Critical Elements for Scientists to Thrive[1]

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Dear Honourable Minister, Magnificence, dear colleagues,

Thank you for inviting me here today to speak at this important conference for the future of higher education and research in Poland.

I understand that it is taking place during a time of intense reflection about how to develop further Science in Poland based on an analysis of the past.

And no doubt you will be receiving lots of advice and recommendations. Not least from a peer review being carried out under the lead of the European Commission's Policy Support Facility.

It is not my intention to try and offer detailed policy recommendations for Poland here today. However, I would like to make some observations about the process of reform in general, and then **to set out some basic principles** that, I believe, are instrumental to make individual scientists thrive. Principles that, I think, have a form of universal relevance.

Firstly, from my years-long experience of taking part in and seeing reform efforts around the world, I would like to suggest that **there is no one set of institutions and policies which you can take "off the shelf" and set-up in a given country, here Poland, which will guarantee the outcomes you want.**

So you should beware of generic advice: each country faces a different set of conditions, a different history which has shaped its institutional environment. As a result, in a given country, policy-makers need to create the conditions in which researchers working there can flourish.

This is not just my opinion. Last year a study funded by the Danish Council for Research and Innovation policy (DFiR)[2] was published. It looked at the relationship between research policy and research performance over a 30-year period from 1980 – 2013. It found that there was a stable group of top performing countries over this period but that this group is *"very diverse in terms of how the national science systems are organized and funded. According to this literature, there is not one optimal national science policy model but rather a number of quite different models which all have shown high performance for several decades."* But there is one striking feature that all the top performing countries **do** share. And that is **a long-term commitment to supporting research, and stability in the funding and governance-conditions**.

So my **second observation** is **the need to be patient and to adopt a long-term perspective**. The countries, which now enjoy good research conditions, do so only because of wise and patient investments over many years.

I do not say this to encourage complacency or argue against the need for reform. Saying that there is not a single way forward does not mean that **any** way forward will deliver good outcomes. But it can take many years for the actors in a system to react to the incentives and structures put in place around them. As a result such a commitment cannot be the project of a single minister or ministry. There must be buy-in across governments and in the long-term by the scientific community. Too often we see a kind of "boom and bust" in research funding in certain countries as administrations change.

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[1] I would like to thank Benjamin TURNER for his major help in preparing this keynote speech.

[2] *Links between research policy and national academic performance A comparative study of Denmark, Sweden and the Netherlands*: ufm.dk/forskning-og-innovation/rad-og-udvalg/danmarks-forsknings-og-innovationspolitiske-rad/publikationer/artikler/links-between-research-policy-and-national-academic-performance-cfa-main-report-2016.pdf

My **third point**: **such a commitment should aim at making the national system become at some point competitive through national resources**, and, in the European context, **be able to twin in the right way with others** in particular as far as researchers are concerned.

In 2014 the overall gross domestic expenditure on research and development (GERD) in the EU was 284 billion €, about 100 billion of which was spent by the public sector. In the same year the EU support to research and innovation was around 9 billion €, i.e. less than 10% of the total **public** spending.

It is therefore obvious that, with its present size, the EU support to research cannot address alone all of the issues facing Science in Europe. Hence, funding coming from the EU cannot replace national funding. But it can provide key reference points and support some ambitious projects as the ERC does, while of course also highly facilitating transnational cooperation.

Still, for the foreseeable future, the primary responsibility for funding basic research in Europe lies at the national level. The duty of us having responsibilities at the European and national levels is to find the optimal combination of strategies, each taking advantage of special situations. The EU is providing a wonderful platform for sharing best practices and reaching critical mass when needed. Its programmes must be fit for these purposes, and the scientific community must make its voice heard to achieve that.
So far I have suggested that Poland needs to make a national commitment to research, to develop its own solutions and to give them time to work. I now turn to the critical elements I believe allow individual scientists to thrive.

There are three main elements:

- **First,** we must not forget that **the most essential element is the researchers themselves**, the human beings that make things work;
- The **second** element I want to emphasise is **the need for researchers to have the time and freedom to explore new knowledge**;
- And **third** I would like **to stress the need for diversity, risk taking and interdisciplinarity in Science**.

During my time in Brussels I have been very struck with the way policy makers of all nationalities talk about research. They talk a lot of structures and systems, of synergies, critical mass and linkages, of eco-systems and societal challenges. There are lots of references to GERD and BERD and R&D intensity and numbers of publications. But very little discussion of the work of scientists themselves and what makes young people decide to do research.

So let me stress again that, for me, **one of the critical elements for the performance of a research system is to give room for initiative to the right people**, attracting some of them and retaining others.

Without the right basic conditions for researchers, the quality of research is affected. Anybody entering a demanding working environment, such as ours, wants to be assured that there is a chance of a career, of advancement, of reward. We should not be surprised to see, when these basic conditions are not met, the best researchers simply leave to carry out their research elsewhere, or leave research altogether. Any country or region which wants to develop its Science therefore needs to get these basic conditions right.

In particular we need to plot out a sustainable career path for talented young researchers, from wherever they come. In some countries this has be invented. We must consider employment and working conditions, open, transparent and merit-based recruitment, without forgetting of course an improved position for women in research. This can only be achieved if an appropriate balance is found between competitive and institutional funding. We must look at ways to enhance the training, skills and experience of researchers in Europe. We must give consideration to the possibility of reconciling professional and private life. Most of all we need to consider researchers, not just as researchers, but as people.

For young researchers having the possibility of being exposed early to other research environments is critical, provided they can do that without having to rush from a one-year position to the next, a situation which leaves no room for maturing some scientific reflection and constructing a personal strategy. Such a complementary training is typically offered by a well built post-doctoral programme such as the one set up by the Swiss National Fond.

This leads me to the **second element** for the performance of a research system which is that it has **to guarantee scientific freedom for researchers**.

There has always been an inherent tension between the demands of policy-makers for relevance and impact, and the deeply-rooted interests of scientists in curiosity-driven research. But I believe that this apparent contradiction is mostly a false one. Let me explain why.

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 Public Research Institutions perform more than 3/4 of the total basic research."

So nobody really disputes that technological progress requires both basic or curiosity-driven research and applied research. Nor is it disputed that governments need to fund basic research. The fundamental reason for pressure on impact is that the applications of such research cannot be foreseen, with a possibly long time-lag between fundamental discoveries and their exploitation.

So why then does the basic research community feel under constant pressure to justify its activities and budgets?

Paradoxically, 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, some people may 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" or "impacts" they might like, as if from a menu.

But of course we know that Science does not, and actually cannot, work that way. All technologies harness natural phenomena. These phenomena exist in the world regardless of our desires. Nobody decided one day that better means of communication were needed and then somebody discovered electromagnetic waves. They were found by Heinrich HERTZ emphasising the beauty of Physics. He based his work on the theoretical considerations of Sir James Clark MAXWELL. The basic circuits used in computers were not found by people whose aim was to build computers. They were discovered in the 1930s by physicists counting nuclear particles, a topic of great interest to them. In 2012 Jennifer DOUDNA was one of the first to recognise the significance of CRISPR, leading to a totally new approach to genetic engineering. She began to work in this area because she thought the chemistry might be "cool".

So I feel scientists need to do a better job of explaining how Science works and how challenging and difficult it is. We need to be honest that not every project or research programme will deliver a "breakthrough" in knowledge. But this does not matter. The channels through which basic research feeds into the economy are many and diverse. The whole story cannot be only occasional breakthroughs.

Fundamentally, basic research increases the stock of useful knowledge, both the kind which is written down (e.g. scientific publications) and the kind that people carry around in their heads (e.g. skills, knowhow and experience). But it also trains skilled graduates 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. The private

sector is very much aware of the needs for highly qualified personnel as they, too, know that what makes the difference finally is the quality of the people they employ.

These channels are the way knowledge spreads around the world and becomes widely used. From the point of view of any one region or country, even for the most scientifically advanced regions in the world today, the majority of new and existing knowledge is developed outside that region or country. A national science base is not therefore primarily about producing "national science". It is about gaining access to all the knowledge that has ever been created or will ever be created anywhere in the world with of course the hope to contribute directly and to take advantage of it!
This is why it is short-sighted not to allow researchers some space to explore the latest frontiers of knowledge, rather than only what might be useful today. They will not automatically produce something revolutionary if you do this, although they might. But they will be able to identify and assimilate potentially exploitable knowledge produced elsewhere if working in that area.

This brings me to my **final element**: **the need for diversity, risk taking and interdisciplinarity in Science**.

I am convinced that a healthy science system needs diversity, and the European Union, by its very nature, does provide such a diversity while having developed compatibility checking mechanisms and circulation tools such as the Marie-Sklodowska-Curie actions. They are of vital importance for young researchers, and especially efficient in their early circulation.

This was another clear finding of the report I mentioned earlier. *"Competitiveness in research tends to be a package: some nations perform well at both a specific and a more general level, while others perform less well across the board. With very few exceptions, all leading scientific nations, both smaller ones such as Switzerland, Denmark and the Netherlands, and larger ones such as the U.S. and UK are thus world-leading not only overall, but also in many individual scientific disciplines. This indicates that excellence in individual disciplines or fields of research is hard to attain without a system that supports excellence at a more general level."*

In other words, in the real world, we do not find examples of strongly performing countries that are specialised in some sub-set of scientific areas. And it is almost universally accepted that some of the best research, and some of the research with the biggest impact lies outside firm disciplinary boundaries. As a consequence, there is need for a variety of effective programmes to support research. Their evaluation must involve people with an inside knowledge of the practices of the discipline and of the environment in which researchers operate.

But ensuring scientific freedom and diversity is not just an issue for policy makers and funding bodies. In each country the scientific community must also look at itself. We, scientists, cannot ask for scientific freedom from the funders and then tie our own hands behind our backs. And, if we are honest, we must recognize that the academic community tends to be conservative.

The quality of the selection mechanisms in the system is therefore one of the most decisive factors. The whole evaluation process is founded on the capabilities and calibre of the evaluators/reviewers. They need a wide understanding of scientific developments. They have to be broad-minded and not to adhere to rigid schools of thought. The criteria and guidelines that funders such as us give to research leaders also matter for the evaluation process, but also for other processes like hiring and promotion decisions. Because we can be conservative not just in terms of Science but in what we regard as the right way to do Science and the right type of scientific career.

So, **in conclusion**, I am very pleased to see that Poland has embarked on the important journey of reflecting on the organisation of its higher education and research system. For me it is very important that they be considered in their close interaction. I am aware that you have travelled a long way already. But such an endeavour is necessarily a long-term effort which will require long-term commitments. If you were expecting from me some secret sauce or shortcut, I have to disappoint you as **I just know none**. It can take years to create even one school attracting top researchers in the world.

I would like to give one example in my own country and my own discipline of a very worrying situation that was turned around and led to great success.

In the 70s, in France, the creation of Computer Science departments in universities was made almost exclusively by taking away positions from Mathematics departments. This led to an almost full stoppage of the recruitment in Mathematics departments. In the early 1980s I was personally confronted with this situation as I was chairing the national committee for Mathematics in the CNRS, and the number of positions which could be attributed every year was very small.

In 1987 mathematicians organized a national conference entitled *"Mathématiques à Venir"* aiming mainly at politicians and journalists to convince them that the French capacity to develop Mathematics at the highest level was in great danger. It was the first effort of this type ever made in the country. The event was met with considerable success while the main newspapers were devoting special pages to speak about the challenges of Mathematics. Its conclusions became the basis for the decision, taken shortly after the reelection of François MITTERRAND as President of the Republic, to give back to Mathematics the positions taken away, as consequence of the creation of a directorship dedicated to Mathematics in the Ministry, the first of its kind. This led to a steady flow of hirings of mathematicians in the next ten years with the possibility of offering them some career perspectives: this produced a wealth of very successful mathematicians, in particular specialists of probability theory and non-linear partial differential equations, two domains which has not been developed so widely before, among whom Fields medallists Wendelin WERNER and Cédric VILLANI.

This proves that changing the trend can be done: there are institutions which prove themselves as magnets, most of the time by combining great scientific leadership by some outstanding individuals and quality facilities with the appropriate flexibility to accommodate the needs of top research.

You certainly have several difficult decisions still ahead of you. I wish you all the best in your efforts. And I have no doubt that, if, after having embarked in the right directions, you maintain your efforts and commitment, you will get to where you want to be.

I thank you for your attention.