

TRANSFORMATION OF UKRAINE'S SCHOLARLY RESEARCH SYSTEM IN THE 1990s: TRANSITION TO THE MARKET

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A new type of society based on knowledge and information is reality of the present-day global civilization. Sustainable economic growth of any country is secured by proper development of science, technology, and innovation. Intellectual potential is the main factor of the harmonious evolution of human being and raising of living standards.

In 2001, Ukraine celebrates the 15th anniversary of its independence. In the last ten years, Ukraine has made a huge step towards the development of political, social, cultural, and economic relations. Today, Ukraine has a considerable industrial and intellectual potential, world-class achievements in some industries, fundamental and applied science, and in its cultural sphere based on centuries-old traditions of one of the world most ancient nations.

Like other CIS countries, in the last decade, Ukraine has undergone complex institutional, structural, and cognitive changes in the publicly administrated scholarly research sector formed and specifically organized in the Soviet times. The formation of a new scientific system organized and financed in a sovereign state under the tran-

sition to market economy and democratic principles is a quite slow process. The reason is, on the one hand, the deep economic crisis that for a relatively short time of existence of sovereign Ukraine has led to economic losses comparable to those incurred by Ukraine during the World War II. Certainly, it had an adverse economic impact on the Ukrainian science that in the Soviet times was funded from the state budget, including by military orders. On the other hand, the negative processes accompanying the transformation of the national research system caused its poor preparedness for radical changes in the society and the introduction of new functional mechanisms (in politics, the transition from totalitarianism to democracy, in the economy, from the public management to the market, in the science, from the public administration to the autonomy, self-organization, and commercialization).

As a result of prolonged systemic crisis of the socio-economic relations, the Ukrainian science was among those social sectors that suffered the most material losses. Thus, the number of researchers over the past decade halved, as funding fell almost ten times. Accordingly, the basic indicators of Ukrainian science, including the number of publi-

cations, patents, subject research and projects implemented, and innovations commercialized, have been slumping. The scholarly elite partly emigrated (about 6 thousand researchers) to countries with more attractive conditions for scientific and technological activities, primarily to Russia, USA, Germany, and Israel. A rapid aging of scientific personnel was reported, chiefly, due to the fact that many young people left the research without any sufficient inflow of young researchers.

However, in some research areas, Ukraine managed not only to maintain but also to enhance its scientific and technological capacity. This is confirmed by internationally recognized research schools in mathematics and decimeter astronomy, physiology and cell biology, low temperature physics, new materials, biotechnology, electrics and the development of unique technologies, particularly, in the field of informatics and telecommunications. The implementation of R&D capacity can secure a proper development of high-tech manufacture of competitive products.

At the state level, a series of important measures aimed at improving the government science and technology policy has been taken, in particular, a new conception of R&D and innovative development of Ukraine, which provides a more active role of the state in the field of science and technology and new possibilities of using innovative knowledge and technologies in the economy and other areas has been adopted; amendments to the Law of Ukraine *On Scientific and R&D Activity*, which addressed, in particular, some social problems of scientists have been approved. The Law of Ukraine *On Priority Directions of Science and Technology in Ukraine* adopted recently facilitates launching new mechanisms of R&D development forecast and identifying the priority areas of science and technology and their competitive public funding. In addition, several laws on intellectual property were adopted and Ukraine joined the relevant international agreements in this field, in particular, in June, the Agreement on scientific and technical cooperation between Ukraine and the USA was ratified.

Ukraine strengthens and develops its contacts in the R&D field with many countries and promotes the expansion of social scientific and technological space. This policy of Ukraine has a positive response from many interested countries, international organizations, and foundations. For instance, in 2001, an international symposium «The role of International Organizations in the Development of the European space» was held in Kyiv, by UNESCO decision.

International research and production (R&P) activities of Ukraine are aimed at integrating the Ukrainian science into the European and international scientific and technological space, attracting investments in R&P sector, preserving R&D capacity and scientific schools of Ukraine, establishing links between Ukrainian researchers and their colleagues from other countries, transferring the Ukrainian R&D products to the international market, and at participating in international division of labor in the science and technology sector.

All this indicates that the scholarly research system of Ukraine is on the threshold of a new stage of its transformation: the purpose-driven and regulated qualitative changes in the science and innovation systems. The successful transformation of the national scientific system is possible provided the strategic directions of science and technology are implemented in the government scientific and technical policy. Decisive aspects are as follows:

Firstly. Transition from keeping to renewing the scholarly research capacity in the fundamental research, in particular, the globally recognized schools.

Secondly. Transition from passive observation to active competition for the world top-ranked places due to new discoveries and implementation of know-how and innovative ideas by supporting respective applied research and science-intensive innovations.

Thirdly. Transition from cost-intensive science to commercialization of knowledge. Recognition of intellectual property as precondition for real

economic growth enables switching from pure consumption to sale of intellectual work products and introducing intellectual property objects to the economy in order to create favorable conditions for sustainable development of Ukraine in the 21st century.

1. INPUT DATA ON THE FORMATION OF THE NATIONAL SCHOLARLY RESEARCH SYSTEM OF UKRAINE

To better understand the prerequisites for the formation of the national scientific system of Ukraine for 90 years, we note the main features of its Soviet heritage.

1. Political priorities to be stuck to. They demanded R&D to be focused on competing for world leadership in the military field through the development of heavy industry and military technologies.

2. Centralized guidance. It enabled to concentrate large material, financial and intellectual resources in certain areas for the implementation of major research projects. There was no control of the society over assignment of resources and identification of research fields.

3. The total use of coercive means. This made it possible to forcibly move the significant human resources for the sake of implementing large-scale projects. In addition, the young staff was allocated based on the needs of planned economy.

4. Regulated planning of scholarly research as economic sector. This required regulated planning of R&D activity in terms of such indicators as quantity, contributions, and funding. Naturally, the researcher salary did not depend on the deliverables.

5. Isolation of society. This led to total confidentiality of R&D works, creation of closed research organizations, impossibility of researcher's work abroad, and limited access of Ukrainian researchers to the global intellectual achievements.

6. The system of benefits. There was a branched administrative system of benefits and rewards for the elite scientists.

7. The high social status of science. Science was treated as a key means of technical and social progress to build communism.

8. Ideological orientation. This was the main reason for separation of the social sciences from the global development. Basically, they served the state ideology.

It should be noted that the social status of researchers in the Soviet Union was very high. The state was both a harsh dictator and a generous patron. Science played a double role, a favorite child and a slave.

Until almost the end of the 1980s, these features described the research system in Ukraine as part of the USSR, which functioned under dominance of administrative and policy rather than economic factors. To manage the science a complex hierarchical system was created: *the party level* (relevant departments of science of the Central Committee of the USSR and those of the Union republics); *the governmental level* (the State Committee for Science and Technology of the USSR – industrial ministries and committees – the republican ministries and committees – R&D institution – research teams (departments, sectors, laboratories). According to this hierarchy, the tangible, financial, and human resources were vertically allocated.

In the USSR, the scholarly research system was structured in a specific way as it consisted of three sectors that, in fact, were identical to the economic branches: the academic sector (Academy of Sciences), the high school sector (universities and higher education polytechnic institutions), and the industrial sector (R&D, research & design, design, and design & exploring institutes subordinated to industries). And there was a separate field, the defense sector, whose scope cannot be reliably assessed for the lack of relevant statistics and double direction of «civilian» R&D institutes.

Such separation of research sectors was explained by various types of their research activities. Thus, the fundamental research was carried out mainly by the academic sector, the applied

research was concentrated primarily in the higher education sector, while the industrial sector dealt with the applied R&D for production purposes.

According to official statistics, at the time of USSR collapse, in Ukraine, 1344 institutions were engaged in R&D activities, 21.7% of which belonged to the academic sector, 10.8% to the higher education sector, and the rest to the industrial one. The R&D and supporting activities embraced 450 thousand employees, including 295 thousand researchers and engineers; 31.2 thousand researchers held DSc or CSc degree, their average age was 55 years for the former and 47 years for the latter. The researchers comprised also postgraduate students (13.6 thousand), with 876.2 thousand students of higher educational establishments referred to potential researchers.

Until 1991, in Ukraine, all R&D expenditure was funded from the state budget and amounted to 3.02% of GDP, in 1990. The majority was financed from the state budget of the USSR, with the rest taken from other government sources: USSR ministerial budgets and from the republican budget.

In the Soviet times, Ukraine as Union republic had an inappreciable part in the funding of its own scientific potential. In 1989–1990, 90% of total expenditure for Ukrainian science was paid from the budget of USSR and only 10% from the budget of Ukraine. In accordance with the funding structure, Ukraine's scientific capacity was used mainly for the needs of totalitarian state.

Neither funds of independent foundations nor bank loans were practically used for financing R&D works in the Soviet Ukraine.

The political collapse and the territorial disintegration of the Soviet Union in 1991 led to the split of the scholarly research system and the scientific potential into pieces having very unequal quantitative size and international economic weight. These phenomena were the starting point of a basic process reforming the scientific system of Ukraine. Since that time, Ukraine itself started to care of its own scientific potential inherited from the Soviet Union.

2. INSTITUTIONAL AND FUNCTIONAL TRANSFORMATION OF THE NATIONAL RESEARCH SYSTEM

The most significant external factors for the restructuring of Ukrainian science in the 1990s were the collapse of international socialistic system of science; the destruction of internal division of labor and cooperation in the field of research activities between the former Soviet republics; the tough economic crisis and the loss priority of science in the government policy of the new independent state.

In the new reality, the majority of research potential of Ukraine that provided the scientific needs of the whole Soviet Union, was excessive for Ukraine. Thus, before the collapse of the USSR, two-thirds of R&D works in Ukraine was based on external orders, the amount of which reached over USD 1 billion. In the 1990s, the amount of orders from the CIS countries fell more than 15 times. At the same time, there was a decline in R&D works for the defense industry that in Soviet times exceeded 40% of total R&D in Ukraine.

The analysis of scientific system formation in Ukraine at the time of its independence shows three stages of transformation and socio-economic factors that influence the development of national science.

The first stage covers 1991–1993. The transformation of scientific system of Ukraine from the regional to the independent national one was influenced by escalating economic crisis.

Changing socio-economic conditions, deep recession, continuous decline in GDP, inflation, budget deficit and loss of priority of science resulted in a significant slump in funding of the R&D activities in Ukraine. In this period, the total assignments for the R&D decreased 3.1 times, with their share in GDP dropping by 2.2 times. A massive outflow of researchers from R&D institutes was reported, so that science and technology in Ukraine lost a quarter of research staff. The number of university students also fell (by ~ 6%) because of the conversion of academic disciplines under the new socio-economic conditions.

New sources of funding science and technology appeared: funds of foreign customers, international foundations and organizations, as well as own funds of R&D institutions. The share of these sources began to increase gradually and reached 11.5%, in 1993.

The arrival of young people in science declined dramatically, while the researchers aged from 40 to 55 years left the R&D activities and moved to new, commercial sector or migrated abroad.

At the same time, in this period, the basic conditions for the formal establishment of the national system of science of independent Ukraine were created, namely:

- ✦ All R&D institutions located within the territory of Ukraine were transferred to Ukraine's jurisdiction;
- ✦ The initial legislative framework for keeping and operating the R&D capacity was elaborated;
- ✦ The research potential started to focus on solving the national socio-economic and other problems by identifying the national scientific and technological priorities, a system of R&D programs and projects, and by introducing the competitive methods of research funding;
- ✦ A new institutional structure (the government – the State Committee of Science and Technology – the branch ministries and committees, the National Academy of Sciences – the R&D institution – the research teams (departments, sectors, laboratories) was created;
- ✦ The conditions for the activities of non-governmental research institutions and new NGO R&D associations were created;
- ✦ The social sciences started to develop on the basis of generally accepted methodological principles.

The second stage (1994–1998). It was characterized by deepening changes of the first stage. The specific feature of this stage is a significant increase in infrastructure spending, lack of funds to pay salaries and almost complete reduction of R&D funding in research organizations. As a result, the actual number of researches decreased as

hidden unemployment in the R&D sphere grew because of the forced introduction of reduced workday. According to analysts, the hidden unemployment in R&D institutions was likely the largest among all economic areas in Ukraine and reached 60%. Many researchers began to take concurrently positions outside the research sector, for instance, in the commercial field.

As a result of these processes, many R&D institutes that previously were fully maintained by the government found themselves on the verge of closing. The share of government funding of research fell from 47% to 29%. At the same time, the share of funding from the business sector and from the foreign sources increased, by 39% and by 2%, respectively. The total research funding as share of GDP reached its bottom in 1990s (1.16%, in 1996).

Untimely and incomplete funding of R&D entailed an increase in the number of uncompleted R&D works, with the completed R&Ds being in low demand in the industry because of low competitive ability and insufficient level of innovative activity of industrial enterprises.

A decrease in orders from the industry, including those of conversion direction, caused a slump in the industrial sector of research whose R&D potential declined persistently. Inflow of HEE graduates that used to be allocated to R&D institutes in Soviet time almost ceased, with the scholarly research being incapable of competing with attractive commercial sector. As a result, despite annual growth in the number of HEE students by 76 000 and postgraduates by 1 400 the R&D potential of Ukraine did not show any significant increase. The average age of DSc and CSc holders engaged in R&D grew by 1 each 2 – 3 years.

At the same time, the nongovernment segment of Ukraine's R&D was established and its share reached 15%, in 1998.

The third stage started with 1999. In parallel with industrial output and GDP growth the adverse trend in the development of Ukrainian scholarly researched paced down.

In particular, the share of researchers got stable (41 researchers per 10 000 employees) that cor-

responded to the average for Europe, and the number of DSc holders started to increase. In the previous two years the amount of R&D done and R&D products sold showed ascending dynamics. The number of industrial corporations dealing with innovation and manufacturing science-intensive products started to increase. Due to these facts Ukraine has kept its place among few countries that have their own R&D potential and are capable of manufacturing innovative products, including in the sphere of aircraft and spacecraft building, on their own.

The social and humanitarian field has undergone the most impressive changes as such important for the independent state directions as sociology, political science, culture science, archeology, and religion science have been completely established.

Some leading academic institutes and national universities are reporting increase in commercialized R&D works due to orders from the industrial corporations. The formation of new innovative structures for Ukraine, regional and industrial innovation centers and parks is going on. The intellectual property market is emerging. The mechanism for accounting the intellectual property objects as intangible assets on the balance of R&D institutions is implemented. This is of crucial importance for real transition of Ukraine's scholarly research to the market relations.

The organization and use of R&D information by the Ukrainian researchers changed due to development of new IT in Ukraine. Computerized technologies are introduced into accumulation, storage, and dissemination of scientific information. In particular, in 2000, Institute for Problems of Information Recording of the NAS of Ukraine and the Vernadskyi National Library of Ukraine launched a nationwide project of *Dzherelo* Ukrainian abstract journal (UAJ). At the same time, in order to ensure access to the foreign periodicals, *Electronic Information for Libraries* project initiated by the Institute for Open Society (Budapest) and the world largest publisher EBSCO was implemented under support of *Vidrodzhennia* Foundation.

The nongovernment segment of R&D sector of Ukraine has been developing. The productivity of R&D works in this segment started to surpass that of state-owned institutions. The basic directions of activities are R&D and provision of R&D services whose share grows annually and has reached 35% of the total volume in Ukraine.

3. ANALYSIS OF THE NATIONAL RESEARCH: RESULTS OF THE TRANSFORMATION DECADE

The analysis of the R&D sphere transformation in Ukraine during the years of its independence has enabled identifying certain important social, economic and other conditions mostly impacting the present-day development of science, its influence on the economic development and solution of state formation problems.

Firstly, this concerns the conditions of transformation of Ukraine's science from the regional to the independent national research system. It should be noted that immediately after the independence, Ukraine and its scientific system, despite having many scientific schools, outstanding scholars and R&D achievements, was a typical regional system; in some fields, even peripheral one. Only the third part of its R&D potential was used directly for its sake. The fundamental research made up only 8-9%, while the major part of applied research and R&D products were aimed at meeting the needs of military complex. All these factors hampered fast transformation of the national economy and its sustainable development.

In the two recent years, the scholarly research system of Ukraine has got features of the research system as such, as fundamental research, applied research, and RDs accounted for (13–14)%, (22–23)%, and (56–58)%, respectively. The R&D services also are developing at a quick pace, as their share adds 1–1.5% annually.

Secondly, the aggravation of social and economic problems caused by typical complications of the transition period and big mistakes in the identification of transformation process model gradually expelled the science from the range of national priorities, which consequently led to a drastic

drop in investments in R&D growth and to a loss of innovation activity.

Although currently, the R&D funding is kept at the same level as in 1995–1996, the stability of funding is quite promising. The main funding sources (national budget, business sector, and foreign customers) even show a sustainable growth.

The legislative assignment of science and engineering priority till 2006 and 30% share of the national budget in the structure of their funding should facilitate radical changes in the R&D sphere of Ukraine, including via reform of budget funding system, first of all of fundamental and applied research.

Thirdly, changes in the national geopolitical tasks, conversion of the military complex, and new defense doctrine of Ukraine have stimulated changing the motivation and reducing the funding of military-purpose R&Ds. In the Soviet times, almost half of investments in the scholarly research is known to be spent for the sake of military complex. Naturally, reorientation of over half of applied research and R&Ds has led to aggravation in the financial status of Ukrainian science, inasmuch as it was too hard to compensate such huge losses.

Fourthly, from very beginning, the scientific system of Ukraine was too much dependent on budget funding. Because of reduced orders from the industry and insignificant international aid, the government assumed a role of key customer of R&Ds, which did not meet the market relations. The fundamental and applied research was separated from the real needs of economy, with the scholarly research system and individual research teams losing ability of objective self-assessment. This adversely affected competitive ability of R&Ds and Ukrainian products.

The current indices of R&D funding both by direction and by weight of funding sources testify to qualitative changes in the scholarly research system of Ukraine. The largest share in the structure of financial investments belongs to the business sector (38%), whereas the budget funds account for 30%, and the foreign customers, international foundations and organizations have a share of 23%.

Over 90% of fundamental research and 55% of the applied research are funded from the national budget. At the same time, the third part of investments in R&Ds is made by foreign customers, and over 25% by the Ukrainian business sector.

Fifthly, the expel of science from the national priorities entailed many social problems, the most important of which was a loss of prestige by science, especially for young gifted people. This negative factor is the most dangerous threat to the Ukrainian R&D potential. It affects the conditions for keeping the scientific schools, trends of research staff outflow from the R&D sector and capacities for effective renewal of R&D personnel. Nowadays, the average age of DSc reaches 60 years, that of CSc is estimated as 51 years.

At the same time, positive changes have taken place. The mismatch between research specializations by field of science and the new social and economic reality of the 1990s led to a sharp (tenfold) increase in the number of postgraduates in political science, law, and psychology, in 1991–2000. Over 12% of the total number of postgraduates belongs to economic directions. At the same time, the total number of postgraduates in 2000 grew 1.5 times as compared with 1991. This facilitates improvement of qualifications of young researchers and partly compensates the lack of professional training among the young people working in economic fields of private sector.

Hence, in general, the social and economic conditions of Ukraine's scholarly research system transformation in the 1990s were unfavorable for systemic positive changes. The recent progress has not become sustainable yet. This depends on many factors, the most important of them are as follows:

- ✦ The main driving forces of the Soviet method of organization of R&D activities disappeared but the forms and institutions which ensured these mechanisms have partly remained.
- ✦ At the government level, the science is treated as separate branch of economy, instead of the foundation for innovative development of economy as a whole. The efforts to reform the na-

tional scholarly research system from have failed inasmuch as they were based on changing the status of responsible government bodies from committee to ministry and vice versa instead of strategic planning of science development.

4. FINAL PROVISIONS AND CONCLUSIONS

Ukraine's path of economic reform has showed that the market means of economy transformation do not work without government regulation of funding the present-day innovative production. As a result, the economy has lost its reproduction capacity and transformed into reallocating system. Such economy is incapable of ensuring raise in living standards, as it leads to exhaustion of material and spiritual wealth of the nation and hampers its smooth reproduction.

Success of economic reforms and keeping the pace of economic growth (in 2001, GDP growth reached over 10%) depend on the reform of national scholarly research system. Aloofness of R&D activities and focus on separate research sectors, trend towards concentration of R&D activities in state-owned research organizations, lack of real competition among fields of research, first of all, because of primarily administration allocation of budget funds, hamper the introduction of advanced scholarly research system in Ukraine.

The use of alternative funding sources and participation of active researchers in international grant funding of R&D works, first of all, in the sphere of fundamental research bring hope for the national scholarly research system to be incorporated into the global research. It should be pointed out that in 1999–2000, within the NATO research program the Ukrainian researchers received more than 480 grants, with Ukraine being the second only to Russia among the members of Euro-Atlantic Partnership Council. At the same time, in 2000–2001, Ukraine provided financial support to all those who received the NATO grants.

Ukraine is at the beginning of long path towards civilized integration into the world and European R&D space. Until it gains the status of equal partner in R&D cooperation, it remains a donor of intellectual potential for the countries with advanced R&D sector. We need urgently to push the transition to equal partnership and not only to stop «brain drain» and to stimulate retrieval of Ukrainian researchers from abroad, but also having created the conditions for working in the fields where Ukraine has globally recognized accomplishments, to engage foreign experts into R&D projects at Ukrainian R&D institutions.