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IS BASIC RESEARCH NECESSARY FOR SMALLER COUNTRIES?

Abstract: The basic research has three attributes:

1. Source of knowledge as basis for innovation;
2. Best tool for training and science education of skilled human resources;
3. Source of national and international prestige for countries, institutions and individuals.

The conclusion is that basic research is a necessary and useful investment rather than a luxury, and therefore, it should be promoted and supported in all countries, regardless of size, economy level and natural resources, as a support for sustainable development and progress.

In a 2003 issue of *Le Monde*, Henry Audier (CNRS) warned that “*if Europe wants to preserve its role in tomorrow’s world, it must redirect its priorities towards education, culture and research.*” In the same issue, the Nobel laureate Francois Jacob noted that “*the power of nations had long been measured by the size of their armies; today it is rated by their scientific potential.*”

The basic (also described as fundamental or pure) research is defined as an investigation and analysis focused on a better or fuller understanding of a subject, phenomenon, or a basic law of nature instead of on a specific practical application of the results.¹ The basic research is driven by a scientist’s *curiosity* or interest in a scientific subject and its main motivation is to *expand man’s knowledge*, not to create or invent something and is “*performed without thought of practical ends*” (Vannevar Bush, “*Science, The Endless Frontier*”).

Basic research knowledge acquired from basic research lays at the foundation of the applied science, and then often important applications (including commercial success) may eventually result.

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¹ <http://www.businessdictionary.com/definition/basicresearch.html#ixzz193icDWUB>

The importance of basic research was officially recognized during the Second World War, for its contribution to the military efforts. It is enough to mention that the radar and the atomic bomb had their origins in basic research, not initially intended for such purposes. As a result the financial support for basic research in the USA after the Second World War became very substantial. This was also understood in some other advanced countries and especially the universities benefitted from this, not to mention some national research institutions.

WHY IS BASIC (OR CURIOSITY DRIVEN) RESEARCH USEFUL?

There are three main reasons that explain the usefulness of basic research.²

First, basic research is *a source of new knowledge* required by applied (problem-solving, target-driven or demand-driven) research, which in turn is the basis for innovation and new technologies and products. Without basic knowledge, cannot be any application.

Second, basic research is an *excellent (perhaps the best) training/education tool* for preparing highly qualified human resources. The basic research is the best way of learning how to find and use information, to operate research equipment, to analyze and solve problems, to write and present reports, etc.). This is an important social effect: scientific and technical expertise attracts investment!

Third, basic research, is *a source of prestige for countries, institutions & individuals*. The scientific production (number of publications and patents produced) and productivity (number of publications and patents versus size of population) as well as the number of citations of published papers are closely monitored and evaluated by various organizations, and this results in (much publicized) rankings of countries, institutions and individuals.

The Value of Fundamental Research is similarly documented by other authors. Thus, in a discussion paper prepared for the IUPAB Council by Cris dos Remedios (from Institute for Biomedical Research, University of Sydney, Australia, Nov 15 th 2008) also considers that there are three benefits of fundamental research: new knowledge, social benefits and economic gains. The *new knowledge* is the primary product of fundamental research. The *social benefits* of educating high quality scientists, technologists and engineers are an immediately return for the funding of fundamental research. Thus, fundamental research is a crucial part of a research training, which in turn has important implications for the social cohesion of a nation. The *economic returns* from fundamental research can be considerable, far in excess of the initial costs of the research.

The US Department of Defense recently concluded that basic research was the principal contributor to product development. Also, a report [Martin, 1996] commissioned by the UK Treasury concluded that new technology depends on ad-

² I. Haiduc: Cercetarea fundamentala si dezvoltarea economica [Fundamental research and economic development – in Roumanian], *Academica* (Bucharest), VIII, Nr. 6 (90) April 1998, p. 27.

vances in basic research, and that there is an interdependence between national strengths in industry and strengths in fundamental research.

BASIC RESEARCH AS SOURCE OF KNOWLEDGE. BASIC VS. APPLIED RESEARCH

Applied research is designed to solve *practical problems* of the modern world, rather than to acquire knowledge for knowledge's sake. The ultimate goal of the applied scientist is to *improve the human condition*. In our time, applied science has the task to solve such the problems as those resulting from global overpopulation, pollution, the overuse of the earth's natural resources, etc.

The distinction between basic and applied research isn't always clear. One way to look at it is to ask the following question: "*How long will it be before some practical application results from the research?*"

If a practical use is only a few years away, then the work can be defined as strictly applied research. If a practical use is still 20-50 years away, then the work is somewhat applied and somewhat basic in nature.

If a practical use cannot be envisioned in the foreseeable future, then the work can be described as purely basic research. (Dr. Ashok Gadgil)

Modern societies need all types of scientific research.³

WHO SHOULD PAY?

There is a major controversy about the costs of basic research as opposite to the applied research. There are several questions in discussion:

- Who should support the cost of the basic research?
- Should the governments concentrate the funding on research of potential economic value instead of spending taxpayer's money on basic research?
- Can all countries or only the rich afford to spend large amounts of money on research that may have no practical ends?
- Should universities and research institutions (e. g. academies) concentrate on basic research, or should they concentrate on more profitable research ?
- Should governments decide for research-funding organizations about the types of scientific research should they support?
- Does industry bear a responsibility to support basic research, since its technological and medical advances are often the result of someone else's basic work?

WHO SHOULD DO BASIC RESEARCH?

It is no news that not much basic research is carried out by the industry, except for some large multinational companies. In general, the industry concentrates

³ K. M. Einhäupl, What does "basic research" mean in today's research environment? Keynote address to the OECD workshop on "Basic research. Policy relevant definitions and measurement", 28-30 October, Oslo, Norway.

on research projects which require *less than 10 years* to produce new products or processes. This is due to the competitive nature of the business world, which cannot afford to spend time and money in long-term research projects. Consequently, *universities and national laboratories or institutes (and academy institutes where they exist) supported by governments laboratories* should assume the task of carrying out basic (fundamental or pure) research and applied research with long-term applicability.

BASIC RESEARCH AS A SOURCE OF PRESTIGE

It was mentioned above that basic research is a source of prestige for countries, institutions and individuals. This is the result of close monitoring. An example is the monitoring of the European Commission, which publishes periodical reports.⁴

The most prestigious and generally used is the monitoring by ISI Thompson Reuters, which produces comprehensive information (available on Internet) about the number of publications, citations data, etc. and generates appropriate rankings.⁵ The place in such a ranking is a matter of pride for those involved.

A recent data source is a new portal, SCImago Journal & Country Rank that includes the journals and country scientific indicators developed from the information contained in the *Scopus*[®] database (*Elsevier B. V.*).⁶

BASIC RESEARCH AND SCIENCE POLICY

The decisions about promoting and financing basic research are part of the science policy in many countries. In a recent study the question: *How much a country should invest in basic research?* has been discussed in some detail.⁷ It is widely recognized that basic research plays a significant role in the economic growth and most advanced countries make consistent investments in basic research. The majority of basic research is performed by a few industrialized countries. For example, the US and Japan together account for almost half of the global basic-research expenditures. It is demonstrated that basic research increases the innovation probability in a country producing local effects and increases the innovation chances of domestic firms. It is noted that there is a positive correlation between basic-research expenditures and the technology levels in a country. Technologically backward countries invest very little in basic research (OECD 2006). Some emergent countries, like China, India and Brazil are coming strongly in the field.

⁴ European Commission Report. Towards a European Research Area: Science, Technology and Innovation. Key Figures 2003-2004

⁵ Web of Knowledge thomsonreuters.com

⁶ <http://www.scimagojr.com>

⁷ H. Gersbach, M. T. Schneider and O. Schneller: On the Design of Basic-Research Policy, CER-ETH – Center of Economic Research at ETH Zurich, Working Paper 08/79, January 2008

The countries investing much in basic research need not be large countries. An example is the case of Norway. Thus, in this country pure research is important and is a vital factor in higher education and researcher recruitment. Pure research has laid the foundation for wealth creation in Norway in areas such as the oil and gas, aluminium and aquaculture industries. Norway's expenditure on pure research comprises approximately 18 per cent of total operating expenditure on R&D. One of the main priorities of Norway's research policy is to further strengthen long-term pure research efforts in all subject areas at universities, university colleges and research institutes. Enhancing and maintaining these institutions is one of the Government's main tasks.⁸

A splendid illustration of the role of basic research in a small country is offered by the case of Israel.⁹ This small country (population of 5.8 million, gross domestic product US\$ 105 billion) established an excellent scientific base that makes it an important exporter of high technologies, most notably software and biotechnology. Israel has succeeded in doing so because of the way it has been concentrating resources in science and technology on basic research as well as its application in order to strengthen its economic base. Thus, at the Weizmann Institute in Rehovot, the philosophy is "*Research for its own sake*", but whenever the results have commercial potential it is energetically pursued, preferably by the country's own industry. For example, a direct consequence of basic research on synthetic models of proteins, the institute developed a drug-vaccine against the multiple sclerosis, Copaxone, approved in 20 countries (including USA, Canada, Switzerland, UK), the sales of which amounted to around US\$ 250 million in the year 2000.

A significant example is the case of South Korea vs. Thailand.¹⁰ In the years of 1960's the GDP of South Korea was smaller than that of Thailand, to become in 1995 more than three times higher. This was due to different science policies: South Korea invested massively in basic research, absorption of modern technologies and developing own technologies and products (cars, electronics, etc.). On the other side, Thailand was open to foreign companies who came with their own technologies, mainly assembly, with little local added value; as a result no Thai originated technologies or products became available on the world markets!

It is stated that basic research can provide enormous economic returns, but these returns are social, not private. For example, the discovery of quantum mechanics (a result of the purest basic research), among other things, was finally responsible for the development of the modern electronics industry. Europe had large benefits from its support of basic research and universities over the past century. Two of the industries most dependent on research, chemical and pharmaceutical,

⁸ Source: Norwegian Ministry of Education and Research |

⁹ M. Sela: On research in a small country. Basic research and its practical applications, EMBO Reports 2, 2001, 8, p. 642.

¹⁰ Y. Kunio, South Korea vs. Thailand. A significant example, J. Sci. Soc. Thailand, 1995, 21, p. 131.

continue to flourish in Europe. Its success is due to a significant degree to outstanding universities and strong commitment to high-quality basic research.¹¹

Basic or fundamental research has led to many important applications that, almost without exception, were not anticipated at the time when the work was undertaken (e. g. the laser, magnetic resonance imaging, etc.). It is important to emphasise two aspects of fundamental research that many politicians find hard to believe: a) most applications cannot be foreseen, and b) the period between a fundamental discovery and eventual applications is often very long compared to the criteria normally used by investors.¹²

It is interesting to mention that the decision by the U. S. government to spend large sums of money towards solving the problem of cancer was of questionable cost-effectiveness because of a lack of fundamental understanding of the nature of the disease process, and a consequent lack of research strategies. Not enough basic research was done before and the problem seems now to be understood, since strong support for basic research in the field can be observed in recent years.

WHERE SHOULD BASIC RESEARCH TO BE DONE?

National traditions vary. In many countries much of the basic research is done in universities, many of which are heavily funded by governments (i. e. taxpayers). The universities are excellent places to provide an independent environment for fundamental research because they are essentially free of bias towards a desired outcome. In some countries, particularly in Central and Eastern Europe, including Russia and Balkans, the National Academies play a major role, equally important, in the development of basic research, while in others such as Germany the Max Planck Institutes, and in France the CNRS laboratories are strong contributors to fundamental research. In all cases, the best way to attract brilliant young minds to enter the field of science is fundamental research.

In recent decades, large corporations, e. g. some pharmaceutical companies, increasingly understand that basic research is a source of new ideas, and support such investigations on their premises or finance basic research in universities or research institutes.

CONCLUSIONS

Basic research is an investment rather than a cost or luxury ! It should be promoted and supported in all countries, regardless of their size, economy level or natural resources

The job of scientists is to convince governments, that there is both a financial return and an even greater social benefit. This should be kept in mind particularly

¹¹ E. Wong, An economic case for basic research, *Nature*, 1996, 381

¹² Cris dos Remedios, The value of fundamental research. A discussion paper prepared for the IUPAB Council by Institute for Biomedical Research, University of Sydney, Australia, Nov. 15 th 2008.

in smaller countries for which a balance between basic and applied research can be vital for their sustainable development.

Basic research is an international issue. According to ALLEA (All European Academies) in Europe the international character of research cannot and should not be restricted to the European Union countries. Scientific collaboration already occurs between EU member and non-EU-member European countries, and this should be further extended. The disadvantaged position of scientists from a number of countries with a less favorable economic status is, however, cause for concern. The general view was that specific measures should be taken to ensure that these countries are able to gain on Western European countries. It was also argued that such measures should be temporary ones, since there is no reason to assume that these countries will not draw level with the rest of Europe in due time.

