Rayevnyeva O. V., Ostapenko V. M. Transformation of the Interaction between the Educational and Scientific Activity of a University in the Innovative Economy

The article aims at studying the technology of transforming the interaction between the educational and scientific activity of a university taking into account the innovative model of economic development, which involves determining the stages of university transformation, while putting emphasis on peculiarities of R&D activity, interaction between the educational and scientific activity, and elements of their control system. The article identifies the factors determining the need for transformation of research and development and innovative activities, and the main areas of transforming research in Ukraine. The algorithm for transforming the interaction between the educational and scientific activity of a university is formed, consisting of individual but interconnected elements, such as legislative and statutory support in the educational and R&D activity; interaction between the educational and R&D activity; transformation of the educational and R&D activity of a university; management of the interaction between the educational and R&D activity. Problems and priority areas in the work of the state policy carried out by the Ministry of Education and Science of Ukraine are highlighted. A number of legislative initiatives of the Ministry, launched in 2020 and planned for the future, have been approved in order to solve the existing problems in these areas. The Ministry of Education and Science has implemented and planned activities aimed at stimulating transformations in education, science and innovation. Legislative and regulatory support in the educational and R&D areas is grouped according to the stages of its adoption. The most common models used at modern universities are characterized in accordance with their peculiarities in combining R&D and educational activities of a university, its structural units and individual faculty members. Specific features of managing of R&D activity at a research (entrepreneurial, innovative) and educational universities are compared. The interaction areas of interaction between educational and scientific transformations in Ukraine that could influence its scientific development and promote its integration into the European Research Area are highlighted.

Keywords: R&D activity, university, transformation, higher education, state policy of the Ministry of Education and Science, interaction between the educational and R&D activity, research (entrepreneurial, innovative) university.

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Раєвнєва О. В., Остапенко В. М. Трансформація взаємодії освітньої та наукової діяльності університету в інноваційній економіці

Метою статті є дослідження технології трансформації взаємодії освітньої та наукової діяльності університету з урахуванням інноваційної моделі економічного розвитку, що передбачає визначення етапів трансформації університету з акценом на особливостях науково-технічної діяльності, взаємодії навчальної та наукової діяльності та елементів системи управління ними. У статті визначено фактори, які обумовлюють наявність трансформації науково-технічної та інноваційної діяльності та основні напрями наукових трансформацій у Україні. Сформовано процес
Introduction. Strengthening the integration of higher education, science and innovative economic activity will provide their compliance with the real needs of the private and public sectors of the national economy. The combination of education and science is a basis for the education system modernization and the main factor for further development of innovative educational activities of the university. Strengthening the link between educational, scientific and innovative components in the system will solve the problems that occur while carrying out a structural reform in the economy, creating new knowledge-intensive innovative industries, and intensifying entrepreneurship.

Research analysis and problem statement. In Ukraine, the problems of transforming educational and scientific activities at the university are conditioned by research and publications in various areas of state regulation, such as humanitarian educational paradigm (D. Bell, E. Denison, I. Kolesnikova, N. Romaea, I. Fomichova, E. Shiyanova, E. Yamburg), and determining the impact on the implementation of social and economic priorities for society (W. Berquist, M. Baumen, I. Bertrand, B. Zueva, J. M. Keynes, Y. Kuzminova, A. Subetto, B. M. Filippova, L. Jacobson, E. Toffler, D. Wheeler, T. Schultz). However, there is a need for studying transformations in educational and scientific activities at a university, e.g. in definitions, purposes and priorities for gaining educational and scientific achievements in certain conditions of the innovative model of national economy.

The aim of the article is to study technological instruments for transforming educational and scientific activities at the university according to the innovative model of economic development, which involves determining the stages of transformation of the university according to the peculiarities and features of scientific activity, its interaction with educational activity, and elements of their management.

Results. The state regulation of education and science is the basis for ensuring human capital development and providing an opportunity to obtain economic benefits, which would provide for Ukraine’s sustainable growth and competitive economy. According to Sustainable Development Goals, there is a need for using «innovative technologies», «innovative approaches» [13] and transforming scientific, technological and innovative activities, because their use, happening due to a number of factors, would correspond to both the European and global trends (Fig. 1).

The transformation of scientific activities is a priority ensuring social, economic, political and scientific development in many countries of the world. In terms of integration into the world and European scientific environment, the current stage of Ukraine’s development is characterized by systemic and radical transformations. The strategic task of the integration process should take into account the peculiarities of national identity and should not be accompanied by the leveling of its own national educational system. The main areas of scientific and technological transformations are presented in Fig. 2. To develop science and innovation, it is necessary to transform Ukrainian science by implementing innovative approaches and methods, and providing universities and scientists with opportunities and resources to conduct research that would positively affect Ukraine’s socio-economic and innovative development. The education and science must become a lever of social equality.
Factors that determine the need for scientific and technological transformation and innovation

Necessity to update the priorities of science, technology and innovation (previous list has expired)

The existing priorities do not reflect the economic and scientific state of the country

Priorities must be combined and ensure an unbroken chain from idea to implementation in the economy

The choice of priorities is to determine the state innovation

Fig. 1. Factors that determine the need for transforming scientific and innovative activities

and cohesion in society, a trigger for Ukraine’s economic development and competitiveness in the world.

Thus, the higher education system must create new conditions for obtaining modern knowledge, solving complex problems, creating high-quality and innovative intellectual products. At present, education in Ukraine does not meet modern needs of the individuals and society, that is the requirements of the economy and global trends. Therefore, a systemic transformation in education, science and innovation is needed in order to ensure the appropriate quality of education. The reforms in science and technology will stop stagnation in research, generate demand for qualitative developments and training, reduce inconsistencies between research and implementation of its results, integrate them into the educational and research space of the EU.

The process of transforming educational and scientific activities at a university consists of individual interconnected elements. The technology of transforming educational and scientific activities at a university comprises the following elements:

- legislative and regulatory support for scientific activity;
- organization of educational and scientific activities at a university;
- interaction between educational and scientific activities at a university;
- management of educational and scientific activities at a university.

Legislative and regulatory support regulating educational and scientific activities comprises two framework laws and a number of regulations governing certain aspects of these activities. To solve the existing problems in these areas, many regulatory initiatives of the Ministry were launched in 2020 and are planned for the future (Table 1) [5].

Table 1

| Stages of approval | Legislative and regulatory support |
|--------------------|-----------------------------------|
| Approved           |                                   |
|                    | • Law “On amendments to some laws of Ukraine on the intensification of science parks” [10]; |
|                    | • Order of the Cabinet of Ministers of Ukraine (CMU) “On changing the composition of the National Council for the Development of Science and Technology” [11]; |
|                    | • Resolution of the CMU “On Amendments to the Regulations on the National Council of Ukraine for the Development of Science and Technology” [7]; |
|                    | • Resolution of the CMU “On Amendments to the Procedure for Formation and Use of Funds of the National Research Fund of Ukraine” [8]; |
|                    | • Resolution of the CMU “On Amendments to the Resolutions of CMU of July 4, 2018 № S28 and of December 4, 2019 № 1007” [9] |
| Prepared           |                                   |
|                    | • Draft Law “On Amendments to Certain Laws of Ukraine on Stimulating Activities in the Sphere of Technology Transfer”, the purpose of which is to increase the level of implementation (commercialization) of research results; |
|                    | • Orders of the CMU “On approval of the Concept of the state program of development of research infrastructures in Ukraine for 2021-2026” and “On approval of the Concept of implementation of the state policy of development of Ukrainian e-infrastructures until 2023 and approval of the Action Plan”; |
|                    | • Draft amendments to the Law “On Scientific and Scientific-Technical Expertise”; |
|                    | • draft amendments to the Law “On Scientific and Scientific-Technical Activities” regarding the settlement of issues related to the National Research Fund of Ukraine; |
|                    | • draft resolution of the CMU “On amendments to the Model Regulations on the procedure for holding a competition to fill vacant scientific positions of a state scientific institution”; |
|                    | • draft resolution of the Cabinet of Ministers of Ukraine “On Amendments to the Resolution of the CMU of April 14, 2004 № 494” to ensure the implementation of the right of researchers to receive an allowance for research experience |
The main directions of scientific transformation

Accession to the international scientific space
- ensuring the procedure of joining the Framework Program for Research and Innovation in the European Union «Horizon Europe»
- creating an international advisory board, that will be the key to the implementation of the best world experience in training the scientific elite, and integrating Ukrainian science into the European and world research space

Improving the quality of academic staff
- conducting state certification of scientific institutions and higher education institutions in terms of conducting scientific activities
- improvement of the mechanism for intellectual property rights protection in scientific institutions with the participation of foreign partners
- determination of internship conditions for young scientists abroad
- creation of «professional graduates (doctoral students)» who will become a highly skilled workforce armed with research skills, thus strengthening the research and production component of technical training and the interaction between government, science, education and business
- introduction of the equivalent calculation method for academic and research load in accordance with the European system, that will make it possible to stimulate scientific activities

Creating a scientific infrastructure
- approval of the state program for the research infrastructure development and the concept of state policy for the development of infrastructures development
- creation and launch of an online platform for communication between representatives of science, business and the state
- creation of a single research center capable of uniting scientists working in different institutions and ensuring their constant coordination with the state, thus providing the state security
- creation of centers for collectively using scientific equipment, providing access to modern scientific and technological information, and of a common open database for experimental equipment and information infrastructure

Defining guidelines for the development of scientific activities
- formation of a new priorities list to develop science and innovation
- creation of scientific developments for the Ukraine's national security, that requires joint efforts and constant coordination of scientists and representatives of the defense, security sector and civil society
- coordination of the state research program and ensuring its implementation
- development of a unified interdepartmental Strategy for the scientific and innovation development system in order to improve the coordination of scientific institutions, economic entities, educational institutions and authorities

Financial support of the scientific sphere
- legislative regulation of issues related to the functioning of the National Research Fund of Ukraine and the provision of the first grants by the National Research Fund

Fig. 2. The main directions of scientific transformations in Ukraine
Ukrainian science system transformation is a priority of the state policy of the MES, that ensures identification of strategic points in developing education alongside with the provision of interaction between science, business and education. This is implemented by preparing strategic documents, guidelines and relevant state target programs (Fig. 3).

Reforming the scientific component of higher education is hampered by the imperfection of regulatory framework.

Successful implementation of the Ukrainian laws «On scientific and scientific and technological activities» [12] and «On higher education» [6] requires the introduction of many supplements and clarifications to these documents, that would regulate such points. The MES has both implemented and planned for the future activities aimed at ensuring transformational processes in education, science and innovation (Table 2).

Transformation occurs both at a university as a whole and in scientific activities, in particular. It is a process of radically changing the object as a whole or its individual elements due to the influence of external and internal factors. These processes are closely interconnected and take place at the same time, that is why we suggest to consider the following main stages of a university transformation in developing its scientific activity (Table 3).

The transformation includes changes in the emphasis in university management placed on scientific activities, goals and approaches to research, interaction with the authorities and stakeholders. According to the global trends in education,

| MES’ results | MES’ goals |
|---------------|------------|
| Research programs have been approved and their implementation has been ensured | Approval of the Concept for the research infrastructures development in Ukraine for 2021-2026 |
| The technological needs of the market and capabilities of enterprises to use Ukrainian technologies have been analyzed | Creating an online platform for communication between participants in the innovation process ("Science and Business" platform) |
| Evaluation of the efficiency of research institutions has been provided. 224 research institutions have been certified by the state | Approval of the Concept for implementing the state policy for the Ukrainian e-infrastructures development until 2023 and the action plan for it |
| The work of the National Research Foundation (NRF) as a source of independent grant funding was ensured and the first competitive selection of research and development projects was conducted by the Foundation | Development of the Law of Ukraine "On the basic principles of formation and implementation of priority areas of scientific, technological and innovative activities in Ukraine" |
| Citizens’ access to open data on scientific activity for individual scientists, research institutions and higher education institutions with state support has been expanded | Finalization of the bill "On Amendments to the Law of Ukraine "On Scientific and Technological Expertise"" |
| Financing for research projects is provided at the expense of the EU aid for Ukraine to fulfill its obligations under "Horizon 2020", the EU Framework Program on Research and Innovation | Development and submission to the Government of legislative acts on Ukraine’s international cooperation with the EU and the United States |
| Ensuring integration into the European and global research space and fulfillment of Ukraine’s international obligations in scientific and technological cooperation | Competitive selection of research and technological projects financed by the EU for Ukraine to fulfill its obligations under "Horizon 2020", the EU Framework Program for Research and Innovation |

Source: compiled on [5]
**The main problem of the scientific sphere:**

Ukrainian science has produced results that do not meet the needs of the state and the world. The ability of Ukrainian leaders to realize their own ideas and get to the point of solving important actual and probable problems in economy has been curtailed.

**Reasons:**

- Opportunities to involve Ukrainian scientists in international research programs and international research infrastructures are insufficient and do not correspond to the real competence of scientists.
- The management and remuneration system in the public sector of research and development is too conservative, which does not enable a quick adaptation of the research infrastructure to the current needs of science and technology and encourage scientists to work productively and professionally.
- Budget funding for science is based on the dominance of single source departmental funding. Grant funding is virtually non-existent.
- Young scientists' opportunities for career and professional growth are limited due to insufficient legal priority and lack of mechanisms for providing clear orientation of the budgetary support for science.

**Strategic goals:**

- Scientists are integrated into European and world research spaces, have access to the world's leading research infrastructures, financial resources for the implementation of the right to academic mobility and are motivated to participate in international scientific and technological cooperation.
- Scientists have a decent wage and access to a research infrastructure that enables research to be conducted at a high quality level.
- Scientists have access to multichannel research funding allocated according to transparent procedures.
- Special programs have been introduced to encourage young scientists to pursue scientific careers.
- Society perceives Ukrainian science as a real source of economic development and welfare of the population, has the opportunity to assess the effectiveness of spending budget funds on science. Pseudoscience is not tolerated in any of its manifestations.

**Results of execution:**

1. Norms on the obligatory coordination of international business trips with the MES and increase in restrictions for full-time employees have been abolished. Staff number of employees of subordinate institutions (Resolution of the Cabinet of Ministers of Ukraine #1007 dated December 4, 2019).
2. A regulatory framework has been created to launch a new competition for Ukrainian scientists at the expense of financial aid provided by the EU to Ukraine under the program Horizon 2020 (CMU Resolution of November 20, 2019).
3. The working group is developing a Concept for the development of research infrastructure. Negotiations are underway with three EU research infrastructures on the subject of Ukraine's accession to them.

1. Centers for the collective use of the scientific equipment are constantly being created in higher education institutions, in which the best modern scientific equipment in a certain area is concentrated and thus can be used by scientists from various universities and research institutions.
2. Certification (attribution) of scientific institutions according to new rules has been launched, which provides for uniform transparent criteria and the involvement of independent experts.
3. Approved amendments to the resolution of the Cabinet of Ministers of Ukraine of July 10, 2019 (On approval of the Procedure for using funds provided in the state budget to support priority areas of research and scientific and technological (experimental) development in higher education institutions) are completed.
4. All procedures necessary to launch the activity of the National Research Fund of Ukraine (Resolution of the Cabinet of Ministers of Ukraine #1007 dated December 4, 2019 and #1170 dated December 27, 2019) are completed.
5. The budget for the young scholars’ competition has been increased. Amendments are adopted to the President of Ukraine’s decrees #1210 dated December 24, 2002 and #446 dated June 17, 2009 (On the Regulations of allocating the annual grants of the President of Ukraine to doctors of science to carry out research).
6. A new search engine for scientists, Open Ukrainian Citation Index, has been created. The difference between OUCI and similar engines lies in the fact that it is completely non-commercial, i.e., access to it is free and open for everybody. At the same time, the filling of the database is based on transparent principles and it has a clear mechanism of protection against manipulation with citations. It helps to search for scientific texts and analyze researchers’ citations. OUCI is the first element of the future National Electronic Scientific Information System.

Fig. 3. Problems and priority areas of the state policy of the Ministry of Education and Science of Ukraine in science [4]
## Stages of transformation of scientific activity development at universities

| Criterion                                      | Traditional University 1.0                                                                 | Modern University 2.0                                                                 | Postmodern University 3.0                                                                 | Integrative University 4.0                                                                 |
|------------------------------------------------|------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
| **Accents**                                    | • powers and hierarchy                                                                     | • results, efficiency and competition                                                   | • dialogue with stakeholders                                                              | • system solutions, co-creation and sustainability                                       |
| **Research**                                   | • search for absolute truths;                                                             | • standardization of research, processes and expert evaluation;                        | • inter- and transdisciplinarity;                                                        | • transdisciplinarity;                                                                    |
|                                                 | • I-concept: observance of universal natural laws;                                        | • I-concept: testing and application of natural laws;                                  | • I-concept: understanding social dynamics;                                               | • joint research;                                                                       |
|                                                 | • focus on strong theories;                                                              | • competition for grants;                                                             | • dialogical research processes;                                                        | • I-concept: co-creation and                                                               |
|                                                 | • focus on basic research and technology transfer                                        | • measuring success, ranking, impact factors, etc.                                   | • solving social problems;                                                              | system transformation;                                                                   |
| **Cooperation with authorities and business structures** | Lack of integration of social change and research, in particular sustainable development (SD), as these studies require interaction and a degree of interdisciplinarity. These demands to adapt to changes in society appeared after the Enlightenment and the rise of modern democracy. | The growth of the research university model has contributed to the mass development of research methods, publication standards and historic innovations. Decisions are made by a selected group of people accountable and responsible for their decisions. There is a hierarchy and a clear division of labor. Performing R&D at the request of industry and creating technologies "to order" | University position is not just as a producer of knowledge, but an agent of change, and is closely associated with civil society and other external actors. Sustainability of management is based on the general institutional approach and promotes inter-organizational decision-making processes. | The main strategy is to promote systemic development based on integrative approaches supported by inter-organizational networks. A successful university networks and works in alliances to solve common problems, including collaboration with internal and external stakeholders. |
the processes of transforming scientific activities at a university are underway and contribute to innovation, economic growth, and solving major global problems. The main areas of strategic development of the world’s leading universities are formed in their strategic documents, development programs, model decisions (Table 4).

Table 4

| Trend                              | Characteristic                                                                 |
|------------------------------------|-------------------------------------------------------------------------------|
| Creating digital strategic partnerships | Forming a global network of universities, corporations and scientific electronic space. Its purpose should be to solve global problems and to set regional and national priorities |
| Localization                       | Strengthening regional ties with local communities, government and business structures emphasizes the fact that the university will act as a community and develop in the region of its location. It provides the promotion of regional joint projects, ensures that both the university and the region develop and strengthen their cooperation in research and production |
| Growth of integrity and practice-orientation | Focus on the employer; integration of business, science, and education; collaboration of university research and training with industry and business taken together consolidate the skills of goal coordination, cooperation and coordination |
| Commercialization of scientific ideas | Technology transfer centers and technology parks at a university give students the opportunity to organize startups and small firms to develop, patent and market technological products. Students create jobs at the university, combining research with the educational process and business. Thus, there is a gradual and predominant privatization of the university system by business, that is increasingly turning scientific technology into a commercial commodity |
| Network integration into the European system | European DIHs (Digital Innovation Hubs) receive constant and huge support from their governments, EU funds, as well as private business, have a developed and systematic brokerage of technology and innovation, use a single information base, and provide support facilities for participants. Support from the MES is needed in such areas as defining the model of innovation ecosystems, determining their official status, searching for sponsors, integration into the DIH network, continuing joint actions within the Innovation Forums, and other activities planned by the Ministry of Education and Science. |

Peculiarities of the university’s scientific mission are conditioned by the ways of organizing research at the national (external-institutional) and university (internal-institutional) levels, i.e. by the peculiarities of scientific, technological and educational activities of an HEI, its structural subdivisions, and individual teachers. None of these models is ideal in modern conditions, as evidenced by the documents of higher education reforms that take place within further convergence of the European Higher Education Area and the European Research Area (Table 5).

Table 5

| Common features                                                                 | Differences                                                                 |
|--------------------------------------------------------------------------------|----------------------------------------------------------------------------|
| • the structure of scientific activities is centralized and is carried out mainly at the macro level of university management; | • the structure of the scientific activities department at the research university is more complex, which is determined by the great variety and scope of tasks facing it; |
| • the most developed are those management structures that provide researchers with assistance in obtaining grants and other financial support; | • at the research university, the activities of the scientific and other departments are promoting external funding of research and the creation of a system of internal grants mainly for young scholars |
| • the structure and distribution of functional responsibilities in the teams of grant writers depend on the nature and scope of research activity at the university | |

The efficiency of the management system of scientific activity at the modern university is a complex multifaceted function, that depends on many external and internal variables (Fig. 4).

The analysis of research at American universities [2] revealed the main trends in the transformation of scientific activities management, evolving in accordance with the rapid progress of society, economy, science, and technology. The effectiveness of scientific activities management, from the standpoint of sociology of management, is to transform the intellectual, material, organizational, financial and other resources of the university into specific results that have social significance and economic feasibility (Fig. 4, 5).
The implementation of tasks that are important for society and the state. The social orientation of research is determined at the national and regional (local – district) levels and play the role of a social order aimed at solving complex social problems of global, national, regional or local significance.

Focus on research with probable significant research potential

Entrepreneurial universities

Social oriented universities

Traditional universities, including state ones

Focus on fundamental research

The implementation of tasks that are important for society and the state. The social orientation of research is determined at the national and regional (local – district) levels and play the role of a social order aimed at solving complex social problems of global, national, regional or local significance.

Management system of scientific activity at the university

Fig. 4. Management system of scientific activities at the university
The effectiveness of the management of scientific and technological activities of the university, first of all, depends on cooperation between the university and industry and society, the latter determining the economic and social components of efficiency, and secondly, on the competence of research administrators and the work of scientists, administrators, teachers, etc. (Table 6).

Transformation of educational and scientific activities at the university includes such elements as reforming the system of state management of scientific activity in Ukraine, organization and redistribution of powers and responsibilities in order to increase the effectiveness of implementing socio-economic development priorities.

Conclusions. The areas of interaction between educational and scientific transformations in Ukraine are determined that will influence the development of Ukrainian science and its significant contribution to the country’s economy due to its integration into the European Research Area. Recommendations for the educational and scientific activities at a university in Ukraine are based on a retrospective analysis of the existing concepts of scientific activities at a university, interaction with authorities and stakeholders, and management system providing for interaction between the educational and scientific activity at a university.

The application of public policy instruments in developed countries is aimed at attracting the potential of the sci-
### Areas for improving the management of the educational and scientific activities at the university

| Level                  | Measures                                                                                                                                                                                                 |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| **Strategic level**    | • To create a strategy for the research system development based on the analysis of the scientific potential of the university staff and the needs of the region.  
                          • To institutionalize research groups, including interdisciplinary ones, that have the potential to attract external funding for research.  
                          • To develop a portfolio of possible sponsors of research work that can be performed by university scientists.  
                          • To create a system of internal grants to initially support forward-looking research. Develop fundraising measures to support the internal grant system. |
| **Administrative level** | • To train the members of the University Research Department to attract external research funding (from agencies, organizations, foundations, individual donors, researchers and university staff who provide organizational and financial services for projects) and organizational support of external grants.  
                          • To develop the University strategy for the commercialization of intellectual property. To familiarize the university staff with international achievements.  
                          • To organize a self-government system of scientific activity for young scholars, aimed at finding additional opportunities for young scholars' self-realization.  
                          • To develop an effective model for evaluating the performance results of the University Research Department.  
                          • To develop a system of indicators for evaluating the results of research activity at university departments.  
                          • To create a website at the Scientific Department of the University to display information of interest for the university researchers and potential sponsors of their research activities. |

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