achieve break-throughs. Top-level large and medium research infrastructures are one of the keys to excellence. They are also a place of convergence that accelerates an interdisciplinary culture. Yet again, this is not enough. Strong R&D efforts on research tools are mandatory to build the future. To be effective, they must be collective, sharing means and innovation.

Science- and techno-hubs: a competitive model for developing outstanding research tools

The capability to invent and construct challenging tools is a key issue for the European research ecosystem. It requires long-term commitment, broad expertise and strong connections with industries. It calls for a dedicated policy[1] techno-logical road maps, specific R&D programmes and dedicated technical facilities and hubs[2] gathering science and technology. CEA has stressed this integrated vision of science and technology by picking "a knowledge factory" as its baseline for its Basic research division.

Research needs are a powerful innovation driver and scientific tools are a large market

This innovation based on research needs should not be confused with innovation resulting from research discoveries. Research needs are so challenging and the research goals so fascinating that they induce a powerful innovation dynamics, e.g. the space technologies. This innovation has a strong impact on research: making possible previously impossible studies, and on economy, scientific tools representing a huge market. The first web browser creation at the CERN is, in this respect, emblematic.

Excellence in research: the impact of training, tools, research and actions on challenges

Excellence is the required performance of the whole research-based chains to achieve their goals. Excellence is about outstanding staff, state-of-the-art tools and beyond, progress and discoveries having an explicit impact on cognitive or societal challenges. It advocates both an interdisciplinary approach and the convergence of science and technologies into a continuous process, from innovative tools to innovative applications. This calls for an integrated European research policy, reinforcing the technological aspects related to tools and instruments, with special focus on recognising science and technology hubs for instrument invention and building capabilities.

1 This technological policy should not be confused with the policy for European equipment, such as the ESFRI roadmap.
2 See in particular the new concept of "technological infrastructure".

Nicolas Cudré-Mauroux
Group Research & Innovation General Manager
Solvay SA
(Belgium)

Added value of excellence in European research

Science-based innovation is the cornerstone of the growth strategy of our Company. This means that the innovation we focus on goes beyond the simple assembly of existing technologies. We see our innovation ecosystem as a continuum going from curiosity-driven science to research and development focused on identifying solutions to technical problems and value creation. We are convinced that investing in understanding fundamental mechanisms behind observed phenomena, the fundamental mission of science is the foundation of further step-change developments.

Achieving excellence in fundamental research depends on significant funding from public sources, but requires strong support from private companies as well. The topics that can be linked, even remotely, to potential value creation can benefit significantly from joint financing and collaboration between public and private entities.

There are several very good examples of such collaboration. At Solvay, the best one we are involved in is the excellent collaboration we have developed over decades with the CNRS. This collaboration has delivered an excellent portfolio of industry-validated fundamental projects as well as multiple personal development opportunities for young scientists.

Looking in more details at the innovation ecosystem, it is important to understand the focus areas and driving forces of the different actors like universities, regional and multinational companies, governments and their research labs, start-ups, etc.

Fundamental research is driven by curiosity and its goal is to develop fundamental understanding behind observations, redefining the limits of knowledge.

Applied research is driven by problems to solve and is aimed at developing solutions, often integrating multiple areas of technology (e.g., in our case, materials, design and manufacturing processes).

Innovation is the multi-functional process linking solutions to markets and customers and is all about creating value from new solutions to problems.

All three areas play a critical role in the ecosystem and must be connected in a way that promotes synergies. The following critical aspects should be considered in order to ensure such synergies are realized:

- Complementarity of roles between universities and companies: Universities should be mainly focused on fundamental research, companies on innovation. The area of applied research is the interface between fundamental research and innovation, between universities and companies.
- Collaboration between universities and companies: Collaboration should be encouraged through simple and efficient funding processes, tax incentives and IP sharing principles.
- Adequate funding and efficient management of universities
- Intellectual property: Laws should be consistent and their enforcement reliable.
- Regulatory environment: Rules should be based on facts and data encompassing all stakeholders' strategies and responsibilities.

Jerzy Duszyński
President
Polish Academy of Sciences, PAN
(Poland)

ERC is the lighthouse for science in Poland

In Poland the scientific excellence issue receives much attention recently. It is one of the priorities of the Ministry of Science and Higher Education. The Scientific Policy Committee, advisory body of the Minister of Science and Higher Education has created a description of the scientific excellence in various disciplines in 2015. According to this guideline two indicators seem significant in general and apply to almost all scientific areas. The first one corresponds to selected papers published in prestigious scientific periodicals (this applies especially to life science and fundamental sciences); papers published in prestigious conference publications (this applies especially to computer science and mathematics); books or monographs published by prestigious scientific publishers (this applies especially to the humanities and social science). Highly regarded are especially works as leading co-author.
The second one corresponds to high interest generated by scientist's research results in the scientific community, documented, depending on the scientific discipline, by the following: citations of author's publications (values adjusted to individual disciplines: total number of citations without self-citations, the Hirsch index) and/or invitations to lectures at prestigious international conferences.

An especially strong indication of excellence is a combination of two of the above elements, e.g. co-occurrence in the scientific output of a highly cited publication with invitations to lecture at prestigious conferences.

When scientific excellence is concerned a proper evaluation of researchers involves assessment of whether they undertake ambitious and risky subjects with a breakthrough potential; subjects that are original and contrary to prevailing paradigms and trends. Such evaluation should be conducted as peer–review. Peer evaluators, however, should possess at least similar scientific competence as the evaluated researcher and preferably such evaluation should be by an interview. In the future I feel that the trend of supremacy of quality over quantity will be enhanced. A very limited number of excellent achievements will be enough for providing a status of excellence to a given institution.

Furthermore, one of leading granting agencies in Poland, National Science Centre, was modelled structurally and operationally on the ERC. Although it spreads the excellence in Polish science it also blocs leading scientists from participating in programs of Horizon 2020. Simply it is much easier for a leading scientist from Poland to win a grant from the National Science Centre then from ERC. This problem needs to be solved. The examples from other EU countries how to cope with this problem would be very helpful.

Jesper Falkheimer
Head of Division, Research, Collaboration and Innovation
Lund University
(Sweden)

The value of scientific excellence and collaboration: a third way approach

The expectations from political and corporate stakeholders on the academic sector are increasing. Research is viewed as a tool for solving societal, economical and political problems. Since several years ago the need of a stronger alignment between scientific research and the surrounding society has been emphasized, based in the premise that increased collaboration lead to useful results and more innovations. The development follows a macro trend in society where borders between different social institutions have been challenged, in academia as well as in many other areas. We live in a trans boundary society, in Scandinavia as well as in the rest of the developed world. The social theorist Zygmunt Bauman differentiated between a solid society and a liquid society, the former being characterized by modernist traits such as a centralization of diverse institutions and by clear roles for different actors in society. In this societal structure, universities, political and corporate institutions have recognizable boundaries separating them. Liquid society, which develops parallel to the solid society and has become all the more of a generic social system, is defined by trans boundary movements, increased perceived uncertainty, information flow and more individual choices. Trust in solid authorities – such as science – is challenged by different publics in society parallel to the increased expectations towards the academic sector to solve current societal problems. One may react to this development using different strategies. Rooted in rational thinking and defending scientific independence from intrusion from other sectors, one possible strategy is to reject this collaborative turn in society. An opposite strategy is also possible: invoking the collaborative turn and focusing on creating collaborative platforms and enhancing trans boundary action. A third way strategy may also be applicable: accepting the late modern structural change and developing market as well as non-market collaborative platforms when applicable, but at the same time defending the crucial need of fundamental non-market research.

At a concrete level, the European Framework Programme for Research and Innovation is of great importance for the research, innovation and internationalization of Lund University. It is our firm belief that the framework programmes must reflect a long-term vision for research and innovation to continue fulfilling this responsibility and to continue increasing Europe's competitiveness. In order to do this, we want to highlight some crucial arguments for the future based in a third way strategic approach. First and foremost *excellence must be the criterion for awarding funding*. There is no other way to develop research and innovation of highest quality. Second, there is *need of more funding opportunities for bottom-up, collaborative research at lower readiness levels*, e.g. when it comes to the field of social innovation. Third, continue to *search for the most effective methods of transferring promising project results to the next level*. We propose flexible collaborations and methods of funding at this stage.

To reach scientific excellence may sometimes mean market collaboration. But we also suggest more focus on fundamental, non-market oriented research. Innovation can be fostered in numerous ways and we argue that it is important to recognize potential of fundamental →

research laying the foundation for technological and societal innovation in the long-term perspective. In other words, a more balanced mix of instruments to trigger long- and short-term innovation than what is the case in the current Framework Progamme (FP) is needed. We also find that there is need of a greater focus on clear-cut research and innovation and inclusion only of core framework programme activities. Some parts of Horizon 2020 are more focused on structuring research and initiatives rather than research and innovation itself.

All together we want to emphasize the need to pay attention to the whole research and innovation chain. Horizon 2020 reflects a too narrow focus on technology and close-to-market activities and a view of innovation as a linear process. We would like the next FP to reflect recognition of the fact that a strong research base is a precondition for innovation in the short and long term perspective, and that innovative research is more than market exploitation. We therefore want to see more basic, collaborative funding opportunities. We support the notion of a funding system with broad challenge-based which are more open for projects at different stages in the research and innovation value chain than what is the case today, and with opportunities for recurrent calls. We are welcoming the integration of research from the social sciences and humanities, but think that not enough has been done. Social Sciences and Humanities (SSH) must be involved in all the phases of the process, including problem formulation, work program drafting and topic design.

It is critical for the future of Europe to increase the research and innovation capacity in all EU countries. However, it is important to safeguard excellence as the main criterion for funding within the FPs, without taking any geographical considerations. Instead of mixing FP and other funding such as the Structural Funds, in the name of synergy, a greater share of the Structural Funds should be allocated to capacity building, career development and mobility, for instance post-doc opportunities to support individual researchers from the countries that are less active in the framework programs today.

Fernando Ferroni
President
National Institute for Nuclear Physics, INFN (Italy)

Building a common playground for excellent science in Europe

INFN (Istituto Nazionale di Fisica Nucleare) is an Italian Research Performing Organisation whose mission is to push back the frontiers of knowledge, by understanding universe elementary components, its structure and its evolution. It encompasses more than 1000 own researchers and about 2500 research associates from different Universities in the Country. Its fundamental assets are human resources. The mission of a Research Performing Organization could not be daily pursued without the driving force of passion and curiosity of the researchers working in it. Their excellent ideas take shapes the achievements of fundamental research, following the path of *Curiosity, Research* and consequent *Innovation*.

This brings immediate attention to the crucial point of the European Research Area, with the must of developing a common vision about research careers and equal-opportunity attractive conditions. Europe must be a place where

researchers can be employed with uniform salaries, where they can find a fertile environment to develop their ideas and where the general goals of research work are shared and equally attained. To this end, it is necessary to address critically the EU policy for equal opportunity and the measures taken to expand the number of actors. The challenge for researchers on whether to remain in their Country or to apply for positions abroad sometimes represents a personal problem, but it may also become a competitiveness issue inside Europe. To be stronger and in line with other growing realities in the world, EU must act as a whole research body, with local specializations and peculiarities through which researchers can easily move and grow.

In this context, excellent ideas need a fertile ground to be developed and become scientific excellence at all levels. Many decades of experience have shown that the availability of research infrastructures as a support for ideas is a plus, and Europe is a territory rich of large research infrastructures like CERN, which has allowed world-class scientific discoveries to blossom and has started the idea of "Science for Peace", now globalized with the SESAME Project in Jordan. These achievements go hand-in-hand with the impact on the European productive and industrial tissue, with top-level technology and its fall-outs on everyday life. INFN has several realities at its National Laboratories that fall in this category. With the increasing of specialization, complexity and technology demand to answer fundamental questions, it is necessary to work towards rules and incentives for improving accessibility to the already existing infrastructures, promoting their update and sustainability, and creating new ones particularly looking East, based on European-wide interests.

The need to answer these fundamental questions clusters researchers around common goals, fostering the capability of working together, enlightening the concept of collaborative research and collective intelligence: there is always a human infrastructure beside the technological one. The path that goes from research to innovation is today characterized by the contribution of expertise from different fields that generate a result whose complexity and impact is in line with the requirements of today´s life. Fundamental research problems as well as societal challenges need a synergic approach, and a structured strategy of collaboration not only inter-nations but also inter-disciplines. An example in Health is represented by the "omics" technologies, which separately produce an enormous amount of data of different nature. Highly inhomogeneous and often incomplete data coming from genetic profiles, medical analysis, radiologic and nuclear imaging, environment and context, could be in principle analysed with new algorithms producing a holistic vision of the patient status and enabling a decision about the best possible treatment that is highly patient-specific. This personalization requires expertise from many fields. In particular, the capacity to manage and analyse *big data* coming from particle physics experiments, makes physicists possible expert actors in this field. In this virtuous research environment, some researchers will invariably build new path for science in diverse fields, allowing for the development of different research facilities (e.g. ESS, XFEL, ESRF). The instruments needed to achieve such goals, allowing progress in the technologies that are at the basis of complex realisations, like GRID/Cloud computing, electronics, vacuum, sensoristic, will intrigue some others, hence creating innovation in these sectors, and fostering a virtuous mechanism of "new research – new applications" studies.

When considering technological innovation and meeting societal requirements, it is essential to remember that they can only come from basic research. Results that can be spent for applications in everyday life can only be obtained by facilitating researchers through all of these paths. Important examples of this process are MRI, PET, accelerators for clinical particle therapy: all stem from basic research, demonstrating the excellent capacity of "thinking aside". This is why such an impact often comes unpredicted and in its own time frame, seldom with short delays. Important fall-outs come with a long pace; hence, a fatal mistake would be to request immediate usability from scientific achievements. Europe can be the place where this principle is pursued and fed, starting from researchers' mobility and equal opportunities, to top-level technologic research infrastructure disseminated in all Countries.

On the other side, the potential revolutionary impact of basic science applications requires the set-up of shared policies to manage the technology transfer, to encourage open innovation and to regulate smart public-private collaborations. There are several best practices and excellent examples in Europe. The goal is to facilitate also the last branch of the path Curiosity-Research-Innovation, in terms of time of transfer, effectiveness of the process and benefit for the final user. Technology transfer in its general meaning should be made more fluid in →

terms of bureaucracy, synchronization of research and industry times and processes as much standardized as possible.

Excellence is always our ultimate goal: only with the best researchers, technologies, environment and policies important results for people life will naturally arise from investigation. For a Research Performing Organization, excellence is doing our mission at the best possible level. Developing the communication among science, society and all the political actors on the European scene is then of the uttermost importance to maintain the boat of excellent research on the right course. A common foresight will provide a mechanism to address the scientific and societal grand challenges, a task strongly needed in this moment where tensions within Europe risk to jeopardize decades of success in gluing citizens, not only researchers.

Lino Guzzella
President
ETH Zürich
(Switzerland)

ETH zürich

The importance of basic research for the innovation pipeline

There is no innovation, especially no disruptive innovation, without basic research. Most every innovation, disruptive or not, begins life as a small-scale experiment. Discoveries in all scientific disciplines are essential for societal and industrial development and more often than not, the societal impact that eventually results had not been well defined from the onset. Fundamental research that addresses relevant scientific questions can ultimately lead to disruptive innovation, far beyond the applications perceived at the time. Thus, investment in outstanding talents and basic research are essential in order to keep the pipeline for disruptive as well as incremental innovation large.

Today, innovation ecosystems are clusters, where individual researchers in companies, research and development (R&D) labs, universities and other actors collaborate. People, infrastructure, economic assets and enabling environment form a vibrant community that requires active nurturing so they thrive and grow. To achieve this a policy is needed – locally, as well as globally – that supports these ecosystems by paying attention to their social dimension: to the development of networking assets that kick-start communities, build networks and provide platforms.

ETH Zurich is convinced that the European Commission and especially Framework Programme 9 (FP9) can and will play a crucial role in this process.

What do we need for FP9?

Selecting the best projects available should be the mission of FP9. If excellence is the key element of the selection process in FP9, Europe will also succeed in becoming a true knowledge-based economy.

ETH Zurich's experience shows how important it is that results from ground-breaking fundamental research are implemented directly into practice. ETH Zurich, a leading technical university, has integrated its efforts along the innovation value chain to allow very early technologies to be taken out of the fundamental research area and be brought on a development level with direct market and industry links.

Hence, the research community needs the following for FP9: Openness, Excellence and Impact.

Openness: FP9 should stand for research funding that is open, flexible and based on trust

Abolishing the work programmes in FP9 and allowing by default thematically open calls for (small and large) collaborative research projects with several cut-off dates throughout the year, with excellence and relevance as main evaluation criteria, we are convinced that a wide variety of essential contemporary research and innovation areas will be covered. Although the majority should be open calls, we strongly advocate that two to three strategic research directions, which are pre-defined by the European Union, are going to be addressed in FP9.

Excellence: FP9 should enhance the ERC on the international level and introduce Expert Review Panels for the whole framework programme

ETH Zurich asks for further enhancing the European Research Council and the FET programme. In addition, in order to enhance excellence, Expert Review Panels following the ERC model should be established for the whole FP9. By adopting such panels, the European Commission would follow a model for peer review that has been extensively tested and is now relied on by most research and innovation agencies. Expert Review Panels would support a well-informed selection process.

Impact: FP9 should ensure the innovation pipeline

Proof-of-Concept schemes as offered today by the ERC and the FET programme should be offered for all FP9 collaborative research projects. This would be FP9's contribution to translation and transfer of knowledge and technology. After the proof-of-concept phase, private funds should ensure further development and exploitation.

Yoav I. Henis
Vice President for Research and Development
Tel Aviv University
(Israel)

TEL AVIV UNIVERSITY
Pursuing the Unknown

Excellence in research at Tel Aviv University: scientific excellence in basic research as the foundation for breakthrough innovations

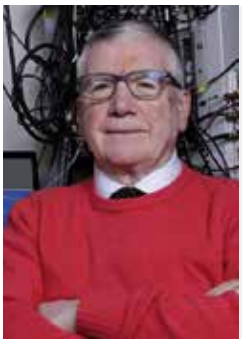
Leading in research areas ranging from neuroscience to nanotechnology, Tel Aviv University (TAU) aims to significantly contribute to the development of medicine, healthcare and technological innovation in Europe and worldwide, encouraging interdisciplinary unorthodox research to create opportunities for innovations that contribute to society and economy.

TAU is the largest Israeli research university, counting about 30,000 students (of which 14,000 are graduate students) and over 1,000 Faculty members. It is a global university, encompassing all disciplines, creating the conditions to nurture unique interdisciplinary research combinations that encourage ground-breaking research and entrepreneurship.

At TAU, we believe that excellence in research is the foundation for any ground-breaking research. Therefore, the single most important task is the recruitment and set-up of excellent young recruits to the university. Our main and primary condition is excellence in research, since we fully support academic freedom. There is no replacement to excellent science, and superb basic research creates the foundations on which novel ideas can grow and produce breakthrough innovations that can then be translated to either medical or technological products. To enable excellence-based recruitment and bring back to Israel and Tel Aviv University the best Israeli scientists and scholars, it is necessary to prioritize the research areas and provide start-up packages that allow the new recruits to initiate their research projects and conduct independent and innovative research. An objective measure to the success in such recruitment is the number of ERC grantees from among the new recruits, and we encourage all new recruits to apply for such grants. Naturally, it is important to assist them in this process, and we devote a lot of efforts for this purpose. The large number of young ERC grants awardees from among our new recruits in the 3 years of the Horizon 2020 program (26 starter ERC grants, 9 consolidator awards) attests to the success of this approach.

In parallel, we invest significant efforts in making the environment in TAU favorable for translational research and for entrepreneurship, by providing special funds for crossing "the death valley" of making the research enticing for commercial companies, and by providing guidance and education to our Professors and students alike in translational aspects of science. The effects of this line of efforts are reflected by the placement of TAU, for the third consecutive year, among the top ten universities in the world for producing VC-backed entrepreneurs, and the 1st outside of the US. The rankings were published by the PitchBook Universities Report 2016–17, which grades universities according to the number of graduates who founded venture-backed start-ups. At the undergraduate level, TAU came 9th, with 515 graduates raising $5.1 billion. TAU ranked 12th in the world in the number of MBA graduates who have become entrepreneurs, ahead of the London Business School. In addition, TAU ranked 8th in the world and the first in Israel in the number of start-ups exits made by graduates, with a total of $5.2 billion paid out.

International cooperation is another cornerstone for excellence in science, and TAU is encouraging the formation and participation in international collaborations. The very essence of science and knowledge is open discussion and exchange of ideas and information, and international collaboration facilitates the proliferation of ideas and knowledge. Moreover, it paves the way for better perspectives on a multitude of society-related issues and studies. We attempt to further our international ties and collaborations, both by encouraging our scientists to participate in grant consortia involving specific groups of researchers (EU grants), and by forging close relationships with universities and research institutions in Europe and worldwide. Aside of participation in consortium grant programs, we assist our researchers to participate in exchange programs of scholars and students, in international study programs, joint degree programs, and joint summer schools.



Massimo Inguscio
President
National Research Council, CNR
(Italy)

Consiglio Nazionale delle Ricerche

Excellence in research as a mean of EU diplomacy: science to revamp the Treaties of Rome

What is the added value of scientific excellence in the European Scenario? What has been the role of research in shaping the actual Europe?

We all know that, in any historical period, science has introduced breakthrough ideas paving the way for disruptive application into future day life, as well as taken advantage of the great discoveries of the past, according to the cyclical nature that characterizes the scientific research process.

Indeed, in the recent European history of science, we faced the creation of the European Union and the launch of a structured programme to systematically fund excellent research ideas.

The interconnection between these two events is beyond dispute. In fact, if on one hand research has assumed a major role in the creation of a united Europe, on the other hand, the European Union facilitated in the last 60 years the development of excellent research in Europe. In this framework of cooperation, what characterized the last 60 years of research can be divided into two time segments of scientific production, before and after the birth of European Research Council (ERC):

While the first period is characterized by pivotal scientific discoveries that have deeply changed the world view and the quality of life, such as the first mission to the moon, lasers in industrial and medical applications, the widespread use of information technology (disruptive innovation), the last ten years differs by an incremental approach of the innovations developed in the previous 50 years, but with the use of these applications, which have modified and improved lifestyle, that we can also define as disruptive, such as connectivity, telecommunications and advances in medical technology (disruptive application).

In the past ten years the ERC, indeed, has been put in place with the objective to support and fund excellent basic research and therefore building the foundation for what will be the „disruptive innovation" of the future.

Nevertheless, if Europe does not support the establishment of a friendly environment able to benefit of the knowledge generated within the ERC context, this investment will have a reduced impact on addressing societal needs. Hence, the creation of an ecosystem that supports the transfer of this knowledge, is needed.

Now it is important to highlight how the challenges we are facing, such as energy and health issues or security aspects, need the contribution of Research and Innovation to be tackled, and it has to be done at European level because no Member State alone is able to address them. We have therefore to revamp the role of research in Europe, supporting the creation of innovation hubs where the scientific excellence can be exploited, in line with the European Commission messages where excellence and impact are jointly promoted.

The added value of scientific excellence can be achieved mainly through three fundamental aspects: Ideas, Mobility, and Innovation.

Ideas – ideas as the engine of scientific excellence that supports the growth of Europe in terms of economy and welfare of the citizens. We have the task of building a fertile ground to sow the knowledge, creating the framework conditions for research and its applications (in terms of facilities, incentives or regulations) increasing also the attractiveness of scientific disciplines at the education level.

Mobility – Interpret as freedom of movement and as circulation of knowledge, people, products, and culture. Connect the scientific progress to the mobility of researchers allows us to highlight the unique features of the research passing from the Erasmus program, through the Marie Curie until the ERC has enabled the removal of cultural barriers and the beginning of scientific relations before governmental.

Innovation – Innovation to support the development of a European industrial base through the promotion of partnerships between stakeholders that exceed national boundaries. Innovation is the natural result of the research. If Europe wants to reverse the trend of stagnation, should focus on products and high-tech services.

It is important therefore to adequately invest in excellent research today to meet tomorrow's challenges, to impact in our society, economy and in our lives through the creation of new knowledge and a new way to build and drive innovation. This can be achieved thanks to investments in frontier research, in strengthening education, skills, entrepreneurship and infrastructures, and in increasing the participation of society.

A united Europe can do much in this direction with a knock-on effect up by the most virtuous countries, but also promoting an „investments and innovation friendly" context. We are facing the risk of a European landscape with few States, isolated in their domestic excellence, which are destined to perish if closed in a "turris eburnean". I strongly believe that, if we want to prevent this involution of the Union into a "Europe of nations", we, as main research representatives from the Member States, have the responsibility to address science with its well-recognized role in diplomacy also within its borders, driving the integration of all European research stakeholders, towards a uniform high level of excellence across whole Europe.

To this end, these concepts will be further debated at the National Research Council of Italy (CNR), in Rome on Friday April 7th 2017, during "60 years of Europe and 10 years of ERC: research as support to European Union unification – towards an effective scientific diplomacy", the major event in the field of research and innovation that will be held during the Italian celebration of 60 years of the Treaty of Rome.

Matthias Kleiner
President
Leibniz Association
(Germany)

Leibniz Association

The intertwined role of long-term knowledge oriented research and breakthrough innovations

In the light of current discussions and planning of the next Framework Programme for Research and Innovation, considerations about a more innovation friendly future European Research Area are being overshadowed by strong centrifugal forces as well as by new international challenges that could and will impact on the future European research funding policy. It is, therefore, essential to reflect on the relationship between long-term knowledge oriented research and breakthrough innovations and, thus, on the added value of scientific excellence in European research. There is no doubt that excellence must be the leading principle in research, both →

in terms of a basic understanding and a direction towards application and use. Although there is mutual consent on the importance of excellence in research, there are diverging approaches in the understanding of excellence.

Let us start with a reflection on the temporal aspects of excellence in research. Many times, excellence is understood as an award mechanism to classify research retrospectively. The Nobel prizes, for example, are a globally recognized key indicator for excellent research. On the other hand, excellence is to be understood as an enabling mechanism as it is the overall guiding principle for the collaboration of the smartest and most talented researchers within the European Research Area.

The Leibniz Association's understanding of excellence is based on reliable and sustainable and competitive national funding mechanisms, a bottom-up approach to ensure the best possible research results and an interdisciplinary and cooperative research approach. Moreover, the Leibniz Association, with its exemplary evaluation system (which is currently subject to an evaluation itself to yet improve the unparalleled quality assurance), stands for international scientific peer review both on the project and the institutional level.

With regard to the current Framework Programme for Research and Innovation Horizon 2020, here, the concept of excellence is explicitly related to the first pillar and its corresponding funding mechanisms. While researchers of Leibniz institutes within the sections for Mathematics, Natural Sciences and Engineering have received ERC Advanced, Consolidator and Starting Grants and funding for Marie Skłodowska-Curie projects and others, the general Leibniz-approach to excellence is broader than the understanding of excellence offered by the Horizon 2020 'Excellent Science' pillar. Leibniz institutes conduct blue sky and application-inspired research in an interdisciplinary and trans disciplinary way. As a specialty, the eight Leibniz-Research Museums conduct a great deal of research and present scientific knowledge and developments to the public and thus also make an important contribution to the dissemination of research. The Leibniz Institutes' overall objective is to provide comprehensive solutions with societal and environmental relevance, which cannot be based on any other but excellent research and insight.

This approach to excellence can be considered as the foundation for long-term knowledge-oriented research and breakthrough innovations. As regards the conditional interdependencies of knowledge oriented research and innovations, the creation of scientific knowledge is pivotal within the functional chain "from ideas to products". Ultimately, the aim should be a balanced and integrated approach to both "ideas" and "products" with opportunities of reciprocally reactive cooperation, as it will create the conditions for tomorrow's breakthrough innovations – big ones and small ones.

Jadran Lenarčič
Director
Jožef Stefan Institute
(Slovenia)

Inconsistencies of national and European policies reduce impact of R&D

1. Distortion in the European research funding harms excellent science and technology development

The European collaborative research funding is, year after year, moving away from basic research to industrial research and development creating a gap between science and technology. This phenomenon is, in my opinion, not based on a thoughtful future-oriented visionary European strategy. The most effective innovation system is one that covers the whole spectrum of research, balancing from basic to industrial. Currently, basic research at the European level is represented mainly by ERC. ERC projects are certainly important superior instruments, but they do not involve collaborative research and they are designed primarily for individuals. An optimum innovation system represents a continuous exchange between basic, applied and industrial research. The lack of European collaboration in basic research thus reduces not only the scientific excellence but also the European technological competitiveness. The gap in funding that spreads through fundamental and applied research restrains the exchange between scientific and technology organisations, universities, institutes and industry. This distortion of the European innovation system cannot be compensated by national investments or cohesion funds. I believe that a solution to this alarming situation must be found as soon as possible at the European level.

2. Significant disparities in terms of research and innovation performance in EU

Even a superficial view on European science shows that the European potential is not fully exploited. The differences in research performance between the countries are too large. They originate mainly in the disproportions between the national investments in R&D. In some countries, especially in EU13, there is the lack of decent research infrastructures. This results in incomplete national innovation systems and in in low-performance scientific research. The weaknesses are then reflected in the involvement and success in European projects. European Commission (EC) has been engaged to resolve the problems by introducing new promotion instruments, such as spreading excellence and widening participation. Objective is to provide support for research institutions to attract and maintain high quality human resources and to implement the structural changes necessary to achieve excellence on a sustainable basis. Despite of serious effort deployed at all levels, EU continues to see significant disparities in terms of research and innovation performance. Clearly, there will be no success without real engagement of national governments, national resources and clear national policies. For most of the EC instruments we can, therefore, say that they have not yet produced desirable results. Even in cases where research organizations from these countries enter into EC projects, problems continue to multiply. Europe should continue to be fully engaged in this area, since EU13 countries possess significant growing potential.

Yves Lévy
President and CEO
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To tackle the question of research excellence at the European level

Where are we?

The European Framework Programs are the main programs supporting research and innovation all around Europe.

Horizon 2020 (H2020) is not perfect, I recognize it, but is there another continent where this type of programs is developed to support research and innovation through collaborative programs, through fundings of excellent teams, through public-private partnerships with the involvement of so many countries (mainly 44 countries of the European Research Area / 28 members States and 16 countries associated to H2020)?

Because of the current European political situation, it is important to display European success stories. For instance:
- Since 1996, 98 000 researchers have benefited from the Marie Sklodowska Curie Actions all around Europe – among them five Nobel laureates.
- Since 2007, more than 7 000 projects have been selected to support outstanding ERC teams throughout the EU Member States and the associated countries.

We need to communicate better with our political representatives and the European citizens to show them one of the best examples of European added value. Framework programs for research and innovation are the best tools to build the European Research Area (ERA) which should be a unified area open to the world in which scientific knowledge, technology and researchers circulate freely.

Nevertheless, it is time to think about the next European Framework Program „FP9". It is a major issue to identify the objectives of the European framework program for research and innovation.

What we need

Simplification:

The efforts undertaken by the European Commission to simplify H2020 should be reinforced. The administrative and financial processes should be simplified, in order to improve the participation of the best scientific teams. The number of instruments/programs and the financial tools should be limited.

Programming/Transparency – selection of topics:

The scientific programming of the work programs should be in coherence with the priorities identified by the scientific communities of the different European countries. It is important to limit the channels of influence in terms of programming and to know all the ones used and listened to by the European Commission and the Parliament.

Coherence National and European levels:

What should be the objectives of the research supported at the European level versus the objectives of the research supported at the national level? The articulation between the European and national levels of programming and support is an important issue to tackle. One of the

objectives of the national support should be the emergence of excellent national teams able to be part of the best European/International consortia initiated and funded at the European level.

Critical mass:

In the field of Life Sciences and Health research, we need to collaborate with the best teams all around Europe to carry out the best research projects able to better understand mechanisms, diseases or to give birth to active molecules, biomarkers, efficient technologies, etc. For research on rare diseases, it is needed to have critical mass to achieve sustainable results. For research on Alzheimer disease, it was necessary to pool all the efforts undertaken in the different European countries and to elaborate a unique research agenda shared by all the stakeholders. For all these topics, the collaborative work at the European level is mandatory if we want to compete with our colleagues from the USA, Japan, China and India.

What are our concerns?

Lack of budget:

Our concerns are relative to the budgetary efforts dedicated to research and innovation by the European Commission. This budget has always been an adjustment variable within the European budget. For instance, more than 2.2 billion € were taken out of Horizon 2020 to fund the first Juncker Plan (European Funds for Strategic Investments - EFSI). Only 23% of the EFSI budget was devoted to research, development and innovation, so it would be a pity to cut the budget of Horizon 2020, for the last years of the program (2018–2020), to finance the Juncker Plan.

The European budget for research and innovation should be increased to make the European Research Area stronger and more attractive, through grants as the main instrument to fund research and innovation. The academic research organisations will not be able to use other financial schemes as loans.

Lack of transparency:

The other concern stems from the lack of transparency in the preparation of the European programs. It is difficult today to understand how the European scientific priorities are identified, selected and funded through the work programs of the European Framework Programs.

Split Research and Innovation:

Regarding the project around the European Innovation Council (EIC) initiated by the Commissioner Moedas, we have to be careful not to create a new tool dedicated to innovation aside the ERC dedicated to research. Is this dichotomy realistic?

Scientific Excellence:

I want to point out that scientific excellence should remain an indispensable prerequisite/the key element for the selection of research projects to be funded through the European framework programs.

Some proposals:

Added value: ERC/Marie Sklodowska Curie Actions / Collaborative projects

The European Framework Program should be focused on funding programs which cannot be implemented at the national level. The Europe-wide competition is a real added value for the European Research Council (ERC), which should be reinforced with an increased budget and the Marie Sklodowska Curie Actions, which are among the best tools to build the European Research Area. The collaborative research through small-scale projects and larger projects if multidisciplinarity and critical mass are necessary, should remain the backbone of the next framework program.

Continuum of Research:

In my expertise area, it will be essential that in designing the next work programs the European Commission with the support of the different Scientific advisory groups and Scientific Panels would address more strongly the challenge of integrating all forms of research, from basic to clinical research and commercial exploitation, while applying the same standards of excellence, to enable a complete virtuous circle that promotes progress and generates a sustainable flow of innovation that responds to society's expectations.

Budget:

The budget of the European Framework Programs should be in line with the ambition of the European Commission and the Parliament in terms of research and innovation. The

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increase of the budget is needed to reduce the oversubscription and improve the success rates (higher than 10–15%), to give the opportunity to get funding for big collaborative projects (HIV virus, sustainable health systems, etc.), similar with the NIH budget allocated to this type of projects.

It is needed to remind politics that research spending has not to be considered as an expense but as an investment. Several studies have shown that one euro invested in research generate much more than one euro. Investment in research is the best gateway to innovation with economical and societal impact. We need a strong „advocacy circle" to convince that the European budget devoted to research should not be the first budget to cut.

Karin Lochte
Director
Alfred Wegener Institute,
Helmholtz Association
(Germany)

HELMHOLTZ GEMEINSCHAFT

Excellence as a prerequisite for impact – three general keys to unlock the European potential

Excellence and impact are often regarded as separated concepts. However, in order to achieve impact that creates a sustainable competitive advantage an excellent starting position is needed. Three key approaches specific for the European level have the highest potential to promote excellence:

Jointly solving the grand societal challenges with excellent collaborative research: European added value is most tangible where big challenges require the joint forces of competences found in Europe. In pillar III (societal challenges) collaborative research projects provide the right framework for bringing together the best scientists and the most innovative enterprises in Europe, and for integrating skills and competencies across disciplines. We strongly urge to recognize them as the strength they are. Collaborative research is most efficient if it focuses on the whole innovation chain with particular emphasis on Technology Readiness Levels (TRL) 1–6. Europe needs game changers, which arise from completely new approaches. Therefore, TRL 1–6 can raise Europe's innovation capacity when it comes to societal (incl. industrial) challenges.

Sharing excellent tools – cooperation on research infrastructures: Maximizing the European added value is especially relevant in the area of research infrastructures (RI) as e.g. research vessels, research airplanes, synchrotrons, high performance computers or structures for data management. Excellent research infrastructures are often the determining factor for a top scientist to come to Europe since scientific break-through in many disciplines depend on RI. They often require such a massive investment that they make joining forces at EU level a necessity. This investment also means that there are high efficiency gains to be gathered from ensuring that Member States share key infrastructures. The EU level is the perfect and the only place where programmes can be set up to provide access across borders between Member States. Making research infrastructures accessible all across the EU is one of the success stories of the framework programmes. Close collaboration of research infrastructures on technological challenges is key to remaining at the cutting-edge of science and needs to be fostered and funded.

Focusing on the best brains for excellent European science: The European Research Council (ERC) has clearly established itself as a European brand and is a prime example for the EU added value of actions which can be done nationally but benefit from adding a "champions league" to challenge the best and to ensure a Europe-wide competition. At the same time the ERC attracts international scientists who with their research contribute to Europe's knowledge base and foster future impact. For these reasons, it is essential to maintain the ERC budget.

First recommendations for the next EU research framework programme to enhance European excellence:

- Reliable budget of at least 100 billion EURO for research are key to ensure that Europe remains globally competitive.
- The EU framework programme should concentrate more on research for novel ideas and game-changing research and less on fine-tuning technologies close to the market.
- There should be no big changes in structure, rules and instruments as stability is the key for maximum development of the EU competitiveness by concentrating on excellence and not on administration.
- Loans have a limited scope and are not suitable to support groundbreaking research; co-funding works better for research projects.
- Innovation is more than market rollout, and high societal and economic impact can be achieved by e.g. a better flood warning system. There is a need of more sophisticated, broader definitions of innovation to assure FP9 can fulfill its whole potential impact.

Emilio Lora-Tamayo D'Ocón
President
Spanish National Research Council, CSIC
(Spain)

"The intertwined role of long-term basic research and breakthrough innovations"[1]

In July 2012, while the Horizon 2020 Framework Programme discussions were in full swing, the CSIC was already deeply concerned about what we consider should be the *élan vital* on research and innovation common understanding and their unclear interaction in the drafts provided by the Commission services.

Regrettably, these fears have already been confirmed. Given that the formula to find the crossing angles between research and innovation has been ambiguously uttered – as it is often the case on Horizon 2020 narrative – this results in a negative impact in the way the practical application of such conceptualisation is processed and turns into research and innovation projects. A very good case would be the increasing prevalence of the Technology Readiness Levels (TRL), long ago used by the NASA and now rediscovered and very complex to apply to long-term fundamental research.

We see every day the defensive arguments in favour of concentration of research efforts in demand-side and markets needs as the panacea to solve our existing competitiveness problems. →

And we are not against that approach but without overlooking the value of excellent long-term basic research. Otherwise, that could be an untenable and dangerous position.

While we agree on the fact that not all innovations with potential commercial value are direct result of previous research, it can be easily proved that long-term research is in the core of the growth that have created value for the society during the last and the current centuries. To give just one example: the long-lasting public investment in ICT research has resulted in a decade of blockbuster products "imaging" by the industry. But even in this well-known case, industrial investigations have shown that two factors are crucial to speed the development and commercialisation of excellence new high-technology product: a long-term view and structured processes[2]. Subsequently, industry and academia have common interests that must be jointly developed.

In that context, the different interests of many stakeholders, policy-makers, academia, industry, and the main one, the society benefit, should be reconciled but, if instead of finding the way to do that, we accept the current imbalanced situation, at the end of the day the scientists will be obliged to generate new and outstanding knowledge based on its potential commercial value; and the R&I host organisations should then only accept those theories and models based on business and financial strategies, very far off the societal challenge target of achieving excellence science for the benefit of the European citizens and the humankind as a whole.

Moreover, what reaffirms our position is that we note with great concern the trend towards widening inequality for sustainable growth and job creation among the Member States. We honestly believe that applying to long-term basic research a kind of market fundamentalism is not the best we can achieve. Stakeholders never must forget that excellent research performed by academia represents the ultimate state-of-the-art and it is the basis and the crucial instrument for transferring high quality knowledge, learning on which breakthrough innovations largely depends. In other words, there is not a kind of catch-22 here: without fundamental excellence research, there will not be excellence innovation and without excellence innovation there will not be growth and competitiveness.

Europe has a strong fundamental science and research foundation accomplished in the last centuries day after day and by very skilful people, and these hard-won gains cannot be neglected in view to only increasing economic impact. And on that grounds – and if we really want that Europe can assert itself as a genuine innovation power – innovation should be inextricably intertwined to research from the cradle to the grave. By correctly interlinking both, we will contribute to ensure a highly qualified workforce, a well-balanced social market economy and the needed democratic stability. These have been, and will be, our strongest advantages.

What we all need, thus, is a new research and innovation covenant. Actors are ready and time is running out to tackle with the challenge to conciliate the unavoidable relationship between long-term basic science and disruptive innovation.

1 From CSIC position paper + SE + other background.

2 Key Factors in Increasing Speed to Market and Improving New Product Success Rates (Industrial Marketing Management. Volume 4) (http://dx.doi.org/10.1016/S0019-8501(98)00008-X).

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SIEMENS

Elements of a coherent European approach to excellent research & technology – an Industry point of view

I. Keep research and innovation policy high on the political agenda

In March 2000 the Lisbon strategy proposed to develop the EU into the world's leading knowledge-based economy and called for member states to increase investment in R&D to 3% of their respective GDPs. In view of the growing importance of innovation for a sustainable economic competitiveness, it is very unfortunate that 17 years later we are still missing this goal by far.

It is true that the EU has been heavily challenged by many unexpected developments such as the financial crisis, the refugee crisis, the Brexit and a volatile geopolitical environment. At the same time, the global research and innovation landscape has never stopped growing, both in volume and in intensity:

- R&D expenditures and IP filings are growing in many industrial as well as emerging countries worldwide; competition in science and technology is intensifying.
- Accelerated innovation cycles in the knowledge based digital economy lead to faster transformation of knowledge into innovation and growth.
- Open innovation plays a crucial role as more and more knowledge is generated outside the traditional boundaries of research institutions and companies; cooperation becomes more important than ever.

Last year's report "Opportunity now – Europe's mission to innovate" by Robert Madelin has once more stressed the importance of research and innovation as major drivers for European competitiveness. Unfortunately it has received little attention. There is an increasing perception that research and innovation have lost significance on the European agenda. It is of paramount importance to renew the focus on research and innovation policy and build the basis for future economic success and societal welfare in the EU.

II. The added value of excellence in European research

Thus the added value of excellence in European research should be discussed bearing this background in mind. Two aspects are noteworthy:

1. Excellence as important criterion in European research funding

Excellence should be strengthened as an important criterion in European research funding. Tax-financed, foundational research is a risky undertaking because the success of any project is – and should be – highly uncertain. Strict application of the Excellence criterion helps to minimize these risks. It should always prevail and not be burdened by regional preferences. Structural & Cohesion funds should be used for setting up R&D infrastructures and rolling out innovations in all member states.

The increased global competition is an additional motivation to concentrate on highest quality in research. This implies the need to focus on specific research topics more consistently and build attractive ecosystems around these for the best scientists worldwide. A consistent focus on excellence within Horizon 2020 and the next framework programme FP9 is therefore highly recommended, even if Excellence is hard to define and even harder to measure. A high-level peer review system, in addition to subject-specific quantitative research performance criteria, seems to be the best way to determine excellence. In this respect the European Research Council and its selection process seem to set a good example.

2. Excellence in research has to be linked with transfer into innovation

Application of the Excellence criterion needs to go along with a consistent support of knowledge transfer from invention to innovation. Under Horizon 2020 this is mainly covered by the impact criteria. As digitisation and globalisation have given rise to accelerated innovation cycles, knowledge transfer is crucial to remain competitive.

As we know in most cases innovation processes do not follow a linear development from research to innovation. They are complex interdependent processes both for incremental innovations and especially for disruptive innovations. For this reason innovation ecosystems play an important role because they foster the exchange between academic research and industrial application.

In this respect the architecture of the European Framework programmes has to be improved. Obstacles have to be removed and new ways of cooperation have to be opened, reflecting the trend to Open Innovation. Against this background it is unfortunate that the participation of industry partners in Horizon 2020 has been declining during the past years. This trend must be reversed as soon as possible. In order to achieve this a number of administrative improvements are necessary to keep Horizon 2020 attractive for industrial players. Furthermore, measures should be taken to reduce the huge oversubscription ratio in Horizon 2020. Finally a more strategic approach is needed to design programmes reflecting the latest developments and trends around e.g. digitisation, data, artificial intelligence and cyber security.

A coherent European approach to address these challenges and to coordinate R&D & Innovation activities across DGs and between member states is needed. In this respect, the strengthening of existing instruments like Joint Technology Initiatives and Public Private Partnerships, or institutions like the European Institute of Technology with its Knowledge and Innovation Communities, seems to be more urgent than the creation of new institutions.

This coherent European approach should start with excellence as the main criterion for public funded research, support knowledge transfer and the creation of vital innovation ecosystems, and also include increased efforts to achieve a Digital Single Market.

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The Czech Academy of Sciences

Scientific excellence in infrastructures – "Czech" experiences by the application of European structural funds

The achievement of an adequate level of research and innovation in the Central Europe research space seems to be one from very important efforts to be developed for a uniform high-level research in Europe. These activities are strongly connected with the maintenance and increase of "knowledge-level" based Europe, as one of the most important mover of the progress and development of our current civilization. Thus the possible role of Europe as the principal power in the area of research, innovation and excellence is expectable. To achieve these goals, the use of EU structural funds focused on the development and enhancement of the infrastructure capacity in so-called "less-developed parts of EU" was crucial.

Since 2010 the Czech Republic is recipient of the European structural funds. Part of the funds has been devoted to the construction and development of the modern research infrastructures divided into two basic categories:
–> Centres of excellence in basic research
–> Regional centres for research application

The massive investment programme for the research infrastructure development was, in general, successful. At present 7 new centres of excellence are operating in the Czech Republic. The centres will become active and modern points to conduct research in different areas of science (medical, molecular biology, physics, technology, eco-biology, etc.).

To be able to fully utilize the potential of new constructed research infrastructures especially for the purpose of achieving some level of excellence, it is necessary to be able to comply with three basic conditions:
– Modern "up-to date" research infrastructure, covering top level instrumentation
– Sufficient amount of scientists who are able to work in excellent scientific teams
– Long-term sustainability of the infrastructure

It is not easy to realize all phases of the new infrastructure construction (preparation, construction, etc.) but crucial is to achieve some level of daily management and operation. For the construction and operation of any new research infrastructure the problem is not only new instrumentation and technology, but primarily to be able to establish an active research team building, and to reach rapidly the level of excellence. There is only one possible and reasonable way to achieve it – international cooperation and scientists recruitment.

Regarding the general problem of excellence's achievement, it is necessary to be able to comply with the three basic conditions:
– Modern "up-to date" research infrastructure covering top level instrumentation
– "Critical- mass" of scientists who are able to work in excellent scientific teams
– Long-term sustainability of the infrastructure from the financial point of view

As mentioned above the principle for the infrastructure operation is the formation of research team composed of "high-quality" researchers. To achieve this level in some reasonable time frame different approaches are possible:
– Recruitment – active and consider „hunting"

of selected scientists – problem in the Central Europe – salary
– Spontaneous income of scientists – the use of European scientific and research area, i.e. open acess and "Short term scientific visit" programme
– Make possible to establish scientific schools by young successful scientists

If particularly the role of scientific personality is accepted as the "hotspot" for the achievement of the excellence at the European research infrastructures, the massive programmes for the mobility support is of great importance. To prepare such a programme, which enables to all efficient scientists to spend short-middle-long term position especially in the new research infrastructures in the Central Europe, seems to be crucial for the next future development of the European competitive and excellent research area.

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ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

Added value of excellence in European research

Excellence is an elusive intangible that is central to academia, to research and, often, to human progress. It is a persistent aspiration in higher education and training. It is something our institutions of higher learning or cutting-edge research wish to possess and, increasingly, is something that they display. It allows a degree of differentiation – and as such is considered as a key factor in what distinguishes an institution or a community from its competitors.

There are many ways of viewing excellence (again, it is elusive and intangible); I will simply, in the lines that follow, merely share a few, somewhat subjective, observations.

The first is that excellence is infectious. We speak of "centres of excellence", and rightly so because they exist. There are places where, in science, engineering, medicine, artistic creation or technological innovation, excellence clearly exists. Those are "centres" in the sense that, from there, excellence tends to spread.

The second is that excellence doesn't just happen; rather, it is to be fostered and passed on, and a main vehicle to this end is the development and nurturing of a certain culture. The notion of institutional culture is anathema to many in academia; nonetheless, it does exist in top research or academic institutions and it is, in fact, much of what makes them "excellent". High-level research institutions need to identify, nurture and communicate their core values. They must engage, through those values and through principles of governance, with their faculty, their staff and their students. And when consistent excellence places them in the top league of the world's research institutions, they often define and then refine this thing that they refer to as their culture, viewing it as a central element of what makes them "excellent". This is not marketing: although a perceived reputation for excellence, for whatever reason, is certainly useful, it is something else entirely to consistently perform with excellence so as to live up to the reputation that comes with it.

The payback for the institution and the world around it is that excellence then becomes contagious. In a community of motivated and self-driven individuals, emulation is a powerful

stimulus. I would like in this context to evoke the role of excellence in doctoral education.

I believe that we have, in doctoral education, a particularly powerful vehicle to foster and spread excellence: it is in fact one of its main vectors. It is when our students come to the cutting edge of research that they see and learn excellence. It is often also they who carry out, in an institution with an appropriate corporate culture, the research that will further that institution's impact and standing; simply put, an institution's doctoral candidates tangibly contribute to its excellence. And finally, and this is in a way the main point I wish to make, it is largely they who will spread excellence: contamination is often through this unique vector, the doctoral graduate.

Which begs the question of how we nurture this particular segment of our research community. The doctorate is, first and foremost, a thesis: an exercise situated somewhere between guided apprenticeship and the first experience of academic freedom and independence. It is thus very free-form but it can be structured in ways that, without causing significant departure from the core-defining feature of the doctorate (the thesis), will give the time spent as a doctoral student a few extra dimensions in which excellence can be further fostered.

One such dimension is provided by the creation of communities. At EPFL we call those doctoral programmes, which we created some 15 years ago. Doctoral programmes welcome, stimulate and drive our PhDs within communities that we strive to make vibrant, spirited and responsible. The second is made of a host of measures, which we believe drive excellence within this community: structured recruitment and supervision, the offering of advanced level courses, strong infrastructure and equipment support together with involvement in teaching and education. Other avenues we explore are an exposure to the processes of innovation and the development of doctoral exchanges with institutions akin to ours - because we believe that excellence is contagious even among the youngest doctoral candidates.

I am convinced that European research offers our institutions, our youth, and our economy, what is perhaps its most fertile ground for the spread of excellence. From the start, research has been collaborative by nature and has crossed borders, no matter how thick or forbidding. Research excellence, together with its outcomes, both tangible and intangible, provides us with plenty of aces for our hands. And it does so increasingly as we launch new, free and open vehicles for the sponsorship of research, such as the ERC grants. We still have work to do: we have a complicated organisational and operational approach, and the coexistence of scientific and auditing cultures is still not entirely easy, but these are surmountable obstacles. We are more than ever in the public eye, and we have a debt in that our livelihood depends to a large degree on public resources provided by an expectant continent that realises the critical importance of being at the forefront of research, of excellence. We must live up to its needs and expectations. Excellence feeds quality: if we care about excellence, we will do innovative work of quality.

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Scientific excellence as a breeding ground for excellent innovation

For more than 900 years, breakthroughs in human knowledge have been achieved, exchanged and transmitted through European universities. From the discovery of relativity, of DNA, and the construction of the first computer, European frontier-led research has transformed our lives and society. We've seen that excellent science requires collaboration, communication, and competition, across country borders, institutional borders, and disciplines. And we've seen that real breakthroughs often are unexpected and defy political cycles.

Europe has a unique concentration of outstanding universities in all of its many regions, connecting generations, cultures, and spaces. Universities generate knowledge, encourage entrepreneurialism, develop intercultural understanding, foster civic engagement, and teach rational argument and critical thinking. Universities are central to the success of the next European Framework Programme, which must foster new ideas and products, enable a wider popular understanding of change, and an engagement with social transformation and inequality.

But we must find ways to further enhance the capacity for excellence across Europe. It is critical to address structural impediments to the pursuit of excellence in lower performing regions. We need to find ways to enhance the movement of researchers between institutions, ensuring outwards and return mobility to avoid a brain drain, without impairing the freedom of movement. Investment in research, innovation and education must be a core component of regional policy.

For the next Framework Programme, the EU must significantly increase spending on research and innovation, an area where the EU has provided particular added value beyond what could possibly be achieved at the national or bilateral level. Enhanced knowledge not only sustains economic growth; it provides understanding of social change and cultural uncertainty, and it facilitates trust in the very essence of public life and its institutions.

Brexit could mean a new era, the risk is that Brexit will put Europe into reverse. A quarter century with the dismantling of borders can now be replaced by an era where new boundaries are created in the European research and education area. This is what we must prevent, with all the forces we can muster.

New industries arising from today's universities will have knowledge as their main resource. Therefore, excellent research and education are ingredients that belong in any recipe for innovation and value creation. Innovative regions throughout the world all have a high density of excellent universities that deliver highly qualified graduates. A university must not be tempted to make value creation and short term profits the primary goals of its activities. But universities must take steps to ensure that their excellent research serves as a natural breeding ground for innovations that can develop into new businesses.

Breakthroughs that serve as breeding grounds for new industries often come where you least expect them. No research council, no government can predict or procure such breakthroughs through earmarked funding. Unbridled curiosity, channeled through free, researcher-initiated projects, is the main driving force for research that changes society. But we cannot be truly excellent without the free movement of students, researchers and talents across Europe.

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Excellence in academia and industry: towards innovation ecosystems

"European Research" encompasses both academic and industrial research. The value of European Research is both to innovate for creating new knowledge in all fields of basic Science, from mathematics/physics/chemistry/biology to Human Sciences, as well as to innovate for creating new industrial applications and services for our Society. In order to address the great challenges of our Society such as the ecological transition, ageing of the population, massive urbanization, air & water quality, scarcity of resources etc., we need both excellent academic research and excellent industrial research & development, so that successful solutions to these challenges can be deployed. Without these two complementary types of excellence, there is no way to transform fundamental scientific breakthroughs into disruptive applied technologies for the benefit of all. The word Excellence can have different colours in these two worlds; Excellence for an Academic researcher will include for example disruption in concepts, development of new fields, understanding of fundamental questions etc. whereas Excellence for an Industrial researcher will include high level disruption in technologies, development of safe and reliable processes, understanding of customer problems, and an ever increasing sophistication by synergistically using a multitude of technologies to effectively exploit the scientific breakthroughs. However, Excellence must be a common value to both Academia and Industry in order to succeed in our environment of intense global competition. Existing and paving the way for the future requires us to surpass ordinary standards day after day.

One of the great added values of Excellence in European Research will arise from the intimate interactions between scientific and industrial researchers striving for successful innovation. There are already numerous interactions between these two worlds through collaboration on common projects, which can be short or long-term. However, these two worlds are still by far too separated. In our fast changing and uncertain World, we need to go one step further, we need to build more bridges between the academic and industrial worlds and ultimately develop real Innovation Ecosystems. By analogy with the well-known biological ecosystems observed in nature, innovation ecosystems should comprise, within a defined local area, a number of "living organisms" such as Universities, Private R&D, business schools, venture capitalists, start-ups, local economic organizations. This must also include world-class infrastructures and resources (funds, equipment, facilities, platforms etc.) and most importantly a vibrant human capital (students, faculty, staff, industry researchers, entrepreneurs etc.) that make up the different entities participating in the ecosystem. An ecosystem can only be considered as a whole, not piecemeal, as every "living organism" of the ecosystem has a functional effect on each other. The essential ingredient to this synergy is simply Excellence. Excellence in fundamental academic research is the foundation of an ecosystem, the roots of innovation in Science and Technology, and also a means to attract the best students who are the innovators of tomorrow. The development of such innovation Ecosystems based on Excellence is key for Europe since in the future, the economic competition will no longer pit Companies against Companies, but Ecosystems against Ecosystems.

One of the most famous European scientists, Isaac Newton, said a long time ago "We build too many walls and not enough bridges". This →

visionary quote is still true, and one pillar of the bridges that we have to build between the academic and industrial worlds is "Excellence". To give a concrete example, last year Air Liquide launched a Scientific Challenge open to the academic community. This initiative was based on 3 scientific questions addressing Societal Challenges such as the Ecological transition. Our approach was to develop a long-term collaboration with groups having achieved remarkable scientific breakthroughs in order to translate these breakthroughs into technologies that can be deployed on the market. For example, green H2-production and valorization of CO2 were two focuses of this Scientific Challenge. It was a great success with more than 130 proposals from 25 countries, with two of the three laureates coming from Europe! Europe has all the assets to be a great innovation powerhouse, let's build together on Excellence!

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Promoting the distribution of scientific excellence in the European Research Area (ERA)

Promoting the distribution of scientific excellence in the European Research Area (ERA) is essential but it is a serious challenge mainly due to the limited availability of funds. Possible strategies could be based on:

A. Spending Review of the budget of the European Commission.

In this moment of crisis of the European Union (EU), it would be very difficult to ask the Member States to increase the budget of the EU to allocate more funds to research (and education). Thus, the only possible solution would be to save on other activities. A successful approach could consider the expenses for defense and security going in the direction of a common European defense[1], proposed as early as 1951 by Fathers of the European Community such as Robert Schuman and Alcide De Gasperi but not finally approved. It is interesting to compare the budget of Horizon 2020 (about € 80 billion for 7 years 2014–2020) with the annual military expenses of the EU (over € 200 billion in 2016 corresponding to the 1.42% of the GDP)[2]. *"The lack of cooperation between Member States in the field of defense and security is estimated to cost annually between 25 and 100 billion € because of inefficiencies, lack of competition and lack of economies of scale for industry and production"* was recently stated in the European Defense Action Plan recently presented by Federica Mogherini, High Representative of the European Union for Foreign Affairs and Security Policy[3]. This strategy would also be useful to strengthen the political cohesion of the EU also by facilitating the circulation of young military personnel who could serve in different Member States in a kind of "military Erasmus". That would also be perfectly in line with the article 42 of the Lisbon Treaty in which it is stated that *"common security and defense policy shall include the progressive framing of a common Union defense policy. This will lead to a common defense, when the European Council, acting unanimously, so decides"*[4].

B. Increasing the budget of the Marie Skłodowska-Curie actions (MSCA).

It is known that the circulation of researchers is key in the distribution of excellent science and could be very effective to enhance creativity and productivity of the European society. MSCA is a very successful programme of the EU, which supported about 100,000 researchers since 1996. From 2014 to 2020, with a budget of € 6.2 billion, the MSCA will fund around 65,000 researchers including 25,000 PhD candidates[5]. These figures are impressive but could be further increased with a relative low financial effort, bringing very significant benefits to the EU by enhancing the feeling of European citizenship and political cohesion. As a comparison, it is very well known that the Erasmus programme (more than 3 million beneficiaries since 1987[6]) proved to be very useful to create enthusiastic European citizens. Instead, the current funds allocated to MSCA are not sufficient to allow a very significant mobility of young researchers in the EU (about 500 million inhabitants) and the success rate of the applications is too low, thus creating frustration among young researchers.

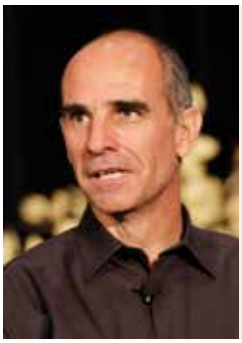
C. Strengthening the Seal of Excellence initiative (SoE)[7].

After 8 framework programmes, the European Commission developed an excellent evaluation system. However, the number of applications is much higher compared to ones that can be funded and many high quality proposals meriting financial support do not succeed just due to the limitation of the resources. Thus, the recent initiative of assigning Seals of Excellence (SoEs)[8] to high quality applications above a certain threshold can be very useful and National Governments and all public funding agencies should be encouraged to take into high consideration projects with SoEs, thus saving money on additional evaluation procedures.

D. Improving the communication with the European Citizens.

As mentioned before, the budget of the Horizon 2020 programme is quite low considering the size of the EU (about 500 million people) and our ambition to be *„the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion"*[9]. Just as a comparison, the annual budget of the National Institutes of Health (NIH) in the US is about $ 32.3 billion only for medical research. To try to increase it, we need to start a long-term strategy aimed at improving the communication with the European citizens (taxpayers) explaining all the benefits of excellence science (and education) for their life, health, and the quality of all aspects of the society they live in.

1 https://eeas.europa.eu/topics/common-security-and-defence-policy-csdp_en?page=1.
2 http://www.eda.europa.eu/info-hub/defence-data-portal.
3 https://eeas.europa.eu/headquarters/headquarters-homepage/16165/mogherini-unveils-european-defence-action-plan_en.
4 http://www.lisbon-treaty.org/wcm/the-lisbon-treaty/treaty-on-european-union-and-comments/title-5-general-provisions-on-the-unions-external-action-and-specific-provisions/chapter-2-specific-provisions-on-the-common-foreign-and-security-policy/section-2-provisions-on-the-common-security-and-defence-policy/129-article-42.html.
5 https://ec.europa.eu/research/mariecurieactions/sites/mariecurie/files/msca-factsheet_en.pdf.
6 http://europa.eu/rapid/press-release_IP-13-657_en.htm.
7 https://ec.europa.eu/research/regions/index.cfm?pg=soe.
8 https://ec.europa.eu/research/soe/index.cfm.
9 https://portal.cor.europa.eu/europe2020/Profiles/Pages/TheLisbonStrategyinshort.aspx.



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Keys to excellence in partnerships with industry

The European Research Center offers companies, like Total, the opportunity to partner with centers of excellence and produce research that the Company may not have achieved on its own or with individuals that it would not have identified. Over the course of his career, the author has had the opportunity to reflect on what makes a partnership successful in the context of collaborations across borders. The lessons learned were shared at the round table held in Brussels in March 2017.

Keys to a successful scientific collaboration

Parties need to enter into a partnership willingly and without reservation
A company like Total will go into a partnership to develop an R&D project for various reasons or combination of reasons including:
- Complementary expertise that is not available in-house.
- Leverage a partner's skill, infrastructure, human talent etc.
- Share financial risks for a large pilot.
- Leverage financial incentives or matching funds.
- To develop know-how or technology that will find an industrial application.

This comment applies to early stage research (low Technology Readiness Levels) and to full-scale multi-million euro semi-industrial pilots as well.

Partners must have a shared vision and objectives on where the consortium wants to go.
These objectives may need to be formalized with periodic controls on where each stakeholder/ partner stands. Coming into the project, individual objectives may not be aligned. A clear understanding of the definition of success of the project (or sub-projects) must be shared by all at a very early stage.

Partners must have shared values and commitment to what each partner is bringing to the table and to working collaboratively. Building trust at the onset of the project is essential. Some successful collaboration efforts go to the extent of writing down how they commit to working together. A document indicating how to share values and objectives (the *what we will do* and the *how we will do it together*) has some merit as it can be referred to at all times. Among other topics, management of Intellectual Property has to be sorted out early with all parties being realistic about the actual worth of what they bring to the table.

Partner principals must display exemplary leadership.
When the leading partner representatives lose interest, change without proper handover or are not prepared to make decisions at steering meetings, this has a trickledown effect on the whole project. On the opposite end of the spectrum, alignment of all leads towards a common objective is an extremely powerful beacon.

A successful collaborative project must brace for the long haul.
The notion of duration must be factored in, as the honeymoon period will rapidly come to an end.

Team cohesion must be maintained, especially during tough times.
When the project runs over several years with partners spread across several countries, pain

points will appear, partners will fall behind or not pull their load, and tension will occur. Working on- and dedicating effort to- maintaining team cohesion is paramount. Helping a struggling partner, provided they have upheld their commitment to the values and objectives, is important for the overall success of the venture.

Governance and key processes must be in-place relatively early in the project, offering some flexibility to adapt as the project moves forward. These include validation, decision processes, payments, IP rights etc. The organizational structure must be robust enough to provide a framework for the collaborative effort but not stifling to the point where it smothers creativity.

Conclusions

In a nutshell, a successful collaboration must be run like a project with professional project management and resources, not as an afterthought. This requires all partners committing to the overall effort and accepting to meet the other partners on common ground, namely on IP management. Total supports strong collaborative research that addresses grand challenges and frontier research. The ERC process provides an opportunity to identify and nurture new talents that pull science to new limits. The ERC framework matches the pioneer spirit that is a core value for Total.

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KU LEUVEN

Added value of excellence in European research

Sufficient investment in frontier research in collaborative setting is crucial for Europe's future knowledge base and innovation.

The collaborative research funding schemes within the European R&I Framework Programmes (FP) provide for major added value in Europe. There simply is *no alternative funding mechanism available* that can fund collaborative research and innovation activities in the same way. These schemes provide funding for partnerships with businesses and other non-academic sectors, and focuses research from different disciplines on addressing societal and industrial challenges.

Within its FP's, however, Europe must *reconsider its focus on technological innovation*. Other forms of innovation such as societal innovation are not given sufficient emphasis, despite these being vital to innovation in society. Moreover, encouraging truly multidisciplinary research, too often considered as not cutting-edge research, can provide real innovation. Real innovation, however, is tightly coupled to frontier and discovery research. This should be better reflected in the European R&I policy and FP's. By focusing too strongly on the 'market readiness' with 'high SRL' projects[1] and less on the early, critical part of the innovation pipeline, this pipeline is at risk of running dry. The European Commission (EC) should take a more balanced approach and spread it's funding for collaborative research over all stages of the innovation pipeline and fund them accordingly.

One could envisage a future European funding scheme for collaborative research that on the one hand aims at quick wins by issuing top-down

topics with short-term impact (e.g. for emerging issues like migration, or towards the digitalization of our economy), and on the other hand aims at 'harvesting' a set of projects within open, broad, recurrent and large-scale topics with a long-term impact on society or economy (e.g. beating infectious diseases etc., sustainable energy storage, climate change mitigation, etc.). Such broad topics would call for collaborative projects at different SRL levels at the same time, its budget equally divided between low, medium, and high SRL type of projects. Making the broad and long-term-impact topics recurrent (and thus predictable to the scientific and entrepreneurial community) would allow passing on results to next levels of SRLs, making better use of the projects' output[2]. Impact of a single project in that sense could mean 'moving up at least one SRL level'.

Look for synergies, but do not mix aims: building capacity vs. creating impact by funding the best ideas and consortia.

One of the most notable high-level outputs the consecutive European Framework Programmes have delivered, is their drive for excellence, implemented through open calls for proposals and international peer-reviewing. The best consortia, performing high quality research and using innovative ways of delivering results to society, win the grants. *"We should not compromise on excellence"* Commissioner Moedas claims, and yet Horizon 2020 intends to introduce a separate funding pot for lower performing EU regions in the next call for Marie Curie for individual fellowships. Likewise, the European Parliament intends to introduce 'geographical balance' as an evaluation sub-criterion in the next FP. These and similar actions, introduced under massive political pressure from lower performing regions, will dilute the FP's quality label, but will especially compromise the much needed drive for excellence in the very same regions.

The Europe-wide climate of competition for excellence has in fact influenced national, regional and institutional R&I policies, and is triggering the most-needed reform: institutions want to get 'on board', and consequently introduce new policies, measures and reform. The European policy makers should not underestimate the huge structuring effects this principle of competition for excellence has within the European Research Area.

Of course, one should not be blind for the innovation divide. *Reform at national or institutional level is going too slow.* Low participation rates of many EU Member States in projects funded by Horizon 2020 are worrisome. But one should cure the disease, not this symptom. There is plenty of talent in these regions but it is up to individual member states to make urgent changes to retain these talents. Structural Funds (ESIF) dedicated to R&I amount to € 100 billion, more than the FP's budget; e.g. Poland received over € 1.2 billion R&I funds from ESIF in the past period, annually, which is a multitude of the funds that stronger Member States were able to secure in the FP competitions. For Europe to continue to be a major global player in the field of research and innovation, it is important to cross the scientific and innovation divide between Member States as soon as possible. A larger and fixed percentage of the ESIF should be clearly 'R&I-labeled' to create synergies with FP, and be invested in talents and research capacity to make that happen.

We as strong research institutions, embedded in well performing regions, have a clear assignment as well: *we should reach out more*, encourage research collaboration with talents and entities in the entire European Union. For that reason, KU Leuven recently established CELSA[3], a strategic alliance between universities in Budapest, Leuven, Ljubljana, and Prague.

1 SRL: Society Readiness Level, extending the scope of the EC's TRL definition (Technology Readiness Level).
2 For more information on this concept, see LERU's Interim Evaluation of Horizon 2020 (Oct. 2016) and the LERU advice paper on FP9 (Spring 2017)
3 CELSA: Central Europe Leuven Strategic Alliance, est. in May 2016.

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What ingredients enable creativity to thrive?

Brexit poses big challenges for UK science and innovation, but what is not in doubt is that we must continue to support a world-class research environment with global reach and outlook; one that develops the most forward-looking ideas and delivers excellence in discovery and innovation. Thus we must ask what conditions are needed in order for excellence to thrive?

They are essentially the conditions needed to gestate, develop and exploit transformative concepts. Ideas can best be validated and tested within a particular type of environment – let's call it an ideas ecosystem – that enables them to arise, grow and to be evaluated rigorously. To continue the ecosystem analogy, in a very real sense revolution derives from evolution: the truly radical ideas arise from the myriad interactions and mutations of ordinary ones.

What, therefore are the central elements of an excellent research and innovation ecosystem? I suggest there are three things that are important:

Critical mass. Only a sufficiently large ecosystem is sustainable. There should be capacity for generating and identifying the best ideas. This is constituted of both breadth and depth: there needs to be frequent enough interactions between researchers (and students) actually generate good and fruitful ideas, and that those that have immediate potential for impact. Since the probability that any given notion will have impact right away is small, the ideas ecosystem must be large enough that it is highly probable that at least one such idea is available at any given time.

Critical mass also underpins innovation, since development of ideas to test them for industrial, commercial or other uses and applications requires capacity and capability: the most immediately fruitful ideas must be identified and exploited rapidly.

Cross-fertilization. In order to generate the random associations that bring forth transformations of the most far reaching kind, interaction of multiple viewpoints is necessary. This requires the collision of different ways of thinking – both cross disciplinary and cross – "culturally" (i.e. the way people think about a problem in one institution is not always the same way they think about it in another.) Research is perhaps the only truly global activity, in which every nation wishes to and most do participate. The EU cannot afford to be anything but a world leader, and the ability of brilliant people to move between excellent institutions is crucial to enable creativity.

Competitive tensioning. Our ideas must be compared with the best in the world if we are to claim to be an internationally leading research area. The role of international competition in all aspects of research activity is critical: resource allocation and acquisition to support research, staff appointments, and recruitment of support staff and students. Competitive tensioning is an efficient means to ascertain what is surpassing merit; it is vital that resources are allocated by such means.

Of course, any ecosystem requires energy input, and in the case of research and teaching that

is resources in the form of infrastructure and funding. But it is important to remember that these are enablers, not outputs.

It is also important to understand that all ecosystems are, in the strictly utilitarian sense, wasteful. There will be many ideas that are not immediately applicable, whose impact cannot yet be seen or imagined, and some that turn out not to lead anywhere. But that's a necessary part of creativity.

It's worth asking how being in the EU has helped generate and propagate these features of the ecosystem, simply in order to identify practical steps we may now seek to take in order to ensure our universities remain at the forefront of the international research and teaching agenda, connected to, and actively engaged across Europe and the world.

The networks that the EU Framework Programmes have supported increase the connectivity of the ecosystem: you get to interact with more people, more often. Critically, it is not simply bi-partite collaboration, but multipartite, and often including industrial or clinical partners. The necessary multi-national character fosters the need to think about even common ideas in a new way and enable projects that could not feasibly take place on a national level, because they require data or expertise that we don't have in the UK. International networks are naturally connected with national networks, so that the threshold of critical mass is exceeded. And new opportunities for students arise easily and in context.

The mechanisms for funding these networks need to recognize the strength of this multi-lateralism. Of course, universities have collaborations worldwide: academics want to work with the best colleagues, no matter where they are. But such collaborations are often bi-partite, and rely on each individual to find local support. The collective nature of EU instruments has been a real benefit to the UK in enabling the connectivity and critical mass.

And the funding of Excellent Science (to use the H2020 pillar labels) is also vital. Ideas are tensioned against not just the best in your neighbourhood, but also the best across the continent, and, indeed, in the ERC programmes, across the world. ERC is now the gold standard of research support: it is a badge of excellence precisely because it is competitive and international. The EU has been exceptionally good in driving this agenda, and the UK has both contributed to and benefitted greatly from it.

Maintaining excellence in research and innovation demands that both national and Europe-wide ecosystems thrive, by enabling the best researchers to work in proximity with each other and, where appropriate, with industry, and to test ideas constantly, by comparing them against each other, and making choices about which offer the most potential for new understanding and new impact. Such an approach has brought Europe to the forefront of discovery in science: it should now build on that excellence in order to realise the fruits of its investment both through new insight and through innovation.

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Can we measure scientific excellence?

The process of producing new scientific knowledge is a complex one, often involving the efforts of a large group of individual scientists working sometimes in collaboration, sometimes in competition. While it is possible to take an historical look at the process and identify great contributions to science, it is much more complicated to evaluate the impact of scientific advances as they are occurring, especially in basic research. Oftentimes, outstanding discoveries are preceded by publications that, though important, made a less memorable impact at the time.

Many evaluative indexes (number of publications, impact factors, citation indices, etc.) have been invented in order to try to provide a quantitative value for the purpose of measuring excellence, but it is clear that each of these indices represent, at best, a point of view that is biased towards the values of the indexer. Even worse are the various rankings of the so-called most outstanding research universities; the differences and inconsistencies among these various rankings are themselves the best proof of their lack of appropriateness.

Moreover, the very process of producing these indices and rankings has created a value system that encourages research institutions to compete on these scales, rather than on the scales of knowledge-creation and innovation. Frankly, the mere definition of scales, based on sets of predefined parameters, is itself destructive, as such scales can inhibit critical and out-of-the-box thinking, and ultimately steer basic researchers to pursue quantity over quality. In addition, indexes and rankings of this type create an "eco-system" which is adverse to risk taking, one of the primary drive for innovation.

If we resist to the urge to measure excellence according to a simple scale (or even to a set of scales), then how might we evaluate it – and more importantly, do we even want to? History shows that, in general, and before all these parameters were codified, the scientific community itself managed to promote and fund the right ideas and the right people. Major scientific ideas developed during the last centuries were funded not because of a meta-analysis of specific indices, but because the scientific community itself was empowered to make its own decision about funding via peer review, and did not need always to demonstrate an immediate impact on the society, certainly not within a defined time frame. In short, *excellence was recognized when it was observed*. Risk-taking was promoted, simply because it was recognized that excellence is not about what you are doing, but rather about who you are. I would argue that it is time we returned to a system in which a significant fraction of research funding is devoted to excellent scientists, and not (perceived) excellent science, which is often mistaken to mean "important" fields. The overly top-down programmatic system that we are experiencing today – in which we depend on long-term scientific strategies – does not promote scientific excellence, and fails to create space for innovative thinking.

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High Energy Stereoscopic System (H.E.S.S.) Telescope, Namibia

An array of four 12-meter-mirror telescopes and a huge telescope with a 28-meter-sized mirror (photo) is observing the sky above the highlands of Namibia. Undisturbed by the light of large cities, the location provides an optimum view of the central part of the Milky Way. The H.E.S.S. experiment is investigating the sources of high-energy gamma rays.

The construction of the new H.E.S.S. II telescope was driven and financed largely by Max Planck Society (MPG) and Centre National de la Recherche Scientifique (CNRS). H.E.S.S. was awarded in 2006 the Descartes Prize of the European Commission – the highest recognition for collaborative research.