УДК 330.341

L. A. Burganova, M. Missler–Behr

THE INFRASTRUCTURE OF TECHNOLOGY TRANSFER IN THE CHEMICAL INDUSTRY OF GERMANY

Keywords: technology transfer, institutions and mechanisms of knowledge transfer, infrastructure of knowledge transfer, Germany chemical industry.

The article describes the experience of Germany in forming the mechanism of technology transfer. The authors analyze the strategies of technology transfer, provide a description of the infrastructure of technology transfer and identify the role of universities and research centres in the production and transfer of knowledge and technologies in the German chemical industry.

Ключевые слова: трансфер технологий, институты и механизмы трансфера знаний, инфраструктура трансфера знаний, химическая промышленность Германии.

В статье рассматривается опыт Германии в создании механизма трансфера технологий. Анализируются стратегии трансфера технологий, дается характеристика инфраструктуры трансфера технологий, определяется роль университетов и исследовательских центров в производство и трансфер знаний и технологий в химическую промышленность Германии.

To create a strong national innovation system, which acts as the institutionalized communicator between the major participants – research centers, universities and industry, to provide the realization of transfer of scientific and technical knowledge and experience with high-tech processes, is one of the challenging task of research and development politics. From this point of view, the developed infrastructure of technology transfer is a key factor in creating an innovative economy, it is the most important source of economic independence of a state, providing its strategic opportunities, and, above all, the development of the internal market as well as its integration into the world economic system. This is clearly confirmed by the experience of Germany, which demonstrated convincingly that to gain the leading position on the world market does not need to have oil, gas, timber and other natural resources.

Before turning to analyze institutions that are active forms of regulation of invention and innovation in the chemical industry in Germany, let's give an interpretation of the key definition of our discourse – "technology transfer". Despite the fact that over the last 30 years, the issue of technology transfer acquired the status of widely researched and actively discussed, there is still no universally accepted definition of this phenomenon. Some researchers account for more than 30 definitions of technology transfer, seeing the cause of mismatch of research positions in the disciplinary affiliation of scientists and in the specifics of their set goals. For example, experts in the field of management focus on technology transfer stages (design, production and sale), and sociologists usually associate it with the innovation process [1, P. 630]. This extremely broad understanding of technology transfer is reduced to its interpretation as the exchange of technology, equipment and knowledge between individuals, enterprises, universities, research centers or governmental agencies at all levels [2, P. 2-3]. Narrow – interpreting it as the licensing process and the transfer of the patent from the university to the appropriate incubator client, and also as the process of converting university research in a commercial product [3], as organizational and economic solution for the transfer of technology from the developer to the industrial plants that provide implementation of technology in the production process [4].

In this article, we understand this phenomenon as a process of invention and technology transfer from research institutions (universities, laboratories, non-profit research centers) to other organizations involved in the production of goods and services.

Among the factors that have a profound impact on the success of Germany in the development of technology transfer, we should note an important role of the German Government, which integrates economic and technical policies with education, and implemented various strategies for Technology Transfer:

1. Orientation towards high technology. In this respect, the Government developed a unified national strategy for improving innovation in Germany, which involves the allocation of three percent of gross domestic product to invest in research and development. The government is implementing a targeted research funding – from the short-and medium-term research projects to medium-and long-term studies. Ministry of Economics and Technology and the Ministry of Education and Science design and implement special programs for urgent projects, aimed at achieving a high level of scientific research. Ministry of Economics and Technology supports especially small and middle enterprises, allocating grants for the implementation of joint projects, business organizations and public research centers [5].

2. Cluster policy aimed at stimulating clusters and networking technology transfer to improve the exchange of innovative technologies between industry and science. The German government has developed a number of measures in order to support high-performance networks, among which we mention the so-called Initiative "Kompetenznetze Deutschland" (Competence Net-

works Germany) aimed at fostering innovation networks in Germany for the exchange of information between potential investors and partners.

3. Commercial agreements on technology transfer, which are given a special economic importance. As such agreements may be not only a positive factor, but also threaten the economic efficiency if the competitors will be able to drive a bargain on redistribution of the market among themselves, or the development of certain obstacles for connecting innovative technologies to the market, the government has adopted a series of laws and regulations on the establishment of networks for such technology. This provides a balance between the protection of competition and the protection of intellectual property rights. The activities of these networks financed from federal grants and income from performing contract research.

It is important to emphasize that in Germany there is no centralized mechanism for the organization and control of research and empirical design activities, which would coordinate research and identifies priorities. German law provides for a limited influence of the federal government's choice of priorities and goals in research that improves the capabilities and incentives of various actors of innovation, primarily universities and research centers, encouraging them to seek different approaches to resolve certain issues.

At the same time a great responsibility and interest in the organization of technology transfer, in the creation of science parks and innovation centers share local authorities, particularly the state governments, that are considering this activity as one of the most important areas in the solution of problems of regional development.

The most important elements of the infrastructure of technology transfer in Germany are non-profit educational and research centers, which forms of participation in technology transfer to industry are diverse.

In Germany there is a wide range of higher education institutions. Total Number of Universities in all of the 16 federal states in Germany is 418; among them the most active in research for industry and in the transfer of knowledge are Universities (Universitäten) and Universities of Applied Sciences (Fachhochschulen), which receive financial support for education and research from the federal governments, as well as same special financing programs from the state government. Since the beginning of 1970s universities began to receive third-party support from the industry, and in the period of 1970-1980s the averaging proportion of third-party support was about 24% of their university budget, and in the next decade in 1980-1990s the proportion increased to 44% [2, P. 274]. Of course, the highest priority was given to research in physics, mechanics, chemistry, computer science and biotechnology.

In the early 1980's German universities have established a special working group of university chancellors, who specifically oversaw this process; and the Ministry of Education and Research has initiated a research project named "Project Society» («Project Wissenschaft»), which was focused on the problem of technology transfer. In the mid-1980s the German Science Council published a recommendation on the transfer of technology. As a result the strict guidelines relating to the budget of the University and responsibilities of university staff as well as the management of technology transfer (for example, external institutions were created) were changed. For example federal state technology transfer centers were founded. According to its expenditure on scientific research they occupy the second position after the economy.

German universities are establishing regular contacts with industry, carrying out not only fundamental research, application-oriented research, but numerous design and construction studies. Between universities themselves also various types of cooperation for pushing forward joint projects, research and knowledge transfer were formed, including in chemical industry. It should be noted that in Germany there is a well-developed infrastructure of interaction between the universities and the chemical industry: 54 universities have chemistry departments, 24 universities are engaged in applied chemical research [6].

Collaborative research between German universities and the industry in the field of chemistry has a long tradition. Chemical companies throughout their history, often signed contracts with university scientists and institutes for consultations. Moreover, the chemical industry by 1950 created a special fund (Fonds der Chemischen Industrie) to support university research, so scientists began to receive funds to carry out their investigations, not necessarily related to a specific order. This assistance has helped to broaden the scope of university research particularly in the core activities. For example, from 1995 to 1997 the Fund has invested 21.7 million German marks for this purpose. On the territory of the largest chemical companies in Germany there are chemical parks (BASF Ludwigshafen, Bayer Industrial Park Brunsbutten etc.), which serve as a platform for interaction between universities and businesses, primarily in the form of exchange of information, transfer of innovative technologies for introduction into production [7]. Chemical industry showed a good example of establishment a stable long-term relationship and cooperation with universities.

Of course, collaborative and contract research – this is only one element of a mechanism for technology transfer. University scientists presented their research results in scientific papers or speeches at conferences; conferences were the most important channel of communication as scientists discussed together with representatives of the business class about the opportunities of industrial application of scientific results. Knowledge transfer also was carried out on the base of various scientific associations, whose members represented not only scientists, but also the members of business community.

Universities, regional and state governmental organizations as well as same large companies also developed such institutes of technology transfer, as technology centers and science parks, aimed at creating technology-oriented businesses near universities. Close cooperation with universities allows enterprises, especially small and middle enterprises, to exploit university equipment, and get intelligent support in the form of scientific expertise of their projects. The creation of

such firms in the technology centers is advantageous for the universities, as they can bring them additional income.

Besides the universities, in Germany also such effective technology transfer agents were developed as non-government, non-profit research institutes. Among them the leading role belongs to societies, that have received international recognition – the Max Planck Society (Max-Planck-Gesellschaft – MPG) and Fraunhofer Society (Fraunhofer-Gesellschaft – FG). Each of these companies is composed of research institutes and special organizations on technology transfer. Both are funded by the government on the same pattern, called the model MPG / FhG.

MPG is second in the world rating by the number of publications in prestigious scientific journals (after Harvard), by the number of prestigious awards in front of it, too. In its institutions there are 17 Nobel laureates in physics, chemistry and medicine.

MPG was founded in February 1948, today it unites 80 institutes and research institutions in Germany, as well as 15 research centers and temporary research groups. In different MPG institutions there are about 16,873 employees, including researchers from other countries. Among the academic staff foreigners make up 26% (including the heads of departments – 27%), and among graduate students – 40%.

MPG specializes in conducting basic research in three areas of knowledge. The first of these integrates research in chemistry, physics, engineering (50%), the second in biology, medicine (38%), and the third covers the area of humanities and social sciences (12%). Since the MPG studies focus on fundamental long-term research problems, there was no place for an institution that would realize engineering application tasks [2, P. 304]. MPG institutes conduct costly studies (which is unaffordable for many universities) in the areas of strategic importance to the industry, though on a more powerful scientific and technical basis in comparison with universities.

MPG has very modest budget, in 2011 it was amounted to 1.4 billion euros, and 95% of this sum was generated from the budget [8]. Basically it is the income from federal and state budgets (in equal parts), and 5% are private donations, contributions from member organizations and earnings, including revenues from the sale of licenses. The new agreement on investment in science and innovation provides an annual investment growth of five percentage up to 2015. In total, this amounts to about 2% of all research spending in Germany.

The most important MPG channel for technology transfer is the exchange of scientists. Almost all MPG institutions are located near major universities, and many of the institutes professors teach at local universities as well as students and graduate students fulfill their thesis research in the laboratories of the Institutes. Very popular in the MPG institutions are schools for young scientists in different scientific fields, which annually invite over thousand people from different countries.

It should be noted that among the employees of MPG institutions there is very high proportion of Ph. Ds, especially in the first study group (chemistry, physics, engineering), and many of them go later to work in the industry, thus carrying out the transfer of knowledge. For example, the Institute of Polymer Research (Max-Planck_Institut fur Polymerforschung) get in touch with many German and foreign enterprises of the chemical industry. It uses as channels of knowledge transfer publications, exhibitions and conferences. It is important to note that MPG research contracts provide the open nature of publications and open access to all of the results of scientific investigation.

Another knowledge transfer example represents the Institute of Biochemistry (Max-Planck_Institut für Biochemie), which is located in a suburb of Munich near such institutions as medical clinic, Center for Genetic Research or the University of Munich. The Institute of Biochemistry isa good example of the integration between basic and applied research between universities and industry. It conducts interdisciplinary research together with applied clinical studies, and the institution serves as the nucleus for the biotech incubator, because there are situated the companies that produce biotechnology.

Scientific activities of each MPG institution is under control of an independent scientific council, which includes the world's best scientists in their field. Twice a year, the Board provides the expertise of employee`s activity, the results of which form the basis for recommendations to improve research.

Although the mission of the MPG Institute is conducting especially basic research, they are able to earn income from the sale of patents and licenses. In 1970 MPG established in Munich an independent company for technology transfer under the name of «Garching Instrumente GmbH» (in 1979 it was transformed into «Garching Innovation GmbH»). The mission of the company is to identify inventions produced in MPG institutes as commercial successful ones, and help promote them to market. Since 1979, the company sold more than 2,300 inventions for a total of 168 million euros and handed over more than 600 licenses to foreign companies.

In contrast to the Max Planck Society Fraunhofer Society (Fraunhofer-Gesellschaft – FhG) is focused primarily on applied studies. FhG was founded in 1949 in order to facilitate the introduction of new technologies in the industry and carry out research of national importance (eg in the field of environmental protection and energy conservation). The system of FhG research institutions includes most research institutes in Germany (among them 60 institutions which are located in more than 40 cities in Germany).

It is an interesting fact that the FhG is permitted to enter into contracts with foreign partners and offices around the world: among their partners are U.S., China, Japan, South Korea, Malaysia, Singapore and Indonesia. In 2005, a FhG office was opened in Russia, where, in particular, were concluded contracts for logistics in the amount of 1 million EUR [9].

Research budget of the association is more than 1.3 billion euros, 70% of which comes from contract research. In FhG there are more than 18,500 employees with an engineering and technical education. The vo-

lume of research for the year 2011 amounted up to 1.66 billion euros, including 1.40 billion Euros earned for realization of orders received from industry and public research projects [10]. 30% of their activity is funded by the federal states from central funding programs. FhG applied research conducts on such issues as health and nutrition, safety, information and communication, transport, energy and housing, manufacturing and defense.

FhG itself is an important institution of transfer, the glue between academic research and applied studies. Important FhG channels for technology transfer are research contracts with the industry, as well as contractual research projects as part of public or governmental programs such as health care, environmental protection, infrastructure, telecommunications, improve technological competitiveness in the world markets of Germany, etc.

Relations between FhG and industry are an important but not the only mechanism of technology transfer. Also we should mention such mechanism as the linkages between basic and applied research. And in this regard are extremely important FhG contracts with universities, which are located in the neighborhood. There are widespread practices as combining the position of an University Professor and the FhG Institute membership, the election of individual professors in Institute Advisory Council, which gives them the opportunity to get a complete picture of the directions of FhG research activity.

Knowledge transfer between the universities and the FhG institutes is based on mutual interest: FhG Institutes may participate in the fundamental research of the university closely with academic researchers. At the same time, universities get acquainted with the needs of applied research, FhG Institute members are also faculty members, and can have a direct impact on research policy.

Thus, the German experience proves that governmental support of innovation can be very effective if it is carried out on the basis of independent non-profit research institutions who take on the role of knowledge transfer from universities to industry.

Bibliography

1. Bozeman B. Technology transfer and public policy: a review of research and theory, Research Policy, 29, 627-655 (2000).
2. Abramson, H. N., J. Encarnacao, P. R. Reid, and U. Schmock (eds.). *Technology Transfer Systems in the United States and Germany*. Fraunhofer Institute for Systems and Innovation Research, National Academy of Engineering, Washington, D.C., 1997.- 448 p.
3. Hodgkins, E. A. *NCHRP Synthesis of Highway Practice 150: Technology Transfer in Selected Highway Agencies*. TRB, National Research Council, Washington, D.C., Dec. 1989.
4. Еськов М.С. Управление трансфером технологий в промышленном секторе: Автореф. дис. канд. экон. наук.. Специальность 08.00.05 – экономика и управление народным хозяйством. С.-Петерб. гос. ун-т экономики и финансов, СПб, 2005. – 15 с.
5. *Гатина Л.И.* Сравнение механизмов поддержки инновационного предпринимательства в России и Германии (на примере химической отрасли), Вестник Казанского технологического университета, 16, 3, 273-278 (2013).
6. Гатина Л.И., Натапова Н.В. Трансфер технологий в промышленности по переработке углеводородного сырья (опыт Германии), Вестник Казанского технологического университета, 15, 5, 215-216 (2012).
7. Сергеева З.Х. Роль химических парков в развитии инновационных технологий в сфере переработки углеводородного сырья (опыт Германии), Вестник Казанского технологического университета, 15, 1, 250-258 (2012).
8. URL: http://www.mpg.de/institute (Free access mode. Date of invoking: 25.12.2012).
9. URL: http:/www. mintrans73.ru/index3_151.htm (Free access mode. Date of invoking: 20.12.2012).
10. URL: http:/www.fraunhofer-forschugsthemen (Free access mode. Date of invoking: 23.12.2012).

L.A. Burganova - д-р социол. наук, проф. каф. государственного, муниципального управления и социологии КНИТУ, labourg@yandex.ru; **M. Missler–Behr -** Dr. Professor of the Chair for Planning and Innovation management of Brandenburg University of Technology, Cottbus, Magdalena.missler-behr@tu-cottbus.de.