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NEW INNOVATION TRENDS OF THE WESTERN WORLD

New forms of scientific cooperation have been described. The global trends in the general principles of scientific research have been defined. The main problems related to funding of fundamental science have been outlined. The necessity of implementing the effective forms of public private partnership (PPP) in innovation has been substantiated. New level of innovation culture should be based on the principle of cooperation of all the entities engaged in creation and commercialization of innovations.

Key words: fundamental research, innovations, research funding, international cooperation, international standards, and innovation culture.

Today, the intellectual property plays a key role in national policy of advanced economies. For long now, it has been the most valuable capital of the society and an important factor in the socio-economic development. In Ukraine, the intellectual property belongs to that sphere of social life which needs more attention from both the state and the society as a whole. The key to economic development is the effective use of resources and expertise, the introduction of cutting-edge technologies, and the creation of high-quality new products and innovations. With no doubt whatsoever, the scientific research is important for any country insofar as it is the framework for the development of creative and innovative potential.

Doing R&D activities within the country, it is necessary to take into consideration the integration processes in the field of science and innovation in the advanced western countries. In this regard, the information on new global trends in scientific research is extremely important.

JOINT INTEGRATED RESEARCH AS A NEW FORM OF SCIENTIFIC COOPERATION

Recently, the number of research projects involving scientists from different countries has been growing rapidly: a quarter of the published articles on research and engineering is written by researchers from more than one country [1, 427]. For instance, in the Central African rainforests, a team of researchers and students from the United States, Cameroon, Gabon, United Kingdom, Germany, France, and the Netherlands is developing a conservation plan for the region, including the mechanisms of regional economic development, which provides solutions of the problems associated with climate change. This team funded by the National Science Foundation (NSF) includes biologists, sociologists, and specialists in agriculture [2, 46]. Hence, the cooperation between researchers from different countries in different disciplines becomes a regular practice in the field of science and technology. Therefore, it is necessary to create a new legal framework for joint integrated research involving experts from different countries.

A variety of research groups contributes to the innovation process. The researchers from different countries, despite different approach to problem, yet can overcome a hidden bias against each other.

However, there is a certain tension in this cooperation. The countries finance their own research primarily to ensure the national priorities, but the knowledge is known to go far beyond the state borders. The intellectual property spreads both within and beyond the state more quickly than the other objects. Indeed, the idea born in mind can face only the conventional boundaries, while the material things should cross the real borders. Therefore, the scientific policy should answer the important questions of our time: «How can the country ensure security and survival of its own generator of innovation in the era of the Internet?»; «How should the nations which are destined to cooperate with each other agree on the general principles of cooperation and the standards for product quality as well as ensure access to this product?». «Is there any effective guarantee that the states will abide by these rules?» The global science will not develop without enforcement of the joint research transparency principles.

The scientists who work in international teams (especially, the newcomers to the global research community) should clearly understand the ethical standards in research practice and other regulations in the field of scientific research. First of all, it is necessary to establish the criteria for examination of research proposals and to provide the scientists with opportunities to share the results of research in compliance with requirements related to confidentiality and protection of intellectual property.

The scientific community needs clear principles and sustainable financial model for ensuring an open access for the stakeholders to publications and data, universities, libraries, professional associations, and publications.

Global foundations dealing with research funding and the governments of some countries have already started to tackle these issues. In 2012, the Global Research Council was founded. It involves the heads of national research foundations from nearly 50 world countries [3]. Dr. *Subra Suresh,* former director of the National Foundation of Science (NFS), and Prof. *Matthias Kleiner*, former President of the German Research Foundation (Deutsche Forschungsgemeinschaft, DFG) played key role in the GRC creation. At the founders' forum, the participants discussed the issue related to peer review, data sharing, research integrity, open access, career development, and ethical issues related to human experimentation. They adopted the following general principles for scientific expertise of projects submitted to the research foundations in order to receive funding:

- *Expert assessment;*
- *Transparency;*
- *Impartiality;*
- *Appropriateness;*
- *Confidentiality*; and
- *Integrity and ethical consideration.*

The unbiased and transparent expert assessment guarantees that public funds are spent properly on the most valuable projects that ensure the progress of science and meet the public needs.

In 2013, the 2nd General Meeting of Global Research Council was held to discuss the issues related to open access to publication and integrity of research. The participants were 70 managing directors of national research foundations.

The open exchange of scientific publications is a means of improving the quality of communication in the field of research. It has been defined as the basic paradigm of scientific communication in the upcoming years. The participants approved an action plan for ensuring open access to publications, which includes activities through which the GRC member organizations can promote a highly flexible open exchange of research results. In this regard, three basic principles have been established: *stimulation*, *raise of awareness*, and *support of researchers* who want to make their results available to the public. The implementation of action plan requires the participation of not

only the scientists, but also the academic institutions, universities, libraries, and publishers.

The Global Research Council proclaimed the principles of good faith in research activities, which implies that the researchers, the scientific institutions, and the universities are ultimately responsible for the research integrity. The research foundations are required to provide an environment for compliance of research supported by them with the highest standards.

It should be noted that the value and the benefits of research entirely depend on its integrity. Despite differences in the organization and conduct of research, due to the national context, the researches, no matter, wherever they are conducted, should comply with certain fundamental principles. The fundamental principles are stated in declaration on research integrity developed during the 2nd World Conference on research integrity in Singapore, in 2010, as guidelines for the proper conduct of research [4]. In particular, this integrity concerns all aspects of research, the openness and transparency of process and results for external control, compliance with professional ethics and respect for colleagues, as well as high quality of research for the benefit of all those whom it may concern.

In general, the Global Research Council is an important step on the path towards the establishment of global innovation culture and an attempt to create a coherent and harmonious structure within the framework of which various scientists can work together. Collaboration and interaction can enhance the quality of science, prevent unnecessary duplication, and ensure effectiveness in addressing the common issues.

The scientific community Ukraine certainly should join this form of international cooperation for potential implementation of relevant developments in the national legislation of Ukraine.

FINANCING OF FUNDAMENTAL RESEARCH

The present-day world is characterized by a wide range of products and services, opportunities in the sphere of health care and medical treatment, gadgets and indulgences, which appear with unpredictable pace. At first, we are surprised by this amazing discovery, and after become dependent on them. Suffice it to recall GPS, smartphones, brain scan and laser eye surgery techniques.

The things that give us comfort and convenience and improve our safety and health care are the results of fundamental researches carried out decades ago in the fields of materials science, software engineering, biology, chemistry, information technology, and so on. Tanks to such tools such as scientific publications and patent applications, today, the fruits of science are implemented and get practical application more actively than ever before. Given the appearance of new actors on the international research arena (China, India, and other countries), there is every reason to expect a more rapid development of science in the future.

However, the science does not generate radical innovations automatically. This process requires time, money, and patience – the things that recently are often tight. Indeed, the traditional methods of transferring discoveries from the laboratory to the real sectors of economy are the result of consistent efforts of past generations. Unless new mechanisms for introducing the scientific discoveries into the real economy are found in the near future, the economic development will have dark prospects.

Previously, the fundamental research and the implementation of relevant results were funded by large corporate laboratories; today, these institutions are not eager to do this. The venture capital also prefers to support risk-free proposals that rarely are the results of fundamental research conducted by academic institutions.

This trend could have a negative impact on implementation of innovations in all spheres of life. On the one hand, research activities require significant investments to roll out the innovative products, and on the other hand, the share of successful innovative projects is insignificant.

Today, the scientific community has faced a

crisis which should be an impetus to search for and build a new, more open system for supporting the innovation cycle at all stages, from the generation of ideas to the commercial distribution. Thus, new mechanisms should be more reliable and comply with the technologies of our time. The large corporate laboratories must be replaced by partnership between the government, the academic institutions, and the private capital. To do this, we need a new culture of innovation, the rules of which imply that all the players are working in concert to achieve a common goal, the creation and commercialization of innovation.

Today, the American science dominates in the world. From 1996 to 2011 the number of cited publications (including articles, reviews, and conference proceedings authored by American scientists) increased from about 310 thousand to almost 470 thousand annually. In absolute terms, this is the world best result, with the growth rate being second after China's one [5, 44].

During the same time period the share of publications with at least one foreign co-researcher also increased from 22 to almost 30 %. This is an evidence of the growth of joint international research and a result of improvement of scientific communication and exchange data. Although these figures are impressive, they also raise some concerns.

For example, let us consider *Siri*, a personal assistant for *iPhone* (application adapted to *iOS* operating system, in 2011). *Siri* is a result of five-years research conducted at the initiative of DARPA government agency. The total public funds spent on this project reach USD 150 million. Research was conducted within the framework of non-profit, independent Centre for Research and Innovation (SRI) International in collaboration with 22 institutions, including MIT, Carnegie Mellon University, and Stanford University. SRI International continued to develop the technology at the expense of venture capital until a spin off was created. In 2010, when an American entrepreneur and inventor Steve Jobs bought it for *Apple*, *Siri* technology absorbed USD 175 million and seven years of development.

Siri is much more than innovation for smartphones. In the future this technology can do more sophisticated and important tasks than processing and responding of requests for search of nearest shopping center. Example of *Siri* shows that a seemingly simple way from the generation to the market introduction of innovation can be long and tortuous.

Material innovations in «clean» energy and pharmaceuticals often require long-term efforts and billion dollar investments. Many technologies that potentially can change the world are full of promise, but have a lack of financial support. Corporate business invests primarily in short-term studies, the results of which can be implemented in the near future. So, the question is «Who should fund the long-term research?»

Legacy of large corporate laboratories. There are many examples of technologies that have a significantly impact on the society, but they would not have been realized unless large corporate laboratories had supported them. The hydraulic fracturing technology dates from the beginning of the 20th century. However, it was commercialized only in 1940, when it was mastered by American *Standard Oil of Indiana* [6, 26—32]. A long-term study was carried out before the successful application of technology to extracting natural gas from previously inaccessible deposits. The 3D printing technique evolved from *Siemens* jet studies in 1950 through the Stanford medical school, *IBM*, and *MID* to the products manufactured by *HP* and other printer manufacturers.

The path from laboratory studies to practical application and successful market entry is long and unpredictable and requires many relationships. Today, the corporations who are focused on the final product do not want to spend money and time on these relationships. However, we hope that joint efforts will be converted into an effective mechanism to attract private investments in innovation. Indeed, there have been reported several cases when the world leading

economies, including the USA and European countries, refused from large corporate research.

Short-term targets. Recently, among a variety of researches the short-term activities are dominating. According to the data of the U.S. National Academy of Sciences the share of federal long-term basic research aimed at fundamental breakthroughs dropped in favor of the short-term research whose main purpose is to improve the existing products and services [5, 46].

During the last 35 years, the U.S. federal government was the main sponsor of basic research, whereas the corporate research laboratories could not afford the high costs and risks related to the fundamental studies. In the United States, the big business prefers to invest into the short-term research with a shorter payback period, and so do the corporations in Europe.

China and India initiated new dynamics of research. China can invest billion dollar state-controlled capital to the studies of innovative products stemming from basic research conducted in the USA, Europe, and Japan. As a result, the country creates new jobs and facilitates economic prosperity. India's strategy raises concerns, as nationalization of important patents for the sake of pharmaceutical industry is expected. However, it has not been clear yet whether this approach extends beyond the field of health care.

The research policy of China and India has also some positive effects. These countries support a significant share of researchers and scientists in other countries hoping that they will create more technological breakthroughs, with consumers benefiting therefrom worldwide. Even if China acquires the results of U.S. research and converts them into innovative products, it will be better than this intellectual property will be kept on the shelves of the research archives for a long time.

CONCLUSIONS

In Ukraine, the situation with funding of R&D activities from the state budget, which remains consistently poor in recent years, raises concerns of the scientific community. Despite the fact that the Law of Ukraine on R&D activities guarantees funding of science at the level of, at least, 1.7 % of GDP, since Ukraine got independence the national science received annually 0.5% of GDP, which was an indicator of underdeveloped country. However, in quantitative terms the public expenditure on science slowly increases. In 2010, the NAS of Ukraine received UAH 2.062 billion [7], while in 2014, UAH 2.761 billion is planned to be assigned [8]. At the same time, the expenditure on law enforcement agencies tends to show a rapid growth: in 2010, the spending on the Internal Affairs of Ukraine amounted to UAH 9.678 billion; that of on the office of Prosecutor General of Ukraine totaled UAH 1.216 billion [7], in 2014, they reached UAH 16.554 billion and UAH 3.2 billion, respectively [8]. The statesmen and the scholars should recognize that certain elements of innovation process (including basic research), which require significant public investments remain unfunded.

The direct budget funding of research is only the first step. Obviously, the budget funding is not enough for supporting the innovative development. Therefore, it is necessary to engage domestic and foreign investors in this sector. It is advisable to fill the gap between the science and the real economy with the help of public-private partnership. It is necessary to encourage partnership between the government institutions, the academic institutions, and the private sector. After all, both the industry and the academic institutions can strengthen their strategic position in terms of technology advancement of common interest. First of all, it is necessary to commercialize national results of intellectual and creative activities and, if there are no similar technologies in Ukraine, to buy a license and to use overseas technologies.

The public-private partnership is not a new mechanism, but it has been still used very seldom, to finance small projects without adequate funding. The cooperation between the scientists and the business in the sphere of incorporating spinoffs that can attract investment at the early

stages of innovation is supported insufficiently on behalf of the government. Ukraine is 54th (between Kazakhstan and Venezuela) in the World Economic Forum ranking of the ease of access to venture capital. The leaders are China (Hong Kong), Israel, Singapore, Sweden, Norway, Bahrain, UAE, USA, Malaysia, and Finland [9].

Unfortunately, the technology transfer centers (departments) at research institutions and universities do not work affectively. There is an urgent need in establishing tax incentives for innovators. In this context, it is advisable to use the experience of advanced countries (USA, Japan, and EU) which introduced various tax benefits for researchers.

The main objective of new innovation policy is to radically change the culture of innovation in the country when investments to long-term research are recognized to be important and reasonable incentives for the involved parties are implemented.

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НОВЫЕ ТЕНДЕНЦИИ ЗАПАДНОГО МИРА В ОБЛАСТИ ИННОВАЦИЙ

Охарактеризованы новые формы кооперации в научной сфере. Определены мировые тенденции касательно общих принципов проведения научных исследований. Очерчиваются основные проблемы финансирования фундаментальной науки. Отмечается необходимость внедрения эффективных форм государственно-частного партнерства в сфере инноваций. Новый уровень инновационной политики должен базироваться на принципе слаженного сотрудничества всех субъектов для создания и внедрения инноваций.

Ключевые слова: фундаментальные исследования, инновации, финансирование исследований, международное сотрудничество, международные стандарты, инновационная культура.

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НОВІ ТЕНДЕНЦІЇ ЗАХІДНОГО СВІТУ У СФЕРІ ІННОВАЦІЙ

Охарактеризовано нові форми кооперації у сфері науки. Визначено світові тенденції щодо загальних принципів проведення наукових досліджень. Окреслюються основні проблеми фінансування фундаментальної науки. Наголошується на необхідності запровадження ефективних форм державно-приватного партнерства у сфері інновацій. Новий рівень інноваційної політики повинен базуватися на принципі злагодженої співпраці усіх суб'єктів для створення та впровадження інновацій.

Ключові слова: фундаментальні дослідження, інновації, фінансування досліджень, міжнародне співробітництво,міжнародні стандарти, інноваційна культура.

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