

What does "basic research" mean in today's research environment?

by

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Introduction

Mr. chairman, ladies and gentlemen,

I am very honoured to be asked to give the keynote address to your workshop. Probably you have invited me because you know that Germany has a recognized tradition in basic research but in fact a problem in using scientific excellence for technological innovations, development and production. The German universities with their long Humboldtian tradition of scientific autonomy and the unity of research and teaching and the Max-Planck-Society with its 79 research institutes are major columns of the German science system and representatives of successful basic research. They contribute to the high potential in our science system but - and that is the other side of the coin - we have some deficiencies in realizing this potential, especially to strengthen the application of scientific knowledge in various fields of society. In my point of view this problem can be generalized for all - so called "modern knowledge societies" - despite of different national science systems.

There might be a second reason to ask the chair of the German "Wissenschaftsrat" to make a statement on this subject. For the German "Wissenschaftsrat" is a rather "exotic" science policy advisory body compared with advisory agencies in other countries. It has in its ranks not only scientists but also representatives of public life and of the Federal government and the states ("Länder") working together as "fully-fledged" partners. Thus one function of the Wissenschaftsrat is to serve as a mediating body between scientists and policy makers. I suppose that many of the problems with basic research today just affect the relationship between scientists and politicians so that a "hybrid-organization" like the Wissenschaftsrat becomes an important forum not only to discuss these questions but to build up confidential relationships between science and state actors.

"Some research is simply done because scientists like it" - I am sure that no one of you will disagree with such a simple truth. On the other hand a statement like this might sound highly provocative if it is taken as a normative rule offering scientists a general dispensation to ignore society's needs. Today's science has to go public and it is almost inevitable that "Public Understanding of Science and Humanities" (PUSH) first of all means to demonstrate the practical usefulness of science to cure diseases, to protect the natural environment or to improve the understanding between different cultures in the world. No one of us will doubt the necessity of research which is mainly "curiosity-driven" and "performed without thought of practical ends" - to cite the classic definition of basic research by Vannevar Bush, whose book *Science, The Endless Frontier* marks the take-off for massive financial support for basic research in the US after World War II. Modern societies need all types of scientific research (according to the quadrant of Donald Stokes (1997): pure basic research (Niels Bohr) as well as use-inspired basic research (Pasteur) as well as pure applied research (Edison) and finally research which is at the beginning neither use-oriented nor done with the aim of generalization. You might think of the scientific work of taxonomists who try to systematize nature and who have been often predecessors for pure basic research (e.g. Darwin's *Origin of Species* or Linné's *Systema Naturae*).

Figure 1

Quadrant Model of Scientific Research

		Considerations of use	
		No	Yes
Quest for fundamental understanding	Yes	Pure basic research) (Bohr	Use – inspired basic research (Pasteur)
	No	exploration and systematization (Linné)	Pure applied research (Edison)

So what exactly is the problem with basic research? In Germany we are convinced that we have to find solutions to the following tasks in the future:¹

- The interaction of the academic sphere and society and the capacity of academic and scientific practice to engage in interdisciplinary research activities directed towards the solution of complex problems must be improved. In those industries that are at the cutting edge of economic development, the academic community can, and indeed must, be actively moving the innovation process forward. The institutions of Higher education and research must become the engines of structural change.
- Academic and scientific knowledge must be imparted to a growing number of people. Here too, the task will be to strengthen the practice-oriented interdisciplinary focus.

Strengthening the application focus and connection to actual practice is one of our major aims and one of the really essential messages the German Science Council addressed to government and science organizations last year when he presented his "*Theses for the Future Development of the System of Higher Education and Research in Germany*" (Cologne 2000). [You can order an english version of the theses via e-mail: [post@ wissenschaftsrat.de](mailto:post@wissenschaftsrat.de)] To my experience all developed countries are interested in closer links between science policy and innovation policy, we all have to deal with these challenges in the future. Of course: Application

¹ ct. Thesen zur künftigen Entwicklung des Wissenschaftssystems in Deutschland, Köln 2000, p.11.

orientation does not mean to cut the support for basic research. But we have to consider that purely curiosity driven research has been under pressure for many years and that there are strong reasons for this. It will be necessary to mention some of these reasons before drawing consequences for the future role of basic research and delineating some recommendations for science policy.

Why is basic research a matter of political discussion?

Why do we discuss the importance and the role of basic research in today's research environment? I think there are at least three answers:

Firstly we have to face the growth of the science system in all developed countries in the last four decades combined with increasing costs for basic research and an increasing scarcity of public money. Often basic research is extremely expensive research without any guarantee that it will pay off in the future. Think, for example, of such research fields like high energy physics, astrophysics or plasmaphysics which raise fundamental questions on the structure and properties of nature. At present the German Science Council is preparing recommendations on the promotion of nine new large scale facilities for fundamental scientific research. In detail these are large research facilities for basic research planned at medium-term with an investment volume from 15 million (for a new High Magnetic Field Laboratory at the Research Center Rossendorf in Dresden) to 4 billion US \$ (for a Linear-Positron-Electron-Collider at the DESY in Hamburg). Of course it will not be possible to support all nine projects so that the German government has to take a decision on the basis of an evaluation by the Science Council. This example shows that promoting basic research today has very much to do with priority setting according to criteria which cannot be based on scientific curiosity only.

Secondly there have been strong expectations in the past that excellent basic research will lead in a linear way to technological innovations and economic growth. From the present point of view this perspective seems to be rather naive. Nobody of those who are responsible for science and technology policy in the industrialized countries will adhere any longer to a position that basic research leads automatically

to desirable economic developments. On the other hand empirical studies show that there are, in addition to productivity growth, a lot of economic effects of basic research: Supply effects might comprise the construction and permanent running of research infrastructure but also human capital and labour market effects or effects on regional development. Demand effects are expectable concerning employment, income or fiscal developments. Last but not least there are direct scientific effects, like new knowledge, education and training, scientist's networks or new research methods and instruments which might lead directly to demand from outside the science system. Anyway: Economic success as a result of basic research is hardly predictable and often non-intended. There is no linear innovation process from basic research to new products and economic growth. The legitimation to support basic research must have a broader base than economic growth expectations, it must be motivated additionally by cultural aims of understanding nature, men and cosmos. Furthermore I am very much convinced that the state must provide a high amount of that money which is necessary to do excellent basic research. The "public-goods-argument" that the production of new basic knowledge is characterized by non-rivalry and non-excludability concerning the use of the knowledge and will therefore lead to market failure because no private actor is interested to produce this good remains a good reason for the state's role in promoting basic science (according to Nelson 1959). The same problem might arise at another level immediately: If a state invests a certain amount of its GNP in basic research, can it be sure that the use of the knowledge is limited to the national borders? To conclude: There are many good reasons not to invest in basic research from a strictly economic point of view - but fortunately this is not the only perspective on the question.

Finally there is a third reason why basic research has a precarious status in today's research environment; you may coin this the „confidence problem“ between science and society. This problem arises directly from the growth of the science system, the fiscal crisis of the state and the uncertain and non-linear effects of basic research on the wealth of nations. The old (post-war) "contrat social" between science and society, giving science continuous financial support for free research in order to get useful knowledge for practical aims has undergone a significant process of erosion in the last two decades in all industrialized countries. Now we are in a time of transition - hopefully to a new contrat social between science and society. One indicator of

change is that politicians, administrators and representatives of interest groups increasingly emphasize the necessity of "programmatic", "mission-oriented" or "strategic" basic research distinguished from pure basic research. I am not sure if a clear cut differentiation between these types of research is really possible and useful - but there must be in some way a "rhetorical need" for these terms. And if these terms serve to bridge the communication gaps between scientists and society they might fulfill an important function. Other more important indicators of change concern the institutional autonomy of the science system: If you think of new governance models of universities, incorporating societal actors, like firms, into leadership structures of universities, if you think of the ideal model of the "entrepreneurial university" with the strong orientation to market conditions and private funds or if you think of the "audit explosion" (Michael Power) in many countries with state led external evaluations of research as a precondition for financial support, you will find the reason for the "irritation" of many basic scientists today. In their view the new governance approach to science and technology endangers the autonomy of the single researcher as well as the norms and values of the scientific community, i.e. mainly to deal with scientific subjects which are generated and defined by the scientific community itself and to produce scientific knowledge which is communicated to and evaluated by members of the scientific community alone. In this perspective institutional arrangements are necessary which keep a "natural" distance between knowledge production and knowledge utilisation. I am familiar with both views, the scientific view and the view of political and state actors and one of my tasks as chair of the German Science Council is just to moderate bargaining processes between scientists and policy makers. As a scientist (in the field of basic research in neurology) I know about coping with an increasing scarcity of resources and state interventions into the universities. But as an actor of science policy I know as well that there is the legitimate expectation that science contributes to the development of society and that science can only expect ongoing and increasing financial support when it is able and willing to introduce the necessary internal reforms. In this context of necessary reforms basic research will have a well defined place. In this process of institutional reforms we might also reach a new and relatively stable „contrat social“ between science and society concerning basic research.

What are the consequences for science policy?

The definition of a new science policy towards basic research is based on "intelligent" institutional arrangements around the promotion of all different types of scientific research. What we need is goal-oriented basic research as well as pure basic research and applied research - on the highest scientific level and using the whole potential of the national and international science system. Furthermore we need instruments of research funding which respect the norms and values of the scientific community and at the same time satisfy the legitimate demands for accountability. I would like to mention four ways to meet these challenges.

At first we have to overcome the institutional walls between different research organizations. In the past types of scientific research were often ascribed to single research organizations so that "domains" of scientific research could develop (in Germany the domain of the MPG was described as "purpose-free basic research", the domain of the FHG as "industry related applied research"). However assigning different research types to single institutional sectors is a false and fruitless political guideline. What we need is more opening and cooperation between the different sectors of the science system and with the science based industry which is engaged in basic research. That does not mean reducing basic research but trying to activate the synergistic potential between the different organizations by establishing research networks.

Secondly we have to combine the instrument of institutional funding of purpose free research with project funding according to important programmatic goals defined by society. To a certain amount every scientist and every science organization should have the opportunity to do curiosity driven free research, there should be no „holy domains“ of either basic or applied research with a board on the door „Entrance strictly prohibited“. To give an example: In the last year the German Science Council passed recommendations on the future development of the National Research Centers which concentrate on long term and complex programmatic research about the structure of nature, environment, traffic systems and space, energy, key technologies or information and communication. To do this successfully the Science Council recommended the principle of programme-based finance in which the

individual centers have to compete for project subsidies. But we also emphasized that the centers need non-ear-marked funds for developing their core competences as well as for new activities. These non-earmarked funds should also ensure scope for research activities that are not planned in advance but are initiated by individual scientists. We suggested that about 20% of a budget of a National Research Center should therefore be reserved for uncommitted research.

Thirdly we have to strengthen institutional competition in the field of basic research. The intellectual competition among individual academics and groups of academics to gain recognition or find the best solution to a given problem is the obvious precondition for scientific excellence. There are already a number of instruments for the promotion of institutional competition, within the academic institutions as well as among them. These instruments must be expanded und utilised more intensively.

Finally to meet the problem of highly expensive basic research especially concerning large-scale-facilities we should give incentives for transnational research organizations and infrastructure. Or to put it in terms of rational choice: If no one can be excluded from the consumption of the results of basic research it seems to be not very reasonable to exclude others from financing the research infrastructure. Cooperation of the industrialized countries in providing expensive research infrastructure enhances the internalisation of science and provides "opportunity structures" for creative disputes among scientists. On the European level we have already established joint research organizations, like CERN or EMBL. But the creation of multinational sponsorship should be pursued with greater determination and more frequently than has been previously the case. Trans-national long-term groups of established National Centers of Excellence could be a first step in this direction.²

Thank you.

² cf. Wissenschaftsrat: Thesen zur künftigen Entwicklung des Wissenschaftssystems in Deutschland, Köln 2000, p.27.