“Technology transfer management culture (education-based approach)”

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TECHNOLOGY TRANSFER MANAGEMENT CULTURE (EDUCATION-BASED APPROACH)

Abstract

Research deals with the analysis of theoretical aspects of increasing the competence of scientists and experts, whose task is to work with technology as a good promotion of technology on the market with a view to its commercialization or search for technological solutions according to the tasks of the organization and to examine the startup methodology as a tool of improving the technology transfer skills efficiency. The new specifics of technology transfer management within the Education 3.0 paradigm are considered. In the paper, the authors analyze the technology transfer as important source of innovation creation and an integral part of business development. Target result of technologies introduction, implemented within limited period with limited resources as an innovative purpose of technology transfer, which is aimed at the best possible development of organization, is identified. The paper also suggests considering processes of technology development and technology transfer based on startup methodology.

Keywords technology transfer, technology development, Education 3.0 paradigm, business development, entrepreneurship culture

JEL Classification I25, O31, O32

INTRODUCTION

Modern education paradigm is oriented for training the specialists with some corporate innovation and entrepreneurship culture, intellectual environment of expanded reproduction of knowledge and dissemination of advanced technologies and core competencies, which are adequate for current scientific and technological challenges of global economy.

Also, in modern conditions, the technology transfer is an important source of innovations creation. This is the way, which allows the companies in the short term to enter new stages of development through the Science-to-Business (S2B) and Business-to-Science (B2S) cooperation (S2B-B2S). But today the complexity of high technologies, as well as speed of development, no longer allow even big international corporations rely on their own resources and research centers, which puts the relevance of technology transfer management on a new level. Therefore, technology transfer, along with the creation of internal innovation environment, becomes an integral part of business innovation development.

The innovation-based role of technology transfer is target result of introduction of technologies, implemented within limited period with limited resources, aimed at the best possible development of organization. At the same time, many companies often refer to a bad expe-

rience in introducing new technologies. This results in significant financial loss or inefficient processes. Therefore, the implementation of technology transfer in different sectors can become a complicated task.

This is particularly important for high-tech, the development of which in modern conditions is associated with the improvement of industry or enterprise technology package based on inter-sectoral cooperation and implementation of high technologies, which is an expensive process.

So, the authors may consider the technology transfer is a new kind of business or business process, which is actively developing in knowledge economy. It differs from a conventional business, because it is a business of contacts and communications management, technology trade, search for the required solutions and demand-driven new technologies development. Often technology transfer is considered even as an alternative career in science. Changing the shape of production of knowledge and technology transfer is emphasizing in the concept of "second kind science" (Gibbons et al., 1994).

The complexity of this type of activity is caused by the fact that in many cases for solving practical problems, it's necessary to bring together people with related research profiles, because this association provides a wider, objective view at the technology and its possible applications.

Today, there is shortage of hard real experts in field of venture business, capable to carry out the commercialization of existing technologies – "output" – to the market research results and search of venture investors in public market. Also, in practice, it often happens that scientists and managers who yet decided to purchase the new technology have not the same exact vision of this technologies and procedures related to its implementation. Also, often in practice, in the choice of technology, only engineers and technical staff are involved, which is one of the reasons of failures. Technology transfer in the broad sense is relevant, because it allows students to search for innovations to implement in their professional sphere.

Experience over the last decades has shown that technology transfer process can be problematic, and transferees often lack the skills to manage it effectively (Ramanathan, 2008).

Dr. Dipanjan Nag (2015), founder and director of Program on Innovation and Technology Transfer (POINTT) in Rutgers University, notes that "Overall, technology transfer is one of the most rewarding careers that you can have. Dealing with the cutting-edge technologies every day, that eventually become the blockbuster drug or the next innovative product in the market is exciting". But despite of above mentioned points, it is still unclear what skills are necessary for considering the various activities of technology transfer within the new innovation models (Moma et al., 2013).

But despite of above mentioned points, it is still unclear what skills are necessary for considering the various activities of technology transfer within the new innovation models (Moma et al., 2013).

Accordingly, the aim of this paper is to analyze the theoretical foundations to increase the competence of scientists and experts, whose task is to work with technology as a good promotion of technology on the market with a view to its commercialization or search for technological solutions according the tasks of the organization and to examine the startup methodology as a tool of improving of technology transfer skills efficiency.

1. THEORETICAL BASIS

In the first part of this article, the authors will consider technology transfer as a main business process in innovation system, which is characterized by cyclical features, cost value, multiple links and uncertainly. According to this, the authors will conclude about the potential of improving the pro-

cess based on interactions in ecosystem, particular with the consumer (Prokopenko & Troian, 2016). In the second part of the article, the authors will show the basics of application startup approach for technology transfer management.

For the purposes of this study, the authors propose to determine innovative activities as the activity in the development and practical application (commercialization) of results of scientific research, technical, technological, organizational and economic innovations.

Angela Loihl as technology manager at the Center for Commercialization at the University of Washington in Seattle underlines that "Working in technology transfer demands teamwork and the ability to assess a huge range of scientific areas. Those who thrive have the right mixture of extroversion, scientific breadth and business sense. They are also able to juggle multiple projects at once" (Schubert, 2012).

In the study by Ferraro and Iovanella (2017), technology transfer environment is considered as a unity of different interacting entities and could be represented as an inter-organizational innovation network composed of nodes and relationships. Within this approach, we can consider strategies for the self-organization, communication patterns, preferential attachments, structural communities establishment. In the research by Nguyen and Atsushi (2015), cultural differences impact on efficient technology transfer (employees' understanding of quality; top managements' communication of clear goals and procedures for technology transfer; nature of collaborative teamwork and frequent communication about technical issues among experts and staff etc.) was empirically considered. Education can be considered as a way to transform culture values into the business values.

According to Ungureanua, Popb, and Ungureanuc (2016), innovation culture represents the sum of all practices previous to the innovation process. The culture that favors innovation can be carried out by promoting new ideas, communications, collaborations, being aware of conflicts, tolerance in failure case. Some of these aspects were considered in study by Marekha and Omelyanenko (2016) on the example of ecological aspect of innovation culture.

So, working in area which includes variety of technology transfer tasks unites (i) ability to organize the work of the creative team to achieve the innovative and (or) scientific goals, to find and to make management decisions, to assess the quality and effectiveness of labor, costs and decisions and (ii) ability to choose (develop) the implementation of commercialization of results of scientific research.

So, technology transfer requires both development of professional and management skills. This context creates special importance of technology transfer as a complex interdisciplinary and also education problem. The authors propose to consider the problem of training of technology transfer skills in the framework of modern educational paradigms (Table 1), especially Education 3.0, which was considered according to the education characteristics in the study by Keats and Schmidt (2007). Education 3.0 was selected for our study as an umbrella term to describe a variety of ways to integrate technology into learning. Within Education 3.0, classes move away from traditional lectures and focus on interactive learning, discussions, labs, and other project-based learning. We believe that Education 3.0 technologies can promote the technology transfer culture.

Klauss (2000) reviews key issues and challenges of educational technologies transfer. Based on the literature of experience in education and the transfer of technology across different country settings, author sets out 5-stage framework (selection, implementation planning, pilot implementation, going to scale and sustainability) for transfer of technology implementing in education. Innovative Education 3.0 is characterized by rich, cross-institutional, cross-cultural educational opportunities within which the learners themselves play a key role as creators of knowledge artifacts that are shared, and where social networking and social benefits outside the immediate scope of activity play a strong role.

Stephen Allott, founder of Cambridge Computer Lab Ring, the association of Cambridge computing graduates, and former president of Micromuse, has coined the term "people flow" to describe three ways in which universities shape, supply

Table 1. Educational generations in higher education and connection of Education 3.0 with the main innovation trends

Source: Developed by authors based on ideas of Keats, and Schmidt (2007).

Characteristics	Education 3.0	Main innovation trends
Primary role of professor	Orchestrator of collaborative knowledge creation	Multidisciplinary of modern innovations
Content arrangements	Free/open educational resources created and reused by students across multiple institutions, disciplines, nations, supplemented by original materials created for them	Open innovation concept
Learning activities	Open, flexible learning activities that focus on creating room for student creativity; social networking outside traditional boundaries of discipline, institution, nation	Learning outside traditional boundaries of discipline, aimed at networking and crowdsourcing
Institutional arrangements	Loose institutional affiliations and relations; entry of new institutions that provide higher education services; regional and institutional boundaries breakdown	Accelerated development of intangible factors of production increasing importance of soft infrastructure
Student behavior	Active, strong sense of ownership of own education, co-creation of resources and opportunities, active choice	Crowd funding (collective cooperation of people who voluntarily combine resources to achieve different goals)
Technology	E-learning driven from the perspective of personal distributed learning environments; consisting of a portfolio of applications	Virtual economy and e-science (change the nature of science, business and competition based of information and open innovations)

and mingle the human capital that creates wealth (Apax Partners, 2005):

1) importing and retaining entrepreneurs;

2) supplying start-ups with talent;

3) supplying industry with research skills.

Therefore, the authors propose to consider technology transfer as a creative process, which is implemented through collaboration and cooperation.

So, it is fully agreed with the educational ecosystem of 21st century and Education 3.0 and S2B-B2S methodology, which consists of:

1) values that correspond to the question "why", motivates and captivates;

2) education that theoretically justifies and triggers the educational process;

3) content that should be practice-oriented;

4) technologies that support to three other elements.

2. RESULTS

To increase the understanding of high technologies transfer is the process of development and implementation of technology that contributes to creation of new research links, exchange of materials, information and specialists with industry, adding new perspectives to university research programs and creating new unique opportunities. As a result, technology transfer includes the transfer of knowledge, methods of manufacture and management and marketing models.

The success of technology transfer depends on several factors.

The first success factor of the degree of technological maturity of the industry depends on model of borrowing and required competence.

Also, the authors note the presence of additional effects of technology transfer.

The main (core) technology in many cases entails the development of group of related technologies and operations (at research and subsequent stages, up to service goods to end user), which may create value in itself and can be applied not only in one technology package (for example, use of space technologies in commercial segment of metallurgy and agriculture). Unfortunately, developers often don't see these opportunities, concentrate only on their primary goal.

When analyzing the technology transfer process, the authors propose to consider the innovation ecosystems concept (Hwang & Horowitt, 2012).

Innovation ecosystem, consisting of partners, customers and platforms manufacturers, will create more efficient innovation than either of them separately. Innovations grow not from the basic components of economic activity, as well as the emerging of how people interact with each other to combine and share ideas, talent and capital. The development and transfer of technology, especially high technology, is the best in the "cloud" side information flow and know-how. Complex innovation systems move in complex trajectories oriented and fuzzy alternative ways of development (the network effect). Innovation ecosystem deals with the network economy development (Krapyvny, Omelyanenko, & Vernydub, 2015; Prokopenko, Eremenko, & Omelyanenko, 2014), which needs to some key agents, who will realize innovation communications function.

So, the authors conclude that technology transfer is a system of economic relations aimed at creating the technical, organizational and economic conditions, fully guaranteeing the transfer of production to a higher technical and socioeconomic level on the basis of science and technology, the use of various innovations (technical, social and so on) to ensure the efficient operation of enterprise. Links within innovation ecosystem can be developed only where they are clearly and profitable, so the market participants interact in searching of most effective results.

Therefore, the relevance of any approaches for coordination of interests is due to the fact that in the process of high technology transfer from the research lab to industrial production of commercial product, a variety of agent's innovation ecosystems are involved: developer and consumer, banks and credit institutions, government and business, media and advertising, marketing and government agencies, funds, etc. In addition, each of them uses its own professional language and has a range of interests and goals and consider the technology from their point of view.

So, the main objective of technology transfer deals also with complications in the case of the creation or improvement of existing technological package that includes number of technologies and, consequently, many elements of innovation ecosystem (first of all supporting technologies networks). Thus, technology transfer isn't one-time action, but long-term cyclical process, which entails significant costs and changes in management system.

In the world practice, the most successful universities combine their campus science, engineering, humanities, medical, business schools and faculties. This results in a set of competencies that can be used to implement projects of any complexity. International companies and are valued it creates a rich environment for entrepreneurship and innovation ecosystem. However, in a number of countries that are developing, we often see the situation when strong engineering competences are not backed by the business skills.

In this case, an ideal variant is education is through problem solving i.e. development of regular participation of students and staff in the joint implementation of actual projects (in the framework of virtual design-oriented instructions) on the orders of enterprises domestic and global industry with the acquisition and using of modern core competencies and computer engineering technologies.

This for example can help students in the future to master the basics of iterative method of product development based on reasonable hypotheses nomination and its testing in close contact with the market, which is critical to any sphere of activity. In this context, it's reasonable to highlight lean startup, which is a method for developing businesses and products, which was first proposed in 2008 by Eric Ries. Based on his previous experience working in several US startups, Ries claims that startups can reduce product development cycles by adopting a combination of business-hypothesis-driven experimentation, iterative product releases, and what he calls validated learning (Ries, 2011).

In this context, technology transfer requires the identification of changes impulse (based on information coming from the external environment, for example, scientific publications, exhibitions, economic problems of industry sector, etc.). So the technology transfer field of competence should include:

1) maximum openness to interdisciplinary treatment of information;

2) ability to organize;

3) systematization and financial analysis as a tool of technology transfer management.

A team of specialists should set technical and economic parameters of new technology, as well as additional features that it may include. Understanding the objectives and parameters of technology will make it possible to study the pre-existing in the world of technological and organizational solutions in this area. As a result, it should be identified possible components of technology (equipment, new competences and organizational changes).

So, technology transfer skills require broad area of knowledge in the field of production technology, science, economics, commerce, sociology, psychology, advertising, math, consulting, communication and conversation, etc.

Also, technology transfer skills include technics of crowdsourcing and open innovation approaches, that allow to engage in innovation processes of new competent world-class specialists. These technologies include collective intelligence, allowing to raise the collective IQ of groups and communities, prediction markets, which is able to anticipate the future, which improves decisions, communities of practice and epistemic community's management, allowing to establish a process of collective solutions to complex problems.

The implementation of these tasks requires the ability to organize the work of the creative team to achieve the scientific goals, to find and to make management decisions, to assess the quality and effectiveness of labor costs and solutions, as well as the ability to select (develop) technology of implementation (commercialization) of scientific research results.

As part of the training within Education 3.0, the authors offer to consider methodological and maintenance tools of high school training. In innovation economy training program should be organized on the basis of project-based learning in the framework of integrated educational programs aimed at solving the existing problems in the field of engineering education and are able to provide training for specialist knowledge with any profile. In order to prepare specialists for complex engineering activities at leading universities of the world the concept of CDIO (Conceive – Design – Implement – Operate), developed at MIT in the middle of 1990s, is realized. Solution of large problems is aimed at addressing the problems and needs that are the most important in the world. Students must work through the projects (individual and team) to solve large-scale social and technical problems.

To implement these areas, an appropriate educational resources that have the characteristics such as redundancy and variety, interactivity, multimedia, a variety of forms of representation, measurement and control measurement, friendly interface and additional tools are needed.

In the context of technology transfer skills training, the authors propose to consider such core technologies that will help to implement innovation communications:

- tools of e-learning (software tools, online courses, teaching systems, educational measurement and evaluation of education quality, CASE-tools etc.);
- computer games for training, simulators, virtual labs, training designers and robotic systems;
- control systems of educational institutions activities of all levels (software, infrastructure solutions, integration solutions, BI systems, the control authorities of the region);
- training equipment (audio-visual equipment, multimedia systems, interactive whiteboards, handheld devices and technology, computers and peripherals;
- electronic library systems and equipment for the library, e-books;
- systems of effective communication in educational environment (video conferencing systems, facilities for webinars, recording technology and training video courses);

- services and consulting in education field (social services accreditation, quality management, business process reengineering, project management, CRM and marketing of educational services, website promotion, promotion of educational services in social networks).

3. DISCUSSION

Actuality analysis of potential of technology transfer from the early stages of technology development is caused the necessity to reduce the potential costs and maximum approximation the final technologies to consumer interests.

This statement is based on the fact that the evaluation of the cost effectiveness of innovation first of all is necessary to solve the problem of evaluating its results. The costs of developing new products is not evenly distributed at all stages of the innovation process and concentrated on development (average up to 15-20%) and technological production preparation (average up to 45-60%) stages. At the same time in the pre-design stage, when ideas related to product innovation are nominated and evaluated, is concentrated a small part of costs (average up to 5-10%). Therefore, the sooner the unsuitability of idea will be found, the less the cost of subsequent stages of the innovation process will be.

Therefore, the control points of technology transfer project set in such steps:

- completion of the audit of technology and determine the source of the technology;
- development of the idea of technology (or technology package);
- elaboration of technological processes and routes;
- coordination of project documentation (creation of engineering infrastructure, stage of commissioning, start-up process or enterprise).

Selection of high technology, which is optimal in each case for solving problem is a sophisticated task because the authors see crossing of areas of applications of technology and equipment developed by different companies. To make a right choice to solve a specific technological problem, it is necessary to consider all the limitations, as well as strengths and weaknesses (SWOT analysis) of each technology in comparison with competing technologies. Without real experience of using technology many of the distinctive technology characteristics remain unknown. Even with full knowledge of these characteristics and limitations, close (tolerant) relationship between technological methods that make multi-criteria selection of technology process for task is observed (Skorodumov et al., 2011).

Among approaches which allow to make gradual evaluation and change of technology and technology transfer process that minimizes potential damage in future the authors highlight start-up approach.

The main differences of start-up project from traditional enterprise development approach, according to experts of Estonian Foundation for Enterprise Development (EAS), are:

- project realization is characterized by high uncertainty of innovative product or service development project;
- project innovativeness, caused by using of innovative technology, innovative business model or a new way of customer satisfaction;
- existence of significant potential demand for established product/service or predicting its uneven growth in short term;
- availability of proactive thinking of startup company founders, ability to learn in process will gather opinions from customers, and lead process of developing products based on experience;
- decision about further project funding is based on consumer reviews;
- high performance and multiple return on investment in a relatively short period (from 3 to 5 years).

The basis of lean startup methodology is the most clearly consumption of resources (money, time and human). For this purpose, a scientific ap-

proach for development (introduction) of any new product, service or idea, formulated the hypothesis, held its testing, evaluation results according to metrics. Only if idea is successful it is done scalable. With growing the set tasks, the variety of technology parameters to be analyzed is the greater. Availability of test cycles will check the loyalty of findings and, in addition, will enable a more complete assessment of technology criteria, according to the latest trends in this area. This approach forms new perception of project results that naturally resonates with the concept of "acceptable quality" and is determined not only by the level of consumers query for product, but is also consistent with the project context (constraints).

In the context of high technology transfer, the concept lean startup is relevant, because it is based on the fact that the most of innovations in product do not have serious impact on consumers, thus complicating it, because each new option should be so necessary and attractive to a buyer was willing to make associated with it additional costs.

Figure 1 illustrates using startup methodology in high technologies transfer from the first stages of technology development.

Lean startup concept is based on such two main principles:

- within the approach basic principles is that instead of spending a lot of time on numerous researches and writing a business plan developer should consider the entire set of untested hypotheses good guesses. Thus, this is scheme of creation (formation) values for future consumers;
- lean startup concept is used to verify the assumptions of the method of the client. It consists of making inquiries of buyers about the characteristics of the products, pricing policies, etc.

Thus, according to startup approach a minimum viable product is initially created (principle "to give up something of value in the short-term for a larger benefit in long-term" (Keats & Schmidt, 2007). Since its establishment according this method, contact with the customer (potential user) again held. After repeated surveys, considering the recommendation of consumers, process is repeated.

This approach to market through the technology transfer is ideal for any start-up, because it contributes to a significant adjustment of ideas and minimizes the time on different studies (first principle of lean startup approach) and is very useful within the innovation management education.

World economy is at the stage towards the new technological revolution, which is based on different network and adaptive production solutions. In order to take all advantages of these new trends,

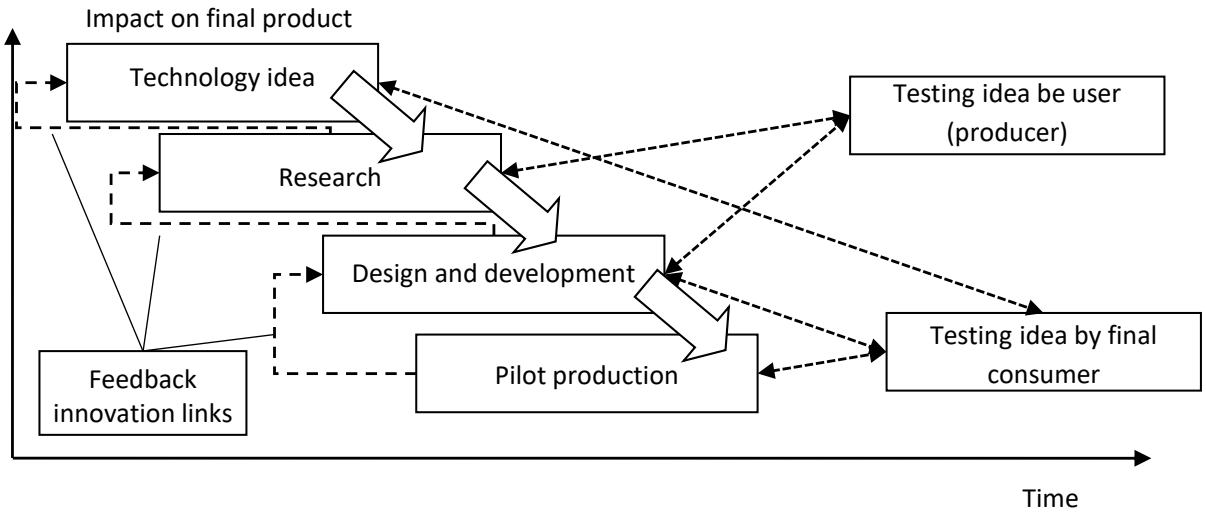

Figure 1. Startup methodology in high technologies transfer (developed by authors)

the radical changes in the labor market are needed according to changing requirements and, as a result, in education concepts, since human capital is the key success factor in new conditions of innovation economy. Therefore, now the nations need to start radically rebuilding the higher education system as a source of intellectual resources, modernizing the information and innovation communications of higher education institutions in order to create qualitatively new jobs and improve the technology transfer

A specialist in field of commercialization and technology transfer must possess a set of outstanding personal qualities: developed intelligence, ability to "sift through" scientific array, investors seeking skills and excellent organizational skills and imagination for transfer of scientific ideas from the mental space in a highly efficient fact of real life. Processing required tools for technology transfer organization, starting from mastering of basic methodology and finishing with features of marketing activities and business skills, communication on the early stages of research in the result of which is planned to get the product. Thus, systematization of interdisciplinary knowledge, motivational aspect, scientific creativity and practice of establishing external relations fit into the base of management approaches for technology transfer design.

In the paper, the authors propose to consider processes of technology development and technology transfer processes interrelated and based start-up methodology. As a result, based on the relationship with the consumer in the life cycle based on start-up methodology in technology development, evolutionary steps to improve some of its characteristics can be made and revolutionary technology may appear, replacing the technology and terminated its existence as an object of market relations. New approach for technology transfer competences formation is based on the fact that between the stages of innovation cycle, cyclic repetitions may occur as a result of technology transfer and can be considered as the commercialization of industrial technology.

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