The German-Russian academic year 2012/2013 offered an outstanding opportunity to discuss overarching themes of German-Russian academic collaboration, to exchange experiences on both sides and to develop prospects – also for further bilateral collaboration. 120 participants from Germany and Russia met in April 2012 at the University of Kassel for the German-Russian Symposium on “Knowledge transfer – the new core task of Higher Education Institutions”.

The contributions in this volume document the aspects of knowledge transfer presented and discussed at the conference. They cover the economic relevance of the Higher Education Institutions for the regional innovation process as well as the strategic role of knowledge transfer back from economy and society to the universities. Best practice examples of innovative concepts and models of knowledge transfer are given by university representatives from Russia and Germany.

The second subject priority sheds light on the bilateral relationships between Germany and Russia in the reciprocal “Knowledge transfer” – the bilateral collaboration in research, teaching and technology.
Reihe OST-WEST-DIALOG
Gabriele Gorzka (Ed.)

Knowledge Transfer
The New Core Responsibility of Higher Education Institutions
Practice and Perspectives in Russia and Germany
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Introduction

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The German-Russian academic year 2012/2013 offered an outstanding opportunity to discuss overarching themes of German-Russian academic collaboration, to exchange experiences on both sides and to develop prospects – also for further bilateral collaboration.

120 participants from Germany and Russia, including more than 40 Rectors and representatives of higher education management, met from 24th – 25th April 2012 at the University of Kassel for the German-Russian Symposium "Wissenstransfer – die neue Kernaufgabe von Hochschulen. Innovationsförderung regional und international: Erfahrungen und Perspektiven in Russland und Deutschland" (Knowledge transfer – the new core task of Higher Education Institution (IHEs). Promoting innovation both regionally and internationally: experiences and prospects in Russia and Germany).

Knowledge transfer has developed as a 'third pillar' in addition to research and teaching and, in terms of the development of IHEs and the integration of it into the regional and international network of relationships, is being perceived and supported as an increasingly important university education and economic factor. This has been the case in Germany since the 1990s with the result that there is a body of experience with different models, and this is true partially also in Russia, where there is great interest in an exchange of information on the subject.

The subjects of 'technology transfer', 'start-up support' or 'further education' are being given more weight in German IHEs. 10 years ago they might have been characterized as marginal or supplementary to the core activities of teaching and research, but now belong to the range of tasks that determine the profile of an IHE and are categorized as relevant strategic variables. This is attributable among other things to the growing autonomy of IHEs that makes it possible to set individual priorities as well as to the increasing competition for national and international location advantages to attract new students, excellent scholars and financial support. The starting point for the stronger orientation towards knowledge transfer is the experience that IHEs represent value-added for the local community by

- carrying over competences via students and graduates to the region concerned,
- initiating new processes and products via joint research, for example with businesses, or
- giving impulses through participation in social, political, cultural and ecological development processes in their region,
- and not least actively supporting new start-up businesses that emanate from the academic world.
But what demands the community in its turn makes of the IHE and how the latter reacts to them, what new forms of academic training develop in response and how the IHE begins to understand itself as an institution that provides increasingly more effective professional qualifications in addition to research and teaching are all further aspects of transfer.

The innovation mechanisms proposed and the methods used to measure them will be discussed in the present volume from a German and Russian perspective. The contributions in this volume document the aspects of knowledge transfer presented and discussed, with an introduction by the Bundesministerium für Bildung und Forschung (Federal Ministry of Education and Research) and the University of Kassel.

Michael Schlicht, Director Cooperation with Russia, CIS, Federal Ministry for Education and Science, emphasizes the importance of bilateral co-operation in the face of global problems and outlines four strategy areas in which German-Russian collaboration could be designed in future.

Martin Lawerenz, Vice-President of Kassel University, in his address makes it clear that knowledge transfer was introduced in Kassel early on as a University policy of structural importance and makes reference to the diverse international transfer activities with Russia via the projects of the East-West Science Centre.

On the general subject of "Knowledge Transfer and Innovation" the economic importance of research institutions and IHEs for regional development is discussed. Vladimir Kiselev, Head of the Interdepartmental Analytical Center in Moscow, draws up a ranking of Russian regions according to their innovation potential, climate and output and compares it with Western European regions.

The strategic importance of knowledge transfer for IHEs is the subject of the papers of leading Russian universities. The chances of leading universities, together with industry, to close the gap currently existing in Russia between academic training and the requirements of an innovative economy, are described by Viktor Koksharovsky and his colleagues at the head of the Federal University of Ural using the example of their own University. Alexander Grudzinskiy and Alexander Bedny, National Research University of Nizhnij Novgorod, develop a knowledge tetrahedron as functional model of an innovation and market-oriented university focused on the training of innovators.

German best practice examples of innovative concepts and models of knowledge transfer are presented by the heads of the transfer unit of the University of Applied Sciences Münster as the prize-winning university in the competition of the German Stifterverband für die Deutsche Wissenschaft" and the unit UniKasselTransfer of the University of Kassel. For Russia the National Research Tomsk Polytechnic University and the St. Petersburg National Research University of Information Technologies, Mechanics and Optics – represented by their Rectors Petr Chubik and
Nikolai Toivonen – present their goals, strategies, practical experiences in knowledge and technology transfer.

**Transfer of knowledge and technology between Russia and Germany**

The second subject priority sheds light on the bilateral relationships between Germany and Russia in the reciprocal "Knowledge transfer" – the bilateral collaboration in research, teaching and technology.

There has been intensive collaboration between the two countries in research since Soviet times. This was continued in the 1990s by the National Joint Research Programmes in the fields of space travel, high temperature conductors, climate, sea and polar research, biotechnology and currently nanosciences. The National Academic Programmes are accompanied by more than 20 researcher groups of individual academic organizations, such as DFG-Graduiertenkollegs (associations for PhD students funded by the German Research Association) or Max-Planck Young Scientists groups, and not least the research associations of project groups in the individual IHEs.

In teaching, over 800 institutional partnerships have emerged from historical contacts, which have expanded into German-language degree programmes in Russia (currently 5 – according to DAAD survey 2011), centres for German Studies (9), bilateral degrees and increasingly also about 20 jointly structured degree programmes.

The symposium discussed in which subject areas and levels of academic exchange there has been intensive co-operation in recent years, which experiences the actors in IHEs and research institutions had made, in order to find out which future common interest areas or fields of action turn out to be priority areas for co-operation and which additional strategies appear to be reasonable to achieve the goals of intensifying German-Russian co-operation. That there is a need for action is shown by an examination of the aspect of the mobility of the academics between the two countries. A current survey of all German academic organizations (study of HIS and DAAD 2011)¹ shows that Russia occupies only 11th place among the countries where German academics spent a research period of more than one month in 2009. By contrast Germany is the number one target country for Russian academics spending a several month research period abroad. The results of the survey reveal an imbalance in partnership co-operation, and the question is: what political means or incentives might be deployed to redress the balance.

The individual presentations give an insight into project activities, communications structure, project goals and results as well as prospects of future interaction. These

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include the collaboration, funded by the Russian government with "mega grants", between the Karlsruhe Institute of Technology and the State University of Novosibirsk in the study of Pulsed Power and Microwave Technology or the cooperation of the Koch-Metschnikow Forum with Russian universities to combat infectious diseases.

Bilateral collaboration in teaching, joint German-Russian degree programmes and graduate centres is illustrated by the first German-Russian doctoral programme in pharmaceutical chemistry between the Universities of Gießen and Marburg and the Russian Academy of Sciences and the State University of Moscow.

Valerij Ivanov, Rector of the International Academy for Business and New Technologies in Yaroslavl, describes the development of city-university partnership that has been in existence for 20 years between Kassel and Yaroslavl on different levels in society: culture, business and education.

Supplementing the reports Helene-Olesja Betuch of the Fraunhofer Zentrum für Mittel- und Osteuropa (Fraunhofer Centre for Central and Eastern European Studies) presents the results of a qualitative data collection on German-Russian transfer of environmental technology.

The German-Russian comparison with respect to the transfer systems and relations between universities and business by E.Demarchuk is part of a Master's thesis completed in 2012 at the University of Kassel.

The consideration of theoretical approaches to knowledge transfer, political strategies in support of innovation, practical experience and future scenarios in both countries presented here offers clues for future interest areas and fields of action and, because of its bilateral orientation, in turn creates a building block in the German-Russian system of knowledge transfer.
Welcome Address

Michael Schlicht

Ladies and Gentlemen,

It is a great pleasure for me to be able to welcome you here today on behalf of the Federal Ministry of Education and Research. I would like to convey best wishes from Federal Minister Schavan and State Secretary Schütte, who are unfortunately unable to be present.

The BMBF is supporting today's symposium "Knowledge Transfer – the New Core Responsibility of Higher Education Institutions" as a particular highlight in the German-Russian Year of Education, Science and Innovation.

Together with Tomsk Polytechnic University, the University of Kassel is studying the current and future role of institutions of higher education in promoting innovation. They are thus dealing with a topic which is high on the political agenda in both Germany and Russia.

Both countries are witnessing a situation whereby scientific and technological transfer is becoming more and more of a mainstay alongside the traditional tasks of teaching and research.

Russia has been making a considerable effort recently to strengthen not only university research but also the translation of results into practical applications.

Germany is leading the way in Europe in this field. Since the 1990s, we have been funding clusters and networks throughout Germany where our research institutions and institutions of higher education collaborate with industry to study and develop new technologies.

Our cooperation is based on a common basic understanding: Germany and Russia agree that research and development can no longer merely be considered within national borders.

This realization is simple and does not only apply to the bilateral German-Russian relationship, but is a global process:

We must work together in order to find solutions to the outstanding questions of our age – let me just mention climate change by way of example, or the question of how we will be able to not only maintain but also improve our standard of living whilst at the same time using fewer natural resources. Together we can develop solutions and work towards overcoming the problems and challenges that affect us all.

The German Government has therefore approved a Strategy for the Internationalization of Science, Research and Development. It is our answer to the challenges of global competition that face our science and innovation system.
We want to systematically extend our cooperation with the world's best and jointly open up the potential for innovation. We are hereby focusing our attention on countries and regions whose economies are developing at a particularly dynamic rate. These include the so-called BRICS states. New markets are springing up everywhere in these countries and offer potential for cooperation with German partners. At the same time, this new dynamism is also affecting the countries' research and innovation systems, resulting in opportunities for research cooperation and innovation partnerships.

This applies quite particularly to our cooperation with Russia. Germany and Russia have been good and reliable partners in science and research for a long time. The Treaty on Scientific and Technical Cooperation that was signed during the Soviet era was amended and modernized in 2009. Bilateral relations have developed tremendously since then and have gathered pace.

In 2005, Germany and Russia established a Strategic Partnership in Education, Research and Innovation. Both sides intend to consolidate and extend the relations between research institutions, higher education institutions and companies. This is precisely the goal that we are pursuing with the current German-Russian Year of Education, Research and Innovation. Working together with important stakeholders in education, research and industry, we intend to underline the successes of our cooperation to date and at the same time get new programmes underway.

The German-Russian Year was initiated by both governments and is due to run until the end of May. We already have every reason to claim that it has been a great success. So far, more than 150 events have taken place in both countries on issues that are important for the future. Science and research organizations, institutions of higher education and commercial companies in both countries have played an active role in Science Year under the motto "Partnership of Ideas".

We have now decided to extend our cooperation in four strategic areas:

1. We want to strengthen our cooperation in the field of cutting-edge research and have introduced decisive measures over the last few months.

   On the one hand, we have taken steps to promote the mutual opening of existing research structures and have agreed new cooperation projects, e.g. in the field of supercomputing.

   But more important still, we have pushed ahead with the foundation of new, joint institutions and laboratories. A German-Russian institute was recently founded at the University of Ulm. The institute's research into energy-relevant nanomaterials is significant for future battery technologies and promises progress in the field of electromobility in particular.

   Parallel to this, both Ministries have made considerable progress with joint project funding. Summer 2011 saw the publication of a Russian call for proposals which corresponds to the BMBF's call in the field of environmental and sustainability research. The first jointly funded projects emerging from these coordinated
competitions began in the course of the Science Year. We intend to extend this promising cooperation to other fields of research in future.

2. We want to expand bilateral exchange programmes in vocational training; Russia is one of the priority countries in our cooperation on vocational education and training. The Federal Institute for Vocational Education and Training (BIBB) signed a cooperation agreement with the newly founded Russian Federal Institute for Educational Development (FIRO) at the launch of the Science Year in Moscow on 23 May 2011. A German-Russian vocational training conference took place in Kaluga at the end of March and is pointing the way for future developments.

The Committee on Eastern European Economic Relations is involved in this work with its companies and plants in Russia.

The new DAAD programme, "Russia in Practice", was introduced as a new component of the "Go East" initiative in 2012. There are plans to fund the first 30 scholarship holders with effect from October 2012 and to provide funding for 50 scholarship holders per year from 2013 onwards.

3. Thirdly, we want to expand German-Russian partnerships in order to speed up the translation of research results and new technologies into marketable products and services. Here too we have made good progress. Several German-Russian innovation conferences and expert workshops have taken place over the last few months, and there are plans to hold more.

Last autumn saw the publication of the fourth joint call by the BMBF and the Russian Fund for Assistance to Small Innovative Enterprises (FASIE). Together we are funding projects in the field of applied research involving Russian and German SMEs and research institutions. This funding instrument is making an important contribution to developing German-Russian innovation partnerships.

4. Our fourth goal is the joint promotion of young research talent and the intensification of exchanges between our two countries.

The Science Year is helping young scientists in Germany and Russia to get to know and understand each other better, and is supporting joint learning and research. Many events in the Science Year are thus specifically addressed to young scientists.

For example, the first German-Russian "Week of the Young Researcher" took place at the Federal University of Kazan under the motto "Man and Energy". Around 50 PhD students, post-docs and professors from both countries presented their research in the areas of energy management, the energy industry, long-term resource planning and new forms of energy.

Students and young researchers are also actively involved in the so-called "living exhibition" on "German-Russian Marine and Polar Research – Focuses of Collaboration".

In order to maintain and take advantage of the momentum of the Science Year, the BMBF is investing additional funds in enhancing the presence and visibility of
German research excellence in Russia. Under the new "Russia and Germany – Partnership of Ideas" campaign, which was launched in March and is due to run for two years, we are funding strategic measures to make it easier for German research institutions and innovative small and medium-sized enterprises to expand their cooperation with partners in Russia.

I am confident that the German-Russian Science Year as well as the new campaign will benefit both Germany and Russia and will be to the advantage of cooperation between our two countries. I hope that your discussions here in Kassel will be successful and wish you all the best for your work and for the further development of relations between Russia and Germany.

Thank you very much.
Welcome address

Martin Lawerenz

Dear ladies and gentlemen,

The University of Kassel is pleased to host the Symposium on "Knowledge Transfer" which is one of the main events in the German-Russian Year of Science 2011/2012. Already in 2003, the University of Kassel has included knowledge transfer into the university strategy. An institutional unit called UniKasselTransfer was created within the University of Kassel which nowadays supports various knowledge transfer interactions between science and society.

From basic research to application is the mission of the University which is a calling for all university disciplines. Accordingly, the knowledge transfer is seen as a wide spectrum of activities starting with patent marketing and promotion of business start-ups, in-service trainings, career Services and cooperative study programmes, and ending with Service learning. The main focus here is co-operation in education and research with external partners from the business sector as well as from other sectors of society.

Last year, the Senate of the Kassel University has established the first comprehensive transfer concept. The objectives of this concept should be achieved within next 5 years. It is important for us that knowledge transfer creates positive effects in the area of education and research which are already proven by multiple best practice examples. Therefore, we strive for strengthening of the knowledge transfer interactions.

I am pleased that in the frame of this event we have an opportunity to share the experiences of knowledge transfer development not only with German but also with Russian colleagues. Among the Speakers and participants of the Symposium are university rectors, heads of transfer units, representatives of ministries, universities and business associations, funding agencies as well as managing directors of German-Russian research and education projects who due to their competence and experiences will fill the Symposium with exciting lectures and stimulating discussions.

The Symposium is being organised by the East-West-Science Centre (OWWZ) of the Kassel University in co-operation with the Tomsk Polytechnic University and New Eurasia Foundation, Moscow. The event was supported by the German Association for East European Studies (DGO) and generously sponsored by the German Federal Ministry of Education and Research (BMBF). The Symposium also provides an opportunity to celebrate the 20th anniversary of the East-West-Science Centre. In 1992, the OWWZ was established at the University of
Kassel as a Service facility. Meanwhile, it has grown into a nationally recognized institution which initiates and supports scientific co-operation with countries of Central and Eastern Europe.

The OWWZ offers information on research and education in Eastern Europe and Germany and initiates cooperation projects in this area; the East-West-Science Centre provides consulting services on financing and intercultural management of East-West projects, it organizes scientific events; and the current Symposium is among them.

Russia is a strong partner country of Kassel University. Since 1989, the University has had strong links to higher education institutions in the partner city of Yaroslavl. The sustainable partnership between the University of Kassel and the Tomsk Polytechnic University has connected the institutions for many years. Besides, the University of Kassel has cooperation agreements in education and research with universities in St. Petersburg, Ufa, Irkutsk, and Yekaterinburg.

Research competencies in Russia made this country the most important cooperation region for the East-West-Science Centre. Currently, the OWWZ coordinates three federal projects:

- **German-Russian Co-operation Network Biotechnology (2005-2013)**
- **German-Russian Network Environmental Research and Technologies (2009-2010)**
- **German-Russian Network NanoBRIDGE (2012-2014).**

The University of Kassel together with the North Hessa region are attractive for Central and Eastern Europe, particularly in new environmental technologies: we carry out scientific consulting projects in the fields of regional energy concepts, energy efficiency, and climate protection policies.

Our environmental qualification programme in Russian language gained very positive publicity. Since 2011, the East-West-Science Centre and UniKasselTransfer together with regional enterprises organize intensive seminars for experts from industrial, research, and administration sectors. During the seminars, the professionals from the Eastern Europe have an opportunity to establish contacts with the German business sector. One of these regional enterprises is the Kassel University spin-off SMA Solar Technology AG (SMA) which is an excellent example of innovation spun out of higher education institution. The excursion to the SMA which is a part of the Symposium programme will surely illustrate a best practice example of knowledge transfer in Germany.

I wish all our guests and all participants a successful symposium and impulses for the further development of cooperation between our countries.
I. Knowledge Transfer and Innovation
Approach to Assess the Role of Universities and Research Institutions in Quantitative Analysis of Innovation Potential of Russian Regions

Vladimir Kiselev

Under modern conditions, while firms' competitiveness at national and global markets is mainly determined by the terms of their innovation development, very few people have doubts concerning the positive role of such phenomenon as knowledge transfer. The knowledge transfer between universities, research organisations and firms and in general, within the framework of the regional innovation system, establishes a special kind of climate which is certainly favorable for innovation development and economic growth.

It is often considered that high number of researchers and high number of students in a country or in a region mainly determine the high rate of knowledge diffusion and hence high rate of innovation potential of the territory. When we speak about the country level, this consideration can be taken as correct, but as far as regional level is concerned, the situation seems to be different. I will try to prove this with the following example of benchmarking analysis.

The current interest to assessment of knowledge diffusion on the part of regional authorities of the Russian Federation (RF) is explained by the fact that in many regions innovation strategies and programs are being implemented andbenchmarking exercises showing the role of knowledge in economic development are regarded as sources of important information for management. Another powerful factor which explains interest to such analysis is the process of globalization and increasing competition at global markets of goods and services. In this respect innovation performance analysis at regional level allows to optimize managerial efforts to enhance competitiveness of regional economy.

In the Russian Federation there are 83 regions that are very different in their population and territory, in their economic capacity and natural resources, in the number of firms, universities and research institutes, etc. Many regions in the framework of their innovation policies provide considerable support to innovative firms and thus improve innovation climate at their territory. At the same time some regions do not have financial resources to support innovation and mainly rely on the federal funding. Another factor – some Russian regions inherit historically established R&D and higher education institutions that are supported through the

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1 Three regions of those 83 are Nenetski autonomous district, Khanty-Mansi autonomous district and Yamalo-Nenetski autonomous district. These autonomous districts are assessed together with the regions they make part of: Arkhangelsk oblast (Nenetski) and Tiumen' oblast (Khanty-Mansi and Yamalo-Nenetski).
federal budget allocations. Very often those institutions are considered as part of regional innovation potential, though regional money do not play a role in their activities.

All these specific features had to be taken into consideration in order to "clean up" results of the comparative regional innovation analysis from the federal policy influence. At the same time in order to avoid the effect of the scale of regional economies the comparative innovation analysis should be based on relative indicators' values.

The following comparative analysis of innovation activity of the Russian Federation regions has been accomplished on the basis of original system of indicators according to the data of 2008 official statistical survey. Results of the analysis allow to compare Russian regions between themselves by values of their Regional Summary Innovation Index (RSII), as well as to distinguish four clusters of leading regions: by innovation potential, by innovation climate, by economic output of innovation activities and by coefficient of the use of innovation potential.

**Historically established centres of research and higher education in Russia**

While formulating indicators for the Russia region's innovation analysis we should take into account that there are several historically established centres of R&D and higher education in the country that have been established and developed through national support and certainly cannot be regarded as results of regional efforts. At present, organisations in those centres are funded mainly through the federal budget, though these institutions are free to carry out contract research and personnel training for regional firms and enterprises.

The main research centres in Russia (by the indicator "number of researchers, head count", 2008) are: city of Moscow (135611), city of St. Petersburg (46743), Moscow region (37954)\(^2\), Nizhniy Novgorod region (18591) and Novosibirsk region (10784)\(^3\). These figures shows that distribution of researchers in Russian regions is very uneven. For example, number of researchers in Novosibirsk region, which holds the 5\(^{th}\) place in the country by this indicator, is almost 13 times less than in the city of Moscow.

Main higher education centres in Russia (by the indicator "number of students per 10 000 population", in 2008/2009) are: city of Moscow (1249), city of St. Petersburg (1001), Tomsk region (884), Magadan region (697), Novosibirsk region (646), Khabarovsk territory (638), Samara region (568). For comparison – the Moscow region (territory around the city of Moscow) and the Leningrad region (territory around the city of St. Petersburg) had the following values of this indicator correspondingly: 257 (75\(^{th}\) place in the Russian Federation) and 112 (80\(^{th}\) place in the

\(^2\) The city of Moscow and the Moscow region are different subjects of the Russian Federation.

\(^3\) Source: Rosstat, Regions of Russia, Socio-economic indicators, 2009.
Russian Federation)\textsuperscript{4} while their population is comparable to that of their capital cities.

In general the above mentioned historic inter-regional distribution of R&D and higher education capacities does not distort indicators of the national innovation potential, but from the point of view of regional comparisons it may lead to wrong conclusions if not regarded correctly.

**Some peculiarities of regional innovation policies**

At present there is rather active process of establishing regional innovation systems in Russia and regional governments play prominent roles in the process. This process includes: a) elaboration and adoption of regional legislative framework to regulate innovation activities; b) elaboration and adoption of regional innovation strategies and programs; c) establishing elements of regional innovation infrastructure; d) carrying out innovation related regional studies etc.\textsuperscript{5}. Successful innovation projects and programs contribute to establishing positive innovation climate on the territory of the region. For this reason all initiatives of regional governments aimed at stimulating innovation activities are important factors that determine innovation climate in the region. Regional innovation policy is an important development factor especially for those regions whose innovation potential is, or in future could become, an important competitive advantage.

In this connection in order to correctly assess the level of regional innovation activity it is expedient to take into consideration indicators that characterize regional governments' efforts to stimulate innovation, aimed at establishing innovation promoting conditions at the territory of the region. Financial resources spent within the regional innovation programs and projects and corresponding expenses of regional firms and enterprises, number of established regional innovation infrastructure institutions, etc. should be taken into consideration as innovation promoting factors as well.

**Some notes concerning Russian innovation statistics**

One of the problems in carrying out comparative innovation analysis of the Russian regions is rather poor statistical data on innovation activities at regional level, which allows only approximate international comparisons of Russian regions. It is necessary to mention that at present the Russian Federation Statistics Service (Rosstat) does not collect data on the following indicators that are used in regional innovation surveys in other countries (for example in Community Innovation Surveys): participation in life-long learning, employment in medium-high & high-

\textsuperscript{4} Ditto.

\textsuperscript{5} National innovation system and state innovation policy of the Russian Federation, Background Report to the OECD Country Review of the Russian Innovation Policy.
tech manufacturing, employment in knowledge-intensive services, and some others. One of major weaknesses of the Russian regular statistics is very poor data on innovative SMEs. So at present the impact and efficiency of small and medium size innovative enterprises in Russian regions cannot be assessed correctly. No special innovation surveys have been carried out in Russia so far. There is no classification of high tech manufacturing and knowledge-intensive services in Russia either, so indicators of employment in those areas are not available and only can be approximately calculated on the basis of other data.

**System of indicators to compare innovation activities of Russian region**

Taking into consideration the international experience, the above mentioned peculiarities of regional innovation policies in the Russian Federation and shortcomings of Russian innovation statistics, it is proposed to assess the innovation activity level of Russian regions on the basis of the following system of indicators (Table 1).

Table 1: System of innovation indicators of the Russian Federation regions

<table>
<thead>
<tr>
<th>Indicator No.</th>
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<tbody>
<tr>
<td><strong>I. Innovation potential</strong></td>
<td></td>
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<tr>
<td>1.</td>
<td>Population with tertiary education (ISCED 5-6) per 100 employed population</td>
</tr>
<tr>
<td>2.</td>
<td>Employment in knowledge-intensive services (communication, ICT, R&amp;D) (% of employed population)</td>
</tr>
<tr>
<td>3.</td>
<td>Regional business R&amp;D expenditures (RBERD) as a percentage of total R&amp;D expenditure in the region</td>
</tr>
<tr>
<td>4.</td>
<td>Regional business expenditure for technological innovation as a percentage of total regional expenditure for technological innovation</td>
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<tr>
<td>5.</td>
<td>Organisations in communications and R&amp;D sectors as a percentage of all firms</td>
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<tr>
<td><strong>II. Innovation climate</strong></td>
<td></td>
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<tr>
<td>6.</td>
<td>Innovation infrastructure organizations as a percentage of all firms of the region</td>
</tr>
<tr>
<td>7.</td>
<td>Expenditures on technological innovation from all sources except for federal budget allocations as a percentage of gross regional product (GRP)</td>
</tr>
<tr>
<td>8.</td>
<td>Firms that had cooperative relations for technological, marketing and organizational innovations as a percentage of all innovative firms of the region</td>
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<tr>
<td>9.</td>
<td>Expenditures on ICT as a percentage of gross regional product (GRP)</td>
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**III. Innovation activities output**

<table>
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<tr>
<th></th>
<th>Description</th>
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<tr>
<td>10</td>
<td>Number of created advanced production technologies per 10,000 regional employment</td>
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<tr>
<td>11</td>
<td>Number of patent applications for inventions and useful models per 1 million regional employment</td>
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<tr>
<td>12</td>
<td>Number of firms that had technological, marketing and organizational innovations as a percentage of all firms of the region</td>
</tr>
<tr>
<td>13</td>
<td>R&amp;D expenditures as a percentage of total volume of delivered goods and services</td>
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<tr>
<td>14</td>
<td>Value of innovative goods and services as a percentage of total volume of delivered goods and services</td>
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<tr>
<td>15</td>
<td>Value of exported innovative goods and services as a percentage of total volume of delivered goods and services</td>
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*indicators have not been weighted in this exercise.

Such a system seems to be quite convenient as it allows to carry out separate analysis and comparison of the innovation potential and innovation output of the regions under survey. Besides it allows to assess efforts of regional governments in creating innovation infrastructure and innovation climate in their regions.

**Results of regional innovation analysis of the Russian Federation**

The following regional innovation analysis has been carried out on the basis of official statistical data of the year 2008. The Regional Summary Innovation Index (RSII) was used as the composite indicator of the level of innovation activity in the RF regions. The RSII calculation methodology is similar to that used in European Scoreboards. In order to carry out comparisons of the RF regions by their innovation potential, innovation climate and innovation output three additional composite indices have been calculated:

- innovation potential index (IPI);
- innovation climate index (ICI);
- innovation output index (IOI);

Having a great number of regions in a comparison exercise it is interesting to know which regions are the most efficient in using their innovation potential. The answer can be obtained via a formal indicator – the coefficient of the use of innovation potential (CUIP, column 7 in the Table 3), which shows the ratio between innovation output and innovation potential indices.

Table 2 shows values of all indicators of some regions of the RF that are given as an example. One can see that some indicators' values differ greatly from one region to another.

---

Table 2: Values of indicators of a group of the RF regions (2008)

<table>
<thead>
<tr>
<th>Indicator No.</th>
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<th>12</th>
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<td>7.6</td>
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<td>0.07</td>
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Columns' numbers correspond to the indicator number of Table 1. Calculations according to the above mentioned methodology using values of innovation indicators (Table 1) have led to the following values of composite innovation indices (Table 3).

Table 3: Innovation indices of the Russian Federation regions (2008)

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
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<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
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<td>0.317</td>
<td>0.332</td>
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<td>0.363</td>
<td>0.193</td>
<td>0.294</td>
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<td>3. Vladimir Oblast</td>
<td>0.398</td>
<td>0.346</td>
<td>0.210</td>
<td>0.318</td>
<td>0.53</td>
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<td>0.231</td>
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<td>0.92</td>
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<tr>
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<td>0.330</td>
<td>0.363</td>
<td>0.88</td>
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</tr>
<tr>
<td>7. Kostroma Oblast</td>
<td>0.302</td>
<td>0.264</td>
<td>0.146</td>
<td>0.237</td>
<td>0.48</td>
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</tr>
<tr>
<td>8. Kursk Oblast</td>
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<td>0.29</td>
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<tr>
<td>9. Lipetsk Oblast</td>
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<td>0.43</td>
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</tr>
<tr>
<td>10. Moscow Oblast</td>
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<td>0.226</td>
<td>0.382</td>
<td>0.352</td>
<td>0.85</td>
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</table>
### Approach to Assess the Role of Universities and Research Institutions in Quantitative Analysis of Innovation Potential of Russian Regions

<table>
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<th>Score 4</th>
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<td>0.343</td>
<td>0.271</td>
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**North-West Federal District**

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**Southern Federal District**

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<th>Score 5</th>
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**Volga Federal District**

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<td>0.396</td>
<td>0.434</td>
<td>0.425</td>
<td>0.98</td>
</tr>
<tr>
<td>Kirov oblast</td>
<td>0.256</td>
<td>0.444</td>
<td>0.277</td>
<td>0.326</td>
<td>1.08</td>
</tr>
</tbody>
</table>
Values of indices presented in columns 3 to 6 of the Table 3 allow to compare regions by their innovation potential, innovation climate and innovation output. As to values of coefficient of the use of innovation potential (CUIP) the current analysis revealed only 4 regions in Russia that in 2008 had the value of CUIP above 1.0 and 7 other regions that have the value of CUIP between 0.9 and 1.0 (Table 4). This result may indicate that only 11 regions have good scores in using their innovation potential. It should be noted that CUIP is a relative indicator showing only the degree
of the innovation potential implementation and indicates neither level of regional innovation system development nor the regional administration efforts in stimulating innovation.

Table 4: Regions with highest values of coefficient of the use of innovation potential (2008)

<table>
<thead>
<tr>
<th>Region</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgorod region</td>
<td>1.26</td>
</tr>
<tr>
<td>Samara region</td>
<td>1.11</td>
</tr>
<tr>
<td>Kirov region</td>
<td>1.08</td>
</tr>
<tr>
<td>Republic Tatarstan</td>
<td>1.06</td>
</tr>
<tr>
<td>Cheliabinsk region</td>
<td>0.99</td>
</tr>
<tr>
<td>Perm' territory</td>
<td>0.98</td>
</tr>
<tr>
<td>Sverdlovsk region</td>
<td>0.96</td>
</tr>
<tr>
<td>Magadan region</td>
<td>0.95</td>
</tr>
<tr>
<td>Republic Tyva</td>
<td>0.92</td>
</tr>
<tr>
<td>Ivanovo region</td>
<td>0.92</td>
</tr>
<tr>
<td>Yaroslavl region</td>
<td>0.90</td>
</tr>
</tbody>
</table>

In accordance with the data of the Table 3 ranking of the RF regions by the Regional Summary Innovation Index is presented in the Table 5.

Table 5: Ranking of the RF regions by the Regional Summary Innovation Index (2008)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Region</th>
<th>RSII</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Magadan oblast</td>
<td>0.457</td>
</tr>
<tr>
<td>2</td>
<td>Perm' territory</td>
<td>0.425</td>
</tr>
<tr>
<td>3</td>
<td>Novgorod oblast</td>
<td>0.423</td>
</tr>
<tr>
<td>4</td>
<td>Ulianovsk oblast</td>
<td>0.422</td>
</tr>
<tr>
<td>5</td>
<td>City of Moscow</td>
<td>0.415</td>
</tr>
<tr>
<td>6</td>
<td>Tomsk oblast</td>
<td>0.411</td>
</tr>
<tr>
<td>7</td>
<td>City of St.Petersburg</td>
<td>0.406</td>
</tr>
<tr>
<td>8</td>
<td>Nizhny Novgorod oblast</td>
<td>0.397</td>
</tr>
<tr>
<td>9</td>
<td>Republic Tatarstan</td>
<td>0.395</td>
</tr>
<tr>
<td>10</td>
<td>Samara oblast</td>
<td>0.380</td>
</tr>
<tr>
<td>11</td>
<td>Republic Chouvashia</td>
<td>0.364</td>
</tr>
<tr>
<td>12</td>
<td>Kaluga oblast</td>
<td>0.363</td>
</tr>
<tr>
<td>13</td>
<td>Yaroslavl oblast</td>
<td>0.354</td>
</tr>
<tr>
<td>14</td>
<td>Moscow oblast</td>
<td>0.352</td>
</tr>
<tr>
<td>15</td>
<td>Voronezh oblast</td>
<td>0.343</td>
</tr>
<tr>
<td>16</td>
<td>Oryol oblast</td>
<td>0.342</td>
</tr>
<tr>
<td>17</td>
<td>Mourmansk region</td>
<td>0.341</td>
</tr>
<tr>
<td>18</td>
<td>Sverdlovsk oblast</td>
<td>0.338</td>
</tr>
<tr>
<td>19</td>
<td>Kirov oblast</td>
<td>0.326</td>
</tr>
<tr>
<td>20</td>
<td>Stavropol territory</td>
<td>0.319</td>
</tr>
<tr>
<td>21</td>
<td>Vladimir oblast</td>
<td>0.318</td>
</tr>
<tr>
<td>22</td>
<td>Republic Mordovia</td>
<td>0.310</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rank</th>
<th>Region</th>
<th>RSII</th>
</tr>
</thead>
<tbody>
<tr>
<td>41</td>
<td>Zabaikalski territory</td>
<td>0.263</td>
</tr>
<tr>
<td>42</td>
<td>Orenbourg oblast</td>
<td>0.262</td>
</tr>
<tr>
<td>43</td>
<td>Cheliabinsk oblast</td>
<td>0.262</td>
</tr>
<tr>
<td>44</td>
<td>Republic Oudmourtia</td>
<td>0.260</td>
</tr>
<tr>
<td>45</td>
<td>Smolensk oblast</td>
<td>0.256</td>
</tr>
<tr>
<td>46</td>
<td>Sakhalin oblast</td>
<td>0.254</td>
</tr>
<tr>
<td>47</td>
<td>Republic Karachayev-Cherkessia</td>
<td>0.250</td>
</tr>
<tr>
<td>48</td>
<td>Lipetsk oblast</td>
<td>0.249</td>
</tr>
<tr>
<td>49</td>
<td>Kachchatka territory</td>
<td>0.249</td>
</tr>
<tr>
<td>50</td>
<td>Tiumen' oblast</td>
<td>0.248</td>
</tr>
<tr>
<td>51</td>
<td>Primorski territory</td>
<td>0.247</td>
</tr>
<tr>
<td>52</td>
<td>Riazan' oblast</td>
<td>0.246</td>
</tr>
<tr>
<td>53</td>
<td>Omsk oblast</td>
<td>0.246</td>
</tr>
<tr>
<td>54</td>
<td>Vologda region</td>
<td>0.245</td>
</tr>
<tr>
<td>55</td>
<td>Ivanovo region</td>
<td>0.243</td>
</tr>
<tr>
<td>56</td>
<td>Rostov region</td>
<td>0.243</td>
</tr>
<tr>
<td>57</td>
<td>Republic Daghestan</td>
<td>0.242</td>
</tr>
<tr>
<td>58</td>
<td>Republic Mariy El</td>
<td>0.240</td>
</tr>
<tr>
<td>59</td>
<td>Altai territory</td>
<td>0.239</td>
</tr>
<tr>
<td>60</td>
<td>Kostroma oblast</td>
<td>0.237</td>
</tr>
<tr>
<td>61</td>
<td>Irkutsk oblast</td>
<td>0.237</td>
</tr>
<tr>
<td>62</td>
<td>Amour oblast</td>
<td>0.226</td>
</tr>
</tbody>
</table>

27
The Table 3 data allow to identify 3 clusters of the RF regions leading by values of IPI, ICI and IOI indices. In Figures 1 to 3 corresponding clusters of leading regions are presented.
Figure 2: Cluster of leading regions by the innovation climate index, 2008

Figure 3: Cluster of leading regions by the innovation output index, 2008

Ranking of the Russian Federation regions by the Regional Summary Innovation Index (Table 5) shows that neither number of researchers nor number of students have provided top positions for cities of Moscow and St. Petersburg.

Figures 4 and 5 present the innovation maps of Russia (2008) showing regional performance groups by the Regional Summary Innovation Index (RSII) and regional performance groups by the Innovation Potential Index (IPI) correspondingly.

Comparing European and Russian innovating regions

The system of indicators (Table 1) allows to carry out approximate comparison of Russian and European regions at least by three innovation profiles: (1) by the composite level of innovation activity: RSII (Russia) and RII (Europe); (2) by innovation potential: IPI (Russia) and Enablers (Europe); (3) by innovation output: IOI (Russia) and Outputs (Europe) (Table 6).
Table 6: Performance characteristics for 5 groups of all European regions

<table>
<thead>
<tr>
<th></th>
<th>High innovators</th>
<th>Medium-high</th>
<th>Average innovators</th>
<th>Medium-low</th>
<th>Low innovators</th>
</tr>
</thead>
<tbody>
<tr>
<td># regions</td>
<td>50</td>
<td>129</td>
<td>62</td>
<td>87</td>
<td>74</td>
</tr>
<tr>
<td># regions 2004</td>
<td>25</td>
<td>63</td>
<td>31</td>
<td>45</td>
<td>37</td>
</tr>
<tr>
<td># regions 2006</td>
<td>25</td>
<td>66</td>
<td>31</td>
<td>42</td>
<td>37</td>
</tr>
<tr>
<td>2004 &amp; 2006 RII</td>
<td>0.672</td>
<td>0.537</td>
<td>0.448</td>
<td>0.360</td>
<td>0.271</td>
</tr>
<tr>
<td>Enablers</td>
<td>0.630</td>
<td>0.563</td>
<td>0.431</td>
<td>0.357</td>
<td>0.260</td>
</tr>
<tr>
<td>Firm activities</td>
<td>0.746</td>
<td>0.540</td>
<td>0.447</td>
<td>0.328</td>
<td>0.238</td>
</tr>
<tr>
<td>Outputs</td>
<td>0.623</td>
<td>0.508</td>
<td>0.466</td>
<td>0.403</td>
<td>0.323</td>
</tr>
</tbody>
</table>

Source: Hollanders, H. / Tarantola, S. / Loschky, A.: Regional Innovation Scoreboard (RIS) 2009, Pro Inno Europe 2009, p. 18

The comparison shows that Russian leading regions by the RSII mainly correspond to European average innovators, Russian leading regions by IPI mainly correspond to European medium-high innovators and Russian leading regions by IOI mainly correspond to European average and medium-low innovators.

It should be repeated however that the above mentioned correspondence of Russian and European innovating regions can be regarded only as approximate for the following reasons: first, the European RIS 2009 includes data of 2004 and 2006 years and the current Russian study includes data of 2008, second, shortcomings of the Russian official innovation statistics (lack of innovation indicators, no data on innovative SMEs, etc.) do not allow to make the system of Russian regional innovation indicators completely adequate to the European one.
Russian Federation regional performance groups for the Regional Summary Innovation index

Figure 4. Russian Federation regional performance groups for the Regional Summary Innovation index (RSI).

Legend:
- High innovators
- Medium High innovators
- Average innovators
- Medium low innovators
- Low innovators
References

1. Rosstat of Russia, Socio-economic indicators, 2009.


Knowledge and Technology Transfer:  
New Strategy for the Leading Russian Universities

Victor Koksharov, Sergey Kortov and Dmitry Shulgin

The article is devoted to summarizing the results of development and implementation of the strategy of Ural Federal University. The work considers current changes in the world and in the Russian economy in particular that, on the one hand, determine the increasing role of universities in the development of regional economies and, on the other hand, open up new challenges and opportunities for the leading universities. Within the frames of the "knowledge triangle" concept it is shown that the leading Russian universities can and should play a leading role in the creation and development of science, education and innovation integration processes in Russia, and innovations serve to play a strategic role in these processes.

The particular attention is paid to the discussion of such strategic objectives of universities as transition from knowledge paradigm of education to the competencies transfer, new approaches to education meeting this objective, development of innovative culture of universities, new forms of cooperation with industry and fixing clear "rules of the game" in the field of intellectual property.

Ural Federal University named after the first President of Russia B.N.Yeltsin is the largest of 9 federal Universities in Russia. In 2010-2011 UrFU united classical and technical universities and thus continued the history of the Ural University founded in 1920. The University comprises 18 institutes, offers more than 140 Bachelor's and more than 80 Master's programs; there are more than 50,000 students, including 1290 foreign students. The university is now ranked in the top-500 QS World University Rankings.

In 2010 UrFU formed a part of the association of leading universities in the country founded by 39 Russian higher educational institutions that includes all the federal universities, national research institutes, MSU and SPSU. These universities present the "network of leaders" and promote the development and reforming of the educational system in the country. The objectives of the association include forming of competitive academic environment, optimization of the higher education financing model, revival of postgraduate study and many others.

According to the Innovative development strategy of Russia until 2020 the level of innovation activity of the Russian economy should become five times higher during 10 years, and it is planned to increase its export potential ten times. The implementation mechanism of this strategy relies on the development and integration of the three elements of the "knowledge triangle" (research, innovation, education) on the basis of investing in the innovation economy. All three elements that are to become the key element of the national innovation system are united in higher educational institutions.
This article presents a summary of the results of work on forming and implementing of the development strategy of the Ural Federal University as an innovative core of the Ural region's innovation system carried out in 2010-2011. The strategic importance of the objectives and problems set for the leading universities of the country requires the analysis of changes in the global and national economies, and, in particular, new challenges and opportunities of the Russian universities. First of all, it concerns the development of the university mission concept, which has evolved throughout the history of its formation; the most significant changes of the concept are specific for the turn of the 20-21 centuries. The major components of the mission of higher educational institutions have always been the generation and transfer of knowledge. However, today it is often discussed that the purposes of university are not limited to training highly qualified personnel and carrying out scientific research as it traditionally used to be. At present, universities are becoming the key players in regional economic and social development [1].

The changes in external and internal environments of universities take place against the background of the increasing role of knowledge as well as global and regional challenges of the modern economy. The increasing role of knowledge in the global economy depends on such factors as (see for example [2]):

- significantly higher rate of knowledge production compared with earlier stages of economic development;
- development of storage and spread of knowledge tool;
- increasing industry needs for innovations which are becoming the main survival chance for the business in a competitive conditions of modern economy.

In the first place one of the global challenges is Russia's substantial lag in all fields of generation and transfer of knowledge, particularly in the technological sphere. It also should be noted that the level of value added of scientific and technical products developed in Russia is rather low. In fact, knowledge is transferred as "raw material" and as a rule, free of charge without the use of opportunities provided by the institute of intellectual property. In particular, according to "Global Innovation Index," in 2009/2010 Russia ranked 64th place [3]. Russia is far behind not only from the world's leading economies according to such indicators of innovative development as publications in leading scientific journals of the world (16th place in 2010), the number of triad patent applications – applications filed simultaneously in EU, U.S. and Japan – (63 in Russia compared to 13 715 in the United States) and others [3].

According to the amount of science funding [4] (taking into account the purchase power of national currencies), Russia ranks 8th place in the world. Besides, Russian science responsible for developing innovations continues to operate within the
traditional model which no longer meets the current economic conditions and is characterized by the dominance of independent research organizations separate from the universities and businesses. According to the data presented in the work [1], they account for about 80% of funds spent on science, given that in market economies companies and universities form the basis of national innovation systems. As for the contribution of universities to new knowledge generation, at present in Russia 45% of higher educational institutions carry out research, they spend about 8% of funds allocated to science (it is 2.5 times lower than the average for OECD countries) [1].

In 2000-2010 the number of national patent applications has increased almost half as much from 28 7000 to 41 400 [5]. It should also be noted that the analysis of trends of filing for inventions in the Russian Federation in 2000-2010 (according to the Annual Report of ROSPATENT [5]) shows forward growth of patent activity of foreign applicants. During this period, the patent activity of Russian applicants increased by about 13%, while the patent activity of foreign applicants increased by 2.8 times, that is a clear indication of growing interest of investors and manufacturers to the Russian market. In 2011 the number of non-resident patent applications to the Russian Patent Office accounted for 36% of the total number of applications, and applicants from the USA, Japan, Korea, Germany, France and Switzerland show the greatest activity in Russia.

Despite the relatively high rate of education quality in "Global Innovation Index" (19th place compared to 64th place according to the total index) in recent years in Russian education there is an increasing gap between the structure and the level of professional training and the needs of innovation economy [1]. This negative background results in the fact that centers of generation and transfer of knowledge and technology move to the private sector where a new segment of innovative activity is formed.

The high rate of knowledge generation, as well as the fact that spheres of real professional activity and industrial production have become the centers of acquiring knowledge, caused the crisis and the relevance loss of "knowledge paradigm of education". The solution of this problem becomes even more complicated due to the age-old Russian traditions of "knowledge-centered" professional education, see example [6].

It also should be noted that the significant structural changes in the chain of generation and transfer of knowledge happened in Russia in the late 20th century. In the pre-reform period, the structure of knowledge generation and transfer included the Russian Academy of Sciences with its fundamental research, industrial research institutes that carried out the development and transfer of technologies to industry, and universities focused mainly on applied research and knowledge transfer to professionals.

The changes that happened in Russia in the 21st century affected the structure "fundamental science – applied science – technology transfer" and resulted in forming a gap due to the fact that industrial research institutes actually ceased to
exist. This gap forms one of the reasons for the significant lag of Russia in the sphere of experimental-industrial production and, according to experts, for the low demand for innovations.

Structural changes that have taken place form a challenge to Russian universities opening new opportunities that allow universities to strengthen their positions in the field of knowledge transfer.

The above-mentioned changes in international and Russian markets made it necessary to form and implement a new strategy for development of the national sphere of generation and transfer of knowledge. This strategy should be aimed at the transition from "raw materials dependence" in all areas of the economy, including the knowledge economy, and increasing the added value (the level of redistribution) of the high-tech products.

The mechanism of implementing this strategy relies on the development and integration of all three elements of the "knowledge triangle" (education, research and innovation) on the basis of strategic investments in intellectual resources of the innovation economy, modernization of research and education system so that they meet challenges of the global knowledge economy [7].

The concept of the knowledge triangle reflects the need for systematic and continuous interaction of science, education and innovation activities formed in the international community. In Europe and the U.S.A. universities play a key role in the development of these processes [8,9]. The need for science, education and innovation integration is conditioned by the high rate of knowledge generation and effacing of boundaries between generation and transfer of knowledge. Thereby the processes of research, technology transfer and education are parallel and interdependent.

Leading Russian universities should play one of the most important roles in creating and developing the processes of integration of research, education and innovation spheres in Russia.

In the educational sphere the strategy of increasing the added value of generated knowledge is based on the "competence approach" which places a priority not on the accumulation of a certain amount of knowledge within a specific educational programme but on the ability to use knowledge and skills for effective solution of actual production tasks.

It is the transfer of competencies that now presents a major task of the educational system; the search for new approaches to education meeting this objective is an issue of strategic development of the whole educational system in general and our university in particular.

One of the paths of development is expanding and deepening cooperation of the university with employers as graduates' potential customers and integration with partner companies. Involvement of employers in the development and implementation of educational programs creates the basis for effective transfer of knowledge and its rapid transformation to the competences in demand.
Such training can be implemented only in close partnership with industrial enterprises by means of organizing joint competence development centers, training and production laboratories and facilities. An example of such cooperation is a training, research and innovation complex, organized by the Institute of Radio Electronics and Information Technologies at the largest instrument making plant NPO Avtomatika, and as we hope among the joint professional centers on the basis of such large corporations as Ural Mining and Metallurgical Company, VSMPO Corporation AVISMA, Ural Electrochemical Combine, TMK plant, Ural Electric Grid Company and a number of other large holdings will become the examples of success as well.

Organization of similar interaction with the scientific community and innovation infrastructure (see below) of the university and the region will contribute to the competences development in the spheres of research and innovations.

One of the most effective implementation instruments is the promotion of students' academic and research work within the frames of actual research and development carried out by the research teams of the University. In particular, every year a significant number of inventions and other intellectual property applications is filed with the participation of the university's undergraduate and graduate students. For the present, it is the individual researchers' initiative, but it should become a standard research practice of the university in the future.

The development strategy in the scientific sphere should be focused on the development of integration ties between fundamental science and following links of generation and knowledge transfer chain. The high significance of the fundamental research results specifies the need for the development of effective scientific results transfer mechanisms both in the spheres of education and applied research.

The system of research and educational centers (RECs) established on the basis of UrFU institutes should play a very important role in the strategy implementation. The purpose of the RECs is achieving world-class scientific results in a wide range of research, retention of research and teaching staff in the sphere of science and education, building effective and sustainable research teams in which young scientists, graduate students and undergraduates work with the most productive scientists of the older generations.

- At present there are five operating RECs at UrFU:
- Nanomaterials and Nanotechnology;
- New metal-containing materials and technologies in metallurgy;
- Nuclear Energy – efficiency and safety;
- Information and telecommunication systems and technologies;
- Basic education.

Another important trend of the innovation economy and a challenge to the traditional system of research at universities (particular tasks and small groups) is a significant increase in the importance of interdisciplinarity and complexity in creating
innovative groundbreaking developments. The majority of such scientific results can no longer be obtained by a research team specializing in one field. This problem is typical not only for Russian science, but also for research in other countries, in particular the U.S.A [9]. The universities now possess great advantages in this sphere and are able to concentrate the efforts of different specialists and solve complex innovation problems. It should be emphasized that in recent years this approach to the development of research activity is stimulated by the system of scientific research state funding in the Russian Federation.

Under the conditions of competing for state funding of scientific research the universities are able to understand the priority needs of the global and national technological markets and involve different research teams and specialists from the spheres of marketing, business and production for achieving their goals will be the most successful.

Tools of integrated management of research and innovation activities developing in the global economy and in Russia at the moment contribute to the integration of research, innovation and industrial areas. In particular, such instruments include the concept of technology platforms [10], as well as the cluster system of innovation management (including the project Skolkovo [11]). The main feature of these tools is forming the scientific and technological development priorities, and strategic research programs based on comprehensive analysis of the production and society needs.

The leading Russian universities actively participate in the implementation of these tools. In particular, at present time the joint research and innovation teams of our university work on the projects within the frames of development of such clusters as Information technology, Nuclear technology, Biomedical technology, Space technology and Telecommunications, Energy-efficient technologies.

In the innovation sphere the new capabilities of universities are conditioned by the scope of factors. In the first place we should note the above-mentioned gap in the chain of generation and transfer of knowledge. This gap creates the conditions for the transition from the transfer of technical solutions to the transfer of complete technologies that are of substantially higher value for the business, have higher costs and yield higher returns for the university.

In recent years we have seen an active government support to innovative development of Russian economy. Despite the difficulties of transition, innovation infrastructure in the regions is actively developing with the substantial government support. The universities play an important role in the development of networks of technology transfer centers and business incubators.

Innovative activity has become one of the three main types of university activities. In September 2010 the UrFU innovation infrastructure was created and now it includes 56 small innovative enterprises, the network of specialized innovation implementation centers, the innovation support system (Center for Technology Transfer and
Entrepreneurship, Department of innovation marketing, Intellectual Property Center, HR Center and Center for innovation development included in the UrFU business incubator), two educational departments delivering Bachelor's and Master's programs in the direction "Innovation." Innovative activity is closely connected with the system of research and educational centers and research laboratories of the University; 15-17 new innovation projects are developed annually on the basis of their fundamental and applied research.

More than 80 innovative projects are being implemented at the university at present, over $ 8 million is annually invested in the development of innovative activity, by 2012 the annual output of innovative products will reach the level of $ 6 million, the annual output growth rate is more than 300%, by 2016 the innovative production index will be $ 35 million.

UrFU is developing its innovative activity based on the concept of open innovations. It actively participates in Russian and international partner networks, takes part in technology platforms and innovation clusters, presents its products and services at Russian and international exhibitions.

It should be emphasized that the strategic role of innovation in the development of integration processes in the field of science, education and innovation is impossible without forming of a layer of innovation-active people (staff, students, businessmen, investors) and the key components of organizational policy, such as innovative business and intellectual property. Innovation university-based entrepreneurship should become a professional competency and result in venture capital investments and profit.

Another important result of the first two years of the UrFU innovative infrastructure activities is that the university has become investment-attractive. There used to be sponsors and benefactors, but there never have been investments in higher educational institutions. This year was the first time when people started asking: "Where are your projects? We are willing to invest money in them".

Innovations being a component of the "knowledge triangle" play a strategic role in the development of integration processes in the field of science, education and innovation through the development of organizational culture and policy, including such components as:

- culture of innovative entrepreneurship.
- intellectual property policy.

Our research points to the fact that until recently higher education systems of Russia and such countries as the U.S.A. and the UK had a huge difference in understanding the importance of innovative entrepreneurship culture development as a factor linking together the knowledge acquired in high school, research skills, production experience and art of business [12].
As a result, graduates of Russian universities, being more prepared in the field of special disciplines than their foreign colleagues, are often behind the latters in the ability to transfer research results to marketable products.

Teaching the basics of innovation entrepreneurship, practical courses in innovative enterprise development and management are represented almost in all universities of the UK and the U.S.A., as well as in many universities of other countries. Great attention is paid to "student environment", bringing students to the conditions of a real business (creating startup companies, search for venture capital, an IPO, etc.) in training of specialists and managers of innovation entrepreneurship. Such programs have recently begun to appear in the Russian universities and their popularity begun to increase 2-3 years ago. Such forms of learning the basics of innovative entrepreneurship as "Innovation Diving", "Innovative Elevator" and other programs could be the excellent examples of this approach implementation in the UrFU. Participants of training are involved in the ideas generation process, they assess market potential, transform the idea to the project, create a small innovative enterprise, may win a grant or find an investor, develop a product marketing strategy. According to the participants of the innovation diving "... here we are taught not only to work, but also to think unconventionally, to develop leadership skills, they help to transform the idea into the project" [13].

The development of the innovative culture in science has no less importance, because one of the burning problems of knowledge transfer is the solution of the problem "a publication or a patent?" It is necessary to resolve the conflict between the scientific interests of a researcher that may require an immediate publication of the results and his or her commercial interests that provide for the temporary securing of obtained results in order to preserve the commercial value by means of subsequent patenting or extension of the know-how status. This problem is typical not only for the Russian universities, but also for many European and American universities, see example [14].

It should also be noted that the process of generation and transfer of knowledge is linked to the conflicts of interests related to the intellectual property rights. In particular, conflicts can arise between the inventors and the university while doing job duties, between customers and executors while carrying out research resulting in the development of new technologies, as well as between other participants of innovative processes.

The analysis of international experience of resolution of internal and external conflicts related to the IP rights [15] and the relatively small Russian practice shows the so-called "win-win" strategy is very important for success. This approach is based on the principle of effective interdependence and formation of mutually beneficial partnership of innovative processes participants based on congruence of their economic interests.

Under the conditions of the development of knowledge economy the "win-win" strategy is becoming very significant at all levels of innovation management: the
state benefits from the development of innovative component of the business stimulated by intellectual property rights on innovation and the universities receive additional competitive advantage in the market of high technology products by means of including the inventors in the commercialization process and providing them with additional profit.

According to this situation there is a demand for clear rules of the game in the sharing of intellectual property rights. These are the key questions to be answered in the process of generation and transfer of knowledge:

- What knowledge is "free" and what knowledge is "for money"?
- How to share intellectual property rights between the university, its employees and a startup-company created on the basis of the present invention?
- How to divide the profit from the use of intellectual property rights between the parties of the innovation processes?

The analysis of the Russian leading universities' sites showed that such a document as the Intellectual property policy is extremely rare in the universities. In our opinion, the most likely cause of this situation is that there had been no practical need until now. For comparison, almost all the leading universities of the world included in the «Times» ranking have the Intellectual property policy.

The significance of the documented rules of the game – the Intellectual property policy of the University – can not be overestimated. The main priorities and principles of the intellectual property policy are (see for example [16]) the following:

1. To ensure that the commercial use of research results will be aimed at support and development of education, research and innovation activities of the university.
2. To establish the principles of sharing of intellectual property rights, and to protect the interests of the University, its employees and third parties in the process of commercialization of intellectual property.
3. To create the necessary conditions to ensure the patent clearance of innovative products and technologies developed by the higher educational institution and to prevent third parties' misuse of intellectual property rights.
4. To promote forming of the business environment through the commercialization of research results.

Typical forms of cooperation with industry are determined by the specific features of the Russian economy. In particular, in the world practice licensing and establishing start-up companies are deemed the most important forms of technology transfer. According to the research data [14] in the United States of America the majority of the university-sector developments are transferred to the large industrial companies through the mechanism of licensing and only 15-20% of technologies are transferred to business through start-up companies. Russian statistics and the statistics of UrFU in the sphere of sale of licenses and innovations have just started to form, so we can
make only preliminary conclusion. However, in our opinion, the inverse correlation in proportion of licenses and establishment of start-up companies is quite predictable. One of the reasons for the underdevelopment of licensing market is a lag in the development of experimental-industrial production in Russia as compared to the countries with well-developed technology markets. Another reason for the predominance of technology transfer in the mode of establishing start-up companies is the active ideological and financial support provided by the state to the process of creating university-based small innovative enterprises.

All the above considered, it is possible to assume that the most widely-spread form of technology commercialization in Russia will be the creation of small innovative enterprises. In this regard, the creation of joint innovation projects and small enterprises with Russian and foreign universities and companies is an important task contributing to the active development of innovative entrepreneurship in Russia and the transformation of the accumulated research results to innovations.

Increasing industry needs for innovation enhance the importance of the university role and capabilities in the "university-industry" alliance. The university is not only an executor of R & D, but also an equal partner in the innovative project.

A new model of economic relations between universities and industry is almost starting to develop. On the one hand, more and more often business representatives want universities to produce innovations and not to limit their activities to carrying out research work. Companies need new developments and universities are treated as partners. On the other hand, our university is willing to invest in research on an equal footing.

In this situation, the university can aspire to participate in the management of intellectual property rights in one form or another. And we have already had such examples in our practice.

Thus, current changes in the world and, in particular, in the Russian economy, as well as the increasing role of universities in the development of regional and national economies open up the new challenges and opportunities for the leading universities of:

1. The need for systematic and continuous interaction of science, education and innovation activities has emerged in the global community. The leading Russian universities should occupy one of the most important positions in creation and development of science, education and innovation integration processes in Russia.

2. As an essential component of the "knowledge triangle" innovations play a strategic role in the development of science, education and innovation integration processes.

3. A new development strategy for higher educational institutions should focus on the transition from "raw materials dependence" in all areas of the economy, including the knowledge economy, and increasing added value (the level of redistribution) of the high-tech products.
4. The structural changes in the scientific sphere that happened in Russia, namely, the gap in the structure "fundamental science – applied science – technology introduction" open up new opportunities for universities that will allow Russian higher educational institutions to strengthen their positions in the knowledge and technology transfer.

5. Transfer of competencies is now the most important task of the education system, and the search for new approaches to education meeting this objective is now an issue of strategic development of the whole education system in general and, in particular, of the leading universities of the country.

6. Innovative activity of universities requires the development of university organizational culture, new forms of cooperation with industry and formation of clear "rules of the game" in the field of intellectual property.

References


13. From the bright idea to a real result: How to make an innovative business with the Ural Federal University / UrFU, 2012.


Innovation Infrastructure of University as Laboratory for Training of Innovators

Alexander Grudzinskiy and Alexander Bedny

In the global knowledge-based economy universities are looking for new models of development appropriate for the current external conditions. The concept of market-oriented innovative university becomes dominant. The article provides a new interpretation of the innovative university model and a way of implementation of its market-oriented functions. It also gives an assessment of the role of modern universities in the world of innovations. The key function of university as a global generator of innovators is highlighted. "Knowledge Tetrahedron" is suggested as a functional model of leading universities in innovation economy.

Rethinking a university functional model is an actual problem that has been staying in the centre of attention of the world academic community already for two decades. Universities are trying to respond to the new requests of the economy and society, they are getting involved into strong competition for resources, merge with each other to form large university centres visible at the international level, actively shaping their public image participating in the world university rankings [1]. Higher education institutions have been buffeted by a complex set of international pressures. Foremost among them is the growing importance of knowledge-led economies that have placed higher education at the centre of national competitiveness agendas. Higher education institutions are increasingly viewed by policy makers as 'economic engines' and are seen as essential for ensuring knowledge production through research and innovation and the education and continuous up-skilling of the workforce [2]. All these sophisticated processes of change became the subjects of numerous discussions about the priorities for development, functional models of modern universities, and about "the products" universities are supplying to the society.

From Humboldtian University to Knowledge Triangle

It has been widely accepted that the German, or the Humboldtian university model, which was dominating in the world since the beginning of the XX century cannot provide efficient responses to major challenges of the modern innovation society. The underlying principles of the Humboldtian university model are academic freedom and unity of scientific research and education. This model assumes that university scientists are financially supported by the state, that they generate basic knowledge mainly in accordance with their own scientific interests, and that they
bring this knowledge to the university students in the volumes and forms they consider the best.

The global knowledge economy which was formed by the beginning of the XXI century forces universities to seek for the new development models, which could fit current external conditions. The new goals stipulated by the demands of the market and society put universities under new pressures, and at the same time provide the academic community with the new opportunities for utilisation of its intellectual potential. In addition to the option of acting in the conditions of academic freedom (publicly funded), academics start to focus on requests of the business community, and to compete at the global market of research and education.

In the modern world innovation is seen as a crucial response to the global economic crisis. Higher education institutions are assumed to be the major actors in finding effective answers to the crisis. In the European Union Innovation Agenda knowledge is increasingly seen as the new strategic production factor [3]. The creation, transfer and application of knowledge are assumed to be of prime importance for a process of economic reorientation and further social and economic development. In the United States the research universities are also considered to be nation's leaders out of the economic crisis, and are expected by those who support them and the public at large to lead the way as far as innovation is concerned [4, P. 3].

The concept of market-oriented innovative university based on the knowledge triangle (Education – Research – Innovation) starts to dominate in all developed parts of the globe.

The search of new development models does not mean the loss of importance of a Humboldtian university "basement". The key concept of fundamental nature of knowledge and education remains a prerequisite, but it is not sufficient for efficient development of a modern university anymore. The additional university function appears, and it is aligned towards the market and society needs. This function is something that a classical university did not deal with, as it had a sufficient public funding.

The realisation of possible ways of implementation of this "market" function has not been completed yet. The acquisition of income from commercialisation of university inventions was among the first discovered ways of implementation of this function. It assumes solving the following problems:

1: Verification of commercialisation potential of research results and developments of university scientists.

The system of Technology Transfer Offices (TTO) was introduced at universities around the world to help solving this problem. The main functions of TTOs include keeping a record of disclosures done by the university scientists, evaluation of its significance, patenting, further legal support, etc.

2: Commercialisation of university intellectual property, bringing a new innovative product or service to the market, creation of university's spin-out companies.
Situations when high revenues from licensing university technologies suddenly appear or shares of a rapidly developing university spin-out company start bringing high income are extremely rare. And this joy is usually short-lived, as revenue from a new perspective technology normally comes for a few years only, unless the technology is getting outdated.

The second way of implementation of a university «market» function is commercialisation of its intellectual property through co-operation with industry, i.e. mainly through contract research implementation. In a way, this is a more reliable and stable option for the university, as industry well knows what particular research and development it needs. Companies can set the specific goals for the university researchers. This means that the university goes to the marketplace having no ready invention "in the pocket". Contract research was a starting point for the growth of the idea of university innovations.

However this form of commercialisation of research results has a number of negative aspects for the university. Firstly, university normally does not retain a full ownership of the intellectual property created under the contract research implementation. Secondly, business and industrial partners are acting as customers in contract research collaboration with the university. And it is absolutely natural that each costumer is pursuing its own business interests.

Moreover, every industrial company normally has its own research staff, and large companies may have their own R&D centres and laboratories which are highly professionalised in the particular areas of research. Thus, the university participating in a contract research is taking upon itself a role of assistant to the industrial company, and falling behind it. If the university wants to catch up with the corporate science, it has to fully concentrate its internal resources on the particular field of research. But this is not possible for a traditional classical university, which embraces a broad spectrum of sciences.

On the one hand a modern university clearly stresses its mission in innovations, and policy-makers of leading countries see them as crucial economic drivers in developing and transferring knowledge to the commercial marketplace [5]. On the other hand, there is a remarkable concern that the role of universities on innovation arena boils down to falling behind the corporations and actually "playing in the second league". Let us try to analyze what is the realistic assessment of universities' position at the global innovation market.

**Universities and Global Innovation Market**

The experience of developed countries shows that large-scale industrial corporations are the major contributors to the market of innovations. In present conditions a fundamental innovation, especially in such critical for the world industry fields as ICT, nanotechnologies, biotechnologies is a very resource-intensive and expensive thing. Normally it can only be afforded by a weighty investor, or an industrial giant.
Not surprisingly, most of the small start-up companies aspire to be acquired by a big corporation, where innovations are mass-produced. Small companies are able to quickly introduce "small" innovations, working as a part of giant corporations' suite. But they are not strong enough to win the battle for the world innovation markets [6]. Universities are not able to carry out production functions of large corporations. The traditional terms used for a university start-up company: "spin-out", or "spin-off" show that there is a sort of centrifugal force forming the development trajectory of such a young company. There are no universities in the world where revenues from innovation activities play a decisive role for the university budget. It shows that the importance of university innovation activities is concentrated not in the financial sphere. This new understanding of the modern reality appeared quite recently, and it tensely paves its way through the ample passion for the financial reward potential of academic innovations.

This realistic assessment of university's potential in technology transfer does not mean that this function is becoming useless, and its development should be hold back. The new functional model of a university – the model of innovative university based on "a knowledge triangle" – has got implanted into our life and is actually a new paradigm for the higher education development. Our message is that when considering university technology transfer results as the main contribution of the university to the development of innovation economy we put the leading universities in an unpromising position of "a catch-up modernisation", when they are trying to turn into something that they are not supposed to, i.e. to turn into an industrial corporation.

The idea of entrepreneurial university was formulated in the end of the XX century, and it continuous to increase its relevance nowadays. The key characteristic of an entrepreneurial university is a comprehensive entrepreneurial culture inside the university, among those who are managing the university, and those who are teaching, and purposeful cultivating of this culture among the students. Entrepreneurial university assumes the new mind-set of its managers, academics, and students, and the new organisational culture of the university in general. Entrepreneurial university is the one, where staff and students are not only generating the new knowledge, but also are thinking about its utility and applicability. The utility of the new knowledge does not necessarily imply the possibility of its immediate commercialisation. If the society and the state want to develop a certain area of basic science, public or governmental foundations may provide funding for it on a competitive basis. Scrambling for this funding is an appearance of entrepreneurial culture of managerial and academic staff of the university. And of course, one of the most important areas of activity of entrepreneurially minded university staff is knowledge transfer in its diverse forms: from technology transfer to various forms of trainings and consultancy addressing costumer's needs and problems.
Entrepreneurship as a category of social behaviour forms a basis for innovation economy development. Famous economist and political scientist Joseph Schumpeter defined entrepreneur as an individual trying to turn a new idea or invention into an innovation. Historically entrepreneurship was considered as one of the key resources of economy, alongside with natural resources, time, knowledge, etc. The importance of this resource became evident nowadays, when we observe incredibly rapid growth of IT companies, where knowledge and entrepreneurship are the main elements of success. The knowledge used in these cases could be open for the public and does not necessarily contain a know-how. The decisive factor for successful development of a new company is remarkable entrepreneurship skills of its founder (the take-off of Facebook social network is a good example in this respect).

It is widely recognised that high-impact innovation requires an entrepreneurial mindset that views big problems as big opportunities. When entrepreneurs and entrepreneurial thinking are injected into the mix, remarkable things happen. Entrepreneurship must be clearly defined as a necessary ingredient for innovation, a particular approach to solving problems, and a complement to the critical methods that are fundamental to the liberal arts and sciences. It must not be viewed as mere commercialisation, wealth accumulation, or management. The fundamental entrepreneurial mind-set, and the techniques that go with it, are the same no matter what your interests, dreams, and values happen to be [4, P.6].

**Knowledge Tetrahedron: Functional Model of Leading Universities in Innovation Economy**

So what can leading universities do for the development of innovation economy? What is their main function? In our opinion they can and they have to provide the innovation economy with its main "fuel" for development, which is highly qualified specialists with innovation entrepreneurship skills and competences, i.e. innovators.

Our point of view is supported by the leaders of the global innovation economy. For example, Leslie Vadasz, Former Executive Vice-President of Intel Corporation giving a speech at the Board Meeting of the U.S. Russia Foundation at University of California, Los Angeles, in January 2012 characterised the role of cooperation with leading world universities for this transnational hi-tech giant, first of all as a tool for search, selection and training of their future staff members. While the tangible outputs of academic research – publications and patents – remain important, equally significant to successful innovation economy is the production of highly skilled human capital [7]. International evidence shows that large-scale transnational companies see their cooperation with leading universities mainly as a mean to select talented students and to bring-up their future employees who has to be highly educated efficient professionals-innovators [8].

Is it possible to teach entrepreneurship? The answer to this question has gone through significant transformations in the last decades. It was a long way from
perception of entrepreneurship skills as a God-given talent to understanding that entrepreneurship skills can be purposefully developed. Today, students graduating from top universities need to understand science and technology, but also need to be able to identify opportunities, understand market forces, commercialise new products, and have the leadership and communication skills to advocate for their ideas. Leadership and entrepreneurship knowledge and skills are increasingly being recognised as essential for the labour market of the global knowledge economy. Innovation entrepreneurship education is increasingly being emphasised at leading world universities given the belief that entrepreneurially-minded people are key solving economic and social grand challenges.

On the basis of the foresaid we can look at the university "knowledge triangle" in a new way. As before, we consider research and education as the basis for development of innovation activities at the university. However, the accent is changed for university innovation activities. We are not denying the importance of production of innovations at the university. At the same time we believe that the most important role of university's innovation infrastructure is training of specialists – entrepreneurs who are good in launching innovation activities in their fields of knowledge. In the same way as participation of students in research activities of a chair or laboratory is an integral part of training highly qualified specialist or a scientists, students' participation in activities of university Technology Transfer Office, or spin-out companies is an essential condition for efficient formation of students' competences in innovation entrepreneurship. University innovation infrastructure in this respect has to play the same role in preparation of new type of specialists – innovators, as does a research laboratory for traditional, "Humboldtian" specialists' training.
This helps us to formulate the main function of modern universities determining their principal contribution to the development of world innovation economy. This function is training of new type of specialists currently demanded by the society and economy, the specialists with developed skills of innovation entrepreneurship, or innovators to be brief. Thereby an Innovator being the main "product" of modern universities is situated on the top of "the Knowledge Tetrahedron", which is a geometrical interpretation of the functional model of leading universities in innovation economy (see Fig. 1). The base of this tetrahedron is formed by "the knowledge triangle" with the three key components of university activities in the apexes: Education, Research, and Innovation.

**Formation of Innovation Infrastructure of Research University**

**The Case of Lobachevsky State University of Nizhni Novgorod**

The processes of university innovation infrastructure development throughout the industrialised world started in 1970s with the purpose of linking universities to industrial innovation more closely. Due to peculiarities of the historical development the same processes in Russia were launched with a marked delay, in the beginning of 1990s only. The conditions of Russian transition economy did not allow the universities to quickly succeed in this complex task. In the recent years Russian government made a number of important steps towards the formation of the pull of leading Russian universities, and allocated significant funding for their efficient innovative development with the clear goal of entering the cohort of leaders of international higher education. In this section we present a case of innovation
infrastructure development of Lobachevsky State university of Nizhni Novgorod – National Research University (UNN).

From the very beginning of the 1990's UNN has been actively developing its own infrastructure for innovations. It includes the following structural elements created in the last two decades:

- Research and Technology Park (1992);
- Specialised continuous professional development programme "Organisation of Innovation Entrepreneurship" (since 1994);
- Chair of Technology Transfer and Innovation Entrepreneurship (1995);
- Centre for Innovation and Technology (2000);
- Centre for Network Integration and Cooperation with Industry (2007);
- Centre of Excellence in Knowledge Transfer (2007);
- Centre for Student Innovation Entrepreneurship Development was established (2011).

In recent years development of Innovation Ecosystem at UNN was strongly supported by the successful participation of the university in all major Russian governmental programmes of higher education support. In 2006 UNN was awarded the right to implement the Innovation Educational Programme under the Prioritised National Project "Education". In 2009 after the first Contest Round UNN was awarded a status of National Research University. In 2010 UNN succeeded in the contest of Programmes for Innovation Infrastructure Development. In 2010-2011 UNN won four grants of Russian Government on Attracting Leading Scientists to Russian Educational Institutions.

Since 2011 UNN participates in implementation of another Federal project on establishment at the university a large interdisciplinary innovation cluster "Zone for Growth: Centre for Innovation Development of Medical Instrument Production and High Biomedical Technologies". This project is co-funded by UNN and by the Federal Programme "Development of Pharmaceutical and Medical Industry of Russian Federation for the period till 2020 and further on".

UNN has over 100 contracts on cooperation with research, industrial, and business institutions. Close cooperation in preparation of high-qualified staff with such giants of high technologies as Intel and Microsoft has got its distinctive shape: joint laboratories and centres of excellence are established at UNN in cooperation with these corporations.

UNN Centre for Innovation and Technology is an official representative of the Foundation for Assistance to Small Innovative Enterprises in Nizhni Novgorod region. During the eight years of "START" programme functioning UNN researchers applied over 70 projects, and 40 of them succeeded in the contest. About 80 young scientists from UNN became winners of "U.M.N.I.K." Programme.

Participation in international projects has become a very significant source of support for UNN innovation ecosystem development on the basis of the leading international
expertise. In the last decade a number of university management projects have been successfully implemented by UNN under the Tempus Programme of European Commission:

- "Becoming Entrepreneurial University" (2002–2004);
- The project objective was to elaborate a mission statement and strategic plan and to train decision makers at all levels of the university in order to provide the university self-development;
- "Achieving Bologna through Total Quality management" (2004–2007);
- The project objective was to develop quality assurance policies, systems and culture in University of Nizhni Novgorod which brings them into line with the requirements of the Bologna Declaration and the university's external clients;
- "University Knowledge Transfer for Sustainable Growth" (2006–2009);
- The project objective was to increase UNN's capacity for income generation by developing a Knowledge Transfer strategy, system and culture; effectively managing the commercial interface between the university and external enterprises; creating a cadre of Knowledge Transfer professionals.

In 2010 UNN succeeded in a competition for the right to participate in Russian-American Programme EURECA (Enhancing University Research and Entrepreneurial Capacity). The Program is aimed at the development of Russian National Research Universities' infrastructure for the successful transfer of the results of university research to the economy through the engagement of the experience and capabilities of U.S. research universities. This program is an initiative of the U.S.-Russia Foundation for Economic Development and the Rule of Law (USRF) and it is supported by the Ministry of Education and Science of Russia. UNN is implementing two pilot projects with two leading U.S. research universities under EURECA: "Centre for Student Entrepreneurship and Innovation" in cooperation with Purdue University; and "Centre for International Cooperation in Technology Transfer" in cooperation with the University of Maryland. Participation in the EURECA Programme is a good opportunity for UNN to enrich the processes of innovation ecosystem development with the expertise of the leading American research universities.

The system of continuous multi-tier entrepreneurship education "Student – Academic staff – University Spin-outs" has been developed at UNN. This system is based upon the many years of methodological and organisational experience of training and retraining of staff and students in the sphere of Innovation Management and Entrepreneurship. Specialists trained within these programs in addition to their major knowledge have competences and skills in innovation entrepreneurship and management.

The system of innovation entrepreneurship education is integrated into UNN innovation infrastructure and it covers the following directions, which are very important for university innovation development:
• Training of academic, administrative and managerial staff;
• Mass entrepreneurship training for students;
• Training of PhD students and young scientists in the sphere of commercialisation of research results;
• Targeted training of university's spin-out companies managers;
• Special training for participants of "U.M.N.I.K." Programme of the Foundation for Assistance to Small Innovative Enterprises;
• Continuous Professional Development programmes for UNN partner companies.

The infrastructure for innovations created at UNN serves as an efficient tool in solving the main task of a modern university, which is training innovators.

Conclusions

New challenges of the global innovation economy have forced leading universities to reconsider the traditional model of their functioning. It became clear that a Humboldtian university that constituted academic freedom and unity of scientific research and education cannot provide efficient responses to major challenges of the modern innovation society.

The concept of market-oriented innovative university based on the knowledge triangle (Education – Research – Innovation) starts to dominate in all developed parts of the globe. The key concept of fundamental nature of knowledge and education remains a prerequisite, but it is not sufficient for efficient development of a modern university anymore. The additional university function appears, and it is aligned towards the market and society needs. The realisation of possible ways of implementation of the third, "market" function of a university has not been completed yet.

The experience of developed countries shows that large-scale industrial corporations are the major contributors to the market of innovations, and universities are not able to efficiently compete with them for a share of this market. At the same time universities can and have to provide the innovation economy with its main "fuel" for development, which is highly qualified specialists with innovation entrepreneurship skills and competences, i.e. innovators.

Today, students graduating from top universities need to understand science and technology, but also need to be able to identify opportunities, understand market forces, commercialise new products, and have the leadership and communication skills to advocate for their ideas. Entrepreneurship knowledge and skills are increasingly being recognised as essential for the labour market of the global knowledge economy. Innovation entrepreneurship education is increasingly being emphasised at leading world universities given the belief that entrepreneurially-minded people are key solving economic and social grand challenges.
The most important role of a university innovation infrastructure is training of innovators – the entrepreneurs who are good in launching innovation activities in their fields of knowledge. Thereby we formulate the main task of a modern university in innovation knowledge society as training of innovators, and define the role-model of innovative university as knowledge tetrahedron with an innovator on its top, and with knowledge triangle as a base for production of innovators.

References


II. Knowledge Transfer:
    Best Practice in Russia and Germany
The Triangle for Innovation in Knowledge Transfer and Partnering at Münster University of Applied Sciences

Carsten Schröder, Thomas Baaken and Nisha Korff

1. Success is based on Quality

The Münster University of Applied Sciences (MUAS) has undergone a long educational tradition: In 1971, it was founded by mergers of several state-owned and private engineering and building schools and, in addition, those institutions providing occupational education. Today, the University of Applied Sciences belongs to the largest and most successful Universities of Applied Sciences in Germany. With headquarters in both Steinfurt and Münster and rather new locations of studies in Ahlen/Beckum/Oelde and Coesfeld, it counts approximately 11,000 registered students. Among its 650 employees, 250 professors teach and undertake research in the field of 14 different faculties and specialist divisions.

Münster University of Applied Sciences' claim is to become the prime address for practical education and research in which quality makes up the claims' basis for all fields. It serves as a measurement for teaching with its various, market-focused offerings. The university is the fundament and basis for excellent research success and serves as incitement for businesses to agree to strategic alliances and partnerships. And it is a trademark of a subtly adjusted system of internal navigation of resources. All of the qualitative characteristics taken together, shape the picture and appearance of a modern, high-performance and customer-oriented university. Whilst supported by a network of strategic partnership, MUAS would like to further enlarge its top position. One of the university’s core strategies is the technology and knowledge transfer, which is constantly being geared at its partners' needs – especially those coming from the economy – in the sense of a service commitment. This self-conception of the university as being a service provider differentiates us from former times.

Setting priorities on research and technology already in the early stage and alongside of premium teaching, was worth it. MUAS is one of the leading German Universities of Applied Sciences in the procurement of third-party funds and additional federal state funds for research and development. Approximately 15 Mio Euro resulted in an increase of third-party funds in 2011; this is nearly an increase of 400%, compared to 2001. A bigger part of this increase resulted by projects with industry, which featured the largest amount of 5,6 Mio Euro. The total sum of 2012 corresponds to 31% of the university's public budget. This is a peak value on state level; the same applies for 50,000 Euro procured in third-party funds per professor in 2010.
2. Triangle for Innovation

This development has arisen from a basic decision made in 1998 and implemented ever since. Both research and teaching are equivalent columns and thus are equally important to us, and result in a mutual quality increase. Research and development activities both provide impulses for practical teaching and act as decisive prerequisites for the Master Program accreditation. Thus, the above success values finally result from this triangle of synergies for innovation. However, MUAS approaches the topic of exchange processes with businesses according to the following three levels: strategically embedded and anchored within the university board, analytically and research-focused through an accredited focus of the research field and operatively through a service provider for technology and knowledge transfer in the form of a company (GmbH).

![Diagram of MUAS Transfer Strategy]

Figure 1: The Triangle of MUAS Transfer Strategy

The corners of this strategic triangle 'cross-fertilise' each other and thus jointly influence methods, processes and projects promoting research and transfer activities at the University of Applied Sciences. The actual paper is going to present both, operating level and the interdependencies and impulses among "Strategic Approach" (2.1), "Analytical-Scientific Approach" (2.2) and "Operational Approach" (2.3), exemplifying selected case studies.

2.1 Strategic Approach

2.1.1 Impulses by the University's Directorate

Research and transfer have always had a tradition at the university. From 1998 under the direction of Rector Klaus Niederdrenk and since 2008 of President Ute von Lojewski a substantial increase in research and transfer activities took place. Amongst others, the Vice Rectors were the driving force for those impulses. In 1998, this position was filled for the first time with a professor with the background of Technology Marketing. By conducting consistent internal and external marketing, he laid the basis for an increase of third-party funds. The idea
was an easy one: if the university intends to co-operate more with research partners from industry, and if it requests more money for its research performance, it finds itself in a market. And, if you want to be successful in this market, do you not need to undergo and conduct marketing activities? Due to this successful approach, in fall 2002, the Research and Development Centre "Science Marketing" was established. Until today, the centre represents on a research operating level knowledge on exchange processes between universities and businesses, University-Business Cooperation (UBC), University Partnership Models and the Marketing of Science.

In 2003 a professor in Technology Marketing took on the position as a "Vice Rector" for research, development and technology transfer, who was very knowledgeable and experienced in the establishment of technology and service companies, due to his prior career. He played a key role in the foundation of the Transferagentur Fachhochschule Münster GmbH (Transfer Agency of Münster University of Applied Sciences – TAFH). In the same term of office of the university directorate the strategic task of partnering with an own prorectorate was established for the first time. Both topics are discussed at a later point.

Since 2008 the CEO of the Transfer Agency of Münster University of Applied Sciences (TAFH) is integrated into the university directorate as a committee representative and later (2010) as Vice-President for Knowledge Transfer and Partnerships. He is responsible for university related tasks such as research funding, research marketing, knowledge and technology transfer, innovation initiatives, business start-ups, exploitation and company partnerships on a strategic and operative level, which is especially facilitating the internal coordination and decision making processes.

2.1.2 Strong Anchoring in University Guidelines

Self-conception towards broad market and demand orientation has increased throughout the last years. Today, German universities and thus, also Münster University of Applied Sciences is facing financial restrictions in unknown dimensions. In order to stay powerful and keep its strengths under these circumstances, the university has – based on all hitherto activities and under consideration of recent and future frameworks and determining factors – defined the following guidelines for research and transfer and anchored these for instance in the university's developmental planning for 2005-2010:

- Research and development is a characteristic for Münster University of Applied Sciences and serves to establish and cultivate long-term partnerships with students, research institutions and businesses.
- Research and teaching are equal columns of the university. Their quality is interdependent. Research and development activities provide important impulses for teaching.
Münster University of Applied Sciences is anchored deeply in regional and supra-regional structures. The university is nationally and internationally being searched for as an innovative partner. MUAS wants to establish long-term and strategic partnerships, which amend to the university's strengths or complement deficiencies in the field of resources and offerings.

Research and development projects with the industry as well as publicly funded projects have the same value for the reputation and thus the third-party budget of the university. All projects are subject to good research practice.

Research and development activities are build on abroad fundament; interdisciplinary cooperation is understood as standard.

Research and development is beneficial for researchers – through research reputation, better structures and personal advantages. People building up and performing good research activities besides education, benefit from this directly.

These guidelines make up the strategic framework for aiding all measurements to enhance and support research and transfer. Further, for the first time the university defined development tendencies for the tasks research and transfer, which were then updated and realigned in the new University Development Plan 2011-2015.

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<td>Expansion of successful competence platforms in form of Internal Institutes</td>
<td>Adoption of interdisciplinary research networks and development of an incentive system</td>
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<td>Fostering of cooperative dissertations and establishment of a centralised graduate program</td>
<td>Adoption of a graduate program and increase the number of cooperative universities for dissertations</td>
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<td>Increase of public and private funded R&amp;D projects</td>
<td>Stabilisation of third-party funds by means of establishing a management system for EU-projects</td>
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<td>Establishment of strategic networks and alliances with companies, universities and communities</td>
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Figure 2: Elements of University Strategic Plans
A central strategic instrument of the University of Applied Sciences and therefore a core element of the current University Development Plan is, since a few years, the Academic Scorecard, as a basis for quality management. If the determination of aims is the starting point of the overall quality development, it is understandable which central function the University Development Plan holds in regard to the quality management. It is here where the aims for not only the whole university, but also for each faculty and institute are documented: Which strategic goals are to be pursued? How can they be formulated more in details? And which strategies or measurements are to be realised to actually achieve those goals within the next five years?

In order to structure and at the same time answer the questions extensively, the University of Applied Sciences makes use of the instrument »Academic Scorecard«. It is a table in which the aims can be presented in a clear manner, concretised and operationalised. The »Academic Scorecard« (ASC) is a university specific variant of the »Balanced Scorecard«. In both tables the institution is viewed from different perspectives to reflect a comprehensive picture of the organisation.

However, clear differences can be detected in the priorisation of objectives: the traditional characteristics classify, besides the common financial aims for profit-oriented companies, three additional views "customers", "internal processes" and "employees". The underlying principle is that the success of a company is based on customer satisfaction, which in turn is influenced by the quality of internal processes and the motivation and qualification of employees.

After intensive consulting between the University Board, the Deans of Faculty, the appointee for quality management of all departments as well as the quality management team and employees of the service centre the Münster University of Applied Sciences decided on the following three perspectives: education, research and resources. Research also comprises the activity transfer.

The financial perspective (in the Balanced Scorecard commonly shown at the top) is to be regarded as a sub-perspective of the resources in the Academic Scorecard. This is also true for the items staff, infrastructure and management. The university wide Academic Scorecard concentrates on the formulation of goals, which can be directly influenced by central measurements. Conversely, the scorecards of the faculties describe all goals the respective department wants to implement in the following five years. By means of a thorough coordination process the compatibility of the strategic and concrete goals with the mission statement and the action plan of the University of Applied Sciences were secured. Further the compatibility of the department goals with the goals of the University Directorate was checked.

The university wide ASC and the scorecards of the departments comprise indicators with which the goal achievement of each goal is monitored continuously. Neither the indicators nor the target level to be achieved by 2015 are made public in the University Development Plan.
For the perspective "research" the following aims and measurements were defined for the strategic aims "strengthen research" and "strengthen transfer":

- "Strengthen key profile": identify key profiles, evaluate internal interdisciplinary research networks and continuously develop them in case of success (e.g. research institutes); develop incentive system for research and transfer (e.g. performance related resources; establish specific target-oriented support measurements for especially successful researchers
- "Extend the research basis": improve research conditions and incentive systems (see above); establish specific support measurements for new appointees and for lecturers not as involved in research activities; strengthen third-party funding for research and transfer activities
- "Support new academics": secure personal/financial resources of the graduate program; gain cooperative universities; support the compatibility of master programs and research project tasks
- "Strengthen exchange processes": systematise and make exchange processes between the University of Applied Sciences and others more visible; secure personal and financial resources of the transfer agency, optimise transfer processes and science marketing; establish a Customer Relationship Management system
- "Develop strategic research and transfer partnerships": define and develop strategic research and transfer partnerships (e.g. through strategy workshops)

2.1.3 Research Initiative and Incentive Scheme

Quality of exchange processes with businesses is lastly ensured and guaranteed by the researchers. Thus, a few years ago, with its research offensive, MUAS laid different building blocks for its system, which serve as incentives for researchers to get involved in more market-oriented research and transfer.

Whoever manages to procure funds, receives a bonus diversified for technical, semi-technical and non-technical faculties and coming from central funds. A certain model prescribes that a faculty receives more square meters of additional area if it raises a certain amount of third-party funds. As not all faculties have the same possibilities to raise large amounts of third-party funds, research performances such as publications, presentations, symposia are assessed according to a certain point system. Thus, those that undertake active research are able to reduce their teaching load.

In addition, the university established a fund for providing licensing support, a fund for research starters intended to support new appointees as well as internal competition based research programs for junior positions and the development of research institutes. Central research facilities can be allocated to projects for a limited period of time.
2.1.4 Target Group-Oriented and Supply-Side Communication of Competencies

Companies do not think in university structures. They search for competencies and solutions to their questions and are especially interested in receiving new impulses for marketable products and services. They are indifferent regarding who is responding to the inquiry in the field of sensor technology, either a researcher from the field of electro technology or physical technology. Thus, a few years ago, together with researchers in the field of research and transfer, MUAS developed the new guiding system of six areas of competency "Building/Environment/Resources", "Health/Life-Sciences", "Product and Process Development", "Applied Social Sciences", "Business and Service Management", and "Communications/Information". These reflect an interdisciplinary approach. Behind each heading various areas of operation – a construction kit of 70 single fields – is found. These bundle hundreds of specific research topics. MUAS' partners can therefore select and combine the relevant areas of competencies according to their own needs. However, the matrix is not a fixed entity. It is being updated regularly due to new research tendencies and changing needs on the markets. The web-based research catalogue gives users direct access to the topics and offerings. One can select the right contact person for your current issue and develop ideas for new projects. In the database you will find an overview of the scientists' profiles, their fields of work and the institutes, competence platforms and main focal areas of research and development.

2.1.5 Research Structures

The Münster University of Applied Sciences does not compare with academic chairs at universities in respect to the basic structure. As such no professor receives basic funding for several employees responsible for research or transfer activities. At the same time MUAS has working groups, consisting of up to 20 academic researchers and doctoral students, financed through third-party funding. In addition there is a great willingness of Universities of Applied Sciences to work interdisciplinary and cross-departmental. Due to this many tasks of external project partners can be solved promising, creative and efficient. As a result a number of research areas are firmly established at Münster University of Applied Sciences. These institutes are led by several professors strengthening the university's profile. Two types of organisation exist: internal institutes and associated institutes. Internal institutes are established within the university structure, spanning several disciplines:

- CCI – Corporate Communication Institute
- Institute for Sustainable Food and Food Industry (iSuN)
- Institute of Construction and Functional Material (IKFM)
- Institute for Optical Technologies
- Institute of Practice Development and Evaluation (IPE)
- Institute for Water • Resources • Environment (IWARU)
- Institute for Process Management and Logistics (IPL)
- Institute for Underground Construction (IuB)

The policy of the associated institutes is also to consistently orientate themselves towards the market. Positioned outside the structures of the higher education institution and its specific basic conditions, associated institutes are able to promote certain research and development topics more effectively. Professor-led associated institutes are strongly embedded in the higher education institution's research strategy by way of cooperation agreements and intensive communication. The associated institutes are:

- Institute of Waste, Waste Water and Facility Management (INFA/ISFM e.V.)
- Institute of Textile Structural and Environmental Engineering (Kiwa TBU GmbH)
- Use Lab

These research structures of the MUAS are completed with the Transfer Agency, five competence platforms and competence centres such as the competence centre for humanitarian aid or the laser centre as well as the doctoral program.

As one of the first University of Applied Sciences, MUAS established a graduate program. Exceptional students have the opportunity to realise their proposed dissertations and at the same time qualify for the following career path in industry or science, in a three year program. To secure international scientific standards, the University of Applied Sciences cooperates with domestic and foreign universities.

2.1.6 Partnering

In 2003, the university installed a 'Vice Rector' for Partnering for a first time. The position aims at advancing and differentiating the university from others and to foster partnerships purposefully. Thus, a system of coordinates must be created in order to bundle different actors of power among the vast amount of faculties, research and development focal points, projects and institutes and to seek and bundle different synergies. Further, a basic aim is to allocate the university in the landscape of other universities in order to differentiate it from other universities and institutions and to supply it with a better position in the national and international competition. With this orientation, the University of Applied Sciences makes allowance for the high importance and meaning of a partnering approach of its university strategy.

A strategic alliance is for MUAS defined by the following criteria:

- more than project work,
- a strong attachment to a few selected partners,
- a win-win-situation,
- positioned on different levels,
- supported by the presidential board,
- building a profile for the university.

In November 2004, the university has undergone a strategic alliance with BASF Coatings GmbH in order to intensify exchange processes between economy and science (e.g. by case studies and presentations), to train junior employees (e.g. through internships, final theses, job postings), to transfer know-how in research, teaching and further education (e.g. through university teaching positions, research and development projects, offerings for further training), and to convert synergies and lead strategic dialogues. This goes as far as giving out internship positions and those for final theses as well as joint personnel development.

The university works closely together with other companies as well. As such, Merck – a worldwide active pharmaceutical and chemistry company – and the university work in the "Merck-Lab" on new materials for LEDs.

Due to the success of the transfer project "TRAIN-Transfer in Steinfurt" another strategic alliances with the district of Steinfurt was formed in 2004. It includes the cooperation in a founding and innovation park in Steinfurt (GRIPS). The third strategic alliance was arranged by the Münster University of Applied Sciences with the mutually strong performing Universities of Applied Sciences of Berlin, Bremen, Köln, Hamburg, München and Osnabrück. Furthermore, cooperation with US universities and others are being advanced as a consortium "UAS 7 – German Universities of Applied Sciences" and researchers supported through the 7th EU-Research Program.

2.2 Analytical-Scientific Approach

After the first success of this approach, in fall 2002, the research centre, "Science Marketing", was established. On an analytical and scientific level, it deals with marketing strategies for research performance in a broad sense. Several research stays abroad (e.g. at the University of Adelaide, Australia, at the ECIC Education Centre for Innovation and Commercialisation (www.ecic.adelaide.edu.au) from January 2003 until March 2004) resulted in an intensive exchange of methods. Also staff from Adelaide (Todd Davey March 07 – now, Antonio Dottore May 08-August 08, Dr. Carolin Plewa on a regular basis e.g. Sept 12- Feb13) is visiting the Research Centre to work with the Münster researchers and to learn and contribute.

2.2.1 Research Centre on "Science-to-Business Marketing"

In order to improve the situation of marketing research through successful models, and in order to develop new models, the research centre with the focus of "Science Marketing" was established. It is geared highly at an international know how, experience and method exchange concerning the topic of research marketing. Co-
operations with foreign universities and businesses have imported to FSA cognitions, challenges and instruments from all over the world and vice versa. S2B Marketing is addressing a new concept of entrepreneurial thinking and behaviour at universities and research organisations and goes far beyond traditional research commercialisation and technology transfer. It is characterised by an active identification of potential users and clients for scientific research. Research is anticipating already in very early stages potential applications and is targeting to benefits for (potential) applicants. Thus S2B Marketing is utilising modern management and marketing concepts, models and instruments and needs a fairly new mind set in today's sciences organisations.

The centre has been start financed by North Rhine-Westphalia (NRW) and raised research funds and third party money from industry. A substantial part of these funds originate from abroad: EU funds from the European Framework Programs, from governments of Japan, UK, Portugal, China and Australia.

2.2.2 Market Research for Science Deliveries

The analytical work of the centre is based mainly on strategic studies, such as market potential studies, market diagnostics, awareness and image surveys, and customer and partner satisfaction measurements. The latter kind of studies seemed the first worldwide that considered expectations versus satisfaction in research markets. Actually companies frequently address R&D institutions, mentioning and describing a certain problem. Thus, companies are R&D institutions' customers. They articulate a need for research which they cannot cover themselves (qualitatively or quantitatively). In turn, R&D institutions provide these services as suppliers. In the study it was mentioned which requirements are being posed to research providers/suppliers by research customers and to which extent these have to be fulfilled, which sources of information research customers use in order to get information on research providers and how decision-making processes concerning external awarding of research tasks are carried out. The aim of the study was to give away to research providers the respective information they need to recognise customers' needs. Success is only achievable, if they focus on these needs and offer exactly the performance their customers need. On the one hand, third-party funds for research providers are being generated; on the other, economy's power of innovation is being empowered.
The following example will serve as an exemplification of the study's approach. The most important factors of research co-operations among businesses and external research institutions were – according to customers in Germany – the research institution's "competence" and the "price-benefit relationship". These points present the highest requirements, on behalf of businesses, researchers need to adhere to and deliver. However, the degree of actual fulfilment is considerably lower than the expectations (see Figure 3). The results show the all decisive (strategic) success factors, which must be fulfilled by suppliers i.e. research providers, if one's research performance is intended to be marketed successfully.

Furthermore, general discrepancies between expectations and fulfilment were detected. This means that customers could not be satisfied with most important factors on behalf of research institutions. Hence, there are different interpretations to these results. These entail three different strategies in order to fill the gap between perceived fulfilment and requirement. The present study provides knowledge about a variety of factors and their assessment on behalf of research customers. Furthermore, due to the study, relevant target persons are being identified, information channels named and assessed according to relevance. Also, many more relevant and important factors related to market cultivation were identified. These in turn served as initial points for formulation of many target-specific marketing instruments for research providers. The same research customer study concerning customer satisfaction was conducted in several countries. Comparison of results brought up differences and similarities. Whenever differences or deviations occurred those countries having received best customer assessment were asked about what they did exactly to better perform on behalf of research providers. The aim was to learn from each other and to take advantage of existing experience and potential. Again, the results were new.

Figure 3: Customers' Expectations vs. Customers' Performance Perception
starting points and instruments, which would lead to more successful market cultivation. Later, also research institutions themselves were examined and it was determined which expectations exist on behalf of customers i.e. ordering party and how research providers themselves would estimate expectations and satisfaction of customers. Another study was on "Benchmarking Research Commercialisation of German and Foreign Universities". Therefore, customer surveys of several countries were compared, contrasting differences in order to identify best practices on performance level, possibly deducting ideas or further models and strategies of successful marketing of research. Also deducted, amongst others, a world-wide study called "Innovative Approaches" (analysis of websites, leaflets and marketing concepts of more than 400 universities and other higher research institutions) of excellent marketing strategies.

2.2.3 Concepts and Testing

Resulting from all the different studies and projects 83 instruments both strategic and operative were developed, which are made available for the university or for others in a toolbox and for a fee, structured and categorised according to specific categorisations. Besides those instruments targeting customers, there are those aimed at the development and optimisation of processes; others concern "internal marketing" and have the aim of motivating researchers to co-operate with businesses.

The instruments are tested both at the Münster University of Applied Sciences and are also applied in further projects. Partners for the project "Optimisation of the scientific value chain through demand-oriented knowledge and technology transfer – new challenges through the development of unilateral transfer towards science-to-business marketing" are SMEs like Schmitz Cargobull AG, TTOs like TTN Hessen, and universities like the RWTH Aachen.

2.2.4 Dissemination and Publications

Cooperation on own university level is reflected in the following. Transfer of scientific results into strategy and operative levels of the university is ensured by regular joint meetings. However, MUAS knowledge is also handed on to others.

One of the important building blocks of international co-operation is conferences, conducted by the research centre in co-operation with partner universities and partner businesses in five different countries (Adelaide, Australia; Münster, Germany; Brussels, Belgium on European level and Pretoria, South Africa and Tokyo, Japan; Beijing, China; Pachuca, Mexico, et al.). A joint conference was conducted during the German-Russian Scientific Year 2011/12 in St. Petersburg on 11.-12. May 2011.
For the next years further conferences are scheduled (Cracow, Poland; San Jose, Costa Rica; Zurich, Swiss).

In addition, researchers of the research centre are invited to further presentations dealing with Münster University of Applied Sciences' newly developed approaches. So far, over 200 presentations in 27 countries were held (besides in European countries also held in the US, Australia, China, South Africa, Japan, etc.) (www.science-marketing.com).

At MUAS, each year a seminar in the form of a "Commercialisation Awareness Seminar" is realised. Synergetic to a teaching event of Science-to-Business Marketing, this seminar was arranged for in the early hours of evening in order to open it for university audiences.

Workshops and seminars concerning "Science Marketing and Technology Transfer" were executed for a fee at five further German universities and also in Switzerland and Poland. In October 2005, 30 persons responsible for transfer from Hessen have attended Science-to-Business Marketing for two-day up to one week seminars. Further, a co-operation with Technical University Berlin is arranged, which offers the new Masters study program of "Wissenschaftsmarketing", including a course on "Science-to-Business Marketing" delivered by the research centre.

2.3 Operative Approach – Transfer Agency Fachhochschule Münster GmbH

In 2001 the county of Steinfurt and the Münster University of Applied Sciences initiated a strategic partnership in the area of knowledge and technology transfer to strengthen the innovation potential of companies in the region. Two employee positions were developed at the Steinfurt campus to actively approach companies and develop cooperation projects with the laboratories. The project got its own name "TRAIN", to identify with its characteristics. TRAIN is anchored in the business promotion and development community of the district Steinfurt mbH (WESI) and the transfer area of the University of Applied Sciences and forms a central project of strategic alliances between the partners till today.

TRAIN is substantial for today's transfer strategy, because MUAS gained additional experiences with exchange processes between university and companies, during the pilot phase 2001-2004. The university experienced intensively that the requirements for transfer processes steadily increase. Businesses are in greater need of innovation due to shorter product and technology lifecycles. Further, research and development results must be on hand even faster. Thus, in 2004, the board reacted to these requirements with a new offer – the Transferagentur Fachhochschule Münster GmbH (Transfer Agency of Münster University of Applied Sciences – TAFH). All of MUAS operative transfer processes are accumulated together in this agency. The 'spin-off' enables MUAS to organise transfer services even more target group-specific and thus, more market-oriented. The TAFH has been established in form of a company. However, the TAFH is still embedded in the university's structures. Both
the offices at Münster and Steinfurt and the integration into university internal decision-making and communications processes guarantee ideal transfer services within the four businesses domains of transfer ordering, transfer projects, transfer management and shareholding.

The business domain of transfer ordering comprises general transfer consultancy and stimulation at the university. Main focus is put on co-operation support with businesses and on network establishment. Thus, university scientists are supported just as well during the acquisition of new projects as during the search for appropriate support possibilities in an increasingly complex aiding landscape. A special program for newly appointed professors offers them various university entry support. Further services that can be taken advantage of by scientists from the Transfer Agency are e.g. patent counselling under specific consideration of marketing strategies or support for trade fair performance and transfer events and first counselling during business start-ups.

The TAFH continuously conducts innovation initiatives, in which industry specific or regional focuses are emphasised. Apart from TRAIN MIAS is an example. The EUREGIO platform for medical technology innovation for an aging society (MIAS) aims at the development of existing cross-border cooperation for the technology and knowledge transfer in the area of medical technology. The central aim of the project is to foster the development of new products, processes and services for companies. The project consists of two parts, the development of a cross-border innovation platform in the area of medical technology and the concrete strengthening of cooperation projects between SMEs and research institutes (S&B, B&S). In total 13 German and Dutch partners from industry, science as well as intermediaries (TAFH, regional association of economic promotion) participate. The TAFH holds the full responsibility for the project management in cooperation with the regional association of economic promotion of the Dutch provinces Overijssel and Gelderland (Oost). The tasks comprise the coordination of the project, the financial management as well as reporting management with respect to the funding bodies. For the Ministry of Science of North Rhine-Westphalia and the Innovation Alliance of NRW-Universities, the TAFH coordinates the funding program "Innovationsgutschein" (Innovation voucher).

Transfer management relates to MUAS services for both accompanying and organising research and development projects. During bigger research projects of the university, the TTO takes over both project configuration, arrangement and contract negotiating and thus, undertake also, if desired, project management. Furthermore, MUAS executes a multitude of research and development projects with external research partners. The TTO GmbH involves researchers of the Münster University of Applied Sciences as project leaders and makes use of the research infrastructure of the university by means of a framework contract. The background to this is that the TAFH GmbH is better able to deal with questions and issues more flexible e.g. liability claims and project requirements arising on behalf of economic project
partners. The aim is to further increase the university's third-party funds coming from the economy. This has worked out so far as shown by parallel increasing research and development turnover by both university and agency. Company shareholding and joint ventures are MUAS' youngest business domain. Graduates who are able to think entrepreneurially have become a model of company personnel policy. The Münster University of Applied Sciences decided to face up to this responsibility by preparing its students and researchers for occupational independence and later business start-up. Hence, the university ties respective teaching content to all study program offerings and pay attention to entrepreneurial experience when appointing new staff, involve entrepreneurs and practitioners into teaching and offer central seminars focusing on foundation, all with support of network partners. On basis of contractual agreements the university permits individual spin-offs to utilise its infrastructure and resources. Within transfer ordering, the Transfer Agency offers competent counselling to founders of new businesses. Those academics interested in creating a new business can take advantage of counselling and coaching offers established by means of a Münster foundation network and strategic co-operation with all economic support institutions at both sites. However, MUAS proceeds even further. In 2006, together with the university board, it laid the basis for the business "shareholding" as a research structure because universities will significantly change in the course of the next years. For this reason, the university will increasingly carry out the establishment of a profile through focus and expansion of selected research fields of excellence. However, these structures will result in a higher need for exploitation structures under private law besides intra-university structures. For the purpose of an overall strategy, the university will tie spin-offs down to the university itself and thus, ensure reflux from the university's "research capital". The solution is the Transfer Agency holding shares in these businesses, where indicators demonstrate an increased research reputation, an innovative structural effect and/or research income in a regular high amount. Since 2006, the Transfer Agency has realised four shareholdings.

3 Mission Statement "Innovation via Partnering"

For 20 years, the field of transfer of MUAS has been engaged with stimulating, moderating and professionalising exchange processes between universities and businesses. During operative implementation of strategic specifications of university policies, principles, constantly considered in context with every single new transfer building block, were developed and are bundled in MUAS' mission statement "Innovation via Partnering". Being demand-oriented leads to service offerings aligned exactly and constantly along at the economic and practical partners' needs. Offer-oriented means that MUAS takes its role as societal and especially regional-economic driving force
seriously. Transfer is not a one-way street but a bi- or multidirectional exchange process between partners. To MUAS’ industrial partners, the economic success of co-operation is what counts at the end of the day. The university was and is being converted from a rather process-oriented to a more result-oriented institution by means of selected and university-geared instruments of Change Management. Thus, new ideas for products, processes and services have to become innovations, actually seizing the market. This means ongoing professionalisation through optimised processes by us and enhanced services. Optimised processes and enhanced services firstly mean focusing on core competencies. Throughout the last years, MUAS has analysed (adapted from politics) the transfer tasks and illustrated these in process chains (blue prints) and created strategic business units. Furthermore, MUAS cooperates purposefully with German and foreign transfer organisations in order to exchange new processes which are conferrable. Thus, regular visitors from e.g. Australia, the US, South Africa and European countries, are coming to the university in order to become acquainted with and adapt innovative instruments of successful knowledge transfer.

The Münster University of Applied Sciences is mentioned several times (Research Offensive, Vice President Partnering, Science-Business Meetings, Science-to-Business Marketing etc.) in the "Good Practice" set of ProTon Europe (Pan European Organisation of TechTransfer Offices of Public funded Research Organisations www.protoneurope.org) and also in European Commission, DG Education and Culture’s study on The State of University-Business Cooperation in Europe, (http://ub-cooperation.eu/pdf/27.pdf). Henceforth, it led to a "Centre of Excellence" for TechTransfer in the Staff Exchange Programs of the European Commission. However, many different partners co-operate despite the high professionalism of exchange processes between business and industry. In order for the exchange to function smoothly and effectively, MUAS is making an effort to design internal structures, processes and decisions to be transparent and comprehensible for its external and internal partners like companies and researchers.

MUAS does not only measure success according to the level of received third-party funds (input factors) or output factors (like patents, spin offs, newly created start-ups, etc.) even though those might be comprehensible and striking indicators. MUAS is targeting to better measure impact factors, the effect and impact of MUAS' transfer activities in companies and the society.
Further Literature referring to Münster University of Applied Sciences' Knowledge Transfer and Partnership Approach:

Baaken, Thomas; von Hagen, Friederike; Raesfeld, Lydia; Pontigo Loyoal, América Patricia (2011): Identifying University Customers and Partners via Science Marketing – a report on a real life case of MUAS in Germany and UAEH in Mexico; in: Badillo Vega, Rosalba; Raesfeld, Lydia; Villalvazo Naranjo, Juan; Baaken, Thomas (Ed.), La vinculación de las instituciones de educación superior con su entorno económico en el contexto internacional Alemania, Centroamérica y México, Pachuca, Mex.; pp. 188-207.


Baaken, Thomas; Davey, Todd; Kliewe, Thorsten; Francis, Anthony (2008): A model for the assessment and extraction of entrepreneurial value from university research, in: Ingle, Sarah; Neuvonen-Rauhala, Marja-Liisa (Eds.) "Promoting Entrepreneurship by Universities", Hämeenlinna, Finland, pp. 204-212.


Zukunftsszenarien des Wissens- und Technologietransfers zwischen Hochschulen und Wirtschaft, Bonn, S. 60-74.


Plewa, Carolin; Korff, Nisha; Johnson, Claire; MacPherson, Gregory; Baaken, Thomas; Rampersad, Giselle (2012): Evolution of University-Industry Linkages – A Framework. Journal of Engineering and Technology Management (accepted).

Transfer Concept of the University of Kassel 2011-2015

Oliver Fromm

A. Introduction

Understanding itself as a reform university the University of Kassel adopted the idea from the beginning that scholarship has to face the challenges of society in a particular way and, with its achievement, contribute to the solution of social problems. This idea has given rise, in the development of study programs, to the need for special practice-orientation and, in research, to openness to urgent social problems and the interdisciplinary collaboration required to solve them. The result was the wish to make competence generated in the University of practical value to society in the form of knowledge transfer. The former GHK was one of the first universities to actively devote itself to knowledge transfer: it was in the vanguard of developing academic further training and building up consultation services in technology and innovation before this field became a general aspect of university policy. Knowledge transfer thus corresponds to an understanding of scholarship cultivated specifically in Kassel and is one of the elements that contribute to the distinctive profile of this University.

Against this background the University Senate, in its deliberations about the development plan for 2010 to 2014, which is fundamental for the strategic development and objectives agreement with the State of Hesse, has been very intensively engaged with the task of knowledge transfer. The Senate has observed that while the University has achieved a standard recognizable at national level in the field of knowledge transfer, new perspectives are opening up in which further development steps are required. It has therefore decided to develop a transfer concept, in agreement with the Faculties and UniKasselTransfer, that will serve to establish the subject in a widely variegated fashion in the entire University. The transfer concept was decided by the Senate on 13th July 2011 and the most important passages of it are presented here.

B. Objectives of the transfer concept

The external effects on society and the region have long been a major consideration in setting up transfer activities of institutes of higher education and are the background of political demands for an extension of university activities in this field. The interplay of knowledge transfer and research, on the other hand, has moved into the foreground of the discussion about academic policy in recent years. Connected with this are new developments in knowledge transfer, which the University wishes to pursue, consistent with its profile " Von der Grundlagenforschung bis zur Anwendung" (From basic research to application), as an institution with vanguard status. The basis of this is the transfer concept. This shows clearly the concrete
value-added and the strategic and profile-forming significance of knowledge transfer in its broad scope for the University. In addition to the social and regional considerations the positive feedback for research and teaching are the heart of this treatment. The most important fields of action of knowledge transfer are identified and it is made clear how the necessary functional responsibilities of the Faculties and the transfer organization are to be divided to achieve worthwhile integration of transfer duties and what has to be done by both groups for the future in order to achieve defined goals. Aspects of gender and diversity, as well as family-friendly considerations, play an appropriate role in accordance with the profile of the University.

C. Goals of knowledge transfer

1. Value-addeds in scholarship

Knowledge transfer is meant to create value-added for the primary tasks of the University, that is for research and teaching, and this includes the employability of graduates.

This focus on internal effects is combined with an understanding of knowledge transfer as an exchange relationship to mutual advantage. This understanding is to be distinguished from the marketing or utilization logic of the transfer, which can also be a goal of higher education policy, but is not of central importance in the transfer concept of the University of Kassel. Knowledge transfer is thus strategically not justified by financial gain, but by its structurally fundamental position as one of the central tasks of the University. At the same time a sustainable basis for the positive effects of knowledge transfer in society is created and, of course, refinancing of transfer activities should as far as possible follow from turnover or third party funds.

Two developments can be described that promote the growth of the importance of knowledge transfer for research and teaching:

– Paradigm change in research-related collaboration –

With regard to research-related collaboration with external partners a clear trend can be observed: Co-operative work that for a long time has been characterized by individual projects and relationships is increasingly being overlaid by a long-term strategic partnership. It is possible here to speak of a paradigm change that is driven from both sides by the knowledge that sustainable gains in knowledge can be achieved only if work methods, cultures, competences are known reciprocally to all sides and there is a measure of trust. Research-oriented knowledge transfer is not a one-way process of knowledge transfer from academic theory to business practice, but rather an exchange that benefits both parties from which there can be important knowledge gains for University research and teaching.

An important value-added for academic work is seen to be in the generation of ideas for research topics. External co-operation offers the possibility of directly distilling the development of leading problems that are likely to be important in academic
research from the results of application. The generation of research topics from academic writings and discussions is supplemented by active engagement with the potential and problems of application. A further value-added is in the possibility of validating research results. In some disciplines, priorities being life sciences and technological sciences, the validation systematically exceeds the academic field and results in practical application, in others this occurs only from time to time in certain cases. It is essentially a question of being able to use the entire chain of value-added of knowledge, including the feedback loops in the application. The application of research results supplements the internal academic testing process. The external cooperation thus serves the quality assurance of research. These value-addeds can be generated only if this interaction takes place in sustainably designed forms of cooperation with the aim of mutual exchange of knowledge gains.

– Knowledge transfer and employability –

As a result of the concept of employability associated with the Bologna Process, activities such as helping business start-ups, the development of further education possibilities, the Career Service and the Integrated Degree Program (Duales Studium) model, which so far have been defined as a supplement to teaching, have become integral components of university education. Knowledge transfer in this scenario acquires a communication function as interface between university and society that is meant to supply help for the Faculties in developing and implementing strategies and measures for academic training.

The communication function is concerned with linking the requirements of the world of work with the goals of academic education and not to orient university education one-sidedly to direct professional application. Arousing and maintaining curiosity, interest in knowledge acquisition and studying as well as the communication of methodological principles therefore have to be fundamental elements of university training. The educational remit of the university, however, also has to react to changes in the world of work: This applies currently in particular to increasing demands for parallel study and work, the growing importance of professional activities that are not genuinely subject-related, especially in the Social Sciences and Humanities, more weight on professional independence than on entrepreneurship within organizations and the requirement of the students for more clearly defined professional orientation in their studies. UniKasselTransfer here is required to combine appropriate activities with the teaching provided by the Faculties and thus contribute to the teaching-related profile of the University of Kassel.

2. Value-addeds for society

Understanding itself as a reform university, the University of Kassel adopted the idea from the beginning that scholarship has to face the challenges of society in a particular way and, with its achievement, contribute to the solution of social problems. This idea has given rise, in the development of degree programs, to the
need for special practice-orientation and, in research, to openness to urgent social problems and the interdisciplinary collaboration required to solve them. The result was the wish to make competence generated in the University of Kassel of practical value to society in the form of knowledge transfer. The former GHK was one of the first universities to actively devote itself to knowledge transfer: it was in the vanguard of developing academic further training and building up consultation services in technology and innovation before this field became a general aspect of university policy. Knowledge transfer thus corresponds to an understanding of scholarship cultivated specifically in Kassel and is one of the elements that contribute to the distinctive profile of this University.

Among the important impulses of knowledge transfer of universities for social development are the following:

- First and foremost, graduates are the most effective means of transmitting new knowledge to society. The latest knowledge generated by scholarship is transferred via their competences to the practice of employing organizations – during their period of study within the framework of internships and degree theses as well as ultimately in employment and parallel work and study.
- Partners in industry benefit, in terms of research and development projects, from access to the latest research results and use them within the framework of their change and innovation processes. This applies not only to business, but to educational institutions, the social sector and the public sector.
- There are also the many facets of applied research (expert opinions, consultancy, lectures), in which social work, psychology, architecture, urban and landscape planning, political science, organic agriculture deal academically, among other things, with very concrete social, planning, cultural or ecological problems in a form that is closely associated with the prospect of practical implementation.
- New businesses set up by the university or graduates contribute demonstrably in a particularly effective way to economic, social and ecological structural change, because new knowledge and competences are converted directly into innovations.

3. Value-added for the region

In Nordhessen (North Hesse) the establishment of the University was closely associated from the start with its potential effects on the regional economy. In the foreground the prominent questions in the 70s were related principally to the immediate effects on employment and demand, which arise within the framework of a 'university production process'. In the knowledge-based system of society and the economy the university as a producer of knowledge has been in the foreground. This is particularly true because – even in the age of new information and communications technology – spatial proximity and personal interaction make a more intensive exchange in the process of knowledge acquisition and diffusion possible. Knowledge transfer between universities and regional partners can therefore be designed particularly efficiently and the potential for innovation...
correspondingly reinforced. The impulses which the university provides for society and which are described in the previous section can be effective when concentrated in the region, if the bases of co-operation are designed appropriately.

D. Fields of action in knowledge transfer

1. Research and application

In its co-operation with external partners the University of Kassel considers it a priority to build and cultivate permanent forms of interaction. The aim is co-operation that takes place only periodically, anecdotally and short-term within the framework of individual projects, but is long-term and partner-related. In the context of collaboration between the University and business the concept of Strategic Partnership has established itself for this form of collaboration. The University of Kassel is pursuing this direction of collaborative relationships across all Faculties and the relevant potential partners. In addition to business these partners are from the social sector, culture, the education sector, public administration and others.

The development of external relationships accentuates the transfer program of the University, which guarantees that co-operation is not understood as an independent new task that will place a strain on the already scarce time resources of the scholars, but as an integral component of research and teaching. The conflict to be resolved was formulated very clearly in the survey of professors in the Social Sciences and Humanities carried out in 2009. Co-operation was regarded as increasingly important for core tasks; the exploitation of research topics was also seen as an advantage in the sense that it enriched teaching through contact with practical questions. At the same time, however, some reservations about knowledge transfer as a further task were expressed.

Against this background the following demands are to be made, from the viewpoint of the University, of co-operation with external partners (Wissenschaftsrat [Academic Council] 2007):

- The research topics have to be based on mutual respect for the relevant missions and be of genuine interest and major importance for both sides.
- The achievements have to support co-operation.
- The external partners should engage in teaching and encouraging younger scholars (lectures, seminars, development of training and further training measures).

The University in previous years consistently pursued the goal of linking with external partners on a long-term basis in the sense of strategic partnerships. One priority was in the Faculties that specialized in technology and management. Examples of institutional links are the application centres of Metakus and IdE as well as the Management School UNIKIMS. Moreover, there are permanent relationships in R & D with a significant number of businesses, which meet the requirements formulated. These activities are to be furthered and at the same time in the Social Sciences and Humanities extended. From 2010 a further field of action has been
opened up in the form of the social sector and the planned competence centres of Sozialrecht und -politik (Social Law and Policy).

With regard to the operative support for scholars there are two priorities:

- A basic challenge posed by research fields that tend to be theoretical is the need to demonstrate the applicability of research results. The wide gap between research and application presents an obstacle to recruiting partners from outside the University. In the natural and technological sciences there is another hurdle, that of licensing patents. The first validation steps in this case have to be organized by the University itself. Because research finance is not normally expended in this area, alternative sources of money have to be located. Politically this gap has been recognized and financial support has been made available at the State and Federal levels, and UniKasselTransfer supports the procurement of such resources. Among them may be mentioned "VIP" (BMBF), the feasibility fund of the State of Hesse and the new program "Erkenntnistransfer" (Knowledge Transfer) der DFG (German Research Council). By way of preparation UniKasselTransfer offers so-called screening interviews, i.e. structured interviews, based on guidelines, with scholars on application possibilities.

- The communication of contacts with potential partners, especially for newcomers, where lecture series (e.g. UNIKIMS lecture series) and invitations to departmental presentations have proved to be effective. This model is to be extended to incorporate the Social Sciences and Humanities. In general other formats are to be created that promote informal exchange, because they are an extraordinarily important catalyst for establishing cooperation of a firm basis – as studies of knowledge transfer show. In this context it is an important task of UniKasselTransfer to cultivate permanent and continuous contacts with relevant partners of the region (businesses, social and cultural institutions, associations, trade unions, etc.). This is a basis on which it is possible to develop precisely targeted collaborative projects for individual University departments and at the same time make the broad scope of University competences available to the partners.

2. Promoting new business ventures

The large number of new businesses, about 300, that have developed from the University of Kassel since its foundation, have a visible effect on the city and the region in economic, social and cultural terms. There is also evidence of the tradition 'entrepreneurship', which is the result of explicitly combining academic and business interests and is a particular feature of this University. Today they are important partners in research and teaching.
New business ventures close a gap between the creation of academic knowledge and the application of it in social and/or market-related contexts and are thus ideal partners for the validation of research results and exploitation of new research ideas. They contribute to the continuity of research fields and offer the opportunity to consolidate know-how, e.g. by the continuing employment of highly qualified members of staff. The mutual advantages of the collaboration develop naturally in the start-up process and generally continue thereafter. It is therefore not surprising that new ventures reveal a demonstrably higher level of co-operation on average than other businesses.

There are also two driving forces for the University's involvement in promoting new business ventures: the value-added for research and teaching, which are quite distinctive with new business ventures and the support for students who see a possibility of employment with the company they are working for.

Promotion of new ventures by the University of Kassel was consolidated in 2006 with the establishment of the institution known as UniKasselTransfer Inkubator and since then has developed successfully. This institution has focused principally on motivating and raising awareness of new business ventures, consultancy support for getting new ideas off the ground, access for support finance (EXIST) as well as supervision of new business ventures. Inkubator creates the 'possible courses of action' for academics, students and graduates interested in entrepreneurship and is aimed at all Faculties. Important principles of the promotion of new businesses are:

- The successfully established ideas competition called Unikat, which motivates students and staff to formulate their entrepreneurial ideas for the first time as well as ideas workshops in which the start-up ideas can be systematically worked out.

- Consulting on how to put start-up ideas into practice in the early phase (first consultancy, EXIST grant for new businesses and EXIST research transfer).

- The Entrepreneurial Council of the Inkubator, with which it has been possible so far to establish a network of national significance. 21 businesses, 13 of which were set up from the University of Kassel, play a positive role in the Entrepreneurial Council, which is actively integrated into the set-up advisory board of Inkubator. For set-up projects that are presented in the bi-annual sessions of the Entrepreneurial Council the business experience of the entrepreneur offers an essential value-added.

- The monitoring of set-up projects in the market, e.g. though the participation of the University and licensing of patents.

The promotion business start-ups is part of the University's profile. The aim is to initiate and support quantitatively more and qualitatively better start-up projects. The EXIST IV competition that started in 2011 (Gründungsprofilierte Hochschule [University with Start-Up Profile]), in combination with the Science Park Center that will be ready in 2013, offers the opportunity to achieve a reputation (and resources) for this activity at the national level.
3. Parallel study and work

The Bologna Process makes parallel study and work at an advanced level, in particular to the Master's level, an integral component of university teaching. Taking up a job after the Bachelor's degree, in this system, is not the equivalent of foregoing a further academic qualification. On the contrary, graduates with a Bachelor's degree are already going on to the work-study Master's level. The change in the world of work and demographic development are additional factors that lead to higher demand for academic further education.

The University in general has to accept that, with its traditional understanding of an educational path oriented to full-time students with Abitur (university entrance qualification) followed by professional employment, it is no longer taking account of the diversity of educational and biographical reality and in this respect is not making the best use of relevant educational potential for the University. This is true especially if the University is attempting to increase the 'quality' of new students and, independently of the development of the number of new students, enhance its significance.

In addition to recruiting qualified students the following are named as immediate value-addeds for teaching and research:

- Further education participants, because of their scarce time resources and professional commitments, from experience make high demands of the quality of teaching. From the perspective of the University the impulses for the development of quality teaching could use further education as a starting point.
- For the academics engaged in further education, the work with usually highly motivated and demanding participants is often particularly rewarding, especially if the professional experiences of the participants is systematically incorporated into the teaching. The academics thus obtain a constant insight into the development of professional fields. This can be used to integrate the subject of "Employability" into the Bachelor's and Master's degree programs.
- The subjects in transfer tasks or degree theses completed in professional practice can be the result of joint projects in applied R & D.

For the University of Kassel academic further education has the potential of a profile-making characteristic. With more than 500 graduates in the last five years and the establishment of the current integrated Master's degree programs the University is well positioned in comparison with other universities.

However, the extension of integrated education presents new requirements in terms of quality management, assessing achievements and admission criteria. In addition to supply-orientation in the first training there has to be demand-orientation. This has implications for the teaching methods adopted by further education teaching, especially the relationship to application and practice as well as transfer-oriented feedback, spatial and temporal organization, efficiency (time expended/knowledge acquired). These aspects have to be considered on different levels (central organization, degree program, module) in such a way that account can be taken of
the demands of the participants. Further new developments for the University are the admission conditions for Integrated Degree Programs are increasingly being opened by the KMK and the accreditation of extramural educational and professional achievements are being pushed forward by the KMK.

To keep the strain on the Faculties to a minimum and use advantages of specialization, the University of Kassel, with UniKasselTransfer and the Management School UNIKIMS, has created a support structure that offers planning, marketing, organization and financial handling of further education offers.

UniKasselTransfer in the early phase of the conceptual development offers support in testing the needs, specification of target groups, estimation of costs and suitable measures for recruiting participants. Similarly, the procurement of third party funds for the development and introduction of degree programs as well as the preparation of necessary university decrees are among the tasks of UniKasselTransfer. The UNIKIMS Management School thus takes on entirely the task of recruiting participants and the responsibility for study operations. In addition, the UNIKIMS bears the financial risk and, under certain circumstances, finances the preliminary costs of degree program development, including the accreditation costs.

4. Teaching and employability

Strategic significance and value-added

Educational policy recommendations have long pointed to the need for systematic support of the transition from study to work on the part of the universities. The background to these recommendations is the structural change in the labour market for graduates:

The labour market for graduates has developed from a niche labour market to a mass labour market with strong differentiation of professional positions. The transition from study to work is today a phase of its own with specific chances and risks, in which the points can be set for later professional success.

Traditional career paths of permanent dependent employment are beginning increasingly to dissolve: short-term jobs are becoming as important as part-time jobs. Independent passages (also freelance work and honorarium contracts) and entrepreneurial activities are becoming components of the working life. There is also the danger, depending on the subjects studied, of unsuitable employment.

Abilities such as initiative, effectiveness etc. are becoming important in business as well as in educational and cultural activities. It is becoming clear that models for success in business and models for the employability of graduates reveal similar personal success factors. Accordingly, they play an increasingly important role as a key qualification even in selection processes.

With the change to the Bachelor-Master system, the German higher education system has found itself in a transition process that has to take account of this change in the labour market: Employability and professional orientation have become a legally fixed study goal. The University of Kassel has set itself the goal "Herausbildung in-
dividueller berufqualifizierender Interessenschwerpunkte im Studium zu fördern und auszubilden." [of promoting and refining the development of individual professionally qualifying interest priorities](University of Kassel 2009, 3). In this sense it is taking account of the fact that the professional success of graduates has become an important characteristic of the image and reputation of the University.

It thus follows that:

For the Career Service as interface between study and work - the traditional contract remains, with new fields of action being added. In addition to the interdisciplinary preparation of students for job entry and development of a partnership exchange between University and professional practice there are also tasks of professional orientation of the students. Subjects that are characterized by an open relationship between study and work see themselves confronted by major challenges as a result of the study goal of professional orientation. This applies particularly to the Humanities and Social Sciences.

- **Integrated Degree Program**, originally developed to take account of personnel development needs of businesses, in this context is to be seen as a study model that leads to the development of outstanding chances of employment as a result of the interlocking combination of research, teaching and professional practice

- **Entrepreneurship**, understood as the competence of the individual to put ideas of one's own into practice, is a key competence of students and graduates that is gaining in importance in the professional world of work and accordingly should be a fixture in the teaching of all Faculties.

### 4.1 Career Service

The Career Service supports students of all subjects by helping them to design their professional biography, make a successful entry into their career and ensure that they continue to be employable. The result is the following fields of action:

- Professional orientation and awareness of strengths and weaknesses.
- Choice and design of internship.
- Help with additional professional qualifications.
- Applying and job entry.
- Recruiting offers for students/graduates and employers

In collaboration with the degree programs a broad spectrum is offered here, including a program of workshops and lectures about the application process and job entry, the idea of professional fields, individual consultancy and checking of applications as well as the sFelf-information area 'Job&Weg' (job and way). For the initial contact with employers a job portal and company addresses fair are offered. Some Faculties have developed their own formats for these (e.g. the business fair organized by FB 16, the Internship Day of the Institut für Sozialwesen [Institute of Social Studies]).
To sustainably promote the professional success of students of the University of Kassel the following are necessary:

1. Reinforcing professional orientation and the communication of internships and jobs in the Faculties of Social Sciences and Humanities have been central to the activities of the Career Service since 2010 and in the coming years will become the priority. The job market for social scientists and humanists has changed sustainably in the last few decades and these changes continue to accelerate. Job opportunities in the classical fields are being reduced, and new fields are opening up. Students in these Faculties have to expect rather difficult transition processes in the job market. Practical orientation and professionally oriented offers during the period of study have to reduce the impact of these processes and promote later professional success. The Career Service is necessary in this process as partner of the new Social Sciences and Humanities and impulse-giver to put the new study goal of professional orientation into practice. It supports the Faculties in the matter of accreditation and applications for third party funds. For example, best practice models are to be developed in the fields of internship support and exploring the professional field.

2. The variety of new degree programs, which often have an interdisciplinary character, leads to a situation where the employer has no overview. The employers must be made aware more actively of the competences acquired by the graduates. The employers must be offered more and professionally-oriented possibilities of establishing contact with students. Recruiting events must be designed by the University itself in order to take account of the specific needs of the degree programs and of the employers interested. The mediating role of the Career Service between students of all Faculties and possible employers must be more decisively in the foreground. The Career Service has to intensify its relationship with the employers and the Faculties. The creation of an internship databank for Social Sciences and Humanities students and the appropriate procurement of offers are both important elements in this scenario.

3. Further new fields of action include the establishment of the so-called service learning, career promotion of women and support in the job entry phase, especially in MINT professions as well as the combination of grant programs with measures of the Career Service.

4. The Career Service is responsible for the central quality management of all relevant offers and formats at the University of Kassel. In the Faculties available career activities (e.g. decentralized fairs) are supported by the Career Service.

4.2 Entrepreneurship in teaching

As the comparative universities ranking on promoting new business ventures (Schmude 2010) shows, there are still considerable deficits in the teaching of entrepreneurship at the University of Kassel. The University wishes to deal with this problem by integrating the subject of Entrepreneurship as a key competence systematically into the teaching of degree programs. Accordingly, Entrepreneurship
as a lateral competence has been taken up as one of the general mandatory key competences for all students. It is defined as a certain ability and mindset that can identify gaps, ask questions and derive options for action from them, assess and implement. This understanding goes beyond a purely managerial view of entrepreneurship.

The University already has some experience in this field, for example with its ideas competition Unikat, which has been running since 2009 and motivates students, staff and graduates alike to put their ideas into practice for the first time. In the previous competitions about 60 ideas were put forward by more than 100 people. Moreover, much of the teaching offers platforms for entrepreneurial project work, and there is also a series of lectures entitled "Unternehmensgründung – Wie plane ich mein Unternehmen" (Setting up a business – how do I plan my business). At the same time there is a need for new-style teaching formats to promote new degree programs, which will take their place alongside the traditional teaching format such as lectures and seminars. All Faculties have to offer appropriate interdisciplinary teaching that is also designed to meet the needs of the subjects studied. Ideas workshops, design thinking and co-working spaces as new methods for the development of ideas and spaces for joint work on entrepreneurial ideas, the integration of role models ("Unternehmer in den Hörsaal" [Entrepreneurs in the Lecture Hall]) or the use of plan games are examples of teaching formats that in various ways are designed to reinforce the subject of Entrepreneurship in various specialist disciplines. The objective is for professors who already study affinities in the course of their research and teaching activities to work out an inter-Faculty teaching model. UniKasselTransfer will co-ordinate the concept development. The aim is to institutionalize the concept.

The tasks of the Faculties is partly to acknowledge the subject in their examination regulations, e.g. as key qualification and partly to develop and implement subject-specialist and innovative teaching formats to reinforce Entrepreneurship as a relevant task for individual professors that can be supported by UniKasselTransfer.

4.3 Integrated Degree Program

The Integrated Degree Program offers university study in combination with professional training. Depending on the study program students achieve a Bachelor's degree in addition to a completed professional training in eight to nine semesters. The package 'academic study and professional practice' can be extended by a further semester into a Master's degree. This was introduced by the Faculty of Mechanical Engineering in 2000, and today it is offered by all technology-related disciplines, Economics, Industrial Engineering and Organic Agriculture. There are 300 students and 255 companies participating in this program, which is growing constantly. The integrative combination of research, teaching and practice enable students to get some idea of practical work and to reflect on the subjects that they are studying. This leads to the development of outstanding employability. The combination of study and work reduces the importance of financing for the student, whether BAFöG
(student loans) or short-term jobs. For the University the Integrated Degree Program is a model that is opening up a new student target group of its own and thus guarantees gain in the increasing competition for capable and motivated students. It is also associated with a high success rate/low dropout rates. Ten years of practical experience show that the University gains outstanding students through this study model.

Because of the central position occupied by the University in this co-operation model UniKasselTransfer, as the interface between academic and business interests, took over the co-ordination of the Integrated Degree Program at the beginning of 2010. UniKasselTransfer is responsible for the co-ordination, extension and further development of the model. The most important tasks are the co-ordination of participating partners (Faculties, businesses, vocational schools, IHK [Chambers of Industry and Commerce]), the active counselling of interested businesses and intensive counselling of new co-operation partners in the entry phase into the Integrated Degree Program as well as the acquisition of new students and the marketing of the model.

The Integrated Degree Program of the University has established itself successfully, and it is now a matter of making its advantages accessible to a larger number of degree programs and students by means of consistent expansion.

E. Spatial development

As the place and symbol of knowledge transfer of the University in its broad scope there is to be, in the north section of the campus, a Science Park Center and from 2013/14 approx. 6,000 m² of office, events, laboratory and workshop space, together with main office of UniKasselTransfer. As a forum for the exchange between academic and practical interests it will offer space for the development of new ideas and their application, support new entrepreneurs on their way into the market and help to create new networks between theory and practice. In this sense the Science Park Center will contribute substantially to realizing the aims set forth in the transfer concept.
Knowledge Transfer in Tomsk Polytechnic University

Petr Chubik

Introduction

Today, in connection with accession of Russia to the World Trade Organisation (WTO), a particular attention and importance is paid to the goal of effective integration of Russia into the global economy, increasing the competitiveness of the country as a whole and individual economic entities in particular. Competitiveness of the national economy is the main indicator of its economic development. In turn, the competitiveness of goods produced by companies and countries is increasingly defined by the ability to generate and implement new technologies.

International experience shows that the most effective model of innovative development is a model based on organization of a complex interaction among three key elements of the innovation system of any country: university, business and government. The initial stage of knowledge generation implies interaction between the government and the university; then, at the stage of technology transfer, university works together with the business; then the result is marketed together with the government and the business. In the course of transitioning towards the economy of knowledge, where knowledge and technology is the key factor of the competitive ability of a country, universities implementing major research and development become an essential resource for high-tech industry. The main step in this direction is construction and development of an appropriate innovation infrastructure of the university.

Innovation infrastructure of the National Research Tomsk Polytechnic University is developing as an integrated system of a complete innovation cycle providing development, creation and product launch on the market of competitive high-technology products, organization of staff, marketing and technological support of innovation entrepreneurship entities under priority areas of the development of the university.

The strategic goal of the development of TPU is its establishment as a world-class university oriented on staff assistance and development of technologies for resource-efficient economy. Development of TPU under the given scenario will have a significant impact on the socio-economic development of Russia because resource-efficient technologies offer a significant multiplicative effect and exhibit it for a long period of time. Inclusion of resource-efficient technologies into the production chain leads to an increase in the economic growth rate and improvement of the quality of life.
Prospective areas of development of the innovative capacity of the university to fulfill social-and-economic needs on regional, national and international levels

The following 5 priority areas of the development of TPU were defined for the pursuance of scientific research, development of advanced scientific technologies and training of globally competitive specialists able to ensure socio-economic development of Russia and improve its competitiveness:

- Rational management and advanced processing of natural resources;
- Conventional and nuclear power engineering, alternative technologies of energy generation;
- Nanotechnologies and plasma-beam technologies for production of materials with defined properties;
- Intelligent information and telecommunication monitoring and control systems;
- Non-destructive testing and diagnostics in manufacturing and social sectors.

Each of the five priority areas integrates the creative potential of the established in TPU innovation infrastructure. This structure is a set of structural subdivisions of the university, as well as legal entities established with participation of the university, which during the implementation of the innovation activity ensure commercialization of R&D and technological developments providing their replication and marketing (Figure 1).

![Figure 1: Innovation infrastructure of TPU](image-url)
The infrastructure of TPU combines:

**Research-educational institutes with their member departments and research laboratories.** There are 7 major research-educational institutes in TPU providing training of staff and conducting of research in priority areas of development:

- **Institute of Natural Resources**: development of high-efficient and environmentally safe technologies for prospecting, recovery, transportation, and processing of oil, gas and solid minerals; development of scientific fundamentals for the use of natural resources and environmental protection; resource assessment and development of technologies for processing of prospective natural sources for production of medicines.

- **Energy Institute**: Research and Education Center in the field of conventional and alternative energy; the priority area is "Smart Grid". Within the framework of the project the institute carries out research on: active-adaptive power grids (FACTS technology); hybrid power systems (wind-solar-diesel power stations); methods for optimization of thermal conditions on thermal and nuclear power plants; high-voltage vacuum technology; dynamic synthesis of superhard materials in high velocity electric-discharge plasma jet; intelligent distributed drive systems, etc.

- **Institute of High Technology Physics**: implementation of research and development, creation of advanced equipment and technologies is carried out in the following fields: plasma-beam technology; electric-discharge technology; technology of nano-materials and new generation materials; optical technology; chemistry and technology of organic and inorganic biomaterials.

- **Institute of Cybernetics**: development of a new generation of intelligent navigation and telecommunication systems for monitoring and control, resource-efficient systems for control over multi-site operations as well as virtual productions of interdisciplinary nature.

- **Institute of Nondestructive Testing**: development of scientific principles, technical means, methods, technologies, and devices for non-destructive testing: radiation, infrared, acoustic-emission, ultrasound, thermal, electrical, and other; carrying out of fundamental and applied research in the field of non-destructive testing, electronics and biomedicine.

- **Physical-Technical Institute**: carries out fundamental research in the field of nuclear physics and elementary particle physics; research on generation of high-power pulsed electron and ion beams, microwave and bremsstrahlung radiation; creation of equipment and technologies for formation of submicron and nano-structured coatings for various applications; fluoride technology; research in the field of hydrogen energy; technologies for production of radiopharmaceuticals for medical diagnostics; methods of neutron activation analysis; technology for neutron transmutation doping of semiconducting materials.
- **Institute of Social-and-Humanitarian Technologies:** technologies for physical and moral development; establishment of the entrepreneurial culture of engineering activity; formation of management competencies in a modern engineer; training of specialists in the field of economics, management, public relations, innovation, human resources, regional studies, customs, tourism and physical education.

**Student Technology Business Incubator (STBI):** provides consistent involvement of students and young scientists of TPU into the entrepreneurial activity by means of educational, organizational, and technical assistance to development and incubation of youth innovative projects, building of competencies that allow combining scientific-research, design and entrepreneurial activities. Regular participants of STBI projects are pupils willing to become familiar with interesting and intellectual work.

**Department of Intellectual Property Legal Protection (DIPLP):** provides effective legal protection of results of the intellectual activity of TPU for attraction of extra-budgetary funds and improvement of the image and competitiveness of the university at the global level.

**Technology Transfer Center (TTC) is designed to perform one of the functions of the knowledge transfer process – provides transfer of new technologies from the creator to the user.** Promotes attraction into the university of extra-budgetary funds by means of commercialization of scientific-technical and technological developments on the basis of balancing the interests of all participants of the innovation process: author, university, investor, and manufacturer; organizes cooperation among the enterprises of the innovation belt of TPU; distributes information on developments of TPU in national and international networks of technology transfer.

**Department of graduate, postgraduate and doctoral studies (DGPDS) provides coordination, support, and improvement of scientific-research work of students and young scientists; provides training of high- and top-qualification specialists.**

**Project-Design Institute with Pilot Production (PDI PP) provides services in the field of technological design: development of design, engineering, normative-technical and operational documentation on scientific-technical products and technologies of TPU; development of experimental products and samples of scientific-and-technical developments.**

**Technological Forecast Laboratory (TFL) is an entity for strategic analysis and planning in the field of R&D and innovations of TPU.** Leading international companies in the field of technological forecast are engaged in the project together with employees of the university – AEA (UK), CEIS (France) and SAMI (UK), as well as 12 foreign experts in foresight.
LLC "Technology Incubator of TPU" – a management company of the project "Design-and-Technology Business Incubator of Tomsk Oblast", provides comprehensive support to startup companies located in DTBI: project management, attraction of venture capital financing, market research, organization of educational programs.

Design-and-Technology Business Incubator (DTBI) is a property complex of the Administration of Tomsk oblast, under the trust management of LLC "Technology Incubator of TPU", which provides office and production space to small innovative enterprises for accommodation of technological equipment.

Engineering Entrepreneurship Department (EED) provides student training in all engineering specialties of TPU under the program "Engineering Entrepreneurship", and training of managers in engineering, technology and scientific-educational fields capable of not only to effectively apply knowledge but to generate and apply on practice new knowledge in the field of innovative project management.

Exhibition Center "Science and Education in TPU: traditions and innovations". The activity of the center is aimed to increase the prestige of scientific-technological, innovation and educational activities of the university; advertisement of competitive ideas, promising investment projects and developments for improvement of commercialization efficiency.

Small innovative enterprises established with share participation of TPU in their equity capital (SIE) is a key element at the final stage of the innovation process. They are established to market high-tech products based on the use of results of the intellectual property of the university.

Performance indicators of the innovation system of TPU

Tomsk Polytechnic University today:

- 7 research-educational institutes, 3 institutes, 74 scientific-educational-research laboratories, 19 of which are international.
- 22,800 students (12% are foreign) studying under 181 educational programs, including: bachelor – 55, specialties – 74, master – 52. The number of graduate students – 781, doctoral students – 54.
- 2 295 faculty members, including: 323 doctors of science, 1 470 candidates of science, 13 academicians and 8 corresponding members of RAS and RAMS.
- Partner of 130 universities in 30 countries.
- 2nd technical and technological institution of higher education in Russia (among 148).
- 3rd among universities of Russian Ministry of Education in terms of R&D, 1st in terms of extra-budgetary funds and the volume of financing from foreign sources.
- Experience in training of more than 150 000 specialists.
- 32 small innovative enterprises established in accordance with the Federal Law No. 217-FZ from 02.08.2009; 2 are residents of the innovation center "Skolkovo". There are more than 80 enterprises in the innovation belt of the university, including 3 residents of Tomsk special economic zone of technical and innovative type.
- 43 licensing agreements signed with companies for the use of results of the intellectual property of TPU.
- 3rd among Russian technical institutions of higher education by the number of patents granted; 154 patents and certificates were received in 2011 alone.
- Various elements of the innovation structure of TPU are coordinating the work of students, post-graduate students, doctorial-students and employees, creating a chain with various links and forming road maps for knowledge transfer.

Road maps of knowledge transfer for pupils, students, employees and external customers

Roadmap of knowledge transfer for students

The chain "pupil-student-professor-entrepreneur" (Figure 2) incorporates the work of departments in conjunction with STBI, DEE and DGPDS, which perform functions of information, consulting and training centers. The work of the system in this chain resolves itself into this:

- attraction of pupils and students to work on projects, which accelerates their socio-economic adaptation in business environment (forming early awareness and acceptance by an individual of current values of society; developing awareness of the need for learning throughout life for personal, civil and social development and/or implementation of employment opportunities);
- mastering by students of competencies of cognitive, research, project-design and entrepreneurship activities through management of pupils' work on projects;
Knowledge Transfer in Tomsk Polytechnic University

Figure 2: Road map of the innovation infrastructure of TPU for students

- promotion of scientific and entrepreneurship activity among youth; formation of the "success story" symbiosis among researchers and entrepreneurs;
- organization of joint decision-making (training, organizational and educational character) for the development of adaptive capability, leadership and entrepreneurial skills for self-employment as well as for creation of jobs for less entrepreneurially-inclined people.

Training is carried out using modern methods and forms of education (activity methods and project-organizational form) on the bases with high level of integration between theory and practice, powerful material-and-technical equipment and operational update of its content, high level of qualification of professors of Engineering Entrepreneurship Department and individual work with students on projects in STBI. The work of students on projects in STBI is carried out in two directions (Figure 3): creativity and project activity. Four laboratories are working in STBI on development of creative thinking: "Robototechnics", "Recreational physics", "Educational company", "Resource Center". Eleven consulting support centers were established on the basis of STBI for development of the youth project activity; in 2012, 32 projects have received consulting support from STBI under the chain "idea-project". As a result, more students successfully master competencies of cognitive, research, project-design and business activities, which helps them to actively participate in various competitions and programs: "UMNIK", BIT, Zvorykin Project, Seliger, FTP, Vladimir Potanin Charity Fund, Mikhail Prokhorov Fund, Skolkovo Institute of Science and Technology.

Schoolchildren, previously working on projects together with students, make better choices while choosing their future profession, adjust better in the university, study better and successfully develop their personal qualities.
Figure 3: Student Technology Business Incubator

Roadmap of knowledge transfer for employees

The chain "idea-project-product" includes the work of TTC, DIPLP, TFL, PDI PP, CC and DTBI, providing search, selection, production of a model, creation of a prototype, its testing, protection, production of a small batch, replication and marketing at the following stages:

1. Development of an idea, building of a project team, accommodation in the business incubator or in the facilities of departments and laboratories, preliminary market research.

2. Technology audit of the development, market research, development of commercialization strategy, patenting, presentation at competitions of different levels, programs: "U.M.N.I.K", "START", BIT, Seliger, FTP, Skolkovo Institute of Science and Technology, competitions of the Administration of Tomsk Oblast.

3. Development of design-engineering documentation, registration of intellectual property items (patents; trade secrets; protected in the "commercial secret" mode; etc.), creation of a prototype.

4. Development of a business plan, signing of a license agreement, foundation of an enterprise (sale of a license), attraction of financing, support.
As a result of work of the entire innovation system, favorable conditions are being created for commercialization of not only R&D or technologies, but of completely packed and fully implemented projects for a specific customer.

Roadmap of knowledge transfer for external customers

The scheme of interaction with external customers – small and medium businesses enterprises, state corporations, etc., is shown on Figure 5. In addition, more than 150 technical proposals have been presented through Russian and international network of technology transfer (the network includes all regions of Russia, as well as Germany, France, Britain and other countries of the European Union), which provides opportunities for attraction of domestic and foreign partners to jointly implement scientific and technical developments, projects, technologies and/or R&D.
TPU cooperates with 130 foreign companies and universities from 30 countries; at the year-end 2011 ranking first by volume of foreign contracts among higher education institutions of Rosobrazovanie.

A significant contribution to the development of knowledge transfer and technologies of TPU is made by International Research-Educational Laboratories of TPU, including two laboratories under the direction of visiting professors T.I. Sigfusson (Iceland) and M. Kroening (Germany), founded within the framework of the RF Government Decree No. 220 from 09.04.2010. In 2011, on the basis of TPU in cooperation with holding "SIBUR", an International Research-Educational Laboratory of Thermosetting Polymers was founded under the direction of the visiting specialist Dirk Vervake (Belgium). It is also worth mentioning the Center of Training and Retraining of Petroleum Engineering Specialists «Petroleum Learning Centre», founded in conjunction with one of the world's leading centers for training of specialists in petroleum engineering – Heriot-Watt University (Edinburgh, UK).

**Innovation belt of TPU**

One of the effective ways of commercialization of results of the intellectual activity of the university is establishment of small innovative enterprises (SIE), where TPU acts as one of the founders, in accordance with the Federal Law No. 217-FZ from 02.08.2009. SIE bring additional revenue to the university due to signing of R&D agreements and dividend payout.

The result of active work was the establishment in TPU of 32 small innovative enterprises (SIE) within the framework of the Federal Law No. 217-FZ from 02.08.2009 (with share participation of TPU in their charter capital), operating in the following...
areas: information technology, medicine, construction materials, mechanical
engineering. More than 40 million rubles have been attracted for implementation of the
projects. In addition to these 32 small innovative enterprises, the innovation belt of TPU
includes other 51 small innovative enterprises:

- 24 enterprises are funded by the Fund for Assistance of Small Innovative
  Enterprises in Science and Technology under the program START;
- 3 enterprises are residents of Tomsk Special Economic Zone of Technical and
  Innovative Type;
- 3 enterprises are residents of the innovation center "Skolkovo";
- One of the most successful examples of technology transfer in TPU is
  commercialization carried out together with leading industrial enterprises under
  the RF Government Decree No. 218 from 09.04.2010:
  - Project "Establishment of industrial manufacture of products from functional and
    structural nanoceramics for high-tech industries", together with OJSC CC
    "Novosibirsk electrovacuum plant – Soyuz".
  - Project "Development of a complex of software and hardware means of design,
    manufacture and testing of a standardized set of electronic modules on the basis
    of the technology "system-on-chip" for control systems and power supply
    systems of spacecrafts (SC) for communication, navigation and remote sensing of
    the Earth with long active life" together with TSU, TUSUR and JSC
    "Academician M.F. Reshetnev Information Satellite Systems"

Another example of successful commercialization of a development of TPU is the first
in the Russian Federation (2003) sale of a license made by a higher education institution.
A regular license fee (royalty) is collected for the use of results of the intellectual
activity of the university: TPU and LLC "Unitech" signed a licensing agreement for
application of a useful model – education-laboratory complex "Chemistry" developed by
employees of the Department of Physical and Analytical Chemistry, TPU. During the
lifetime of an exclusive license, the volume of license fees (royalty) and contract works
with TPU within the framework of implementation of the ELC "Chemistry" amounted
to 7.82 million rubles.

Within the framework of knowledge transfer, TPU is actively cooperating with Russian
and foreign corporations, establishing joint research-educational centers for joint
research, training and retraining of staff, in particular:

- Lighting testing laboratory performing certification and quality control of LED
devices produced by OJSC "Scientific-Research Institute of Semiconductor
  Devices";
- Russia's first educational-and-scientific center of the American company
  «Woodward» – the leading manufacturer and supplier of equipment for power
  plants throughout the world;
- Research-education center of space device engineering, in cooperation with OJSC "Academician M.F. Reshetnev Information Satellite Systems" and OJSC Scientific-Production Center "Polus";
- Unique research-education center for training of specialists in pharmaceutical and biotechnological industries, established in cooperation with Russia's largest pharmaceutical company "R-Farm";
- Educational center for training of highly qualified personnel for the state corporation "Rosatom" and its foreign partners.

By far, these are not the only examples that reflect the efficiency of knowledge and technology transfer in Tomsk Polytechnic University and the commitment to continuous development and strengthening of collaboration with industry leaders in the region, Russia and worldwide.

Through strenuous work of the innovation infrastructure of TPU, an association of small innovative enterprises was established together with development and commissioning of an Internet-portal for systematization of their activity. It allows optimizing the interaction between the university and the established with its help enterprises in the field of intellectual property commercialization and technology transfer, as well as in deriving of additional revenues from the activity of small innovative enterprises.

**Significance of knowledge transfer in TPU**

Interest of TPU in transfer of knowledge and technology can be summarized as follows:

1. Attraction of extra-budgetary funds:
   - license fees from enterprises (royalties);
   - dividends from share in charter capital of SIE.

2. Creation of new jobs, employment of graduates and advanced training of employees in conditions of interaction with the real sector of economy.

3. Increase in research and development works and services:
   - conclusion of economic agreements with SIE to perform R&D;
   - implementation of scientific research by students, including graduate qualification works and master's thesis under the subject of SIE;
   - fulfillment of SIE production orders.

The amount of funds attracted for development of the innovation activity of TPU in 2011 exceeded 70 million rubles. (Figure 6).
Implementation in TPU of the innovation development strategy and commercialization of research-and-development promotes an increase of extrabudgetary funds (Figure 7). The volume of scientific extrabudget of TPU amounts to more than 60% from the volume of all Tomsk higher education institutions and nearly 40% from the whole Tomsk scientific-educational complex. In 2010, for the first time, the volume of R&D exceeded one billion rubles; in 2011 – more than 1.5 billion rubles. In 2011, on average 460.8 thousand rubles per year went to each educational-research employee (average of the RF Ministry of Education is 174.1 thousand rubles). International cooperation is actively developing – agreements have been signed with enterprises from 11 countries for the amount of 56 million rubles.

Consolidated budget of TPU in 2011 amounted to 5.02 billion rubles (which is 117% from the revenue for the year of 2010). It allowed the subdivisions of the university to ensure reproduction of educational, scientific, and social fields of activity, to provide social and material support to students and employees, to carry out mass cultural and recreational activities, to conduct advance training of employees with assistance from foreign experts. Average salary of university employees has increased by 9%.
Conclusion

Today, TPU is in the "Top 10 best universities of the country" and is listed seventh, according to the results of the national ranking compiled by "Interfax" with the support of the Ministry of Education and Science of the RF; TPU holds the 892\textsuperscript{nd} place in the world ranking Webometrics and the 567\textsuperscript{th} in the ranking QS World University Rankings. The innovation infrastructure of TPU is a complex system of a complete innovation cycle, providing development, production and marketing of competitive high-technology products in the field of energy- and resource-efficiency, organization of human resource, marketing and technological support of subjects of the innovation entrepreneurship under the priority areas of the university development.

It is fair to say that the achieved results in strengthening and development of the innovation infrastructure of TPU, including the material-technical base, improvement of the system of legal protection and intellectual property management, establishment and development of small innovative enterprises, development of target programs in the field of innovative entrepreneurship, advanced training of employees and engagement of foreign experts, have led to a synergistic effect – an increase in the scientific-research and innovation potential of TPU, and have created favorable conditions for addressing the issue of training and securing specialists that are able to conduct entrepreneurial activity in the scientific-and-technical sphere.
Conceptual Framework of Created University Innovation Structures

Nikolai Toivonen and Vladimir Vasilev

1. Introduction

The course of the Russian state for modernization of the economy, formation of the knowledge based economy automatically assumes involvement of higher education institutions and R&D organizations into commercialization and technology transfer development.

During the last five years, the following large scale programs to support the sphere of higher education were initiated, implemented, and are being implemented:

a. during the period from 2006 to 2008, 57 Russian universities – with support of the Ministry of Education and Science of the Russian Federation (hereinafter – the Ministry) – took part in creation of innovation educational programs and improving of professional training quality in the important areas of economy development;

b. during the period from 2009 to 2018, 29 Russian universities – with support of the Ministry – implement development programs to create the universities of a new category – national research universities (hereinafter – NRU) which "...are effective in both educational and research activities based on science and education integration principles"¹. According to the Russian government vision, the ability to generate knowledge and provide effective technology transfer to economy shall be the most important distinctive feature of the national research universities;

c. since 2006, in Russia, one more class of universities has been created and developed – "federal universities" which are intended to train, retrain and build expertise of human recourses by applying modern educational technologies for complex social and economic development of the region, implementation of fundamental and applied scientific research in a wide range of disciplines, integration of science, education and production, including practical application of the results of intellectual activity (hereinafter – RIA);

d. since autumn of 2010, several programs have been implemented which were initiated by the corresponding Decrees of the Government of the Russian Federation of April 9th, 2010:

¹ See, for example, the presentation of S. V. Ivanets, Deputy Minister of Education and Science of the Russian Federation. (http://mon.gov.ru/files/materials/5087/08.12.12-ivanec.pdf)
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- No. 218 "On Measures of State Support of Developing Cooperation Between the Russian Higher Education Institutions and Organizations Implementing Complex Projects of Hi-Tech Production Development";
- No. 219 "On State Support of Development of Innovation Infrastructure in the Federal Educational Institutions of Higher Professional Education";
- No. 220 "Measures to Attract Leading Scientists to Russian Educational Institutions".

All six framework programs stated above are to some extent involved into support of Russian universities for development of various kinds of innovation activity in the basic fields of activities – educational, scientific, and entrepreneurial.

Sampling analysis of the applications for participation in these programs submitted by universities demonstrates a high diversity of the administrative and organizational structures and forms to be created and/or developed which are aimed to provide both required coordination and development process management in a university and information, consulting or technical services to solve specific tasks in the discussed sphere of activity.

Particularly, in their programs and projects, the universities intend to create and improve their innovation environments, systems, ecosystems, and hub. Thus, these terms are often confused with each other, and some concepts are substituted with others.

In this article, a classification is offered which allows to clearly define/identify the concepts mentioned above by demonstration of their realization on an example of Saint Petersburg National Research University of Information Technologies, Mechanics and Optics (hereinafter – ITMO).

2. Conceptual Framework

One of the system problems of innovation development in Russia is inefficiency of the legislative framework, in general, and absence of the required number of the legal concepts, in particular.

It this publication, the author proposes defining of the concepts of innovation environments (milieu), systems, ecosystems, and hubs using the concept of "system" and the concepts of "commercialization of scientific and (or) scientific and technical results", "innovation", "innovation project", "innovation infrastructure", and "innovation activity" formulated in the Federal Law (Russian Federation) of July

The concept of "system" comes from Greek и means "the whole which consists of separate parts". There are plenty of definitions for the "system" concept. In particular, according to the definition of V.N. Sagatovsky\(^3\), "the system is a set of functional elements and relations between them which is selected from the environment for a definite purpose within a definite period of time". Let's note that any system is supposed to consist of "elements" и "relations" between them, as well as "to be selected" from the common environment and to function in accordance with its own goals and objectives, including a possibility of damage of external, non-system, elements. Both system objects and subjects are considered the elements in this definition.

According to the Letter of the Government of the Russian Federation\(^4\), "the innovation system is a set of innovation activity subjects and objects which interact in the process of creation and implementation of innovation products and operate under the state innovation system development policy".

Unfortunately, in Russia, there are no federal level regulating documents which define the innovation activity elements – the "object" and the "subject".

In this publication, the "innovation system subjects" are understood as organizational structures (legal entities and subdivisions) and physical persons involved into innovation activity development (including research, technological, organizational, financial, and commercial activities) focused on implementation of innovation projects, as well as on creation of the innovation infrastructure and provision of its activity.

Innovation system subjects can be both the structures (institutions) and persons directly participating in implementation of innovation projects and improvement of the innovation infrastructure, and the structures and persons that provide support and definite types of services.

For example, R&D institutions, laboratories, research centers, and small innovation enterprises shall be reckoned among the subjects directly participating in implementation of innovation projects.

A set of subjects which help implement innovation projects, including rendering of managerial, material and technical, financial, information, recruiting, consulting, and organizational services, is usually referred to the "innovation infrastructure"\(^5\). The innovation infrastructure subjects include, for example, the following: technology

\(^3\) Sagatovsky, V.N.: Fundamentals of Universal Category Systematization. Tomsk. 1973


transfer centers, business incubators, innovation technology centers, technology parks, centers of staff training for innovation activity.

"Innovation system objects" are understood as any types of innovation which, in the result of commercialization, can be embodied into an introduced, new or significantly improved product (item of goods, service) or into a process, new sales method or new organizational method in business practice, worksite organization or external communications.

For example, the following system elements can be classified as the innovation activity objects:

- knowledge-consumptive business ideas, for example, in the field of web-technologies;
- research, development, innovation and entrepreneurial projects funded through the budget, economic agreements or own resources (for example, endowment fund);
- research activity results – the results of finished research, development or technological work and projects;
- intellectual property objects (inventions, utility models, production pieces, etc.);
- means of individualization for persons and goods (brand name, trademark, service mark, designation of origin);
- prototypes and samples of goods and services in the form of technologies, technical devices.

Along with the "objects" and "subjects", the "conditions and factors" of their existence and interaction (the "relations" in the V.N. Sagatovsky's definition) are considered as an integral part of any system. In case of an innovation system, the conditions and factors depend on the definite configuration in question. It is obvious that the conditions and factors of a national innovation system differ from a regional or a corporate (belonging to a separate organization) one. However, we can note the areas which refer to the common conditions and factors, in particular:

- "ideological" support of the upper management and its focus on development of innovation and entrepreneurial types of activity;
- regulatory base governing the relations of the subjects both between each other and with the objects;
- high educational and entrepreneurial level of the society/group;
- educational programs, trainings, internships on a wide range of innovation development issues;
- entrepreneurial culture and a positive image of "innovator" in the society/group;
- service support maturity.

Therefore, the concept of "system" can be simplified to the set of three components – objects, subjects, and conditions/factors. The components which belong to different innovation structures and their combinations allow to unambiguously define the concepts of the university innovation environment, system, ecosystem, and hub.
2.1. University Innovation Environment

In this publication, you can see author's variant of the "university innovation environment" concept developed using the concept of "enterprise environment" which is actively discussed in scientific publications.

The "university innovation environment" is understood as a set of subjects – external and internal organizational structures ("institutions", companies, organizations, subdivisions, etc.) and the conditions/factors which allow the university to develop and implement innovation projects, as well as to create and provide its innovation infrastructure operation.

The University innovation system is schematically shown in Fig. 1, where the components belonging to this concept are included into outline IV (see explanations below).

Similarly to the "enterprise environment" concept, the university innovation environment is divided into external and internal ones.

The university external innovation environment is a set of the conditions and factors (economic, social, natural, etc.) and the subjects, also including municipal, regional, national, foreign, and international institutional structures which, directly or indirectly, influence development and implementation of university's innovation projects, creation and provision of its innovation infrastructure operation (see, for example, Frolova, T. A.: Company Economics: Notes. Taganrog: TSRTU, 2005. http://www.aup.ru/books/m170/1_3.htm).

The university external innovation environment, in turn, is divided into macro- and micro-environment.

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6 It is important to note that an enterprise is an open system which can only exist under the condition of active interaction with the external environment via an interchange of substance, energy, information, etc. Open systems are only stable in presence of such interchange.

7 "Institutions" are understood as government authority and business structures, public organizations, and other organizations whose activities to some extent influence innovation development in universities.

8 In Fig. 1, the university external innovation environment is indicated by "ExtUIS"

9 Sathe, Vijay: Corporate Entrepreneurship: Top Managers and New Business Creation. Cambridge : Cambridge University Press, 2003 ("The external business environment includes customers, competitors, suppliers, and other industry and competitive forces, as well as the legal, regulatory, technological, and economic environment (Chapter 3)").

The external macro-environment is understood as the environment which indirectly influences university innovation activity, in particular, its natural, demographic, scientific and technical, economic, ecological, political, and international environment (see Fig. 1 – S3 and C&F3).

The external micro-environment is understood as the environment which directly influences (see Fig. 1 – C&F2) university innovation activity and which is created by external business and institutional subjects (see Fig. 1 – S2), in particular, by consumers of university innovation products (goods and services), corporate licensees purchasing the rights for university technology transfer, suppliers of material and technical resources, financial institutions, dealers and market mediators, competitors, state bodies, insurance companies, etc. In case of direct impact, the environment directly influences the scale, types, rates and efficiency of university innovation activity.

The university internal innovation environment is a set of subjects (university subdivisions (Fig. 1 – S1)), intra-university conditions and factors (see Fig. 1 – C&F1) which provide development and implementation of university innovation project, creation and provision of its innovation infrastructure (see Fig. 1 – O1). To explain this definition, let's consider some examples of subjects, conditions and factors which may be involved into provision of university innovation activity:

- **Subjects:** staff, trainees, and structural subdivisions, including:
  - R&D subdivisions aimed at obtaining of RIA;
  - educational subdivisions developing new teaching materials;

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11 In Fig. 1, the university internal innovation environment is shown as "IntUIS".

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- innovation infrastructure subjects, etc.

b. conditions:
- support by the university upper management, first of all, the Rector;
- advanced regulatory base which provides the rights and motivation of the academic teaching staff (hereinafter – the staff) and trainees to innovation activity development;
- active and effective educational, research, and entrepreneurial activity of the university;
- favorable sociocultural conditions, first of all, working conditions for the staff, and learning environment for students, postgraduate students, and non-degree students;

c. factors:
- goals and objectives;
- management structure;
- R&D organizational mechanisms;
- staff's and trainees' ability to perform innovation activities;
- quality of RIA with market potential;
- availability of material and spacial resources to accommodate the innovation activity subjects;
- financial support, including remuneration for successful innovation activity;
- information support, etc.

2.2. University Innovation System

Ove Granstrand defines the "corporate innovation system" as "a set of players, activities, resources, and institutions, as well as causal relationships which, in a sense, are important for corporate innovation activity". A set of corporate innovation system elements used in the definition is easily allocated among the system components stated above: the subject is identical to the "players"; the object – to the "activities", the conditions and factors – to the "resources", "institutions", and "causal relationships".

In consideration of the definitions of Ove Granstrand, Ludwig von Bertalanffy12 and the innovation system definition formulated in the Letter of the Government of the Russian Federation of 05.08.2010 No. 2473P-P7, the "university innovation system" is understood as a set of innovation activity subjects and objects interacting in the process of innovation products creation and implementation under coordinating

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guidance of the university that provides relevance of the internal conditions and factors and accounting of the external ones. The university innovation system components are shown in outline III (see Fig. 1).

The university innovation system subjects, in particular, include:

a. university research and educational subdivisions, which are initiators of innovation projects;

b. subjects of the university innovation infrastructure, as well as of external organizations if the commercialization and technology transfer processes are implemented on their basis;

c. university companies created within the meaning of Federal Law № 217-FZ of 02.08.2009 "On introducing amendments to RF legislation governing the creation of companies by state-run research and education institutions with the aim for intellectual property application (implementation)" (hereinafter – FZ-217);

d. external economic entities (see the list of external economic entities and institutional subjects mentioned when defining the external micro-environment) which directly participate in university innovation activity development.

The list of innovation system objects is provided in the Introduction, Section II (Fig. 1. – O₁ и O₂).

The university innovation environment conditions and factors include the conditions and factors of the university internal innovation environment (Fig. 1. – C&F₁) and those of the micro-environment within the university external innovation environment (Fig. 1. – C&F₂), in particular:

- support of the local authorities, mainly through various target programs for development of innovations, medium and small business, contests;
- high level of consumer effective demand;
- stable research and technical relations between the university and large and medium high-tech enterprises;
- regional availability of highly qualified experts majoring in the university R&D field, including those who have definite experience in RIA commercialization;
- favorable social conditions and cultural environment;
- regional availability of business angels, seed and venture funds;
- regional availability of the advanced innovation infrastructure, etc.;
- regional availability of the information and consulting service infrastructure.

According to this definition, the "university innovation system" is a part of the "regional" and/or "national" innovation systems, and belongs to the open system class.
2.3. Innovation Ecosystem

The term "innovation ecosystem" is widely used in the scientific and publicistic literature and is very useful when describing a mechanism of effective management and operation of organizations, companies, and structural subdivisions conducting innovation activities.

The term "ecosystem" was introduced by Roy Clapham, a British plant biologist, in 1930 and assumed a combination of physical and biological environment components. In the modern scientific literature, in particular, the following definition of Dr. E. P. Odum\textsuperscript{13} is used: "any unit that includes all of the organisms (i.e.: the "community") in a given area interacting with the physical environment so that a flow of energy leads to clearly defined trophic structure, biotic diversity, and material cycles (i.e.: exchange of materials between living and nonliving parts) within the system is an ecosystem".

Methodically, ecosystem descriptions in business and biology are very similar\textsuperscript{14}, for example, you can draw an analogy between the following elements of business and biology respectively:

- subjects: companies/firms/organizations and organisms;
- objects: RIA/projects/goods/services and mechanisms of survival, cooperation, competition.

Introducing of the biological term "ecosystem" with reference to university innovation activity is intended to draw attention, on the one hand, to considering both positive and negative influence of the external condition and factors on university innovation success and, on the other hand, to considering mutual influence of its various subsystems and subjects on each other as this activity matures\textsuperscript{15}.

To explain the latter statement, let's consider a hypothetic example of interaction between research and innovation areas of university activity. "Linear" upholding of innovation system interests, in particular:

- assignment of more financial and material resources for innovation activity development in comparison with R&D works from the limited university-wide budget allocated, for example, within the program for creation of federal and national research universities;
- active engagement of the university staff and talented young people into work in small innovation enterprises (hereinafter – SIE) established within the meaning of FZ-217;

lend-lease of scientific and laboratory equipment to use for innovation projects
with significant reduction of its usability for fundamental, research, and applied
studies, etc.

will automatically lead to a disbenefit of the scientific system and further along the
logical chain: 1) degradation of university research will decrease the R&D volume
and quality; 2) that, in turn, will decrease the RIA volume and quality; 3) that, in
turn, will decrease the … quality of the innovation activity deliverables.

There is also an opposite example\textsuperscript{16} – success of innovation and entrepreneurial
activity, for example, within a created SIE, generates additional scientific tasks to be
solved in the university on SIE demand in the frame of R&D works.

Assumptionally, the given example is similar to a well-known biological problem of
coe-existence of wolves and hares in the same forest.

Therefore, interaction between different university systems, in particular, innovation
and research activities, shall be formed considering the principles of both
competition and cooperation (win-win cooperation).

A need for interlinkage of different system interests affecting each other's interests
during activity development determines the importance of the introduced term – the
"ecosystem".

The "university innovation ecosystem" is understood as a set of the university
internal innovation systems, external subjects, conditions and factors that are directly
involved into or provide harmonious и effective organization of university
innovation activity (see Fig. 1).

The components of the university innovation ecosystem are shown in outline II (see
Fig. 1).

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{Fig1.png}
\caption{University Innovation Ecosystem Components}
\end{figure}

2.4. Innovation Hub

The "innovation hub" concept is widely used in foreign literature to describe activity
of an industrial company\textsuperscript{17}, university\textsuperscript{18}, and country\textsuperscript{19}.

In case of an innovation company, the innovation hub acts as the idea pool. Filling of
the pool is made by the "gatherers" who collect ideas created in business

\textsuperscript{16} See interaction between NPO UNICHIMTEK (Director General – Prof. V.V. Avdeev) and
department of chemical engineering and new materials of Moscow State University
\url{http://www.unichimtek.ru/about/}

\textsuperscript{17} Leifer, Richard / Mcdermott, Christopher M. / Colarelli O'Connor, Gina / Peters, Lois S. / Price,

\textsuperscript{18} Youtie, Jan / Shapira, Philip: Building an Innovation Hub: A Case Study of the Transformation
of University Roles in Regional Technological and Economic Development. Research Policy.

\textsuperscript{19} Baark, Erik / Sharif, Naubahar: "From Trade Hub to Innovation Hub: The Role of Hong
Kong's Innovation System in Linking China to Global Markets." Innovation: Management,
subdivisions, and the "hunters" who collect information from outside of the company. Then, the ideas are analyzed by the upper management for initial assessment. In case of unfavorable decision, the idea is returned to the pool to be commercialized in the future, when there are the necessary team competences or business environment changes. In case of approval, the idea is examined for specific deployment and project initiation. The peculiarity of this hub is in-house implementation of business projects.

At the same time, in the service market, there are various consulting and service companies, including the innovation infrastructure subjects rendering complex services (information, financial, etc.) for commercialization of the innovation activity objects with different level of readiness.

A distinctive feature of the university as the knowledge-based innovation hub is that it can simultaneously act as:

a. a consulting company providing the customer with the required service to attract external organizations and resources for commercialization of the innovation activity object;
b. a research and educational institution that can organize and conduct R&D works, develop necessary educational programs, etc;
c. an owner/founder of one or several innovation infrastructure subjects that provides the customer with the required service to address commercialization process issues;
d. an industrial company that can solve all commercialization tasks – from provision of all required intellectual and financial resources to development of an item/service prototype or sample.

Activity of the university as an extended option of the innovation hub – knowledge hub is described and detailed in an article of Jan Youtie and Philip Shapira19 on an example of Georgia Institute of Technology.

The requirements for organizations acting as the innovation hub include availability of the following components in their innovation system:

a. its own advanced innovation ecosystem which includes the following main components:
   - the innovation and production infrastructure;
   - employees with knowledge, experience and skills necessary for performing innovation and entrepreneurial activity, independently or in partnership;
   - the regulatory base that regulates development of innovation activity within the university;
   - wide network interaction with existing and potential partners that are innovation infrastructure and activity subjects, including potential customers, co-executors, component suppliers, financial "institutions", etc.;
b. employees with knowledge, experience and skills necessary for rendering information and consulting services for external organizations in the field of innovations;
c. regulatory base, proven approaches and technologies to render information and consulting services for external organizations in the field of innovations;
d. material, information, time and other resources necessary for service organization.

The main directions of innovation hub activity are addressed to representatives of external legal entities and physical persons. They include the following:

a. rendering of information and consulting services:
   - organization of trainings and internships on a wide spectrum of innovation and entrepreneurial activity development issues;
   - assistance in registration and legal protection of intellectual property objects;
   - conducting of economic and technical audits;
   - search of potential partners for development and implementation of business projects;
   - engaging of financial "institutions" into implementation of business projects in the form of grants, seed venture funding;
   - conducting of marketing research at any phase of business project implementation;
   - assistance in organization and implementation of technology transfer, commercialization and R&D works on companies' demand;
   - assistance in establishment and modernization of the innovation infrastructure, system, and ecosystem;
   - propagation of a need to develop innovation and entrepreneurial activity by means of public events (contests, conferences, etc.), information resources, mass media, etc.

b. rendering of scientific and innovation services:
   - performing of applied scientific research, R&D, innovation and production works;
   - organization of works and creation of an item/service prototype and/or sample, etc.

Summing up all aforesaid, we come to the conclusion that the "innovation hub" is a kind of "innovation system", where, in addition to innovation development based on independent RIA, a special service for commercialization of external organizations' innovation activity objects is established.
The "innovation hub" is understood as an "innovation system" which, in addition to the development of proprietary innovation projects and innovation infrastructure, provides external organizations with information and consulting, scientific and
Conceptual Framework of Created University Innovation Structures

...technological, infrastructural and production services to solve tasks on commercialization of innovation activity objects.

3. ITMO Case

Innovation and entrepreneurial activity development is one of the three basic directions of University development both by formal (along with educational and research activities) and by actual reasons that is reflected in the following documents:

- Program for Development of ITMO for 2009-2018 approved by the Order of the Ministry of Education and Science of the Russian Federation No. 614 of 17.11.2009, according to which the university is awarded with a new category – "national research university";
- Program for Development of Innovation Infrastructure for 2010-2017 approved by the University Academic Council on 25.06.2010 and, after follow-up revision, on 28.06.2011. Stratagem 2 in the Program for Development of ITMO is a fact to confirm actuality of innovation and entrepreneurial activity development in the University. It says that "establishment of the University as a national innovation hub"\(^{20}\) aimed at effective commercialization of R&D results in the field of information and optical technologies with participation of Russian and foreign innovation activity subjects.

Moreover, considering importance of creation of an adequate and efficient system to manage all branches of University's activities, according to stratagem 6, "modernization of the university management system aimed at provision of dynamic development and financial stability based on the "university as a business" principles".

The stratagems mentioned above show University's focus on creation of the effective and efficient innovation support and development system.

3.1. Development of ITMO Innovation Ecosystem

The university innovation ecosystem, similarly to the innovation capacity, is an integral indicator which reflects the state, prospect of development, and relationships both of internal "players" and resources which is directly involved into or provides innovation and entrepreneurial activity and external conditions and factors, including opportunities and threats.

\(^{20}\) In English, the "hub" means the concentrator, communication node. In the final edition of the program, on the insistence of Ministry of Education and Science of the Russian Federation, the term "hub" was replaced with the "complex" because there is no concept of "hub" in the Russian legislation.
ITMO has one of the most sophisticated and effective innovation infrastructures among Russian universities (see Fig. 2).

The innovation infrastructure includes the following structural subdivisions:

- **Center for Scientific and Technology Foresight (4 persons)** which is responsible for strategic analysis, planning, search for strategic scientific and technological, innovation, and educational priorities and development prospects of ITMO; this department also develops business ideas which are implemented by the University in co-operation with its partners;

- **Project Management Department (4 persons)** which is responsible for development of the university-wide project management system aimed at attraction into the university of additional financial resources to develop educational, scientific, innovation and entrepreneurial activities; the department supports the staff and trainees both in development of project ideas and in attraction of financial resources in the form of grants for development of educational, scientific, and innovation activities;

- **Office of Intellectual Property and Scientific Information (3 persons)** which is responsible for protection of the staff's and trainees' RIA obtained during R&D works and other creative activities;

- **Center for Project Appraisal (3 persons)** which is responsible for economic, technological, legal, and organizational audit of all intellectual property objects the legal owner of which is the University, and for the support of the staff and

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21 Conventional abbreviations: Office of IP and SI stands for Office of Intellectual Property and Scientific Information; ISBI QD stands for Interuniversity Student Business Incubator QD (Quattuor Dimensionis – Fourth Dimension); Center for RAYE & TI stands for Center for rendering assistance for youth entrepreneurship and technological innovation.
trainees in creation of SIEs in accordance with FZ-217 and maintenance of their activities on behalf of the University as the founder;

- Marketing Bureau (3 persons) which provides marketing support of the main University development areas – educational, scientific, innovation and entrepreneurial, in general, and support of the staff and trainees in marketing of the developed innovation projects and products, in particular;
- Interuniversity Student Business Incubator QD (5 persons), Center for Rendering Assistance for Youth Entrepreneurship and Technological Innovation (3 persons) and Business Incubator at Birzhevaya lane (3 persons) which are responsible for engagement of the trainees, young people and faculty members into various types of innovation activity;
- Technology park (3 persons) which provides SIEs with a complex of services (legal, accounting, etc.).

The ITMO innovation infrastructure distinctive feature is availability of a seed and venture fund (Investment Fund "QD") within its innovation ecosystem. This fund was created by members of the ITMO Alumni Association. For three years of existence, the fund has supported more than 10 projects, one of which has reached the Russian national level. Another resource of venture capital for innovation projects is presented by Startup-Accelerator "iDeal Machine" (with budget of 6 Mln US$). It was created in March 2012 jointly by ITMO and RSV Venture Partners LP and invests $15,000 to $20,000, on average, depending on the number of founders and additional expenses required by the project.

The ITMO innovation infrastructure provides obtaining, storage, assistance in commercialization, usage, and transfer of knowledge and technologies focused on innovation activity development. It should be noted that the innovation infrastructure is a part of university-wide project support system which includes the following:

- system of forecasting of scientific and technical development in the field of information and photon technologies which is responsible for conducting and provision the staff and trainees with program documents concerning development (forecast and foresight) of the specified knowledge and industry areas;
- project management system which provides the staff and trainees with support for solving of the entire complex of the tasks on attraction funds to perform project activities in the fields of education, science, and innovative and entrepreneurial activities;
- technology transfer and commercialization system which provides support for introduction of RIA into the market of innovation products and services.

An advantage of the university-wide project support system consists in information support and maintenance of practically all business processes within the unified University management information system (hereinafter – the University MIS) created and developed on the basis of the ORACLE DBMS. Besides, at the University, the information and consulting system (hereinafter – the ICS) based on
Microsoft 2010 was developed and is used. The system is intended for organization of the system activity of all concerned parties involved into development of project ideas and proposals. This system is a communication landscape designed, first of all, for the managers responsible for project activity development.

In the nearest future, integration of the ICS with the corresponding project support subsystem of the University MIS is scheduled to be completed.

In fact, the problem of organization harmonious and effective interaction among different university activity areas, first of all, "scientific" and "innovative", is solved in ITMO within the framework of university-wide project support system. The latter is comprised of three levels:

- Coordination Council including the Rector and Vice-Rectors;
- Coordination Group including the heads of the University administrative subdivisions which are to some extent responsible for project activity organization, coordination and maintenance;
- Working Group which includes project managers from the University research and educational subdivisions.

Vice-Rector for Innovation Activity and Project Development Department act as the "moderators" of these system activities.

We can present the following data as quantitative indicators of ITMO innovation ecosystem activities:

a. intellectual property objects:
   - more than 50 protectable RIAs are on the books; the cost of University intangible assets entered in budgetary accounting records exceeds 81 million rubles;
   - 21 license agreements have been signed concerning the right to use RIAs the owner of which is ITMO;

b. external innovation activity subjects which are a part of the University innovation ecosystem:
   - 25 SIEs created within the meaning of FZ-217, 5 of them involve foreign capital;
   - 8 companies created by the University students;
   - over 40 companies which are the University innovation infrastructure subject residents with an annual turnover more than 0.8 billion rubles;
   - over 45 large and medium industrial enterprises, corporations, etc. acting as the University customers, suppliers, partners, etc. when performing R&D works, technology transfer processes.

The important integral parts of ITMO innovation system include its laboratory, material and technical facilities. For the last 5 years, the University has significantly consolidated these facilities as it was a winner of the innovation educational program
implemented in 2007-2008, the national research university program, and programs which are implemented under the Government Decrees No. 218 and No. 220 (the University was awarded 2 grants within GD218 and 2 grants within GD220). ITMO, inherently being a technical university, has powerful human resources in the field of engineering and natural-science disciplines. Below, there are several figures and facts to characterize the ITMO staff composition:

- over 600 representatives of the academic teaching staff hold a degree of Doctor of Science and Candidate of Science (equivalent to PhD) that is more than 75% of the staff size;
- 80% representatives of the academic teaching staff are experts in the priority University development areas – information and photon technologies;
- in 2010, one of the University employees, Pavel A. Belov, Doctor of Physical and Mathematical Sciences, was awarded the Prize of the President of the Russian Federation in the field of science and innovations for young scientist for an outstanding contribution to development of metamaterial physics and creation of superresolution image transmission and processing;
- the number of postgraduate students in the University is over 450 people that is the second result in St. Petersburg;
- the number of Master's Degree students is growing in arithmetic progression: in 2009, there were 952; in 2010 – 1257; in 2011 – 1526 Master's Degree students; and it is important to note their geography – in 2011, the bachelors graduated from 101 Russian universities became Master's Degree students.

In ITMO, special attention is paid to improvement of the conditions for innovation and entrepreneurial activity development.

First, various educational programs for the staff and trainees are implemented, in particular:

- at the University, regular trainings (professional development) to improve both project management and innovation and entrepreneurial activity are held;
- Institute of International Business and Law at ITMO, which is the basic organization of the Russian Agency for Patents and Trademarks (Rospatent), has been training non-degree students in the WIPO-RUSSIA Summer School on RIA protection issues together with the World Intellectual Property Organization, Russian Agency for Patents and Trademarks, and Russian State Academy of Intellectual Property since 2009;
- since 2010, at the University, the Innovation Management and Technology Entrepreneurship Master's program is implemented at the Master's Corporate Faculty; entrepreneurs for hi-tech industries are trained within this program;
- meetings with successful entrepreneurs, heads of companies and financial "institutions" are regularly held for the trainees to make them familiar with the "best practices" in the sphere of innovation and entrepreneurial activity, etc.
Second, the regulatory base is continuously enhanced that regulates the areas of responsibility, rights and KPIs of administrative, research and educational, and service subdivisions involved into the University innovation and entrepreneurial activity development.

Third, the RIA early detection system with high commercial potential is being completed and implemented. The powerful project support infrastructure, which includes over 30 project managers engaged into University research and educational subdivisions, simplifies this system development.

Fourth, the system of financial support for the staff's successful research, innovation, and entrepreneurial activity is being improved. In particular, the system to stimulate scientific publications in the journals under review, defending Doctor's and Candidate's dissertations, etc. has been implemented. Thus, the bonus accrual information is taken from the staff and subdivision portfolios (placed in the University MIS) which are mandatory for filling. The latter allows the University upper management to obtain the relevant information about the educational, research, innovation, and entrepreneurial activity performed by the staff.

Fifth, the staff's and trainees' developments are promoted in the markets of innovation products and services, including advertising and PR efforts, in particular:

a. the University has concluded two agreements with the "Skolkovo Foundation for development of the New Technologies Development and Commercialization Centre" non-profit organization (hereinafter – Skolkovo Foundation):
   - Memorandum of Cooperation was signed on 20.09.2010;
   - Agreement on Creation of Cooperative Centre of Computer and Photon Technologies was signed on 24.05.2011;

b. the University actively participates in exhibitions (for example, "Russian Industrialist"), it organizes and takes part in youth (for example, "Innovation Technology Business", "Young. Daring. Perspective.") and other contests (for example, St. Petersburg Administration Award for the Best Innovation In-Cluster Project);

c. social events are organized (for example, since 2009, the University together with its partners – Monomax Congress Service LLC, NP RUSSOFT, and the "Innovations" journal – takes part in organization of the annual International Innovation Forum "From Science to Business", www.fs2b.ru);

d. information materials are regularly published on electronic media (en.ifmo.ru) and on paper (the "ITMO University" periodical), etc.
3.2. Development of ITMO Innovation Hub

Another important direction of ITMO innovation activity development is provision of its functioning as the innovation hub on the basis of the established and effectively operating innovation ecosystem (see Section III.1.).

The ITMO primary goals for innovation hub completion on its own basis for the next 18 months are the following innovation activities:

- training of the staff with the knowledge, experience, and skills necessary to render information and consulting services for external organizations;
- regulatory base improvement, approbation of approaches and technologies to render information and consulting services for external organizations;
- diversification and extension of network interaction with potential service customers and partners to provide the innovation hub with a constant inflow of orders and their successful fulfillment.

A distinctive feature of the innovation hub created in ITMO is internationalization of its activity areas that is caused by both objective factors, in particular, St. Petersburg geographical and economic position, and subjective factors – availability of the experts with wide experience in development of international cooperation.

ITMO solves the tasks stated above in co-ordination with its US partners:

- University of California, Los-Angeles (UCLA);
- National Association of Seed and Venture Funding (NASVF);
- Association of University Technology Transfer Managers (AUTM)

within the framework of the gained EURECA (Enhancing University Research and Entrepreneurial Capacity) program contest of the US Russia Foundation for Economic Advancement and the Rule of Law (USRF) since April, 2011.

During this program implementation, ITMO plans to solve the specified tasks; thus, considering the international character of the partnership, the University-based innovation hub is supposed to have competencies for operation in the global market of innovation products and services. In particular, enhancement of the staff's global level competencies for RIA legal protection, marketing, and fundraising will be the priorities of the ITMO program.
It is necessary to note that innovation hub creation and maintenance should not be interpreted restrictively, only as a tool for attraction of additional financial resources into the University at the expense of rendering consulting services.

In the specific case of ITMO, the interest lies in creation and implementation of an additional mechanism for achievement of the goal22 declared by the University in its program of development as a national research university by means of, in particular, the following activities:

- assistance to industrial enterprises in transfer of the technologies developed by various research and educational institutions;
- assistance to research and educational institutions in creation and implementation of technology transfer processes to real economy enterprises and RIA commercialization;
- assistance in establishment of network partnership among research and educational organizations (institutions) and industrial enterprises to address R&D tasks and market launch of hi-tech products;
- assistance in creation and development throughout the country of new class of innovation managers in hi-tech industries, including for small and medium enterprises.

It should be noted that when creating of the innovation hub, ITMO gains extra "bonuses", in particular:

- diversification of network partnership with research and educational organizations for expansion and deepening of performed research to gain shared RIA and practical effect;
- diversification of partnership with large, medium, and small businesses in order to address pressing economic and social issues within R&D;
- internationalization of the University basic activity areas through expansion of international integration in the innovation sphere;
- staff quality improvement (and stabilization) based on engagement of the most skilled employees into solving of innovation hub complex problems, etc.

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22 "Creation of competitive advantages of Russia in the sphere of information and optical technologies in the conditions of accelerating scientific and technological development and world economy globalization"
4. Conclusion

In this publication, an attempt was made to define the clear bounds of creation and functioning of innovation structures in the form of innovation environment, system, ecosystem, and hub on an example of ITMO. It is obvious that more detailed methodical and methodological analysis of each concept and their interrelations is required.

At the same time, the concept of "system" which consists of three basic components – subjects, objects, and conditions/factors – can be effectively used to differentiate the distinguishing features of each concept and, therefore, to formulate their definitions.

Participation of Russian universities in "system-forming" higher school development programs, in particular, creation of federal and national research universities, implementation of the projects financed within the framework of Russian Federation Government Decrees No. 218, No. 219, and No. 220 (of 09.04.2010) will allow to gain additional knowledge and experience for further improvement of the conceptual construct.
III. Bilateral Cooperation
in Research and Study Programmes
Megagrant Research Project: 
Laboratory of Advanced Research on Millimeter and Terahertz Radiation at Novosibirsk State University

Manfred Thumm et. al.1

**Abstract:** On November 24, 2010 started the 1st generation megagrant research project # 11.G34.31.003, entitled "Laboratory of Advanced Research on Millimeter and Terahertz Radiation", according to the decree no. 220 of the Government of the Russian Federation at the Novosibirsk State University. The first author of this article serves as so-called Leading Scientist. The project should concentrate on the investigation of novel schemes to generate mm- and sub-mm wave electromagnetic (EM) radiation by high power relativistic electron beams (REBs) in vacuum electronic and plasma devices and the application of strong microwaves for fusion energy research and materials processing. Five research topics have been implemented for the project:

1. Generation of sub-mm EM radiation in plasmas on the basis of plasmon-plasmon merging
2. Generation of sub-mm EM radiation on the basis of a two-stage scheme
3. in a planar free electron maser (FEM)
4. Development of novel quasi – optical components and systems for the
5. diagnostics of sub-mm-wave radiation
6. Application of high power microwaves for electron cyclotron resonance
7. Heating (ECRH) of plasmas in a magnetic mirror device
8. Microwave processing for production of novel materials.

The present article reports about the status of this project after a running time of approximately 17 months.

1. **Introduction to the Russian Megagrant Projects**

On April 9, 2010 the Government of the Russian Federation (RF) adopted Resolution No. 220 "On measures designed to attract leading scientists to Russian institutions of higher learning". Pursuant to this resolution, the RF Government issued subsidies for eligible purposes in the following amounts: 3 billion roubles in 2010, 5 billion roubles in 2011, and 4 billion roubles in 2012. The funds are made available in the form of "megagrants" of up to 150 million roubles each awarded on a competitive basis to

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support research projects implemented in 2010-2012 with the possibility of extension for an additional one and/or two years. The grants are being awarded on the basis of decisions made by the Grant Board of the Government of the RF for support of scientific research projects implemented under the supervision of so-called Leading Scientists at Russian institutions of higher learning (hereinafter referred to as "Grant Board") established by Resolution No. 517 of the Government of the RF adopted on April 9, 2010. The Grant Board supports research projects designed to be implemented within one of the following eligible scientific disciplines: astronomy and astrophysics, nuclear power and nuclear technologies, biology, biotechnologies, information technologies and computing systems, space research and technologies, mathematics, engineering, health sciences and technologies, mechanics and management processes, nanotechnologies, Earth sciences, material sciences and technologies, psychology, cognitive research, construction and architecture, physics, chemistry, ecology, economics, international research, sociology, power production, energy efficiency and energy saving.

The Grant Board requires that the Leading Scientists personally oversee their research project activities implemented at their respective research laboratories by being physically present at the relevant host institutions of higher learning for not less than an aggregate of four months in each calendar year starting with 2011. The grants of the Government of the RF designed to support scientific research projects implemented under the supervision of leading scientists at Russian institutions of higher learning (hereinafter referred to as "Grants") will be paid in installments to the host institutions of higher learning where the recipients (Leading Scientists) implement their research projects. The host institutions of higher learning are not authorised to spend the grants without prior consent of the Leading Scientists supervising their research projects. The grant competition is open which means that applicants from among Leading Scientists may submit their grant applications in collaboration with institutions of higher learning of any legal-organizational form. The grant competition regulations do not impose any limitations on the Leading Scientist's citizenship or country or permanent residence. A Leading Scientist may submit only one grant application but the number of research activities implemented at the host institution under the same project is not limited. The grant competition regulations do not impose any limitations on the subject area of the research project proposed in the grant application as long as the research project activities fall within one of the aforementioned scientific disciplines determined by the Grant Board as eligible for governmental support. All research projects supported under the grant competition will be implemented in compliance with the terms and conditions of the grant agreement executed by and between the Leading Scientist, the host institution of higher learning, and the Ministry of Education and Science of the Russian Federation. Pursuant to the terms and conditions of the grant agreement, the Leading Scientist is responsible for supervising the implementation of his research project and submitting regular progress reports,
whereas the host institution of higher learning is responsible for ensuring the requisite project implementation conditions.

Pursuant to the terms and conditions of the grant agreement, the host institution of higher learning has the right to execute contracts (agreements) with the Leading Scientist’s permanent employer-organization to account for its interests in the research project implemented at the host institution of higher learning, as well as the results of its commercial application. The grant calls in 2010 (1st generation) and 2011 (2nd generation) each had more than 500 applications. Up to now 78 grants are running. On November 24, 2010 started the present 1st generation megagrant research project # 11.G34.31.003, entitled "Laboratory of Advanced Research on Millimeter and Terahertz Radiation", according to the decree no. 220 of the Government of the Russian Federation at the Novosibirsk State University. The first author of this article serves as Leading Scientist.

2. Introduction and Background of the Present Megagrant Project

The process of conversion of plasma waves into electromagnetic (EM) radiation at strong Langmuir turbulence (LT) can be used to generate sub-millimeter and THz radiation [1-3]. Such conditions can exist either in space plasmas [4,5] or in laboratory plasmas heated by a high power particle beam [6]. First sub-THz emission studies on the multi-mirror machine GOL-3 at BINP Novosibirsk were reported in [7, 8]. In the present paper studies of sub-THz emission from GOL-3 plasmas during injection of a 10-µs-relativistic electron beam (REB) are reported. The experiments focused on investigating emission around the 2nd harmonic of the plasma frequency 2ωp at plasma densities n ≈ 10^{14}–10^{15} cm^{-3} at a magnetic field of 4 T.

In experiments on the ELMI-device at BINP Novosibirsk the operation of a 4-mm single channel free electron maser (FEM) with planar geometry and two-dimensional distributed feedback had been demonstrated (20-40 MW, 300 ns) [9]. For the case of two parallel sheet beams in two slit channels it was proposed to exploit an inter-cavity Doppler up-shift scattering scheme for two-stage generation of sub-THz radiation (0.6 THz) [10,11].

Both the GOL-3 multi-mirror trap plasma and ELMI-FEM experiments require the development of components and systems for spectral diagnostics of sub-THz radiation. The basis for these novel devices are micro-structured quasi-optical elements where amplitude, phase and polarization responses are controlled by frequency selective surface (FSS) topologies, manufactured by photolithography and electroforming [12,13].

The large magnetic mirror device Gas Dynamic Trap (GDT, BINP) is considered as a source of 14 MeV fusion neutrons to test and validate inner wall components of future thermonuclear fusion reactors or for nuclear waste processing [14-16]. A new system for electron cyclotron resonance heating (ECRH) is currently under construction at GDT [17]. This system based on two 400 kW / 54.5 GHz gyrotrons is aimed at
increasing the electron temperature up to the range 250–350 eV for improved energy confinement of hot ions which would strongly increase the efficiency of neutron-flux production. The key physical issue of the GDT magnetic field topology is that conventional ECRH geometries are not accessible. The proposed solution is based on the effect of radiation trapping in inhomogeneous magnetized plasma. The present paper discusses the design and the status of the new ECRH system.

In recent years, there has been increasing interest in microwave processing of materials, like sintering of advanced nano-ceramics or metal-powder compounds, joining of ceramics and metals, novel methods for production of new carbon materials, as well as microwave processing in an-organic and organic chemistry. Volumetric heating resulting from the absorption of microwave energy within the bulk of the samples and enhanced transport lead to significant savings in energy and processing time as well as to products with improved quality. Environmentally advantageous new solvent-free microwave extraction methods allow to obtain amino-acid derivates and other biologically active substances important for pharmacy. Here we present examples of our activities in this field of microwave materials processing.

3. Generation of Sub-THz Radiation in Turbulent Plasmas by Plasmon-Plasmon Merging

3.1. Experimental setup and background physics

Experimental studies have been carried out at the multiple-mirror magnetic trap GOL-3 at BINP (Fig. 1). The main objectives of its research program are the physics of collective plasma heating by a high-power REB and the physics of plasma confinement in a multi-mirror (periodically modulated along the axis) magnetic field (see, e.g., [18,19]). The major parameters and operational regimes of GOL-3 are: deuterium plasmas are confined in a 12-meter-long solenoid, which has 52 corrugation periods (cells of multi-mirror system) of 22 cm length each; the magnetic field in the maxima is 4.8 T and that in the minima 3.2 T (mirror ratio 1.5). The solenoid ends are provided by magnetic mirrors with a field of 8-9 T. In the experiments being discussed here, the deuterium plasma had a density of \((1 \div 8) \times 10^{14} \text{ cm}^{-3}\) with a bell-shaped axial density profile (due to gas-puffing technology where some dense gas was also puffed into the beam compression area). Plasma heating is provided by the high-power REB. The electron beam is initially generated in a sheet (planar) diode of the U-2 accelerator. After compression by a magnetic field it gets a circular cross-section. Then this REB is injected through one solenoid end and propagates in the plasma along the magnetic field lines. The main parameters of the REB are: energy \(\sim 0.7\ \text{MeV}\), current \(\sim 20\ \text{kA}\), pulse duration \(\sim 12\ \mu\text{s}\), and initial energy content \(\sim 90\ \text{kJ}\). The plasma in the GOL-3 is initially created by a high-current linear pre-discharge along the magnetic field. The cold plasma diameter is \(\sim 8\ \text{cm}\) and the electron beam diameter at \(B = 3.2\ \text{T}\) is approximately 4 cm. When the REB is injected into the plasma a strong collective relaxation of the beam electrons is observed. The classical free path length of a single
beam electron in the GOL-3 plasma is some 1000 km, nevertheless we observe a strong average deceleration of the beam electrons. The measured mean energy loss of the REB can exceed 50% after passing the plasma column [20]. The plasma heating is highly non-uniform along the axis. This was naturally explained by the concurrence of several processes, including gradual degradation of the REB quality, change of the ratio of electron beam density to plasma density, particle and energy transport, etc. The measured almost linear growth of the plasma pressure is plotted in Fig. 2.

Here we will concentrate on the first phase of the experiment when the high-power REB is injected into the plasma and a high-level LT is pumped during the beam-plasma interaction. The turbulence in turn dramatically affects the properties of the plasma. The known collective phenomena in the GOL-3 plasma are summarized in ref. [18-25].

Registration of EM emission was performed at two distances from the REB injection plane: about 0.8 m and 1.8 m, where the magnetic field is $B \approx 4$ T. Diamagnetic signals show that the maximum efficiency of REB-plasma interaction is in this area. Information about the intensity of the beam-plasma interaction was obtained by comparison of measurements of the electron energy distribution function before and after injection into the plasma column.

![Figure 1: Schematic of the GOL-3 multi-mirror magnetic trap at BINP.](image)
In order to measure the plasma parameters we apply a Thomson scattering diagnostic system based on a Nd-glass laser (1.054 µm). The laser generates two independently triggered pulses with 10-20 J energy and 20 - 40 ns duration each. The time delay between the two pulses can be varied from 0.1 - 100 µs. This system allows to measure the plasma density at 8 locations over the plasma cross section at a distance of 1.4 m from the REB injection point. The Thomson scattering system was also used to measure the velocity distribution of heated plasma electrons. Time dynamics of the integrated plasma density is registered at a distance of 0.8 m from the REB injection point by a Michelson interferometer based on a CO₂ laser. We developed two radiometric systems capable of measuring the power of the sub-THz emission which will be described in Chapter 5.

3.2. Experimental results

First experiments confirmed that the spectrum of the emitted EM radiation depends on the plasma density in the investigated area of the plasma column. For example, in the case of constant plasma density of \( n_0 \approx 3 \cdot 10^{14} \text{ cm}^{-3} \) during 6 µs of electron beam injection the radiated spectrum is broad and we measured a slowly varying ratio between the signals for 3 frequency bands [8]: 275GHz, 312 GHz, and 350 GHz with the maximal radiation power at the 312 GHz.

The opposite case is when the plasma density increases during the REB injection time. This occurs when the ionization degree at the start of beam injection is about 50% and then increases up to 100% with the increase of the plasma electron temperature up to 2-3 keV. Measurements for the final values of the plasma density \( n_e \approx 5 \cdot 10^{14} \text{ cm}^{-3} \) and \( n_e \approx 7 \cdot 10^{14} \text{ cm}^{-3} \) showed an up-shifting of the maximum of the spectral power density and a smaller bandwidth of generated radiation. Such behavior can be explained by the dependence of the frequency spectrum on the ratio of electron cyclotron frequency to plasma frequency [26].

![Figure 2: Dynamics of plasma heating in a typical shot. Waveforms of diode voltage \( U_d \) and diamagnetic signal \( W_D \) are shown at \( z = 264 \text{ cm} \) from the input mirror.](image-url)
At $z = 0.8$ m the power density of LT – induced sub-mm-wave emission during injection of a 10-$\mu$s-REB at plasma densities of $n \approx 10^{14} - 10^{15}$ cm$^{-3}$ and magnetic $B \approx 4$ T was measured to be up to $5 - 10$ kW/cm$^3$ in the frequency band above 100 GHz. For the plasma density $10^{14}$ cm$^{-3}$ the measured specific power of the emitted radiation in the band from 250 to 300 GHz was 1 kW/cm$^3$. Theoretical estimations [3] assuming a ratio of the energy density of the LT to the total plasma energy density of 0.1 result in a theoretical value of 7 kW/cm$^3$. The measured maximal power level of emission around $2\omega_p$ is localized close to the region with maximal plasma pressure at approximately 0.8 m from the REB injection point (see Fig. 3) and increases with increasing magnetic field due to the increasing plasma pressure.

Figure 3: Total energy of emitted EM radiation measured by the bolometer along the plasma column from $z = 0.5$ m to 2.0 m.

4. Generation of Sub-mm Wave Radiation by a Two-Stage Scheme in a Planar FEM

In the first step of experimental realization of we have studied simultaneous generation and transport of two intense relativistic sheet electron beams in two parallel slit channels, which are similar to the electrodynamic system of the proposed two-channel sub-THz FEM.

4.1. Experimental setup

In these experiments the parameters of the generated REBs were the following: 0.8 MeV electron energy, 3 kA total current of each beam, 0.4 cm x 7 cm cross section and 3 $\mu$s pulse duration. The electron beams were applied to drive two parallel channels of the planar FEM with 2D distributed feedback. A schematic of the experimental arrangement is presented in Fig. 4. The interaction circuit of each
channel is a planar hybrid Bragg resonator, formed by the upstream 2D and the output 1D Bragg reflectors with a length of 20 cm each, connected by a regular waveguide section with a cross section of 0.95 cm x 9 cm and a length of 32 cm in a guiding magnetic field of up to 1.7 T [27]. The upstream reflector has a 2D chessboard profile with a period of 4 mm and a corrugation depth of 0.17 mm, the downstream reflector has a 1D rectangular profile with a corrugation depth of 0.07 mm. To eliminate the influence of parasitic modes due to reflection from the side walls of the 2D reflector we used a wave disperser with comb surface which consists of conducting segments inclined at a random angle with a period of 2 cm [27]. The undulator has a period of 4 cm with 12 cm long field tapering sections and a maximum transverse magnetic field of 0.17 T.

In the first series of experiments the two channels of the planar FEM were separated by a baffle in the region of the 2D Bragg reflectors. Nevertheless some inter channel diffraction coupling can take place in the output section. After passing the resonators the REBs are transported to the collectors. Hereafter beam cross-section expansion diffraction coupling can take place in the output section. After passing the resonators a baffle in the region of the 2D Bragg reflectors. Nevertheless some inter channel...
4.2. Experimental results

The experimental results on generation of mm-wave radiation in the two-channel FEM are shown in Figs. 5 which plots the oscilloscope traces of the diode voltage, beam current and mm-wave pulse of a typical shot. Analyzing the data obtained from the 4-channel spectral diagnostics (Fig. 6) we have observed that in the shots with high values of the mm-wave radiation power the main power fraction (~70%) is contained in the 1\textsuperscript{st} band (74.5 - 75.5 GHz) and about 30% in the 2\textsuperscript{nd} band (77 - 77.8 GHz).

The experiments demonstrate that the main part of the generated mm-wave radiation is detected in the 1\textsuperscript{st} frequency band which corresponds to the design frequency and belongs to the longitudinal eigenmodes of our hybrid Bragg resonator [27]. Single-mode operation at the center frequency 75.1 GHz has been confirmed. The admixture of mm-wave power in the 2\textsuperscript{nd} band is related to parasitic coupling of the TEM and TM\textsubscript{2} waves on the 1D corrugation of the downstream reflector and reflection of the plasma coming from the REB diode.

The next series of measurements have been made to study mm-wave power in these two bands as a function of the undulator magnetic field amplitude at various values of the guide magnetic field. Increase of the undulator field above the threshold 0.9 – 1.0 kG provides a rapid growth of the generated mm-wave power from the noise-level to its maximal value, which depends on the guide magnetic field. This behavior agrees with numerical simulations [28].

Measurements of the energy of the radiation pulse for frequencies higher than 70 GHz by means of the TK absolute power/energy meter gave a value of 4 - 6 J and an average power of 20 - 40 MW from each of the two channels of the FEM.

Figure 5: Traces of a typical FEM shot: $U_{\text{diode}}$ is the diode voltage, $I_{\text{beam1}}$, $I_{\text{beam2}}$ are the beam currents in two FEM channels, and $P_{\text{MW}}$ is the mm-wave radiation power in 1\textsuperscript{st} band of spectral diagnostic.
Figure 6: Spectral densities in the different sub-bands of the W-band 4-channel spectral diagnostics.

4.3. Future sub-THz experiments

The principle of generation of sub-THz radiation by a two-stage scheme in a planar FEM is the following: the mm-wave radiation generated by the lower sheet REB (see Fig. 4) in a joined planar Bragg resonator of the FEM is scattered on the upper REB with Doppler conversion of the wavelength $\lambda$ from 4 mm (75 GHz) to approximately 0.5 mm (0.6 THz) [10]. First experiments on this two-stage scheme will be carried out in the SASE regime (self-amplification of spontaneous emission). Later experiments will employ advanced tunable Bragg reflectors based on coupling of propagating and cutoff waves. On the basis of such feedback it is possible to combine the mechanisms of mode selection used in gyrotrons and orotrons with Doppler frequency up-conversion. Coupled-wave analysis together with 3D EM simulations show that such advanced Bragg structures are able to provide selectivity up to transverse sizes of $10 \leq 20 \lambda$ [29]. Compatibility with transportation of an intense REB encourages the use of these novel Bragg reflectors in our sub-mm wave experiment. Tunability can be achieved by variation of the distance between the reflector plates. For a frequency of 0.6 THz the period of corrugation is 0.5 mm and the corrugation depth e.g. 0.05 mm.

5. Development of Novel Quasi-Optical Components and Systems for Sub-THz Diagnostics

Realization of sub-THz experiments demands adequate selective quasi-optical components and systems for controlling or measuring the properties of the radiated beams. As a rule, the best solution is attained when such components are implemented on the basis of planar regularly patterned metalized microstructures of sub-wavelength topology. Appropriate choice of topology enables to control amplitude, phase and polarization response of the structure and allows easy fabrication via well-proven photolithographic or other micromachining techniques of micrometer accuracy [12,13,30]. Commonly referred to in the literature as frequency selective surfaces
Megagrant Research Project: Laboratory of Advanced Research on Millimeter and Terahertz Radiation at Novosibirsk State University

(FSSs) [31], such resonance structures are exploited when the resonance frequency \( \omega_{\text{res}} = \frac{2\pi c}{\lambda_{\text{res}}} \) lies below the value of the diffraction lobes onset: \( g/\lambda_{\text{res}} < 1/[1 + \sin \theta] \) (here \( g, \lambda_{\text{res}}, \theta, c \) are the FSS lattice constant, operating wavelength, radiation incidence angle, and light speed respectively). For filter applications, FSSs with moderate-scaled topological micro-pattern (\( g \approx 0.3 \times 0.7 \lambda_{\text{res}} \)) are utilized, while more sub-wavelength FSSs (\( g \ll \lambda_{\text{res}} \)) are used as the basic elements in planar EM metamaterials [32].

In our R&D activities, we elaborated a broad line of passive FSS-based quasi-optical components designed for operation frequencies from 0.05 THz up to several THz [12,13]. The components include frequency filters, beam splitters, polarization and phase transformers, focusing devices, and thin resonant absorbers, which are produced in a qualified cycle of the consecutive stages: Full-wave electromagnetic analysis → Lithographic fabrication → Spectral characterization [12]. In this paper we present recent results on developing band-pass FSS-filters for plasma diagnostics.

5.1. THz bandpass filters using frequency selective surfaces

In [33] we reported on a 4-channel radiometric system for spectral measurements of sub-THz emission in the GOL-3 plasma experiments in 4 parallel frequency-shifted spectral bands overlapping the range 250-420 GHz. The principle of the system was based on quasi optical de-multiplexing of the input radiation beam onto 4 spatially separated channels with subsequent frequency filtering by quasi-optical FSS-filters and spectral signal detection by Schottky detectors matched with receiving horn-lens antennas (Fig. 7). The FSS-filters were implemented as bi-layer interference structures embedded into polypropylene (PP) with the following configuration: "320\( \mu \)m PP + FSS + 160\( \mu \)m PP + FSS + 320\( \mu \)mPP", where "320\( \mu \)mPP" and "160\( \mu \)mPP" designate PP-films with the specified thickness. The topology of inductive anisotropic resonant dipole slots (Fig. 7a) was utilized for the FSSs, which were produced by photolithographic patterning of the Al layer (0.4 \( \mu \)m thick) deposited on the surface of bearing PP-films, as described in [12], and further fused into the interference structure via a hot lamination technique. Anisotropic topology was chosen to realize ~35-38 GHz frequency shift of the transmission bands for orthogonally polarized radiation components. This allowed us to employ only two hardware filters for implementing 4 spectral channels in order to reduce the total fabrication costs. These FSS-filters demonstrated a transmission bandwidth of ~40 GHz at an out-of-band attenuation -20 to -30 dB with maximum transmission of ~50%.

For this year's GOL-3 experiments, the 4-channel radiometric system was recently upgraded to 8-channels. This 8-channel system overlaps the frequency band ~100-400 GHz and is intended for spectral measurements of sub-THz emission both in the vicinity of the second and the first harmonics of the plasma frequency. For the upgraded system we developed a new set of the band-pass high-performance FSS-filters with improved selectivity, which include 8 polarization insensitive
structures based on isotropic FSSs. Our experience showed that isotropic FSSs proved to be more convenient for multi-channel systems due to the opportunity of independent adjustment of all spectral channels when changing the filters.

![Image](image1.png)

Figure 7: Principal experimental set-up (a) and photograph (b) of the 4-channel radiometric system (250-420 GHz) for GOL-3 plasma experiments.

In contrast to the aforementioned filters from the 4-channel system, each of the new filters is comprised by three substrate-free self-bearing copper FSSs 8 μm thick, which differ in lattice constants and are designed as multiplex (non-interference) structures. The new FSSs have the topology of hexagonally-packed inductive tripole slots and were fabricated by an electroplating technique, specially adapted in this work to the THz filter implementation.
6. Application of High Power Microwaves for Electron Cyclotron Resonance Heating (ECRH) of Plasmas in a Magnetic Mirror Device

This ECRH system based on two 400 kW / 54.5 GHz gyrotrons is aimed at increasing the electron temperature up to the range 250–350 eV for improved energy confinement of hot ions [17]. The key physical issue of the GDT magnetic field topology is that conventional ECRH geometries are not accessible. The proposed solution is based on a peculiar effect of radiation trapping in inhomogeneous magnetized plasma [17]. Under specific conditions oblique launch of gyrotron radiation results in generation of right-hand-polarized (R) electromagnetic waves propagating with high N|| in the vicinity of the cyclotron resonance layer, which leads to effective single-pass absorption of the injected microwave power. In the present paper we introduce the proposed mechanism of wave propagation and discuss the design of the ECRH system which is currently under construction at the BINP.
6.1. Physics of ECRH in GDT

A ray-tracing model allows to investigate numerically a number of optimized ECRH scenarios at 54.5 GHz based on the proposed mechanism of wave trapping [17]. The most efficient geometry which was finally used for the hardware design is described here. In this geometry the magnetic field in the mirrors is close to its maximal value 14 T, while the midplane (in the central cell) field is close to its nominal value 0.3 T. Increasing the mirror field results in a shift of the electron cyclotron resonance from the plug. The distance between the electron cyclotron resonance layer and the plug (maximum of $B$) is about 45 cm on the axis.

In the example shown in Fig. 9 (top) one can see how a set of rays may be split into trapped and not trapped fractions depending on the initial launching angle or the bulk plasma density. In Fig. 9 (bottom) the effect of bulk (central) plasma density on ray trapping is demonstrated. Note that all trapped rays are 100% absorbed.

Modeling shows that trapping is possible in a sufficiently wide range of plasma densities and for various density profiles. The most important results are summarized in Fig. 10 where the trapping regions are mapped in the plasma density – launching angle diagram. Here we consider three possible positions for the last mirror shown in the inset. In the "launch 1" geometry the last mirror is matched to the existing vacuum port. Such scheme seems to be the most simple from a technical point of view but provides slightly less angular resolution. In contrary, "launch 2" is characterized by the best angular range but its realization requires an additional mirror placed beneath the vacuum port very close to the plasma boundary what may complicate the run of the whole system. The "launch 3" is an intermediate solution between the two previous ones based on the "launch 1" geometry but with the last mirror shifted more close to the plasma edge. After some discussion, the "launch 1" was chosen for the reference design presented below as it is the most reliable one, still providing acceptable operating range and ready for future up-grade to the "launch 3". Correspondingly, this geometry allows operating in the density range $0.5 \sim 2.5 \times 10^{19} \text{ m}^{-3}$ using a $50\degree \sim 55\degree$ angular window.
Figure 9: Top – geometric-optical rays for a set of launching angles 15° – 70°. The bulk plasma density is $1.5 \cdot 10^{19} \text{ m}^{-3}$. Bottom – rays launched with the same angle 55° for a set of plasma densities in the range of $n_0 = 0.5–2.5 \cdot 10^{19} \text{ m}^{-3}$ [17].

Figure 10: Operating windows in angle – density plot for three positions for the ECRH launcher. Launch 1 has been finally selected for manufacturing [17].
6.2. Design and construction of the ECRH system

The ECRH system designed for the GDT device consists of two 54.5 GHz, 400 kW gyrotrons (GYCOM: Buran-A type) [17]. Each gyrotron module is equipped with a waveguide transmission line and a launcher. Each transmission line includes a matching optical unit (MOU) to prepare a Gaussian microwave beam with parameters suitable for transmission, a corrugated HE_{11} waveguide (inner $\varnothing$63.5 mm) and three 90° miter bend units shown in Fig. 11. One of these miter bends is just a plane reflector, another one is combined with transmitted and reflected microwave power monitors, and the third is combined with a universal polariser to provide microwave beam polarisation optimal for launching and absorption in the plasma. The polariser is formed by two rotatable grating mirrors with harmonic corrugation and one central mirror with a synthesized profile for matching the input and output wave fields. The output polarisation depends on the tilting angles $\psi_1$ and $\psi_2$ of the two corrugated mirrors as shown in Fig. 12. Adjusting these angles will provide high X mode content (more than 95%) at the output of the launcher. The total length of the waveguide line is about 31 m.

The design of the plasma facing launching system is shown in Fig. 13. The ECRH launcher consists of three mirrors: mirror number 1 is plane, while mirrors 2 and 3 are parabolic focusing. The system provides a fundamental harmonic X mode Gaussian beam launched with $\vartheta = 53^\circ$ with respect to the vertical and focused at the point at $r = 4$ cm, $z = 306$ cm corresponding to the plasma boundary. The distance from this point to the last mirror is $l = 36.5$ cm. The beam waist radius is $a_0 = 0.15$ cm which corresponds to the angular divergence $\delta\vartheta = 1/ka_0 \approx 3.3^\circ$ which is acceptable for the proposed ECRH scheme. The positions of the two ECRH ports on the general sketch of the GDT facility are indicated in Fig. 14.

The described 2 x 400 kW 54.5 GHz ECRH system is now under construction at the GDT device in the BINP. The gyrotrons have already been successfully tested in 300 microsecond operation. The start-up of the first transmission line is expected in May 2012.
Figure 11: Schematic of the different miter bends used in the transmission line [17].

Figure 12: Output polarization after the universal polarizer depending on the tilting angles $\psi_1$ and $\psi_2$. Isolines of elongation of the polarization ellipse (red curves) and its inclination with respect to the incidence plane (in deg., blue curves) are shown. The input wave beam is linearly polarized. A,B,C: linear polarization like incident one; D: clockwise circular polarization; E: counter-clockwise circular pol.; F,G: linear polarization perpendicular to incident one [17].
Microwave Processing for Production of Novel Materials

Our microwave processing laboratory is equipped with a series of applicators operating at two different Industrial-Scientific-Medical (ISM) frequencies. The 2.45 GHz magnetron devices manufactured by the CEM Corporation (USA) are: DISCOVER S-CLASS (300 W, 10 and 35 ml vials, single-mode cavity), EXPLORER-48 (300 W, 10 and 35 ml vials, single-mode cavity, auto sampler, 48 positions), VOYAGER Stop Flow (300 W, 80 ml vial, single-mode cavity, flowing sampler), and MARSXpress (1.6 kW, 8 x 50 ml vials, multi-mode cavity).

A resonator Microwave Heating Station (6 kW, multi-mode cavity) designed and manufactured at the Institute of Applied Physics (IAP) in Nizhny Novgorod, Russia, also employs a magnetron microwave source. At 24.15 GHz we are operating a 5 kW Gyrotron Microwave Complex with multi-mode applicator developed by GYCOM (Russia). Here we present examples of our activities in the field of microwave materials processing.
7.1. Microwave heating of intercalation compounds of fluorinated graphite

Layered compounds based on a fluorinated graphite matrix with various guest molecules (intercalates) are a very interesting group of intercalation compounds. Interest in these new materials is due to their application as so-called molecular containers for either various gases (BrF3, CH4, NO2, HF, etc.) or condensed phases (C6H6, CH3(CO)CH3, etc.) [35].

Atoms of a fluorine, chemically bounded with carbon atoms of graphitic layers, provide high stability of the molecules inserted from an exposure and long terms of storage.

Advantages of these materials are:

- Unique stability of materials on the basis of intercalation compounds of fluorinated graphite to the influence of external factors (oxygen of air, moisture, temperature, time etc.).
- Simplicity of modification of their functional properties by selection of insertion compounds.
- High capacitance of composite materials on the basis intercalation compounds (to 30 mass %).

One of the directions of our research is the study of microwave-assisted decomposition of intercalation compounds with different intercalants as a method for producing nanostructured carbon materials (highly exfoliated graphites - HEG) [36].

The processes of decomposition of intercalation compounds of chlorine trifluoride and intercalation compounds with acetone, acetonitrile, benzene and carbon tetrachloride, embedded in the interlayer space of a polyfluoriddicarbon matrix were investigated. It has been shown that microwave energy deposition is determined by the complex dielectric permeability of the compounds intercalated into the interlayer spaces of the matrix (the presence of a dipole moment and its mobility). Microwave energy deposition decomposes the matrix under formation of nanostructured carbon. The threshold temperature for carbon formation is essentially lower as for traditional convection heating. In the final stage of the microwave heating process energy deposition is due to ohmic heating of the carbon as well.

Highly exfoliated graphites are precursors for graphene production. We produced new materials with a low number of graphene layers, with increased interlayer distances, specific surface areas up to 370 m²/g, low bulk densities of 0.4–0.7 g/l, and increased sorption capacities to organic and inorganic liquids, including toxic and dangerous ones. SEM images for intercalation the compounds C2F•ClF3 and C2F•(CH3)2CO before and after microwave decomposition are shown in Fig. 15. The formation of high-frequency corona discharge on the surface of carbon material leads to the formation of highly exfoliated graphite.
7.2. Development of new microwave-assisted techniques for synthesis of volatile beta-diketonates of platinum-group metals

Attention to β-diketonate complexes of metals is because these compounds exhibit high vapor pressure at relatively low temperature, thermal stability in the condensed phase (at vaporization temperature) and the gas phase, stability to external influences, stability during storage, and low toxicity. These properties define the promising character of their practical use as precursors in the processes of chemical vapor deposition (MOCVD – Metal-Organic Chemical Vapor Deposition) of films and coatings for various functional purposes.

For successful realization of MOCVD processes, it is important that the initial compound can be isolated in the synthesis with high yield, which to a higher extent relates to the complexes of platinum group metals because of their high cost. Analysis of the few existing literature data showed that there are no universal procedures for the synthesis of β-diketonates of platinum group metals, in particular acetylacetonates with the general formula $\text{M(acac)}_n$ ($\text{acac}=2,4$-pentanedionato$(-)$, $[\text{CH}_3\text{-CO-CH-CO-CH}_3]$–) [37], and ketoiminates with the formula $\text{M(i-acac)}_n$ (i-acac=2-imino-4-pentanonoato$(-)$, $[\text{CH}_3\text{-CNH-CH-CO-CH}_3]$–) [38].

The high cost of the initial reagents and the wide range of applications of the final products require the development of rapid and efficient methods for the synthesis of beta-diketonates of these precious metals. The transition to non-conventional synthesis methods using microwave activation processes allows one to develop ecologically pure synthesis methods with the return of unreacted product into the initial mixture, that is, almost waste-free production.
The goal of the present work was the development and optimization of procedures for the synthesis of tris-acetylacetonates of ruthenium (III) (Ru(acac)$_3$), rhodium (III) (Rh(acac)$_3$) and bis-ketoiminate of palladium (II) (Pd(i-acac)$_2$) involving microwave heating.

Investigating the possibility of microwave synthesis, we studied two versions of the initial reaction compositions: solid-phase systems and reaction systems with organic solvents and water. The initial metal compounds were rhodium and ruthenium chloride hydrates, and the ammonia complex of palladium chloride [Pd(NH$_3$)$_4$]Cl$_2$. The best results were obtained when the synthesis was carried out in aqueous solutions under the following conditions: Rh(acac)$_3$ (Ru(acac)$_3$) was obtained with the yield of 70% (85%) under the microwave action with a power of 100 W at a temperature of 110 °C (100 °C) on the 0.15 M solution of rhodium (ruthenium) chloride and a five-fold excess of acetylacetone for 60 (35) minutes. Pd(i-acac)$_2$ was obtained with the yield of 80% under the microwave action with the power of 150 W at a temperature of 110 °C on the 0.1 M ammonia solution of palladium chloride and a 1.5-fold excess of ketoimine, for 2 minutes.

It should be noted that the maximal yields described in literature for Ru(acac)$_3$ and Rh(acac)$_3$ are equal to 60% and 70%, while the minimal time of their synthesis is 8 and 30 h, respectively. Our investigations showed that the process of preliminary microwave activation of the corresponding metal chlorides takes place within 15 – 30 minutes and causes a substantial increase in the yield of tris-acetylacetonates of platinum metals. In addition, according to the data of thin layer chromatography and elemental analysis, the solid precipitate formed during synthesis and separated by filtering completely corresponds to the target product and does not require additional purification.

Thus we developed a laboratory ecologically safe procedure for the microwave synthesis of ruthenium (III), rhodium (III) tris-acetylacetonates and palladium (II) bis-ketoiminate in aqueous solutions, allowing one to obtain these compounds with the yield exceeding those published in literature, with substantial simplification of synthesis procedure and decrease in the time of experiment to several minutes. The solid precipitates of chelates can be separated by filtering without additional purification of the product. This procedure can be used to synthesize beta-diketonate derivatives also of other platinum metals.
7.3. Microwave assisted extraction of biologically active substances from medicinal plant material

Sophora flavescens is widely distributed in East Siberia, China and Tibet and has been used in herbal medicine in folk and traditional oriental medicine. It was proved that unique tetracyclic quinolizidine alkaloids present in their roots have many pharmacological functions and have been used for treatment of humans, animals and plants [39]. Various extraction conditions under microwave irradiation were studied to develop an effective procedure for isolation of these alkaloids. The influence of microwave power, temperature, irradiation time and solvent (ethanol, water) on the yield of alkaloids was determined. The best conditions for microwave extraction were found when the yield of alkaloids was improved up to 3 times using ethanol, and up to 4 times using water as solvent in comparison with the routine procedure. The selectivity of microwave extraction was high, the time of irradiation – very short (20 minutes). It is important to note that the microwave extraction of alkaloids with such a high efficiency using water is really the unique result.

7.4. Investigation of the microwave assisted synthesis leading to phthalimides of amino acids under solvent-free conditions

Phthalimide derivatives are an important class of chemical substances due to their synthetic applications as well as physiological properties. Glycine and γ-aminobutyric acid (GABA) are known to act as neurotransmitters in the brain, and the derivatives of these amino acids including both phthalimido derivatives of glycine and phthalimides of GABA have been shown to have anticonvulsant properties. Here the microwave assisted interaction of phthalic anhydride and amino acid glycine under solvent-free conditions was investigated. The heating rate of each reactant separately was studied under microwave activation. The changing of the temperature rate in dependence on microwave power was monitored. It was found that a sharp increase in heating rate (30-40 times) occurs around the melting points of the products, presumably due to an increase in polarity associated with the change from solid to liquid phase. Many tests gave the optimum two-step reaction conditions: the solid reagents were hold at 130°C, when phtalic anhydride melted, and after that the reaction mass was hold at higher temperature (240 °C) [40]. According to this solvent-free microwave procedure the syntheses of phthalimides of a series of amino acids were performed (Table 1).
Table 1: Solvent-free microwave methods for obtaining amino acid derivatives.

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<td>Phthaloyl-Glycine</td>
<td>10</td>
<td>92</td>
<td>196, [194]</td>
<td>2.5</td>
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<tr>
<td>Phthaloyl-D,L-alanine</td>
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<td>75</td>
<td>162, [161]</td>
<td>2.5</td>
<td>23</td>
</tr>
<tr>
<td>Phthaloyl-L-phenylalanine</td>
<td>11</td>
<td>92</td>
<td>179, [179]</td>
<td>2.5</td>
<td>58</td>
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<td>Phthaloyl-L-leucine</td>
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<td>142, [141]</td>
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<td>144, [149]</td>
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<tr>
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<td>11</td>
<td>98</td>
<td>113, [115]</td>
<td>4</td>
<td>83</td>
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</tbody>
</table>

7.5. Investigation of microwave assisted synthesis of heterocycles for pharmacy and catalysis

The reaction of trans-epoxide as Na-salts of thiols as heterocycles was carried out in a special 35 ml reaction vessel. A reaction period of 35-40 min was sufficient to synthesize β-hydroxy sulfides of the 3-carene series and heterocycle analogues in very good preparative yields. The reaction time was reduced by a factor of 10-15 in comparison with known procedures [41]. Complexes of these substances with metals may be used as catalysts. Aminoalcohol phosphonates found wide application in biochemistry and pharmacology. The synthesis of these substances under microwave heating was investigated and the stereoisomeric composition of the products was examined. The microwave synthesis led to two diastereomeric products with total yield up to 85 %. The ratio of the products depends on the reaction conditions and catalyst used. With certain catalysts microwave irradiation with simultaneous cooling can increase or invert the diastereomeric ratio of the products.

8. Conclusions

Sub-THz radiation can be generated by conversion of plasma waves into electromagnetic (EM) radiation at strong Langmuir (LT) turbulence via a two-stream instability induced by a high current relativistic electron beam (REB). Nonlinear plasmon-plasmon merging results in the generation of photons nearby the 2nd harmonic of the plasma frequency $2\omega_p$ ("2$\omega_p$-process"). For plasma densities $10^{14}$–$10^{15}$ cm$^{-3}$, these frequencies are in the range of sub-mm waves: 370-570 GHz. The power density of sub-mm-wave emission from plasmas in the multi-mirror trap GOL-3 (BINP) during injection of a 10-μs-REB at plasma densities $n_e \approx 5 \cdot 10^{14}$ cm$^{-3}$, electron temperatures $T_e \approx 1.5$ keV and magnetic field $B \approx 4$ T was measured to be
between 5 – 10 kW/cm³ in the frequency band above 100 GHz. Experiments on the ELMI device (BINP) demonstrated the operation of two parallel mm-wave single-channel free electron masers (FEMs) with planar cavity geometry and 2D distributed feedback. Measurements have shown single-mode single-frequency generation (75 GHz) with about 300 ns pulse duration at the power level of 20-40 MW from each of the two FEM channels. Now we plan to investigate an inter-cavity scattering scheme for two-stage generation of sub-mm wave radiation. Both the GOL-3 and FEM experiments need spectral diagnostics of sub-THz radiation. Novel micro-structured quasi-optical elements have been developed where amplitude, phase and polarization responses are controlled by frequency selective surfaces (FSSs) manufactured by photolithography and electroforming. Bandpass filters (70 mm aperture diameter) with center frequency (CF) from 112 to 376 GHz show > 90% transmission and have a FWHM bandwidth of ~ 12% and an out-of-band attenuation of higher than 40 dB.

the ECRH system being under construction at the GDT magnetic mirror device at BINP can provide essential enhancement of the electron temperature in the central cell up to 400 eV. At such temperatures a GDT like neutron source is quite attractive in comparison to accelerator based systems. Ray-tracing calculations show that for launching angles 50° – 55° the oblique launch of ECRH waves results in generation of right-hand-polarized electromagnetic waves propagating with high N|| in the vicinity of the cyclotron resonance layer. This leads to effective single-pass absorption of the injected microwave power. The ECRH system being installed at GDT consists of two 54.5 GHz, 400 kW gyrotron modules (GYCOM: Buran-A type) equipped with a matching optical unit (MOU) to prepare a Gaussian microwave beam with parameters suitable for transmission through a corrugated HE11 waveguide (inner Ø63.5 mm) employing three 90° miter bend units. One of these miter bends is combined with a universal polariser to provide a microwave beam. The start-up of the first transmission line is expected in May 2012.

Microwave processing was very successfully applied to: (1) Heating of intercalation compounds of fluorinated graphite; (2) Development of new microwave-assisted techniques for synthesis of volatile beta-diketonates of platinum-group metals; (3) Microwave assisted extraction of biologically active substances from medicinal plant material; (4) Investigation of the microwave assisted synthesis leading to phthalimides of amino acids under solvent-free conditions, and (5) Investigation of microwave assisted synthesis of heterocycles for pharmacy.

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manufacturing FSS structures and in THz measurements. Herewith we gratefully acknowledge the support of this research by the Russian Federation (RF) Government Grants #11.G34.31.0033 and #NSh7792.2010.2, by the Contract #16.740.11.03.77 of the Ministry Education and Science of the RF, by the contract 16.740.11.0377 of the Federal Target Program, and by the Program 30 of RAS.

References

[34] Microwave Conference (EuMC-2009), Rome, Italy, 173 (2009).
International Research Training Group (IRTG) "Enzymes and Multienzyme Complexes Acting on Nucleic Acids" – the first German-Russian Doctoral Program

Roland K. Hartmann

Fig. 1: Location of partner institutions (red dots) of the IRTG.

Background

The International Research Training Group (IRTG) "Enzymes and Multienzyme Complexes acting on Nucleic Acids" (RFBR 08-04-919(70-76) – DFG GRK 1384) is a structured doctoral program network in the field of biology, biochemistry and chemistry, with scientists from the Justus-Liebig University (Giessen), the Philipps-University (Marburg), the Russian Academy of Science and the M.V. Lomonosov Moscow State University. In addition, scientists from the Institute of Biotechnology (Vilnius) and the International Institute of Molecular and Cell Biology (Warsaw) are associated partners of the network. Speakers on the German side are Prof. Peter Friedhoff and myself (Vice-Speaker), and Prof. Tatiana Oretskaya and Prof. Elena Kubareva on the Russian side.

Our IRTG 1384, the first German-Russian network of its kind and one of two currently existing ones, was launched in fall 2006 for 4.5 years and was prolonged in April 2011 for another 4.5 years. Currently, the network comprises 9 Russian, 11 German as well as two associated research groups in Vilnius and one in Warsaw.
Research topics and common scientific interests

As implicated by the title of the IRTG "Enzymes and Multienzyme Complexes acting on Nucleic Acids", there is a common interest in DNA:protein and RNA:protein interactions. Research groups were recruited based on the strength of their expertise in molecular and cellular biology, bioinformatics and computational biology, enzymology, bioorganic chemistry, biophysical chemistry, and structural biology. Since malfunction of several of the investigated enzymes and enzyme complexes is causally related to human diseases, in particular some forms of cancer, a better understanding of their mechanisms of action is expected to contribute to new therapeutic concepts, such as repair of defective genes.

The profile description of our 2006 application puts in a nutshell what we think is a major benefit for all participating doctoral students and principal investigators: “The diversity of enzyme systems and their investigation within this interdisciplinary network will allow us to perceive and approach individual enzyme systems from a broader and multilayered perspective (intellectually and technically). Individual research projects will thus mutually benefit from knowledge acquired within the network.”

There is complementarity and synergism in expertise and methodology between the Russian and German research groups, being the major scientific benefit arising from the internationality of the IRTG.

Fig. 2: Group photo of the Suzdal workshop in June 2007
Fig. 3: Flow scheme of the doctoral program of the IRTG

Fig. 4: Doctoral development, research, training and assessment in the GRK 1384
Program structure and goals

The program for the doctoral students of our IRTG is sketched in Fig. 3 and detailed in Fig. 4. Each research group contributes one funded and one associated graduate to the network. A thesis (advisory) committee is assigned to each student, consisting of the local supervisor, a local co-supervisor and an international mentor, usually the foreign group leader with whom the supervisor cooperates. The thesis committee accompanies the doctoral student over the entire doctoral period. The structured doctoral program (German side) involves several elements. Doctoral students alternately report (in a 20 to 30-min oral presentation) on the progress of their scientific work within the biweekly regular seminar. This seminar program is interspersed with talks given by the principal investigators (PIs) of the network who provide an overview of the ongoing research in their groups. After seminar contributions given by doctoral students, the supervisor and the co-supervisor meet with the student to discuss, fine-tune or redirect the project. In addition, invited expert lectures are arranged between the regular seminars. Doctoral students are further obliged to spend research periods in the corresponding partner country, with emphasis on a balanced exchange in both directions (Giessen/Marburg and vice versa). Tailored practical training courses for doctoral students in partner laboratories (in German, Russian or associate partner groups) permit our students to expand their methodological repertoire. At the beginning, each student has to formulate a career development plan (predicted project status after year 1, 2 and 3), has to write a research proposal (~ 1500 words) after half a year and a mid-term progress report (~ 1500 words) after 1.5 years. All three items are discussed with and assessed by the thesis committee. Scientific workshops and international meetings with oral or poster presentations by the doctoral students are part of the program as well, including a workshop with doctoral students only (in the absence of PIs). Students in Marburg and Giessen are further enrolled at Doctoral Development Programs (MARA and GGL) of the two universities and are offered a Russian language course as well workshops and seminars in the areas of research management, communication skills, writing skills, presentation techniques, fund raising, career development, teaching skills, as well as mentoring programs for female researchers such as 'SciMento'. It is noteworthy that our IRTG has installed a 2-day career development workshop (“Pathways to a successful career”; in spring 2012 and 2014), for which advanced scientists with a large spectrum of careers ranging from academia, research institutions, small- and medium-sized biotech companies, and large pharmaceutical companies, to science management in international organizations, journalism, and politics have been invited. This helps young researchers to become aware that there are many more than two or three career paths and that individual careers usually include detours. By opening up career perspectives, such career development workshops encourage students to pursue individual careers tailored to their personal skills, affinities and ambitions. Last not least, publications in scientific peer-reviewed international journals,
particularly joint publications of Russian and German partner groups, are an essential goal and indicator for the success of the doctoral work.

**Critical issues of the program**

A fairly balanced doctoral student exchange (research periods abroad) between the two partner countries has not been easy to achieve. There have been more research visits from Moscow to Giessen/Marburg than vice versa. One reason is that laboratory infrastructure is often, although not always, better in Germany than Russia. Another reason is that research in the summer months is more difficult to conduct in Moscow, as many Russian laboratory suppliers close down their services during this period of the year. Thirdly, German students are more difficult to adapt to living in Russia as compared with Russian students in Germany, mainly owing to communication (language) problems with people outside of Institute walls. The aforementioned imbalance is reduced the more the cooperating Russian and German research groups interdigitate their common research activities. The principle that the costs for living of an exchange student are paid by the host country has also favored a more balanced bilateral exchange. Exactly this is going to be blocked by a 2012 verdict of the Russian audit court, arguing that supporting foreigners with Russian tax money is incompatible with Russian national law. This is clearly a severe drawback that will make similar exchange programs more difficult in the future.

Successful experimental work, fulfillment of the numerous tasks of the program (Fig. 4) and additional teaching duties sum up to a challenging work package for each doctoral student. In our experience, this is a tightrope walk and there is constant danger to overload such a structured program. As a rule of thumb, it is advisable to try to relieve the pressure on the doctoral students whenever possible. Particularly, administrative burdens should be kept as low as possible.

**Organization and management**

The network is steered by an International Steering Committee consisting of the Russian and German (vice-)speakers and two doctoral students on each side. The International Steering Committee tightly cooperates with the Project Manager of the IRTG, Dr. Anja Drescher (Giessen; paid from the GRK 1384 grant), who takes care of the practical organization of workshops and meetings, of visa applications and communication with travel agencies, and handles the finances on the German side. Her role is essential to keep the administrative and organizational burden at an endurable level for our students.


**Starting point of the network, history, difficulties**

The focal point that provided the basis for the development of this network was a bilateral cooperation initiated in the 1990’s between Alfred Pingoud’s group at Giessen and Tatiana Oretskaya’s and Elena Kubareva’s groups in Moscow. This cooperation resulted in five common publications between 2000 and 2005.

When the first preparatory activities were ignited in early 2005, the main task was to find a forceful scientific topic for which roughly ten Russian and ten German groups could be identified that match the topic, are internationally visible and contribute to the multidisciplinarity of the network. This critical selection process was finalized after some of us had traveled to Moscow in September 2005 for a two-day scientific symposium plus consultations. At this stage, we already involved Dr. Christian Schaich (German Research Foundation, DFG), at that time head of the DFG office in Moscow. He and also several other DFG representatives were indispensable in this initial and the following period, by mediating a mutual understanding of the different national scientific and funding cultures. A critical issue was at that point to gather research groups that fulfill the criterion of international visibility and evidence of excellence. This collided in some cases with the ambition to include PIs on the basis of old friendship. In fall 2005, the DFG began to negotiate with the Russian Foundation for Basic Research (RFBR), giving us important advice for the application, e.g. that the scientific program (practical courses, participation in research, etc.) for German doctoral students visiting Moscow would be a critical issue. The first constituting international “kick-off” meeting of the IRTG took then place in October 2006 in Giessen, followed by the workshop in Suzdal, northeast of Moscow, in June 2007. Immediately before the Suzdal workshop, some of us met Prof. Matthias Kleiner, President of the DFG, in Moscow, shortly after he had signed a memorandum with the RFBR, which, among other issues, regulated cooperations at the level of international graduate programs, the so-called International Research Training Groups (IRTGs). For the year 2007, the Russian PIs received individual RFBR grants for cooperation projects with selected German partners. Funding was then extended for three years in 2008 (2008-2010).

**Problem of non-synchronized funding systems**

After the DFG had approved our application for the second period in fall 2010, continuation of funding by the RFBR faltered, owing to structural rearrangements and priority changes at the RFBR. The RFBR only assured funding for 2011, with uncertain prospect of annual fundings in 2012 and 2013. In addition, the Russian PIs were obliged to deliver annual reports, which essentially correspond to annual re-evaluations. Funding by RFBR for this program will definitely stop after the triennial period, (2011-2013), although funding on the German side will continue until September 2015. Also, the Russian groups get access to their funds not before July of the year of granting, but have to spend the money within the same financial year.
These uncertainties and disparities have had a demotivating effect on the entire network, leaving a feeling of insecurity and impeding long-term planning. The aforementioned problem is critical as long-term bilateral cooperation depends on an assured and predictable financial framework that is synchronized between the two countries. Likewise, the decision that Russian grants cannot cover the costs for living of German exchange students in Moscow (see above) is counterproductive as well, as it aggravates the process of intensifying the bilateral cooperation. For example, German PIs will increasingly hesitate to send students for exchange to Moscow if the entire costs have to be paid from German grants. Moreover, if the same rules were applied by the German funding agency, then many Russian groups could simply not afford to send their students to Germany often.

Assets of the network
Apart from the disparities in the funding systems, the work of the IRTG has been extremely fruitful. Approx. 150 publications of doctoral students have been published, a substantial fraction in high-ranking international journals. More than 30 doctoral students have successfully defended their theses, and approx. ten prices/stipends have been awarded to our graduates. The number of joint publications of Russian and German groups has increased over the years. Overall, a trustful cooperation atmosphere has developed in the network and durable friendships have grown.

Cultural benefits and political dimension
Bi- or multilateral networks such as our IRTG contribute to international understanding and thus to a peaceful coexistence of peoples on the European continent, and hopefully also back up democratization processes. Moreover, scientific and economic accomplishments in Europe will be the more significant the tighter cooperation between Russia and other European nations will become. Of course, this is a complex process that requires convergence and harmonization of the different systems at the level of scientific funding, decision making/administration, economics and politics, as well as continuous efforts to decrease cultural barriers and to improve mutual understanding. We have experienced through our IRTG that such a process can be brought forward.
The Koch-Mechnikov-Forum
as platform for a long-term partnership in healthcare

Helmut Hahn and Timo Ulrichs

1. Foundation, structure, and scope of activities of KMF

KMF was founded in Dresden on the occasion of the 6th Petersburg Dialogue in October 2006. As a nongovernmental organization, it was defined as an initiative of the Petersburg Dialogue, and given the task of acting as a mediator of competence in health between the Russian Federation and Germany. The aim of KMF is to make a contribution to the harmonization of health systems in both countries. KMF’s activities are politically wanted and politically accompanied. KMF brings together health initiatives from scientific cooperative projects, both in basic and applied research, clinical competence as well as competence in the medical products and pharmaceutical industries.

Thus, the activities of KMF are broadly based. Concomitantly, KMF’s activities are organized in appropriate sections covering most aspects in the biomedical and healthcare fields.

In fulfilling its task, KMF

- Organizes and executes both basic and applied research projects;
- Organizes conferences, symposia and workshops as platforms for exchange of medical competence, knowledge, and ideas;
- Organizes exchange programs for medical personnel, scientists, post- and pregraduate students; and
- Education and training in the broadest sense including education and training of non professionals.

Joint projects form the basis of all KMF activities. They pave the way for the development of mutual trust, which in turn is a necessary precondition for the successful implementation of joint projects. Conferences, if organized on a regular basis, such as our annual KMF-Conferences, have proven to be well-suited instruments for bringing together researchers, clinicians, and scientists, as well as political decision makers, representatives from medically oriented industries, and academic institutions.

Exchange programs comprising scientific visits, internships of specialists as well as short- and long-term visits of students and postgraduates to programs have proven important tools in realizing the Modernization Partnership between the Russian Federation and the European Union. In this context, KMF holds university partnerships in highest regard as stabilizing factors for longlasting cooperation.
KMF’s work is funded by the following sources:

- Membership fees for individual and institutional as well as industrial members
- Project-based grants with an overhead percentage for running the central office; by foundations, private persons or governmental institutions.
- Third party funding as provided by the German Research Foundation (DFG) together with the Russian Fund for Fundamental Research (RFFR), the International office of the German Federal Ministry for Education and Research (IB-BMBF), the German Academic Exchange Council (DAAD), the International Science and Technology Center (ISTC), the German Federal Ministry of Health (BMG) and private foundations.
- Industrial partners of KMF often sponsor single events.

2. Achievements

In the course of its activities so far, KMF has established a network of partners which extends from Western Russia (Smolensk, Central and Northern Russia (Voronezh, Moscow, Saint Petersburg to places as far away as Siberia (Novosibirsk, Tomsk, Irkutsk, Tyva).

The network of our partners also includes former Soviet Union (CIS) States such as Armenia, Azerbaijan, and Georgia as well as Moldova.

The results of our previous activities were chosen as the material basis for the German-Russian Inter-Ministerial Health Agreement of 2010 signed between the Ministries of Health of both countries during the intergovernmental consultations held in Yekaterinburg in July 2010.

This agreement is of particular importance for our work as it now gives KMF’s activities a firm legal guideline in Russia, as well as it gives directions in which activities are to be concentrated as well as main topics.

The latter include:

- Exchange programs for experts and scientists as well as students.
- Realization of health programs
- Congresses, symposia.
- Exchange of health-related information as well as assistance in the development of infrastructure in the health system.

Problem areas of priority as have been defined:

- Prevention of diseases,
- Public Health
- Health of Mother and Child, rare diseases, pediatric oncology and hemato-oncology,
- Socially relevant infections such as TB, HIV/AIDS, hepatitis B and C, sexually transmitted diseases,
• normative regulations such mutual recognition of health diplomas from either country.

Pilot projects.
Further additions to this list are IT in Health as well as emergency and catastrophe medicine. A German-Russian Commission has been founded with the task of implementing the agreement.
With this paper in hand, we can now pursue our activities more safely and more self-confidently with respect to problems to be tackled as well as instruments used for implementation, simply because we now move on safer grounds.

3. Fighting Tuberculosis as a Role Model of KMF's work

Tuberculosis being one of the biggest threats to human health worldwide is also rampant in Eastern Europe including Russia. The WHO-Euro office declared tuberculosis a regional health emergency after alarming epidemiological developments have taken place in the past years.

Two developments complicate an efficient containment of the TB disease:
Multidrug-resistant M. tuberculosis strains, which mainly spread from East to West in the WHO-Euro region.
Unfortunately, another problem emerged in the form of a rising HIV epidemic in the Russian Federation and other GIS states.

The following chapter summarizes experiences gathered in German-Russian collaboration in tuberculosis research and control.
Countries in the former Soviet Union currently struggle with multidrug resistant tuberculosis. Efficient TB containment becomes more and more difficult, and international efforts are needed to fight TB disease, especially in the WHO-Euro region. Consequently, KMF's TB section is very active in basic and applied research, education and training, exchange programs, conferences etc. Partnerships with Russian TB specialists and with those from other countries in Eastern Europe, Southern Caucasus and Central Asia, have been established to develop rational strategies against tuberculosis.

3.1 Tuberculosis projects

Starting from a formal partnership between the Berlin Max-Planck-Institute (MPI) for Infection Biology and the Central Tuberculosis Research Institute (CTRI) of the Russian Academy of Medical Sciences in Moscow aimed at characterizing the local immune response in infected human lung tissue, a better understanding of direct interactions between the host immune system and the pathogen Mycobacterium tuberculosis forms the basis for the development of a novel vaccine against tuberculosis as well as for new interventions in treatment and new techniques in TB diagnosis.
Other joint projects with CTRI aim at improving the laboratory diagnosis of tuberculosis.
With the Institute for Phthisiopulmonology in St. Petersburg, the Federal Tuberculosis Institute in Novosibirsk and the tuberculosis institutions of the Siberian State Medical University in Tomsk, more Russian partners joined the scientific network of tuberculosis research between Germany and Russia.
In Germany, the Institute of Medical Microbiology of Charité, the German Reference for Diagnosis of TB in Borstel as well as the Institute of Medical Microbiology and Hygiene of the German Red Cross in Berlin all by now have joined the project team.
The research activities are being flanked by increasing efforts in education and training. Train-the-trainer seminars help to ensure technical expertise in personnel running newly purchased laboratory equipment. These seminars are now being organized on a regular basis in many of KMF’s partner TB institutions as there is a high turnover in specialized medical personnel.
Educational projects in tuberculosis extend into medical education in Russian Medical Academies. Joint lectures as part of the normal TB curriculum and courses on specific aspects in diagnosis, clinical and preventive fields of tuberculosis control have turned out to be very successful.

3.2 Examples of German-Russian TB projects

3.2.1 Moscow

The Central Tuberculosis Research Institute CTRI in Moscow has two main departments: the department of immunology and the department of microbiology. The first one focuses on basic research, whereas the second one deals with diagnostic research. KMF cooperates with both. The project of immunological characterization of the local immune response comprises histological, genetic and cellular immunological approaches and has revealed new insights in the host-pathogen interaction.

The different immunological research groups at CTRI are working at a very high scientific level and can compete with the most advanced TB research laboratories worldwide. During the past years, CTRI invested big amounts in infrastructure and in modernizing the laboratory building. A visit of Dr. Kosmiadi at the MPI for Infection Biology in Berlin in September 2012 offered new aspects of the immunological projects for the coming years.

The department of microbiology cooperates with KMF in some diagnostic research questions and uses equipment and techniques developed by KMF’s industrial partners. These trilateral scientific projects in establishing and evaluating novel diagnostic techniques have been beneficial for all sides. The department of microbiology of CTRI is well positioned for becoming a national reference center for TB diagnosis and partner for the supranational quality control network in TB diagnosis.
3.2.2 St. Petersburg

In St. Petersburg, KMF cooperates with three partners in TB research and control: The Institute for Phthisiopulmonology, the Pavlov Institute for Experimental Medicine, and the Mechnikov Academy/University. In 2003, a research project was started with the Institute for Phthisiopulmonology dealing with genetic patterns for resistance and susceptibility to M. tuberculosis infection and TB disease. DNA and RNA from tuberculosis patients were collected together with clinical data on their TB disease. Microarray analyses gave insight into the gene expression patterns in different stages of the disease as well as during latent TB infection. The project ended 2006. Cooperation with the Institute for Phthisiopulmonology was revitalized when Prof. Pjotr Yablonskij became the new director and at the same time the Main Specialist of the Russian Federation for tuberculosis control. In a new letter of intent between his institute and KMF, the future fields of cooperation have been determined:

- Research projects namely in immunology and diagnosis;
- A joint German-Russian center for education and training at the institute in St. Petersburg dedicated to continuous training of TB experts in all Russian-speaking countries;
- Regular conferences on tuberculosis in Russia and Germany.

The first joint conference was the All-Russian Tuberculosis Conference in St. Petersburg in October 2012. On this platform, all responsible TB decision makers could be reached and the KMF tuberculosis network was enlarged. Every other year, the Pavlov Institute for Experimental Medicine organizes the "Immunology Days" in St. Petersburg, an immunological conference with special sections on infection immunology. KMF co-organized several satellite symposia and working sessions on TB immunology within the Immunology Days. The upcoming Immunology Days in 2013 will again have a special section on tuberculosis.

In 2012, the Mechikov-University became KMF's major partner in academic cooperation in St. Petersburg. Several years ago, a cooperation in teaching and training was established between KMF and its German university partners, such as the faculty for Public Health of the University of Bielefeld and the Berlin School for Public Health, and the Mechnikov-Academy (which was merged with the Institute for Medical Education in St. Petersburg to become the Northwestern State Medical University, named after Ilya I. Mechnikov; "Mechnikov University"). KMF and the Mechnikov-University founded the Koch-Mechnikov International Center for Research and Education in Public Health at the Mechnikov-University. The founding act took place in September 2012, the first students for the master studies in Public Health (MPH) will enroll in February 2013. The new Public Health Center will focus on three fields:
Education and training in Public Health (master of public health, MPH, according to the Bologna criteria);
Research in Public Health, as joint German-Russian projects and with a special focus on infection epidemiology;
Consultancy for administration and government institutions.

Of course, tuberculosis will be one very important subject for both research and education in public health in St. Petersburg, illustrating basic principles in infection control and intervention strategies.

3.2.3 Voronezh
The Burdenko Academy in Voronezh has been cooperating with Charité University Medicine and the German Heart Center Berlin for many years. The involvement of specialists of KMF started a few years ago. Tuberculosis is part of the medical curriculum and is taught by KMF on a regular basis at the Burdenko Academy. In 2011, KMF co-organized with the Burdenko-Academy the 10th Annual Koch-Mechnikov Conference in Voronezh, which was a teaching conference involving both students and postgraduates.

It is planned to enlarge the cooperation with Voronezh in terms of initiating epidemiological research studies on the local spread of multidrug-resistant tuberculosis.

3.2.4 Smolensk
Funded by ISTC, an international tuberculosis conference was organized in Moscow in 2011, focusing on childhood tuberculosis. The different contributions were directly transmitted into the audience hall of the Smolensk State Medical University. The head of KMF's TB section was subsequently invited to Smolensk, and a formal partnership between KMF and SSMU was established in 2012, resulting in two visits of Smolensk TB delegations to Berlin and Borstel. A university partnership is planned.

3.2.5 Yekaterinburg
In 2010, the German-Russian governmental consultations and the Petersburg Dialogue took place in Yekaterinburg (see below). Relationships between KMF and the Institute for Phthisiopulmonology existed much longer, as representatives from Yekaterinburg took place in various TB conferences of KMF in both Russia and Germany. In 2012, two visits of German TB experts strengthened the bilateral partnership between KMF and Yekaterinburg.
3.2.6 Cooperations with other successor states of the former Soviet Union

KMF is very active in collaboration in TB research and education with partners in Georgia and the Republic of Moldova. Some bilateral projects are ongoing with Uzbekistan (since 2006) and Turkmenistan (started in 2012).

3.3 Structural and political activities in tuberculosis control

KMF was involved in two major projects with direct impact on the German-Russian partnership in tuberculosis research and control:

- Creating and adopting the Berlin Declaration on Tuberculosis, Berlin, October 2007;
- Preparing and contributing to contents of the German-Russian Agreement in Cooperation in Healthcare, Yekaterinburg, July 2010.

3.3.1 The Berlin Declaration on Tuberculosis

To respond to the declaration of TB as regional health emergency by the WHO-Euro office (see above), the German Federal Ministry of Health together with WHO-Euro invited the health ministers of all 53 member states of the WHO-Euro region to Berlin, to attend a Ministerial Forum on tuberculosis. Most of them followed the invitation, and at the end of the forum, they adopted the so-called Berlin Declaration on Tuberculosis (www.who-euro.int).

The declaration names the main problems in containing TB in the WHO region, calls upon the member states to increase their involvement in TB control and lists self-commitments of high- and low-burden countries. At the end, it is stated that progress in fighting TB should be evaluated every two years (see below).

3.3.2 The German-Russian Agreement in Healthcare

Activities in German-Russian collaborative projects of KMF formed the basis of this agreement of 2010. In 2008, both governments agreed on a 2 year "action program" for this collaboration, and KMF contributed to this program in many biomedical and healthcare fields, among those also the various TB projects.

In July 2010, the Agreement was signed by the health ministers of both countries on the occasion of the bilateral governmental consultations in Yekaterinburg. For all ongoing and future KMF projects, the Agreement now forms the legal framework.
3.4 Conferences and meetings on tuberculosis

3.4.1 Scientific symposium on World Tuberculosis Day

In order to scientifically prepare the Ministerial Forum in 2007 (see above, 3.3.1) and at the same time to commemorate the 125th anniversary of Robert Koch's groundbreaking presentation "Ueber Tuberculose", KMF together with other TB organizations in Germany organized a scientific symposium on the occasion of World Tuberculosis Day in March 2007. The results of the symposium formed the basis of the discussion preparing the declaration. In turn, the Berlin Declaration on Tuberculosis is still nowadays the basis of all activities of the KMF in TB research and control in bilateral scientific projects with partners in Eastern Europe and Central Asia.

As the first scientific symposium on World Tuberculosis Day was successful, KMF decided to organize symposia every year in March on the occasion of World TB Day.

The following scientific symposia were organized by KMF on the occasion of World TB Day:

<table>
<thead>
<tr>
<th>Year</th>
<th>Main focus</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>Current status of research in diagnostics, treatment and prevention of TB</td>
</tr>
<tr>
<td>2009</td>
<td>Public Health issues of tuberculosis control</td>
</tr>
<tr>
<td>2010</td>
<td>Exchanging expertise: Problems and challenges in Sub-Saharan Africa and the WHO Euro Region</td>
</tr>
<tr>
<td>2011</td>
<td>Childhood Tuberculosis</td>
</tr>
<tr>
<td>2012</td>
<td>Evaluating the progress five years after the Berlin Declaration on Tuberculosis; festive symposium on the occasion of the 75th birthday of Prof. Helmut Hahn, the president of KMF</td>
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</table>

Every single scientific symposium of KMF at World TB Day referred to the Berlin Declaration, even if the main focus of the symposium was different. All symposia were organized by KMF together with representatives of the WHO-Euro office, and some symposia were used to officially launch WHO reports on different subjects in TB control, such as the report on MDR TB.
3.4.2 Contributions in the field of tuberculosis to the World Health Summit

KMF promoted the Berlin Declaration also at the World Health Summit (WHS, www.worldhealthsummit.org), which is organized by Charité University Medicine and its partners of the M8 Alliance every year in Berlin in October. 2009, at the first World Health Summit, a symposium was organized by KMF focusing on the evaluation of the progress made two years after the Ministerial Forum. The main topic of this symposium was HIV-TB comorbidity. Two years later, at the third WHS 2011, the evaluation of the progress made was presented with a political focus. The symposium on World TB Day 2012 focused on the scientific evaluation and its epidemiological and Public Health outcomes (see above, table with World TB Day symposia). In order to avoid that the Berlin Declaration on Tuberculosis will end up as just another paper printed with nice plans to stop TB, KMF will continue organizing symposia, conducting studies in Eastern Europe and providing the political platform to develop and employ strategies to stop TB in the WHO Euro region. The scientific symposia on the occasion of World Tuberculosis Day form the backbone of these activities.

4. Summary and outlook

KMF’s activities have led over time to a build-up of a network of actual and potential cooperation partners in the Russian Federation in various fields of healthcare and at various levels: academic, governmental, institutional and scientific. These partners act as "receptors" for German interests in cooperation in a broader sense. Experience has shown that such partnerships result in long-lasting collaborative projects, producing sustainable results in both countries and in this way function as a very strong stabilizing factor, independent of day-to-day political interferences.
Structure in Sections:

- Endocrinology und Diabetology
- Nephrology
- Nursing studies
- Clinical Pharmacology
- Public Health
- Tuberculosis
- medical technologyMedizintechnik
- HIV/AIDS
- Microbiology and hospital hygiene
- Urology
- eHealth
- quality control in virus diagnostics
- and others
Russian-German Dialogue in the Yaroslavl Region: Cooperation between the MUBiNT Academy in Yaroslavl and the East-West Science Centre of the University of Kassel

Valeriy Ivanov

The development of the new forms and content of international cooperation is very important in contemporary Russia. How did the bilateral Russian-German cooperation in Yaroslavl develop? How did its traditions emerge and progress in the region? The article presents the positive experience of the Russian-German cooperation in the academic and cultural environment in the city of Yaroslavl.

20 years ago the East-West Science Centre of the University of Kassel was established, and in the same year the cooperation agreement with a modern university – MUBiNT Academy, which had just appeared in Yaroslavl, was signed. Relationship between partner cities Yaroslavl and Kassel fixed in the 1988 bilateral agreement became the basis for the establishment and development of cooperation between the MUBiNT Academy and the East-West Science Centre. The authorities of the city of Kassel, the Vice-President of Kassel University Dr. Gabriele Gorzka, on the German side, and the Administration of the city of Yaroslavl and the Rector of the Yaroslavl State Technical University Yu.A.Moskvichev, on the Russian side, were the originators of the two cities' partnership.

The initiative in the Russian-German civil dialogue was taken by the friendship societies "Partners of Germany" in Yaroslavl and "Partners of Yaroslavl" in Kassel, emerged in the perestroika times. It was the period of "people's diplomacy" which helped to solve the main task: "break the ice" of mutual mistrust and open a direct dialogue between citizens of two countries. Numerous events held in the twin-cities – meetings, exhibitions, concerts – allowed people to get to know each other better.

The scope of cooperation and mutual interest required new institutional and infrastructural approaches and solutions. That was why the citizens and the city administration unanimously supported the idea expressed by Gabriele Gorzka to open a German-Russian House of Friendship (Deutsch-russische Begegnungsstaette) in Yaroslavl. The MUBiNT Academy actively joined in the implementation of the project. In 1991 an old mansion in the city center, a striking example of wooden architecture in Yaroslavl, was bought. It was reconstructed with the joint effort from the German and the Russian side. In 1994 the first House of the Russian-German friendship in Russia was opened, having become an unprecedented example of civic and business initiative.

The House of Friendship has played a unique leading role in strengthening and developing ties between the two cities. Meetings of official delegations, performances of artists and public figures of the two countries, exhibitions of
German painters and photographers were held in the House, German festivals were celebrated there. The House became a Russian-German cultural center in Yaroslavl. With the development of multilateral relations "people's diplomacy" lost its unique value. Cultural exchanges started to develop in scope and depth, new business relations and economic projects, where both parties acted as equal partners, and professionalism and responsibility were primarily valued, came to the fore.

Information Bureau of the East-West Science Centre was opened in the House of Friendship. In cooperation with the University of Kassel, MUBiNT Academy, Yaroslavl City Administration, Kassel City Administration, the Bureau organized many seminars, conferences, meetings between the two countries. The topics of seminars covered the automation of the municipal government (1994-1995), public and private partnerships and citizen participation in city development (1998-2000), quality management at Yaroslavl enterprises (1998-2002), new library technology in Germany (2004), technological innovation in environmental construction (2004). Among the activities was an exhibition of young painters from Kassel (1994), a presentation of animated films (1997), an exhibition of Sh.Mitzlaff's illustrations of Osip Mandelstam poems. Summer and winter academies for high school didactics were organized.

All these activities, of course, contributed to the development of professional collaboration, enabled to build cooperation in economics, culture and education.

The East-West Science Centre has a wide range of partners in Germany and Russia. A unique feature of the Centre management is that they do not just implement partnerships, but actively engage partners in interaction with each other. The East-West Science Centre has become an effective instrument for promoting mutually beneficial cooperation in the region. It has helped to establish contacts and partnerships with leading German organizations: the German Embassy in Russia, the Goethe Institute, the German Academic Exchange Service, the Konrad Adenauer Foundation, the Robert Bosch Foundation.

The Russian – German cooperation in Yaroslavl reached a new level of its development.

The expansion of direct business and cultural contacts between the residents of the two countries generated considerable interest of Yaroslavl citizens in learning the German language. In 1996 the German Language Centre working in accordance with international standards was established at the MUBiNT Academy. It was initiated by the East-West Science Centre that the German Language Centre became the first Russian official partner of the Goethe Institute, and was further included into a corporate network of German language centres in Russia.

German Language Centre of the MUBiNT Academy today is a well-known brand in Yaroslavl. Teaching staff of the Centre undertook multiple internships in Germany and systematically participate in seminars of the Goethe Institute in Russia and abroad. They are working on a fundamentally new level, using efficient methods and relevant authentic teaching materials, and are geared to the European standards of
foreign language. They get their students acquainted with the current vibrant and diverse image of Germany, with the dynamics of the Russian-German economic and cultural dialogue, as well as opportunities for scholarships of numerous German educational funds.

Residents of the Yaroslavl and the neighboring regions (Kostroma, Ivanovo, Vologda) have a great opportunity to take exams in German language and get international certificates of various levels of complexity at the Centre. Thus, an examination Start Deutsch 1, requiring the minimum number of hours of the German language, is demanded by those Russian citizens who intend to permanently reside in Germany. Test DaF confirms knowledge of German language at a level sufficient for studying at any university in Germany. This exam is offered in a small number of Russian cities, including Yaroslavl. Demand for this examination among the young people of our city grows due to the desire of students and young researchers to participate in numerous educational scholarship programs of German foundations, and also due to the fact that in 2010 tuition fees at universities in many federal states in Germany were abolished.

Over 3,500 people took their courses in the Centre over the period of its existence. About 300 people received international certificates in the German language. In 2011 the Centre was internationally accredited, and its level of compliance with world quality standards was confirmed.

It should be noted that the establishment of horizontal interaction with the educational, cultural organizations and companies from Germany represented in Russia is an effective tool of development of mutually beneficial cooperation. Cooperation with the German educational organizations and foundations helps to demonstrate broad career opportunities for young professionals while they have a sufficient level of German language.

The MUBiNT Academy successfully cooperates with the German Academic Exchange Service (DAAD). The Academy locates the DAAD representative in Yaroslavl, which allows students to obtain first hand information about the scholarship programs, training opportunities and research in Germany. DAAD supports groups travelling to Germany with educational purposes, and that is particularly attractive for students preparing to become professional translators, experts in intercultural communication.

Intense political processes take place in Russia and Germany. To study the experiences of our countries is of interest for us. In this respect, an annual conference for students and postgraduates "Russia in the period of transformation" supported by the Konrad Adenauer Foundation for six years, has become a unique opportunity for both staff and students. It is important that the support of the Foundation is, above all things, the support for young people who have the opportunity to attend the conference in Yaroslavl from abroad, from Kassel, for instance. It is impossible to overestimate the significance of such meetings and discussions for the future of both Russia and Germany. Successful cooperation with the Foundation makes itself felt in
a variety of seminars and conferences on local government, demographics, and civil society.

This year, following the interaction with the Hans Seidel Foundation, MUBiNT Academy established partnership and signed a cooperation agreement with the Amberg-Weiden School of Applied Economics in Bavaria, which was added to the list of German universities the Academy has a long fruitful cooperation with (Universität Bielefeld, Universität Kassel, Ruhr-Universität in Bochum).

Cooperation with German universities, opportunity to attend lectures of visiting German professors, to participate in study trips and research internships in Germany can be attributed to a number of factors that motivate students and staff of the Academy. The cooperation with several German educational institutions allowed the MUBiNT Academy to prepare for a project named "German Economic Faculty", designed to show in practice the spirit of the Bologna agreement features of academic mobility, the opportunity to study separate modules in the partner institution, to demonstrate the reality of dual degrees in future. We look forward to the successful implementation of the project.

Major focus events that we carry out help us to show progress and identify a vector for the future. These are such events as The Days of Germany in Yaroslavl, which are organized annually by MUBiNT Academy with the support from the German Embassy in Russia and the Robert Bosch Foundation since 2002. A wide range of activities held within this project is able to satisfy every taste: contests and quizzes discovering the knowledge of German language and culture, film festivals and readings, photomarathon and seminars, exhibitions and theatrical performances, podium discussions and discos. Many of our partners take part in these events addressed to different target groups. Many important people, including the German ambassador to Russia become guests of The Days of Germany in Yaroslavl. "Germany Days" are also a result of our collaboration with the East-West Science Centre.

Awarding the city of Yaroslavl (the only one among the Russian cities) with the Honorary Sign of the Council of Europe, The Chairman of the Sub-Committee on the European Prize G. Lengan noted that The Days of Germany in Yaroslavl became an important event in the international life of the city. Recognition of the MUBiNT Academy's activity in the development of the Russian-German dialogue is confirmed by its inclusion into the official visit programs of the German Ambassadors to Yaroslavl, as it was, for example, last January 25, 2011.

In addition to social and cultural activities, the practical results of cooperation are important. It is crucial that the German companies such as Astron Buildings, Arvato group Bertelsmann, Baltika brewery, Volkswagen and others actively invest in the region.

The MUBiNT Academy and the East-West Science Centre celebrate 20 years of their cooperation in 2012. We are grateful to our colleagues in Kassel for a serious
intellectual, organizational, informational support at all stages of development of the Academy.

MUBiNT Academy today is a major educational, research, innovative and entrepreneurial company. It is one of the leading non-state higher educational institutions in the country. We are developing partnerships with foreign universities. We were among the first who certified the quality management system of the university. MUBiNT is a leader in e-learning, knowledge management, the winner of awards in quality management. It was logical that our City Administration requested the Academy to develop the concept of celebrating the Yaroslavl Millennium. A broad public discussion of the concept paragraphs was organized, interests of various stakeholders were taken into account. Government Commission approved the project prepared by the Academy. And the slogan "Yaroslavl is the ancient city heading for the future", will be linked to the Millennium in the memory of Yaroslavl citizens and the city guests.

Today MUBiNT implements the project "Quality management as a key factor of the modernization in Russia", called "Yaroslavl initiative". The project's objective is to involve the world's experts in improving the state and municipal administration, as well as management in business, health and education.

MUBiNT Academy initiated holding a major International Forum "Innovation. Business. Education" in Yaroslavl. We were supported by our colleagues from the East-West Science Centre, and an impressive delegation of experts from Kassel attended the first Forum and presented high-priority issues of energy efficiency and environmental safety. Forum drew wide public attention. It brought together experts from 14 countries and 42 Russian regions. By the decision of the Regional Government, the Forum has acquired the status of the official annual event of the Yaroslavl region.

The Third International Forum "Innovation. Business. Education" will take place on 01-03 November, 2012. Its main topic is "Management efficiency: theory and practice".

The Forum aims to develop solutions for the increase of management effectiveness and efficiency in the state and municipal administration sphere, in industrial sector, small and medium-size business sector, in education and non-profit organizations. Federal Ministries, key higher educational institutions, public organizations, associations of industrialists, entrepreneurs, scientists, education and culture professionals, representatives of foreign universities and public bodies take part in the preparations for the Forum.

2012 is a Russian-German Year of Education, Science and Innovation, and we look forward to further cooperation between the MUBiNT Academy and the East-West Science Center, and to the implementation of new challenging and important projects.
IV. Surveys on Technology Transfer
Germany – Russia
Introduction

In today's world, ideas, knowledge, and technologies are shared between geographically separated individuals and organizations, as well as across cultures and nations. Thus, understanding how those elements can be transferred is gaining increasing importance. Especially since competitive capacity and value creation increasingly depend on a better use of knowledge and technology, irrespective of the level of development and, irrespective of its form and irrespective of its origin, new products and process technologies are therefore developed domestically, or the reuse and novel combination of knowledge is developed elsewhere.¹

Knowledge and technology transfer (KTT) is often laborious and time consuming in order to be achieved effectively – particularly with regard to differences in the nature of knowledge (e.g. because of its disciplinary origin or the weight of tacit and explicit elements involved). In addition, various channels of KTT exist (e.g. collaborative research, contract research, consultancy, spin-off and start-up companies, incubator facilities, licensing, and patenting). Even though science and the economy know no boundaries regarding their horizon for possibilities and influence, especially within the framework of globalization, the success of transnational transfer cooperation depends on several key factors. These factors can constrain or abet transfer processes as well as vary significantly between different countries and scientific or industrial sectors.

Against this background, there is a greater need to understand and also to optimize the transnational transfer of knowledge and technology. In this context, the project GRETTO (German-Russian Environmental Technology Transfer Optimization) was intended to explore key drivers and barriers to bilateral cooperation between partners from the Federal Republic of Germany and the Russian Federation. Therefore, this report focuses on the analysis of factors that influence transnational transfer cooperation in the context of publicly funded German-Russian projects in the field of the environment.² The main research question addressed in this report is: Are the intervening factors of language, capabilities, culture, and knowhow either drivers or barriers?


Using a qualitative survey of participants in bilateral transfer cooperation, the perception of driving forces and barriers was captured and displayed. In addition to the identification of the key factors, the qualitative assessment was supplemented by an investigation into the basic political and legal conditions of German-Russian cooperation. The aim, on the one hand, was to better understand the key elements in transnational transfer projects. On the other hand, the aim was also to carry out an analysis of the factors that have a positive or negative influence on how successful cooperation takes place. Data for research was collected using a qualitative survey conducted via guided interviews with experts (project coordinators, project contributors, consultants, and initiators; N=48; n=25 participants from Germany; n=23 participants from the Russian Federation).

1. Research design

Theoreticians and practitioners define the concepts of knowledge and technology transfer in diverse ways. Given the research setting, it is worth the time to explain the definition of transnational (knowledge and technology) transfer cooperation, or transnational (knowledge and technology) transfer projects applied. The term transnational is understood as across different countries or across borders. Bilateral is understood within the context of the specific case of cooperation between Germany and the Russian Federation. Knowledge and technology transfer has been defined as a process by which scientific and technological knowledge is passed by one organizational unit (e.g. individual, team, group, department, or organization) via some channel to another. Thereby, the exchanged knowledge (scientific or technological) can be reused unchanged or adopted, or can serve as input for the generation of new knowledge (e.g. methods, technologies or products). Thus, since the focus has been on publicly funded transnational cooperation (e.g. cooperative research, consultancy, or preparatory actions), the definition of knowledge and technology transfer when applied is actually broader and transcends the definitions used by the World Trade Organization (WTO) or the European Union (EU).

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The conceptual basis for an integrated framework to assess the different dimensions of transnational knowledge and technology transfer in the context of publicly funded German-Russian cooperation in the field of the environment is presented below (Figure 1). The model embodies the complexity within transnational transfer cooperation.

The first assumption is that external factors (national political system, transnational political framework such as agreements, landscape as well as policy of science, technology and innovation (STI) of the respective country, and also IP regime) constitute a framework for transnational transfer cooperation. Furthermore, the initiators of transnational transfer cooperation can be located on the local, regional, national, or international level since publicly funded transnational transfer projects can be supported by governments, the United Nations, the European Commission, and other national and international public funding organizations. Due to their interdependent relationship, transnational transfer cooperation participants and their respective partners are in interplay with the initiators and both influence each other in various ways.

The second assumption is that transnational transfer cooperation occurs between partners or participants who are embedded in a tree-fold layer: country context embodies the cultures and systems surrounding the interaction; organizational context corresponds to the structures, capabilities, and constraints of the unit involved, and the partner context relating to the individual, team, group, or department participating. These separate environments strongly influence the perceptions, behaviors, and options for action for each partner involved. Transnational transfer cooperation can have a direct or indirect, tacit or explicit character. However, transfer within transnational cooperation in most cases, depending on the KTT channel, implies also a feedback loop i.e. reciprocal interaction of the other project partner respectively participant (demand, feedback, gain in knowledge or other form of input).

Furthermore, as the main research question of this report addresses, transnational transfer cooperation may be effected by the key factors negatively or positively.

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Figure 1: Model of transnational knowledge and technology transfer cooperation developed within the project GRETTO.

Source: Betuch, 2012, own illustration, based on.5

**External factors to transnational transfer cooperation**

While the process of KTT faces some barriers, transfer on the transnational level faces extra challenges due to the political, social, and economic dimensions that influence transfer performance – in other words, they face additional yet significant external factors. These conditions are differently developed as well as shaped in individual countries and sectors. Besides, particular elements of transnational transfer are not fully assessed by international regulations. Hence, national states do not have an insignificant role: On the one hand, they can create suitable political frameworks. On the other hand, they can also establish appropriate funding mechanisms and structures for transnational knowledge and technology transfer.

Scientific cooperation between Germany and the Russian Federation is traditionally well established: within the context of scientific and technological cooperation, sustainable, close relations as well as common agreements and declarations exist. Those agreements regulate the bilateral cooperation and provide a stable political and

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legal framework for transnational transfer projects. In contrast, the frameworks for transnational transfer cooperation on the national level are thoroughly different. For instance: the publicly funded basic research has a traditionally high significance in the Russian Federation. Initiatives of the Russian government, such as Skolkovo, place particular emphasis on a stronger market orientation of research activities in order to overcome the gap between science and industry. Generally, a few Russian enterprises, in particular small and medium-sized enterprises (SMEs), have experience in cooperation with university and non-university research organizations as well as the possession of well-developed absorptive capacities.\(^6\) The analyzed cases of German-Russian transfer cooperation revealed that over 75\% of partners have been research organizations (n=36). Enterprises have been rarely involved (12,5\% within analyzed cases (n=6)). Thus, the arrangement of bilateral transfer cooperation depends on the landscape of science, technology and innovation of the individual countries involved.

2. Results of a qualitative assessment

In addition to major bilateral transfer projects, cooperation between German and Russian partners consists of numerous individual projects. Thematic key aspects within the examined cases of transnational transfer cooperation in the field of the environment were on the waste and water sector both of which reflect the greatest ecological and economic challenges on the global level as well as on the level of national states.

Barriers within transnational transfer cooperation

The figure (Figure 2) below presents the results of the qualitative survey on the main barriers that negatively affect transnational transfer projects.\(^7\)

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\(^7\) In order to create more transparency the results of the qualitative survey are presented separate by the professional origin of participating experts in figures 2 and 3 (n=36 of experts from research organizations, n= 6 of experts from enterprises, and n=6 of experts from public bodies).
The greatest barrier within transnational transfer cooperation has been identified in the field of capabilities. Eighty-three percent of the participants from enterprises (n=5), seventy-two percent of the participants from research organization (n=26), and sixty-six percent of the participants from public bodies (n=4) involved in bilateral transfer cooperation stated this factor to have a negative effect within German-Russian projects.

The work in a transnational context bears always administrative complexity with regard to the national, organizational, and professional distance. Formal aspects such as visa and customs have been named as unreasonably hindering. Although those obstacles need to be overcome by every traveler, they can become crucial within transnational transfer cooperation because, in some cases, project activities and implementation depend on equipment or on personal meetings on a short notice. Though, physical distance (i.e. relative geographical locations of project partners) has not been explicitly stated to be a concrete barrier due to the application of information and communication technology in our today's world, hints have been made related to the visa regime.

The handling of patents and intellectual property also has been identified within the field of capabilities as a barrier. Although a bilateral legal framework exists within the agreement on scientific and technological cooperation, impediments may exist when such cooperation is realistically implemented. Professional legal management therefore plays a significant role in cooperative applied research projects.

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Furthermore, considering the administrative complexity on the level of organizations, distance has been identified as a barrier – i.e. differences in authority and hierarchical structures or varying contact persons have been stated as obstacles in bilateral cooperation. Also, administrative practices in the Russian Federation are in general possessing a highly informal character and are based thereupon accordingly. Additional differences have been named as having a negative effect on transnational transfer projects within the barrier capabilities; these are specifically related to organizational culture and resources, leadership, as well as rules and procedures.

In general, the field of capabilities has been identified to be a barrier equally by both sides of the transnational transfer cooperation participants; on average 79% of experts from Germany as well as the Russian Federation (n=38) mentioned aspects of capabilities to be a barrier. In particular, repeating and reiterating small incidents and seemingly trivial matters provoked additional burden.

As a second main barrier, the financial aspects of transnational transfer cooperation in the context of publicly funded projects have been stated. Fifty-five percent of survey participants from research organizations (n=20) had the opinion that within transnational transfer cooperation it is more difficult to deal with financial issues, followed by participants from public bodies with thirty-three percent (n=2). With seventeen % participants from enterprises observed financial issues less of a barrier (n=1). The factor of financial contribution, including funding mechanisms, is always relevant within publicly funded projects. This is true irrespective of whether it is on the national or the transnational level, whether it is in Saxony or in the European Union. However, the factor has been stated within German-Russian transfer projects as a barrier. Here, the aspects of differing funding structures and processes were also included.

The third main barrier to be identified is caused by the distance in space, time, culture, and language between transnational transfer cooperation partners. In particular, the last one – difference in natural languages – has been identified (25% by participants from research organizations (n=9) and 17% by participants from enterprises (n=1)) to be a barrier having implications on access, sharing, and absorption of knowledge and technologies. Noteworthy, transfer cooperation between Germany and the Russian Federation has been realized and accomplished by using up to three languages.

Drivers within transnational transfer cooperation

Identified main drivers having a positive impact on transfer projects between Germany and the Russian Federation are: culture of the respective country, know-how, and long-term cooperation.
The major driver in transnational transfer cooperation has been foremost identified to be the culture of the respective country (stated by 61% of experts from research organizations (n=22), 50% of experts from enterprises (n=3), and 33% of experts from public bodies (n=2)). Aspects such as hospitality and kindness, for example, as well as willingness to learn have been emphasized. A further related aspect has been stated to be man-driven projects – in other words, the personal engagement of the individual partner and respectively the partner institution stimulating the cooperation. Furthermore, a distance in know-how (i.e. knowledge and technology) has not been identified. On the contrary, the general role of sciences, i.e. common goals and interests within transnational transfer cooperation, was positively emphasized. In this context, 42% of participants from research organizations (n=15) mentioned know-how as a positive factor, followed by 33% from enterprises (n=2), and 17% from public bodies (n=1). Also, such aspects as complementary competences e.g. organizations specialized in basic research in the Russian Federation cooperating with applied research organizations from Germany has been also stated positively within transfer projects. 

The extent to which participating organizations and their respective partners know and relate to each other also influences the success of transnational transfer cooperation. Therefore, relational distance is greatest when participating organizations cooperate for the first time, and as time passes, the distance tends to decrease. Consequently, long-term cooperation has been stated (by 34% of participants from research organizations (n=12) and by 17% of participants from enterprises (n=1)) as a third main driver. Although the level of complexity in transnational transfer projects is higher, flexibility and persistence are worthwhile. Thus, the specifics of the partner country, partner organization as well as the
individual partner or team become familiar and therefore, trust based on past relationships grows as along with the ability to resolve conflicts. Over long relationships participants of transnational transfer cooperation develop behavioral relationships and an understanding of each other, and eventually become subjects to norms of reciprocity.9 These driving forces enhance cooperation and collaboration in a variety of ways that contribute to the overall success of transnational (knowledge and technology) transfer projects.

A set of practical observations for enhancing German-Russian transfer cooperation

For partners of transnational transfer cooperation

- Awareness of legal differences. Due to the character of transnational transfer cooperation, legal consultancy may be of significant importance. Within the framework of bilateral projects including knowledge and technology transfer, a possible strategy (depending on the content), could be to divide the cooperation in sub-steps and to externalize specific information only after intermediate project results are established or according to requirements.
- Involving and managing stakeholders within transnational transfer projects. In particular, engaging various stakeholders' (e.g. local public bodies, local industry and local policy) and creating networks can have a positive impact on project implementation.
- Capacity building in social and intercultural competences which are significant in transnational transfer cooperation. Moreover, language skills shall not be underestimated – especially with regard to personal contacts and face-to-face discussions within informal structures.

For initiators of the German-Russian transfer cooperation

- Holding transnational conferences and workshops in order to bring together potential project partners from Germany and the Russian Federation, and to provide a platform for discussions concerning priority areas and mechanisms of cooperation as well as to maintaining contacts.
- Optimization of administrative burdens as well as continuously strengthening the cooperation on the level of policy and ministries in order to develop adequate instruments as also political framework and to set highlights with regard to STI as well as linkages between different actors (science, academia, industry) and thus, enhancing transnational transfer cooperation.

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Promoting human resource development, educational projects and high-quality R&D because transfer requires a profoundly human endeavor. Thus, appreciation of the human component is significant since knowledge and technology transfer involves more than simply moving knowledge or technology from point "A" to point "B". On the contrary, it is an interactive process necessitating a great amount of back-and forth-exchange among individuals over an extended period of time which is even more difficult across different countries.

3. Conclusions

The addressed question (Are the intervening factors of language, capabilities, culture, and know-how either drivers or barriers?) could be answered within the investigated research. Moreover, two additional key factors (finances and long-term cooperation) to transitional transfer projects have been identified. Thus, six factors have been stated as the key factors affecting transnational knowledge and technology transfer cooperation. Capabilities have been regarded by a majority of experts (79 %, based on average mention by survey participants from Germany and from the Russian Federation (n=38)), as the main barrier affecting German-Russian transfer cooperation. Furthermore, financial aspects and lack of a common language have been stated to have negative effects on transnational transfer projects. As for drivers, culture of the respective country has been regarded a major driver by 69 % Russian (n=16) and 52 % (n=13) of German experts, followed by know-how as well as long-term cooperation. Science in general as content of knowledge and technology transfer has been viewed as a driving force for transnational cooperation. In addition, complementary competences of project partners as well as flexibility have been regarded having a positive effect on transnational transfer cooperation and thus, growing professional and personal trust.

Within the framework for analyzing factors affecting transnational transfer cooperation, the identified driving and restraining key factors relate mainly to the components of actors (involved in the knowledge and technology transfer process) and context (where the interaction takes place). Albeit, further components such as content (transferred between actors) and media (by which the transfer is carried out), should not be underestimated within transnational transfer cooperation. Furthermore, the presented results highlight key factors that are significant for the practical implementation of transnational transfer cooperation. Thus, sustainable

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partnerships between Germany and the Russian Federation should be expanded in consideration of adequate reciprocity. In particular, transnational knowledge and technology transfer is more complex and less researched in the context of publicly funded cooperation in comparison to business-related transfer on the individual, intra-organizational, and inter-organizational levels. Albeit, transnational transfer cooperation in the context of publicly funded projects prepares the ground for a broader transfer of knowledge and technologies, and thus forms a basis for the solution of central challenges in Germany and the Russian Federation. However, the strengthening of knowledge and technology transfer is desirable on all levels: horizontal between congeneric research organizations or enterprises, vertical between producers and users of knowledge as well as transnational across different countries.

The project GRETTO – German-Russian Environmental Technology Transfer Optimization (Treiber und Barrieren deutsch-russischer Technologietransferprojekte im Bereich Umwelttechnologien, RUS 10/Q07) which is the basis for this report has been funded by the Federal Ministry of Education and Research (BMBF). All responsibility for the content of this publication is assumed by the author.

**Fraunhofer MOEZ**

The economy, science, politics and society are becoming increasingly internationalized and the interdependencies between sectors are growing. The Fraunhofer MOEZ focuses on the fundamental change processes in a globalized world. Some significant trends are the worldwide development towards a knowledge economy, the global shift in generating value creation and the growing realization of the need to promote sustainable development at a regional and international level. From the Fraunhofer MOEZ's point of view, these are the challenges of the future.

The institute provides its clients and customers from the economy, science and politics with support in meeting these challenges successfully. Analyses are compiled and recommended procedures developed. Political structures, economic constitutions and systems, as well as structural conditions, such as the infrastructure and human capital, are examined as to the extent to which they can stand their ground in the competition for internationalized value creation processes.

In order that companies have constant access to the latest knowledge and this knowledge can be processed quickly and used independently of the location, the institute supports the transfer of knowledge from science to the economy. For individual companies and/or sectors the ability to absorb innovations is additionally analyzed and the development and realization of economic sustainability strategies supported.
Technology Transfer Systems and University-Industry Relations in Germany and Russia: Comparative Study

Ekaterina Demarchuk

1 Actuality, Background and Scope of the Study

As far as science and technology (S&T) became an important component of economic growth, it became more necessary to monitor and examine technology performance, to study national strategies, institutional structures, and to examine mechanisms of technology transfer (TT) functioning. Despite of the progress in the TT development, there are some real misunderstandings in functioning of the research systems when dealing with different national systems (e.g. institutional systems function differently). A study on two countries makes it possible to make S&T comparable and to understand their structures from different national perspectives of Germany and Russia. In different countries, S&T data are used for different purposes. In France and Mexico, for instance, quantitative indicators are used in the decision to give individual researchers more funding; in the US they are used more widely by management for general policy and awareness of trends (Grupp & Mogee, 2004, p. 80). This study may be used for similar purposes by policy makers and makes it possible to provoke steps towards improvement of TT activities. This study responds to the need to promote trans-national and bilateral dimension of TT between Russia and Germany which is often hindered by a range of factors such as structural differences, legal barriers, fragmented knowledge on TT in partner countries, and lack of incentives, which affects mutual cooperation agreements and economic actions (Commission of the European Communities, 2007, pp. 2-4).

Among TT participants, higher education institutions (HEIs) are generators of knowledge. Historically, according to the Humboldtian model of university, the role of the universities in the societies involved the functions of higher education (HE) as well as basic and long-term research. This Humboldt's model shaped the philosophy of HEIs in last centuries in Germany as well as in Russia. Recently, the HEIs are in focus of innovation and economic growth discussion. They have complemented their task with another element often labelled as 'technology transfer' or so-called 'third mission' and started to act entrepreneurially. This phenomenon was described by Henry Etzkowitz as the 'second academic revolution' where the university is not only a provider of human resources and research results but generator of innovations and economic activity (Etzkowitz, 2001, pp. 13, 19). That does not mean that HEIs serve for the economic profit but stimulate and guide the utilisation of knowledge for social and economic development and needs.
As a field of study, the comparison of technologies development is not new. Already in 1873, a remarkable work of Alphonse de Candolle (1873) *Histoire des sciences et des savants depuis deux siècles* described the scientific strength of the nations and tried to find 'environmental factors' of scientific success (de Candolle, 1873). One century later, Francis Narin (Narin, 1976) invented the concept of 'evaluative biometrics' and became pioneer in development of research performance indicators on the national level which became a breakthrough in measuring performance of countries (van Raan, 2004, p. 23). Since then, the competitiveness on research performance between the countries increased and innovation became a central part of this competition in developed industrial countries. The new link between research and economy put scientific efficiency into focus of the national strategies. The science may no longer be linked to autonomous activity and internal norms but validate the knowledge in the society and economy. The validation of knowledge is a process when scientific knowledge is applicable directly in the 'real world' (Barré, 2004, p. 116). The high speed of TT development as well as its multidimensionality increases complexity of this topic. The systematisation of TT practices became contemporary research area and therefore it is very demanding.

In this study, the S&T systems of two national systems will be compared. The role of HE in the research and technology systems will be assessed and institutional structures will be contrasted. Additionally, the study will attempt to make general assessment of TT between HEIs and industry in both countries. On example of comparative study between Germany and Russia, current study reflects a variety of attributes of the S&T systems, includes relevant indicators assessing national TT systems as well as central technology agents. The mechanisms of TT will be described and the study will attempt to assess the university-industry relationship using already existing statistical data.

The S&T indicators are extracted from the *FRASCATI MANUAL* of the OECD (OECD, 2002a), the OECD indicators from the *Pilot Study on Benchmarking of Industry-Science Relationships in France and the UK* (OECD, 2002b); the UNESCO *International Review of Science and Technology Statistics and Indicators* (UNESCO, 2003); *Innovation and Research Indicators of the Centre for European Economic Research* (ZEW, 2004); *OECD Main S&T Indicators* (OECD, 2010); the *European Union Innovation Scoreboard* (European Union, 2012), and the OECD *Science, Technology and Industry Scoreboard* (OECD, 2011b). The main statistical data were retrieved by the latest available years from the sources: OECD, Eurostat, UNESCO, World Economic Forum, and some other sources.

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1 History of science and scientists of last two centuries
2 Theoretical Framework

2.1 Outline of Basic Issues

Due to complexity of the technology transfer levels and processes, it gets difficult to define this term. The definition therefore depends on the understanding of technology and the context in which the transfer takes place. Barry Bozeman gives three reasons why it is difficult to understand TT: (1) it is not easy to put boundaries on 'technology'; (2) due to many concurrent processes, it is virtually impossible to outline TT; (3) numerous impacts of measuring TT challenges makes it difficult for scholars and evaluators to determine TT and its effectiveness which provokes multiple conflicting definitions (Bozeman, 2000, p. 627). For the mentioned above reasons it is noteworthy to outline the working definition of the TT and terms related to it.

Innovation is broadly understood as everything, which is considered to be new (Gurbiel, 2002, p. 4). Innovation\(^2\), by definition of Stephen J. Kline and Nathan Rosenberg (1986), involves the creation and marketing of the new. Any successful innovation requires a design that meets all the requirements of manufacturing, market needs and other supportive activities (Kline & Rosenberg, 1986, pp. 275, 277).

One of traditional definitions of technology was made by John Galbraith, a Canadian-American economist, who described 'technology' as "systematic application of scientific or other organised knowledge to practical tasks" (Galbraith, 1967, p. 12). The United Nations Conference on Trade and Development (UNCTAD) proposed in its International Code of Conduct on the Transfer of Technology that 'technology' means the "systematic knowledge for the manufacture of a product, for the application of a process or for the rendering of a service" (UNCTAD, 2001, p. 5). Considering that the level of knowledge as well as that of technological development may vary from the time period and from country to country, it becomes difficult to define 'technology'. Whereas 'innovation' is defined by the element of 'novelty', it is possible to conclude that both of 'technology' and 'innovation' may be transferred (e.g. from HEIs into industry) where the former includes the element of novelty and know-how and the latter includes all existing systematic knowledge application. Both 'technology' and 'innovation' transfer do not necessarily exclude each other. Technology, however, has a broader definition: it is not something new which is transferred but all knowledge in its use and application (Bozeman, 2000, p. 628).

Historically, the notion of 'technology' was understood differently. According to Ulrich Schmoch (2006), efforts to improve the use of research results of universities in the industry have been often labelled by the catchword 'technology transfer'. TT has often been seen as "interaction of universities and industrial enterprises" when

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\(^2\) The term 'innovation' in the current study excludes the notion of 'military innovation' which has distinctly different characteristics (after Kline & Rosenberg, 1986, p. 275).
research results as prototypes were handed over by HEIs to enterprises. This concept belongs to traditional linear model of innovation which was already reconsidered. The delivery of prototypes is a probable but rare mechanism (Schmoch, 2006, pp. 51, 52). Prototypes as elements of innovation are just a part of TT activities. Other TT interactions are "contract and collaborative research, conferences, informal contacts, consultancy, publications", etc. (Schmoch, 2006, p. 52). Devendra Sahal (1981, 1982) states that a transfer object, i.e. 'technology', must rely on set of processes and products. Focusing on the products is not enough to study technology transfer: not just the product is transferred but its use and application. Which also solves the problem of definition between 'knowledge' and 'technology' transfer: "when a technological product is transferred [...], the knowledge upon which its composition is based is also [transferred]. Without the knowledge, technology cannot be put into use" (Bozeman, 2000, p. 629 after Sahal 1981, 1982). The mentioned above approaches solve the problem of distinction between 'technology' and 'knowledge' transfer. Thus, knowledge and technology transfer are indivisible. This definition of TT will be considered as working definition.

Broadly defined, the process of TT may be seen as movement of technology from one entity to another (Ramanathan, 2009, p. 4). This movement takes place between a technology owner/holder and technology buyer/user (Gurbiel, 2002, p. 3). This process should not be confused with 'technology diffusion' which means "spreading of technological knowledge within specific population" whereas 'technology transfer' is an intentional and goal-oriented process of both dissemination and acquirement of knowledge, which, unlike diffusion, requires 'agreement' (Ramanathan, 2009, p. 5).

2.2 National Innovation Systems and Technological Performance

Research and innovation policies are critical to sustain a country's technological performance. As far as successful innovation policies have to react to challenges, (1) it is important that national innovation policies have to learn from other countries' experiences and approaches, (2) innovation policies may be regarded as determinants of a country's technological performance and may become incentives or disincentives for new innovation and research decisions, and (3) international comparisons may serve as reference in the debate on the current state and perspectives of national efforts of countries (Rammer, 2006, pp. 265-266).

The main rationale for innovation policy relies on the paradigm of market failure (Rammer, 2006, p. 267). This paradigm is based on the idea that the market is the most efficient allocator of goods and services, but the government role is to interfere by removing barriers to the free market, through appropriate intellectual property policies, free trade agreements, neutral impact taxation, and limited regulation of enterprise. The main role of HEIs is not as a trader of technology but an educator and a provider of public research (Bozeman, 2000, pp. 631-632).
Among the new conceptual approaches that have influenced the innovation policy worldwide is national innovation system which stresses the role of interaction of various actors and institutions (Rammer, 2006, p. 267) and the concept of path dependency. The concept of path dependency assumes that the interaction between research players is strongly characterised by path dependency and thus faces the structural problem of adopting new technological modes and technology paths not quickly enough e.g., the speed of innovation is higher in technologically leading countries than in less developed economies. The path dependency states that various economic, technological, social and cultural factors interlock and strengthen each other mutually. The concept of national innovation systems replaces investigation of productivity differences by a system of networks, participants, and interactions. According to this approach, a national innovation system consists of participants involved into the research process such as enterprises, universities, research institutes, etc. The national research system includes the role of main players and their division of labour, available resources (e.g. human capital) and infrastructure (e.g. education, public research) (Meyer-Krahmer & Schmoch, 1998, pp. 845-846, p. 849).

### 2.3 Mechanisms of University-Industry Interactions

Since about the 1970s, the topic of interaction between universities and industry became highly discussed. Rikard Stankiewicz (1986) distinguished three major schools of thought on models of TT at that time: the internalist, the externalist, and the integrationist schools. The internalist school aimed internal modification of the academic system in order to increase industrially relevant research by creating new technology-oriented departments, or establishing specific grant programmes for funding technology-oriented research. The externalist school saw a clear division of labour between HEIs and industry and did not mix different R&D functions within a single institutional framework (Stankiewicz, 1986, p. 104). The school favoured creation of external interface institutions to play the transitional role. The integrationist school was against the conservatism of universities and considered the "institutional separation from science counter-productive for both" (Stankiewicz, 1986, p.113). The school suggested a new concept of university with integration of science and technology, active networking with the environment, and the high level of autonomy (Schmoch, 2006, pp. 51-53 after Stankiewicz, 1986).

In recent years, many technology transfer offices, innovation units or even innovation ministries were set up within public administrations of many countries (Rammer, 2006, p. 267). Now, it is clear that knowledge generators, i.e. research institutions, need to play a more active role in their relationship with industry in order to make the most of research results. Other TT players e.g., small and medium enterprises (SMEs) develop "open innovation approaches to R&D" combining resources and aiming to maximize economic value, therewith they begun to treat
public research as a strategic resource (Commission of the European Communities, 2007, pp. 2-4). Research institutions, in their turn, try to orient research towards needs of society, having not commercial but social goals ahead. As already mentioned, the phenomenon of emerged university-industry relations was exposed by Henry Etzkowitz as 'second academic revolution' in contrast with Humboldtain 'first academic revolution' (Etzkowitz, 2001, p. 13, p. 19). Gibbons et al. (1994) also define two states; they talk about 'old' and 'new mode of knowledge production' or so-called 'Mode 1' and 'Mode 2'. In Mode 1, problems are solved governed by academic interests of a specific community; in Mode 2, knowledge is carried out in context of application. Mode 1 is disciplinary, characterised by homogeneity, hierarchical and tends to preserve its form, while Mode 2 is transdisciplinary, characterised by heterogeneity, heterarchical and transient. Mode 2 is intended to be useful whether in industry, government or society and will not be produced unless the interests of actors are included. The idea of TT goes beyond the market: the technology is transferred throughout society that is why TT may be considered as 'socially distributed knowledge' (Gibbons et al, 1994, pp. 3-4). According to René Yves Carraz (2011), history showed that almost every scientific discovery was made for its own sake without any direct aim of attainment of particular advantage. Universities are "the proper places for such pursuit of 'pure science'" (Carraz, 2011, p. 38).

The main mechanisms for TT include interrelationships between suppliers and consumers/ makers and users of technology. Organisations learn by consolidating new information and technologies enhanced by practical experiences into their knowledge base. In case an organisation is closed, it can provide obstacles for innovations, i.e. dis-learning (Keeble & Wilkinson, 1999, pp. 298-299). Therefore linkages are important for initiation and transfer of knowledge. That is why openness to outside is required. That means that both HEIs and industry must be open in order to operate effectively. The interface between the parties is usually filled by pathways of transfer. These pathways are instruments or mechanisms of TT which is bi-dimensional. In some way "TT is like a chain: it breaks when the weakest link fails". Therefore strengthening that chain by integrating the transfer actions can greatly contribute to efficiency of TT (UNEP, 2001, p. 17).

Various interaction mechanisms and lack of comparable data make it difficult to assess the interaction relations. OECD (2002b) defined formal and informal mechanisms of industry-science relationships. The formal include joint labs, spin-offs, licensing, and research contracts. The informal mechanisms are mobility of researchers, co-publications, conferences / expos / specialised media, informal contacts within professional networks, and flow of graduates to industry (OECD, 2002b, p. 23). Frieder Meyer-Krahmer and Ulrich Schmoch (2006) defined the following mechanisms of university-industry interaction: patents, spin-offs, contract and collaborative research, consultancy, institutional arrangements, networking (Schmoch, 2006, pp. 55-64) as well as informal contacts, education of personnel,
doctrinal theses, conferences, seminars for industry, scientist exchange, publications, and committees (Meyer-Krahmer & Schmoch, 1998, p. 840). Barry Bozeman (2000) defined transfer media in his effectiveness model of TT. These are open literature, patent / copyright, license, informal contacts, personnel exchange, on-site demonstration, and spin-offs (Bozeman, 2000, p. 636). Elisa Giuliani and Valeria Arzab (2009) defined the ways facilitating the formation of university-industry linkages: employment by industry of university graduates, informal meetings and joint research programmes, consultancy, licensing, prototypes, etc. (Giuliani & Arzab, 2009, p. 907). Robert J.W. Tijssen (2004) also defined personal contacts and professional networks as TT communication channels (Tijssen, 2004, p. 697). Based on the classifications above, the mechanisms of industry-university relations may be listed as follows:

Table 1: Mechanisms of Industry-University Relations

<table>
<thead>
<tr>
<th>Formal Mechanisms</th>
<th>Spin-offs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intellectual property rights</td>
</tr>
<tr>
<td></td>
<td>Prototypes</td>
</tr>
<tr>
<td></td>
<td>Licensing</td>
</tr>
<tr>
<td></td>
<td>Contract and collaborative research</td>
</tr>
<tr>
<td></td>
<td>Consultancy</td>
</tr>
<tr>
<td></td>
<td>Institutional arrangements</td>
</tr>
<tr>
<td>Informal Mechanisms</td>
<td>Human capital and tacit knowledge transfer</td>
</tr>
<tr>
<td></td>
<td>Literature, publications, doctoral theses, etc.</td>
</tr>
</tbody>
</table>

3. **German and Russian TT Systems in Comparison**

A comparison of the policies, performance and organisation of the German and Russian national R&D systems will reveal a number of similarities and differences. This comparison may become a foundation for examination of TT processes in both countries.

3.1 **Research and Development Orientation: Inputs**

3.1.1 R&D Expenditures, Finance and Support

The most widely used indicator in policy documents worldwide is 'research intensity', which reflects the expenditure in Research and Development (R&D) as a percentage of Gross Domestic Product (GDP) (Ellis et al., 2009, p. 171). The OECD, the World Bank as well as Eurostat use these indicators in order to measure the level of technology and innovation. Domestic Spending on Research and Development (GERD) covers all R&D carried out on national territory in the year concerned (OECD, 2010, p. 3). The Centre for European Economic Research (2004) states that GERD is good for international comparability (ZEW, 2004, p. 13); and OECD sees
GERD as "the basis of international comparisons of R&D expenditures" and as "main expenditure aggregate used for international comparison" (OECD, 2002a, pp. 21, 121). For more accuracy, the OECD advises to compare R&D inputs with a corresponding economic series e.g. by taking GERD per capita, etc. (OECD, 2002a, p. 28). The table below demonstrates GERD spent in Germany and Russia in last years in total and by sectors of performance.

Table 2: GERD by sectors of performance and total

<table>
<thead>
<tr>
<th></th>
<th>Germany</th>
<th></th>
<th>Russia</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2008</td>
<td>2009</td>
<td>2010 (p)</td>
<td>2008</td>
</tr>
<tr>
<td>Business enterprise sector</td>
<td>1,86</td>
<td>1,91</td>
<td>1,9</td>
<td>0,65</td>
</tr>
<tr>
<td>Government sector</td>
<td>0,38 (i)</td>
<td>0,42 (i)</td>
<td>0,41 (e)</td>
<td>0,31</td>
</tr>
<tr>
<td>Higher education sector</td>
<td>0,45</td>
<td>0,5</td>
<td>0,51 (e)</td>
<td>0,07</td>
</tr>
<tr>
<td>Private non-profit sector</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
<td>0</td>
</tr>
<tr>
<td>Total by Eurostat</td>
<td>2,69</td>
<td>2,82</td>
<td>2,82 (e)</td>
<td>1,04</td>
</tr>
<tr>
<td>Total by the World Bank</td>
<td>2,7</td>
<td>2,8</td>
<td>n.a.</td>
<td>1</td>
</tr>
</tbody>
</table>

Source: composed from the sources of Eurostat and World Bank (only total)\(^3\),\(^4\).

- e – estimated
- p – provisional
- i – see metadata
- 0 – less than half the final digit shown and greater than real zero
- n.a. – not available

The overall context is that research intensity in Germany, according to the Eurostat, amounted 2.82% of GDP in 2009, which is more than twice higher than that of in Russia where this figure amounts 1.24% of GDP. To compare inputs with a corresponding social element, it is possible to see GERD in relation to the population. In Germany, GERD 2009 per capita population amounted 817.2 Euro whereas in Russia this index was more than 10 times lower than the German one and amounted 77.6 Euro.

Table 3: GERD in EUR per capita population by sectors of performance

<table>
<thead>
<tr>
<th></th>
<th>Germany</th>
<th></th>
<th>Russia</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2008</td>
<td>2009</td>
<td>2010</td>
<td>2008</td>
</tr>
<tr>
<td>Business enterprise sector</td>
<td>560.4</td>
<td>552.1</td>
<td>574.3 (p)</td>
<td>52.4</td>
</tr>
<tr>
<td>Government sector</td>
<td>113.7 (i)</td>
<td>121.1 (i)</td>
<td>125.1 (e)</td>
<td>25.1</td>
</tr>
<tr>
<td>Higher education sector</td>
<td>135.2</td>
<td>144</td>
<td>154 (e)</td>
<td>5.6</td>
</tr>
<tr>
<td>Private non-profit sector</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
<td>0.2</td>
</tr>
<tr>
<td>Total</td>
<td>809.2</td>
<td>817.2</td>
<td>853.4 (e)</td>
<td>83.3</td>
</tr>
</tbody>
</table>

Source: composed from the sources of Eurostat

e – estimated  
n.a. – not available  
i – see metadata  
p – provisional

R&D expenditures in the business enterprise sector as % of GDP, according to the Innovation Union Scoreboard, "captures the formal creation of new knowledge within firms" (European Union, 2012, p. 66). This indicator amounted in Germany in 2010 to 1.9% of GDP; in Russia this figure amounted 0.67% of GDP which almost trice smaller than the German index. Thus, the knowledge is less enabled in Russian business sector than the German one. In prices per inhabitant, this figure is more differentiated: R&D expenditures in the business sector in Germany per inhabitant in Euro are 11 times higher than in Russia (552.1 vs. 48.4 Euro in 2009).

Russian R&D expenditures in the sector of HE is more than five and half times lower than the German index. In GERD per capita, this figure amounts 144 Euro per capita in German HE sector (2009) which is 21 times higher than the Russian index with 5.5 Euro per capita in HE (2009). Noteworthy is that German R&D expenditures are higher in the HE sector than that of government one. In Russia the situation is the opposite.

GERD in the government sector is similar in both countries and varies in the span of 0.4%. In order to estimate governmental S&T policy could be possible to see in more detail government budget appropriations or outlays for R&D (GBAORD) by classifying GBAORD by socio-economic objectives. Nevertheless, during the comparison of German and Russian GBAORD by socio-economic objectives in Eurostat, it became clear that the data availability of Russian GBAORD is restricted: expenditures on exploration and exploitation of the Earth, general advancement of knowledge in general university funds (GUF) and other funds, defence, and total civil R&D appropriations are missing. Therewith it is not possible to make certain conclusions about Russian government S&T policies or priorities. The OECD Library also provides data on government budget appropriations in prices; US dollars were comparable currency for both countries. However, the needed data are missing

here as well. It is possible to conclude that government budget appropriations or outlays for R&D in Russia are not transparent or have a gap in the reporting system. "There is a complex interplay between the public and private sectors in the funding and performance of R&D" (OECD, 2011b, p. 25). The public-private cross-funding of R&D in Germany and Russia is possible to assess due to the following indicators: government-financed R&D in business; business-funded R&D in the HE and government sectors, and percentage of HE R&D expenditures financed by industry. The OECD Science, Technology and Industry Scoreboard (2011b) provided comparative data on government-financed R&D in business, and business-funded R&D in the HE and government sectors (2009). Governments choose among various tools to leverage business sector R&D and they do it traditionally directly via grants, some types of loans as well as contracts. It does not include R&D tax credits or other indirect support measures (OECD, 2011b, pp. 25, 146).

Table 4: Public-private cross-funding of R&D, as % of R&D in the sectors, 2009

<table>
<thead>
<tr>
<th></th>
<th>Germany</th>
<th>Russia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government-financed R&amp;D in business sector, %</td>
<td>4,49</td>
<td>57,37</td>
</tr>
<tr>
<td>Business-funded R&amp;D in the HE and government sectors, %</td>
<td>12,44</td>
<td>13,24</td>
</tr>
</tbody>
</table>

Source: composed from the OECD, Research and Development Database, June 2011

Over 57% of R&D in the business sector is financed directly by the government of the Russian Federation which makes Russia the OECD leader on government-financed R&D in business sector. German government finances directly about 4.5% of business R&D. The Russian case may be explained by the fact that the largest 100 enterprises form a mix of private financial-industrial groups and state-owned enterprises/state corporations that dominate markets in Russia. Gazprom, Lukoil, Alfa Group, Rosneft, Renova, Severstal, Norilsk Nickel, Tatneft, and other large state enterprises (OECD, 2011a, p. 147). In business-funded R&D in the HE and government sectors, Germany and Russia stay literally next to each other in the OECD statistics. The indexes are 12.44% and 13.24% accordingly. This statistic does not show, however, how many allocations are made by the business sector directly to the HE sector. Therefore, a separate indicator is needed: percentage of HE R&D expenditures financed by industry.

6 [http://dx.doi.org/10.1787/888932486165](http://dx.doi.org/10.1787/888932486165)
7 [http://dx.doi.org/10.1787/888932486184](http://dx.doi.org/10.1787/888932486184)
Table 5: Percentage of HE R&D expenditures financed by industry

<table>
<thead>
<tr>
<th></th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>15.14</td>
<td>14.31</td>
<td>n.a.</td>
</tr>
<tr>
<td>Russia</td>
<td>28.56</td>
<td>22.43</td>
<td>24.53</td>
</tr>
</tbody>
</table>

Source: OECD.StatExtracts, Main Science and Technology indicators
n.a. – not available

In 2009, 22.43% of HE R&D was financed by industry in Russia whereas in Germany this percentage is lower: 14.31%. Ulrich Schmoch (2006) refers to the share of industrial funds within the total research budget of universities as an indicator reflecting important interaction channels, such as co-operative or contract research (Schmoch, 2006, p. 53), therefore it is possible to suppose that the cooperative or contract research between industry and university in Russia is 8% higher than in Germany. It is not clear which type of funds were counted in the statistics: in Germany, according to Ulrich Schmoch (2006), enterprises pay direct costs to HEIs, it is not clear, whether the Russian statistics consider general or direct costs and to what extent this difference is adequately reflected in the statistics (Schmoch, 2006, pp. 57-58). Frieder Meyer-Krahmer and Ulrich Schmoch (1998) estimate that many university departments e.g., humanities or social sciences do not receive any industrial funds, so a big part of industrial share of funding comes to the engineering and other technology-related sciences (Meyer-Krahmer & Schmoch, 1998, p. 835).

Innovative firms play an important role in TT. "In some countries governments play a key role in funding R&D activities of SMEs". In most OECD countries, between 40% and 80% of government-financed business expenditures in R&D go to SMEs. This figure e.g., reaches over 90% in Estonia and Hungary (OECD, 2011b, p. 52). The support of innovative SMEs is very important for the reason that collaboration of firms with universities and research centres within the context of publicity-funded R&D offers the sites an attractive way of acquiring know-how and provision of TT (Kaar & Müller, 2011, p. 40).

Table 6: Firms receiving public support for innovation by size, as % of innovative firms

<table>
<thead>
<tr>
<th></th>
<th>SMEs</th>
<th>All firms (2006-08)</th>
<th>Large firms</th>
<th>All firms (2002-04)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>18.54</td>
<td>19.19</td>
<td>28.19</td>
<td>14.10</td>
</tr>
<tr>
<td>Russia (manufacturing)</td>
<td>6.13</td>
<td>8.89</td>
<td>10.03</td>
<td>n.a.</td>
</tr>
</tbody>
</table>

Source: composed from the OECD based on Eurostat [CIS-2008, CIS-2006 and CIS-2004 (CIS4)] and national data sources, June 2011

For the Russian Federation, data refer to manufacturing firms with 15 or more employees.

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8 [http://dx.doi.org/10.1787/888932487267](http://dx.doi.org/10.1787/888932487267)
In Germany, by 2006-2008, there were 19.19% of innovative firms, and in Russia 8.89% of innovative firms receiving public support, which is more than twice less than in Germany. 28.19% of innovative large firms and 18.54% of innovative SMEs receive public support in Germany whereas in Russia these indexes are 10.03% and 6.13% accordingly. In both countries, large innovative firms tend to benefit more from the public sector than SMEs. Russia is behind Germany regarding the public support of innovative firms which seems unusual considering that the government-financed R&D in business sector amounts 57.37%. This, however, may be reasoned by the fact that only manufacturing firms were considered in the statistics or that government supports firms that are not concentrated on innovation activities.

3.1.2 Human Capital, R&D Personnel

Data on the utilisation of scientific and technical personnel provide concrete measurements for international comparisons of resources devoted to R&D (OECD, 2002a, p. 20). All persons employed in R&D should be counted (OECD, 2002a, p. 92). Therefore different categories of occupation should be observed. As far as the data on the R&D personnel and researchers in the Russian Federation are not accurate for the reason that full-time employed researchers overrate headcount of researchers, only the headcounts will be compared. The data on German headcounts are mostly provided in 2009 that is why this year of performance will be discussed. Generally speaking, the amount of R&D personnel in physical persons in Germany and Russia is alike: 774 271 and 742 433 accordingly. Germany has, however, about 32 thousand more R&D personnel than Russia. The amount of researchers in Germany is 484 566 whereas in Russia this figure is lower: 369 237; the difference makes 115 329 in physical persons. Analysing the business enterprise sector, the Russian Federation possesses more R&D personnel in this area: 432 415, whereas in Germany this index is 383 559 persons. The difference is 48 856 persons. The amount of researchers in the business sector is very similar: 210 995 and 201 668 in Germany and Russia accordingly. The governmental sector in Russia (260 360) has more than twice higher amount of the R&D personnel than Germany (102 975) which makes the difference of 157 385 of physical persons. Regarding the researchers in the governmental sector, Russia has 132 955 whereas Germany 58 097 of physical persons (See explanations for this contrast in Chapter 3.2.2). The HE sector is very contrasting. Germany has 287 736 of R&D personnel which is almost six times higher than in Russia with 48 498 of R&D personnel, the same difference is observed for researchers. In order to make these headcounts comparable, it is noteworthy to see R&D personnel per thousand of employed (OECD, 2002a, p. 28). According to the OECD (2002a), international comparisons are sometimes restricted to researchers (or graduates) and not to R&D personnel.

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9 OECD Library (2012), "R&D personnel by sector of employment and occupation"
10.1787/data-00197-en
personnel; because it is considered that researchers are the true core of the R&D system (OECD, 2002 a, p. 22).

Table 7: Researchers by R&D performing sector, per thousand employments, 2009

<table>
<thead>
<tr>
<th></th>
<th>Business enterprises</th>
<th>Higher education</th>
<th>Government</th>
<th>Private non-profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>4.46</td>
<td>2.05</td>
<td>1.22</td>
<td>0.00</td>
</tr>
<tr>
<td>Russia</td>
<td>3.12</td>
<td>1.12</td>
<td>2.11</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Source: composed from the sources of the OECD, Main Science and Technology Indicators Database, June 201110.

From table above one can see that the amount of researchers in the business enterprise sector of Germany was in 2009 higher than in Russia (4.46 vs. 3.12) considering the dynamics of socio-economic activities such as employment (thousand population). The HE sector in Germany possesses twice more researchers than the Russian HE sector (2.05 vs. 1.12). The government sector in Russia possesses twice more researchers than the German one. The statistics of researchers per thousand employments confirms the trends in headcounts with exception of the business sector.

It was not possible to find data related to R&D occupations. Moreover, according to the OECD (2002a), national perceptions of these norms may be different, notably for […] the analysis of R&D personnel by occupation, such differences are impossible to quantify (OECD, 2002a, p. 26). Nevertheless, it was possible to trace some science field tendencies at the doctorate level. Doctorate holders are considered as researchers so according to this logic, it is possible to see tendencies in the researchers' occupations by having available data on holders of doctorate degrees. This category includes holders of degrees earned at universities and also at specialised institutes of university status (OECD, 2002a, pp. 95, 97).

10 [http://dx.doi.org/10.1787/888932485899](http://dx.doi.org/10.1787/888932485899)
### Table 8: Employed doctorate holders, % by field and employment status, 2009

<table>
<thead>
<tr>
<th>Field</th>
<th>Total, %</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Germany</td>
<td>Russia</td>
<td></td>
</tr>
<tr>
<td>Natural sciences</td>
<td>27,1</td>
<td>37,5</td>
<td></td>
</tr>
<tr>
<td>Employees</td>
<td>94,1</td>
<td>90,0</td>
<td></td>
</tr>
<tr>
<td>Self-employed</td>
<td>5,9</td>
<td>8,0</td>
<td></td>
</tr>
<tr>
<td>Unspecified</td>
<td>-</td>
<td>2,0</td>
<td></td>
</tr>
<tr>
<td>Total, %</td>
<td>9,8</td>
<td>26,2</td>
<td></td>
</tr>
<tr>
<td>Employees</td>
<td>92,5</td>
<td>93,1</td>
<td></td>
</tr>
<tr>
<td>Self-employed</td>
<td>7,5</td>
<td>4,8</td>
<td></td>
</tr>
<tr>
<td>Unspecified</td>
<td>-</td>
<td>2,2</td>
<td></td>
</tr>
<tr>
<td>Medical sciences</td>
<td>32,9</td>
<td>6,0</td>
<td></td>
</tr>
<tr>
<td>Employees</td>
<td>67,0</td>
<td>91,0</td>
<td></td>
</tr>
<tr>
<td>Self-employed</td>
<td>33,0</td>
<td>7,0</td>
<td></td>
</tr>
<tr>
<td>Unspecified</td>
<td>-</td>
<td>2,0</td>
<td></td>
</tr>
<tr>
<td>Agricultural Sciences</td>
<td>2,9</td>
<td>5,1</td>
<td></td>
</tr>
<tr>
<td>Employees</td>
<td>76,4</td>
<td>90,1</td>
<td></td>
</tr>
<tr>
<td>Self-employed</td>
<td>23,6</td>
<td>5,8</td>
<td></td>
</tr>
<tr>
<td>Unspecified</td>
<td>-</td>
<td>4,1</td>
<td></td>
</tr>
<tr>
<td>Social sciences</td>
<td>19,6</td>
<td>18,2</td>
<td></td>
</tr>
<tr>
<td>Employees</td>
<td>80,7</td>
<td>92,0</td>
<td></td>
</tr>
<tr>
<td>Self-employed</td>
<td>19,2</td>
<td>5,6</td>
<td></td>
</tr>
<tr>
<td>Unspecified</td>
<td>-</td>
<td>2,5</td>
<td></td>
</tr>
<tr>
<td>Humanities</td>
<td>6,9</td>
<td>7,1</td>
<td></td>
</tr>
<tr>
<td>Employees</td>
<td>81,1</td>
<td>91,1</td>
<td></td>
</tr>
<tr>
<td>Self-employed</td>
<td>17,9</td>
<td>4,6</td>
<td></td>
</tr>
<tr>
<td>Unspecified</td>
<td>-</td>
<td>4,2</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Employees</td>
<td>81,0</td>
<td>91,3</td>
<td></td>
</tr>
<tr>
<td>Self-employed</td>
<td>19,0</td>
<td>6,3</td>
<td></td>
</tr>
<tr>
<td>Unspecified</td>
<td>-</td>
<td>2,4</td>
<td></td>
</tr>
</tbody>
</table>

Source: composed from OECD based on OECD/UNESCO Institute for Statistics/Eurostat data collection on careers of doctorate holders 2010\(^{11}\).

Highest rates are marked in red, totals are marked in blue.

The table above presents the tendencies on employed doctorate holders by field of study and employment status. In both countries the doctorate holders do not tend to be self-employed. In Germany, the highest rate of degree holders is in medical sciences. The second highest field is 'natural sciences' and the third is 'social sciences'. In Russia, the highest rate in doctorate degrees is in natural sciences, the second is 'engineering' and the third is 'social sciences'. Doctoral degrees in medical sciences are particularly high in Germany, whereas in Russia they are lower but still significant.

\(^{11}\) [http://www.oecd.org/dataoecd/44/36/49867563.xlsx](http://www.oecd.org/dataoecd/44/36/49867563.xlsx)
sciences, comparing to Germany with 32.9%, take only 6% of employed doctoral holders in Russia. Laudeline Auriol from the OECD identified the role of doctoral holders in research and innovation: (1) they are specifically trained for research; (2) they hold degree of the highest education level, and (3) they are best qualified for the creation, implementation and diffusion of knowledge and innovation (Auriol, 2010, p. 6). Therefore, it is significant to see the stocks of doctorate holders in both countries and see the graduation rates at doctoral level.

Table 9: Total doctorate holders by age class, percentage 2009

<table>
<thead>
<tr>
<th>Age Class</th>
<th>Below 35 years old</th>
<th>35-44 years old</th>
<th>45-54 years old</th>
<th>55-64 years old</th>
<th>65-69 years old</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>22.6</td>
<td>50.4</td>
<td>23.6</td>
<td>2.9</td>
<td>0.5</td>
</tr>
<tr>
<td>Russia</td>
<td>16.7</td>
<td>14.6</td>
<td>24.2</td>
<td>33.1</td>
<td>11.4</td>
</tr>
</tbody>
</table>

Source: composed from OECD, based on OECD/UNESCO Institute for Statistics/Eurostat data collection on careers of doctorate holders 2010\(^\text{12}\)

In Germany, the highest rate of doctorate holders is in 35-44 years old group which make over 50% of all doctorates. In Russia, the highest rate (33%) of doctorate holders is in the age of 55-64 years old. In the age class 35-44 years old, Germany has over 50% of doctorate holders whereas in Russia 14.6% of doctorate holders are of this age group. In the age class 45-54 years old, Germany and Russia have similar percentage 23.6% and 24.2% of doctoral holders accordingly. These tendencies show that the most of the Russian doctoral holders are approaching at the rental age. The share of new doctorate graduates is one of the OECD Science, Technology and Industry indicators (2011b) which shows the number of graduates at a point in time as a stock measure (OECD, 2011b, p. 14).

Table 10: Graduation rates at doctorate level as % of population, 2009

<table>
<thead>
<tr>
<th>Graduation rates at doctorate level</th>
<th>Germany</th>
<th>Russia</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.5</td>
<td>1.4</td>
</tr>
</tbody>
</table>


Graduation rates at doctoral level show the intensity of young scientists' increase. Germany with 2.5% is over the OECD average (1.5%), whereas Russia is close to the OECD average point with 1.4% of doctorate graduation rates.

\(^{12}\) http://www.oecd.org/dataoecd/44/36/49867563.xlsx

\(^{13}\) http://dx.doi.org/10.1787/sti_scoreboard-2011-47-en
Table 11: Firms engaged in innovation training by size, as % of innovative firms

<table>
<thead>
<tr>
<th></th>
<th>SMEs</th>
<th>All firms (2006-08)</th>
<th>Large firms</th>
<th>All firms (2002-04)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>53.49</td>
<td>54.91</td>
<td>74.53</td>
<td>56.12</td>
</tr>
<tr>
<td>Russia</td>
<td>13.57</td>
<td>23.27</td>
<td>27.29</td>
<td>n.a.</td>
</tr>
</tbody>
</table>

Source: composed from: OECD based on Eurostat [CIS-2008, CIS-2006 and CIS-2004 (CIS4)] and national data sources, June 2011. For the Russian Federation, data refer to manufacturing firms with 15 or more employees. n.a. – not available

The human capital inputs are not only the storage of scientists but also the investments into the human capital. Regular training activities are one of the means by which firms can maximise the potential of their human capital. Training, according to the OECD (2011b), relates to internal or external training for personnel specifically for the development of and/or introduction of new or significantly improved products or processes (OECD, 2011b, p. 146). In both Germany and Russia, large firms tend to do more regular training activities than SMEs. Nevertheless, German firms are significantly more engaged into innovation-related training than the Russian ones: 53.5% vs. 13.6% of SMEs and 74.5% vs. 27.3% of large firms accordingly.

3.2 Key Technology Transfer Agents in Germany and Russia

According to the World Economic Forum (2010), the importance of institutional environment has become very apparent due to the economic crises and the quality of those institutions "has a strong bearing on competitiveness and growth". Although the economic literature is mainly focused on public institutions, private business institutions are also an important element (World Economic Forum, 2010, p. 4). According to the OECD (2011d), in most countries, more than half of all product-innovating firms engage in R&D (OECD, 2011d, p. 12). Current comparison considers the public and industrial research institutions with particular attention to the structural comparison of the public sector in Germany and Russia.

3.2.1 Key R&D Players in Germany

The public research institutional structure in Germany is complex. Half of the public research institutions in Germany are HEIs (OECD, 2004, p. 111). Germany has over 370 universities including approximately 200 universities of applied sciences. The educational system is characterised by a close link between instruction and research. German universities do not see themselves as "schools" […] but as centres where "research and teaching are united". The largest scientific organisation in Germany is
the Helmholtz Association of German Research Centres (HGF, Helmholtz-Gemeinschaft) which conducts long-term oriented basic research, includes large scale of research facilities and possesses 17 research centres. The Fraunhofer Society (Fraunhofer-Gesellschaft) has more than 80 research facilities including 60 Fraunhofer Institutes. It is the largest organisation for applied research in Europe. The Fraunhofer Society conducts applied research for both private and public enterprises, as well as for the general benefit of the public and has promotion of technology transfer to industry as its main objective. The Leibniz Association (Leibniz-Gemeinschaft) is the umbrella organisation for 87 research institutes which conduct both applied and basic research and perform research-based services. The Max Planck Society (Max-Planck-Gesellschaft) focuses on basic research primarily in natural sciences and humanities and comprises 80 institutes. The Max Planck Society also complements research projects at universities and well-known for its excellence in research. German academies of science have guidance, advice to policymakers, and finding suitable answers to current issues and problems as main functions. They run symposia and public events and contribute to dialogue between science, society and industry. Federal Ministries of Germany hold 38 Federal R&D institutions, so-called departmental research institutes (Bundesforschungseinrichtungen) which relate directly to each ministry’s field of activity and provide the required scientific foundation for the execution of sovereign tasks. The Robert Koch Institute is an example of a departmental research institute which is responsible for disease control and prevention. It is the central Federal reference institution for both applied and response-oriented research, as well as for the public health sector. The Federal States of Germany operate several research institutes which support the research activities of the States (Länder) and act as research funding bodies. There are 130 Federal States research organisations (Landesforschungseinrichtungen) in 13 Federal States of Germany (OECD, 2004, p. 111; Research in Germany – Land of Ideas, 2012, pp. Universities, Helmholtz Association, Fraunhofer-Gesellschaft, Leibniz Association, Max Planck Society, Research Academies, Federal Institutions, and "Länder" Institutions).

As discussed in Chapter 3.1.1, the business enterprise sector in Germany has the highest R&D spending among the sectors. The most of the R&D in private sector is conducted by large firms (OECD, 2004, p. 111). German industry is among the most inventive in Europe and especially involved into the field of applied research, working together with the globally operating network of Fraunhofer Institutes, the German Federation of Industrial Research Associations "Otto von Guericke" (AiF, Arbeitsgemeinschaft industrieller Forschungsvereinigungen), the Helmholtz Association having 2,400 collaborative projects with industry for instance, in energy research or in nanotechnology and biotechnology, and other R&D agents. The German Federation of Industrial Research Associations (AiF), founded in 1954, is a non-profit association organised by industry, which promotes R&D in all industrial sectors in favour of SMEs and acts at Federal and European level. Over last years,
Ekaterina Demarchuk

the Federal Ministry of Education and Research (BMBF) and the Federal Ministry of Economics and Technology (BMWi) has initiated a series of programmes and competitions which aim to create networks and clusters promoting new technologies. One aim of these networks and clusters arranged with respect to regional representation, research topics, specific application areas and future markets is to promote TT (Research in Germany – Land of Ideas, 2012, pp. Companies / Industrial Research, Industrial Research Associations, Networks and Clusters).

Table 12: Patenting in Germany, % of patents by firms, at EPO and USPTO, 2007-09

<table>
<thead>
<tr>
<th>High- and medium-high-technology manufactures</th>
<th>Medium-low-technology manufactures</th>
<th>Business sector services, excluding real estate</th>
<th>Other sectors</th>
<th>Number of matched patenting firms, 2007-09</th>
</tr>
</thead>
<tbody>
<tr>
<td>64,8</td>
<td>7,6</td>
<td>23,5</td>
<td>4,1</td>
<td>5,884</td>
</tr>
</tbody>
</table>

Source: composed from OECD calculations based on the Worldwide Patent Statistical Database, EPO, April 2011; and ORBIS© Database, Bureau van Dijk Electronic Publishing, December 2010; matched using algorithms in the Imalinker system developed for the OECD by IDENER, Seville, 201115.

Statistics above, that match patent and enterprise data, show that firms in high- and medium-high-technology manufacturing sectors perform a large proportion of patenting activity with 64.8% of patenting firms in Germany. Young firms and their patent activity underline the inventive dynamics of firms early in their development (OECD, 2011b, p. 71). The table below demonstrates the share of young patenting firms and share of patents filled by them (only for EPO and USPTO).

Table 13: Young patenting firms and patents filed by them at EPO and USPTO, 2007-09

<table>
<thead>
<tr>
<th>Share of patents filed by firms under 5 years old</th>
<th>Share of patenting firms under 5 years old</th>
<th>Average number of patents filed by firms under 5 years old</th>
</tr>
</thead>
<tbody>
<tr>
<td>11,17</td>
<td>20,74</td>
<td>5,0</td>
</tr>
</tbody>
</table>

Source: composed from OECD calculations based on the Worldwide Patent Statistical Database, EPO, April 2011; and ORBIS© Database, Bureau van Dijk Electronic Publishing, December 2010; matched using algorithms in the Imalinker system developed for the OECD by IDENER, Seville, 201116.

Statistics show that average number of patents filed by firms under 5 years old is 5.0%. Young patenting firms make 20.74% and their patenting share makes 11.17%. Germany is ranked 3rd among 139 economies analysed by the World Economic Forum for very sophisticated businesses. However, some factors breaking business in

15 http://dx.doi.org/10.1787/888932488084
16 http://dx.doi.org/10.1787/888932488122
Germany still exist (See Chapter 3.3.1 for most problematic factors for doing business in Germany).

3.2.2 Key R&D Players in Russia

Government research sector accounts for about 30% of the R&D expenditures in Russia. This is a high proportion, according to the international standards (OECD, 2011a, pp. 154-155). The government research sector is responsible for most of the basic research performed in Russia, much of it performed by the institutes of the various academies of science and ministries. The statistics reflects that the R&D in HE is badly financed in relation to the % of GDP and in Euro per inhabitant. This reflects low intensity of research and development in the HE sector. In 2008, the academies in Russia totalled 865 R&D institutes, more than half of which belonged to the Russian Academy of Sciences (RAS) with 468 institutes. The remaining institutes belong to field-specific academies; and their budgets, according to the OECD (2011a), altogether, amount to less than one-third of the RAS budget (OECD, 2011a, pp. 154-155). The huge system of State Academies is a remnant of the Soviet legacy (Kuklina et al., 2009, p. 20). RAS is the largest of the academies of science and the largest from the research performers in Russia. RAS is a self-governing non-profit organisation with public status. It includes the head office in Moscow and several regional branches: Ural, Siberian, and Far Eastern. RAS allocates its resources among different thematic branches with priority in physical sciences, chemistry and material sciences (OECD, 2011a, p. 156).

RAS is a prestigious organisation with outstanding scientific contributions, however, is has been a subject of criticism for "misusing its prestige to resist the necessary reforms of the Russian science system, including the reinforcement of the research role of universities". It is hard to make objective judgements as far as, according to the OECD (2011a), "there has never been a thorough and systematic evaluation of the Academy and its institute network" which "itself indicates some problems" (OECD, 2011a, p. 157). Some consider RAS as 'undemocratic' for the reason that at the top of the RAS hierarchy are Yuri Osipov, who has been RAS President since 1991, and the RAS Presidium, whose more than 40 members are appointed by the President. The Presidium, according to the German independent Life Science journal Lab Times, "has the final say when it comes to budget allocations and appointments of directors of research institutes" (Schreck, 2011, p. 1). It has been estimated that "perhaps only half of the statutory researchers of RAS are engaged in real research" (OECD, 2011a, p. 157; Schreck, 2011, p. 1), almost one-third of RAS researchers are 60 years old (OECD, 2011a, p. 157 after HSE, 2010, Science and Technology Indicators in the Russian Federation, Higher School of Economics, Moscow) and "the institute's funding [is] based on headcounts rather than on performance" (OECD, 2011a, p. 157). According to the OECD Review of Innovation

Policy on Russian Federation (2011a), the field-specific academies the Russian Academy of Agricultural Sciences (RAAS) and the Academy of Medical Sciences (RAMS) perform relatively well regarding R&D personnel (OECD, 2011a, p. 157). Apart from the academies, there are other public research institutes in Russia. State research centres (SRCs) are 50 Russian organisations with extra budgetary resources as well as tax privileges, especially regarding property and land. They operate in priority areas such as nuclear physics, power generation, aerospace, chemistry, machine building, biology, computer sciences and optics. Many of them conduct research in the defence complex. Federal research and production centres (FRPCs) are organisations operating in the defence, aerospace and nuclear industries that perform development, manufacturing, repair or testing activities and work on the basis of federal defence orders. The Ministry of Industry and Trade, the Russian Space Agency Rosatom, and the Ministry of Education and Science evaluate the activities of FRPCs every five years. The legal statuses of the FRPCs are a 'federal public enterprise' or a 'joint stock company with federal ownership'. National research centres (NRCs) were first introduced in 2008. This status has been awarded to only one organisation, Kurchatov Institute, Russia's largest research centre. NRCs "are free to make R&D contracts, their researchers are free to take part in the commercialisation of their research results, including through technology-based firms and start-ups" (OECD, 2011a, pp. 154, 212).

As mentioned in Chapter 3.1.1, HE expenditures on R&D as a percentage of GDP was at 0.09% in 2009 and 2010. The low level of the R&D activity in HEIs may be historically explained. At the Soviet Union, research by HEIs was recognised at the legislative level but it was not included in the centralised planning and financing system. Nowadays, the tradition of separating research and teaching functions is still a source of tensions between the RAS and the universities, especially after recent governmental support to develop research activities within HEIs (OECD, 2011a, pp. 158, 214). The government has adopted several programmes in this dimension. In recent years, 9 federal universities and 29 national research universities were established. These universities are in close interaction with RAS. The programme "Innovative Universities" has been developed where universities compete for substantial two year grants for the purchase of new equipment and development of new educational techniques and materials (Spiesberger, 2008, p. 11). According to ERAWATCH, grants to 57 Russian universities for purchase of equipment and training of staff were provided in frames of this programme. In 2009 a new law No. 217 pushed by President Medvedev aimed regulation of spin-offs, IPR allowing universities and research institutions to establish companies for the commercialisation of generated innovations (ERAWATCH, 2010, p. Research Performers). After the adoption of the Federal Law No. 217 a need for by-laws appeared (as far as the original Law had certain gaps). Underdeveloped innovation infrastructure and lack of qualified specialists,
unwillingness of private sector to engage in long-term risky innovation projects are some of the reasons breaking development of enterprises within universities and the law has not brought the expected results (Kuklina et al., 2009, p. 21).

The Russian data on industry engaged in technological innovations are mostly available for the manufacturing sector in the OECD statistics. By 2006-08, the innovative manufacturing firms in Russia made 39% vs 61% of firms without R&D\(^{19}\). According to the data provided by the Higher School of Economics, around 10% of surveyed enterprises reported technological innovation activity in 2008 which is a very weak performance, according to the OECD (OECD, 2011a, p. 132 after Higher School of Economics, 2010).

Russian top 100 enterprises are a mixture of majority state-owned enterprises and state corporations. Many of the largest \textit{state-owned enterprises} are conglomerates created by merging existing state-owned enterprises e.g., United Aircraft Corporation. These new corporations usually keep dominant market positions in their fields of activity, and participation of private sector including foreign investors is strongly controlled.

Recently, a new type of enterprise was created. It is labelled as \textit{State Corporation}. \textit{Rostechnologii} operating mostly in the military-industrial complex; Rosnano, leading development in fields of nanotechnology and related industries; Rosatom operating development of the nuclear energy industrial complex; and \textit{Vnesheconombank} charged with enhancing innovation, competitiveness, financing infrastructure, and supporting SMEs development belong to this type of enterprise. Some leading conglomerates have established collaborations with HEIs and research institutes although this practice is not widespread. Research activities are concentrated in state corporations and state-owned enterprises (OECD, 2011a, p. 149). Therewith there are many barriers a more innovation-driven economy (See Chapter 3.3.1 for most problematic factors for doing business in Russia).

3.3 Scientific & Technological Productivity

Although the relation of universities and industrial enterprises are an important topic, only a limited number of studies on the linking mechanisms have been undertaken (Meyer-Krahmer & Schmoch, 1998, pp. 838-839). This point may be supported by the fact that a few comparable international statistical data were found concerning the whole range of university-industry relations between Germany and Russia, and the research literature carries more descriptive than tangible character, figures are usually missing.

\(^{19}\) \url{http://dx.doi.org/10.1787/888932487134}
3.3.1 Growth of Firms, SMEs, and Spin-offs

Entry of new firms to the market, their growth and their adaptability to the changing economy are necessary for TT. The policy environment that fosters the spin-offs and start-ups and growth of new firms is essential for innovation to flourish. No comparable data were available in order to compare the spin-off activities and start-ups in the public research of Germany and Russia. The fact is that in Germany, already in the 1990s the business start-ups in research and knowledge-intensive industries20 amounted 64,400 (Egeln et al., 2002, p. 10). In Russia, spin-offs from universities are a rare and new phenomenon with some exceptions. For example, in Tomsk, co-ordinated actions by the regional and city authorities and the federal government have allowed the development of a significant number of new technology-based firms, most as spin-offs from universities (OECD, 2011d, p. 243). This, however, is more an exception as a rule.

The number of days needed to open a business (duration indicated by incorporation lawyers as necessary to complete the procedures) shows progress or hampering in the dimension of new firms establishment. On average in the OECD area, it takes 14 days to start a business (OECD, 2011d, p. 56). The number of days needed to open a business in Germany and Russia differ significantly. The German index is close to the OECD average: 15 days, whereas in Russia it is twice higher than in Germany: 30 days are needed to start a business.

Table 14: Days needed to start a business, 2003 and 2010

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>OECD average</td>
<td>14</td>
<td>34</td>
</tr>
<tr>
<td>Germany</td>
<td>15</td>
<td>45</td>
</tr>
<tr>
<td>Russia</td>
<td>30</td>
<td>44</td>
</tr>
</tbody>
</table>

Source: composed from OECD Science, Technology and Industry Scoreboard 2011; World Bank, Doing Business Database, June 201121

Another indicator proposed by OECD is 'barriers to entrepreneurship' which measures regulations affecting entrepreneurship on a scale of zero to six; lower values suggest lower barriers. The index is composed of barriers to competition (legal barriers, antitrust exemptions, barriers in network sectors and in retail and professional services); regulatory and administrative opacity (licences, permits, simplicity of procedures); and administrative burdens for creating new firms (OECD, 2011d, p. 56). These indicators also signalise barriers to the firms created out of universities and public institutions.

20 ZEW-Gründungspanels, ZEW - Spinoff Befragung 2001, hochgerechnete Werte
21 http://dx.doi.org/10.1787/888932487438
Table 15: Barriers to entrepreneurship, 2008

<table>
<thead>
<tr>
<th></th>
<th>Regulatory and administrative opacity</th>
<th>Administrative burdens on start-ups</th>
<th>Barriers to competition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>0.67</td>
<td>0.16</td>
<td>0.47</td>
</tr>
<tr>
<td>Russia</td>
<td>0.33</td>
<td>0.77</td>
<td>0.66</td>
</tr>
</tbody>
</table>

Source: composed from OECD, Product Market Regulation Database, May 2011

The Russian Federation suggests twice lower barriers in the regulatory and administrative capacity than Germany: 0.33 vs. 0.67. Administrative burdens on start-ups, however, are almost five times higher in Russia than in Germany: 0.16 vs. 0.77. Barriers to competition in Germany are 0.47 vs Russian 0.66 which is 1.4 times higher than those in Germany. The World Economic Forum defined a broader range the factors that hamper doing business in Germany and Russia. According to the World Economic Forum (2010), German businesses are aggressive in adopting technologies for productivity enhancements which makes this country ranked 10th among 139 economies (World Economic Forum, 2010, pp. 23, 502). However, there are some restraints for making business in Germany. The World Economic Forum (2010) states that Germany's labour market and tax regulations remain rigid and become problematic factors for making business (World Economic Forum, 2010, p. 164). As argued in the OECD Economic Survey Germany (2012), high social security contributions are the reason for strict taxation and labour regulations and therefore a need for a reform of the tax structure was recommended (OECD, 2012, p. 10). But generally speaking, Germany was ranked as 5th in the Global Competitiveness Index 2010-2011 according to the 12 pillars of competitiveness (World Economic Forum, 2010, pp. 15-16). The Russian respondents see corruption and access to financing as a hampering factor for doing business in Russia. Tax regulations are ranked as 3rd highest hampering factor. The Global Competitiveness Report sees a particular challenge for Russia in its very weak institutions ranked 118th in this area, insufficient protection of property rights (126th), and weak corporate governance standards (119th) (World Economic Forum, 2010, pp. 27, 284). Generally speaking, Russia was ranked as 63rd in the Global Competitiveness Index 2010-2011 according to the 12 pillars of competitiveness (World Economic Forum, 2010, pp. 15-16). Russia's competitiveness continues to worsen due to inefficient anti-monopoly policies as well as restrictions on trade and foreign ownership (World Economic Forum, 2010, p. 27).

http://dx.doi.org/10.1787/888932487457

The Global Competitiveness Index includes institutions, infrastructure, macroeconomic environment, health and primary education, higher education and training, goods market efficiency, labour market efficiency, financial market development, technological readiness, market size, business sophistication and innovation (World Economic Forum (2010), The Global Competitiveness Report 2010-2011, p. 9).
3.3.2 Intellectual Property

Protection of IPR through patents, trademarks, related publication requirements etc. stimulates research, encourages technology transfer and helps prevent costly duplication of research results. IPR, according to the OECD (2004), determine the returns of innovation (OECD, 2004, p. 118). While the relationship between the IPR and innovation is complex, the adoption and implementation of modern IPR legislation is an essential part of the overall framework conditions for innovation (OECD, 2011a, p. 92). Both Germany and Russia provide protection for IPR and have according legislation for these purposes.

According to the OECD (2004), the degree of IPR protection within Germany is similar to the one in other high-income countries. Patent protection is almost the strongest in the OECD, and the German IPR system has served as a model for other countries as well as for the European Patent Office (EPO). The German system for minor non-patented inventions (Gebrauchsmuster) has also been adopted by many countries (OECD, 2004, p. 118). IPR in Germany depend on policies of the EU and the European Patent convention established by the EPO (OECD, 2004, p. 118). The largest and oldest association in Germany devoted to the protection of intellectual property is the German Association for the Protection of Intellectual Property (GRUR), also known under the name Green Association (Grüner Verein), was founded in 1891 in Berlin. GRUR has as members German and foreign individuals: "lawyers, patent attorneys, judges, academics, as well as enterprises, associations of enterprises and their respective staff members and representatives". The purpose of the GRUR is academic advancement and development of industrial property and copyright law at the German, European and international level (GRUR, 2012, pp. home, about us). The central authority in the field of industrial property protection in Germany is German Patent and Trade Mark Office (DPMA, Deutsches Patent- und Markenamt) which operates within the portfolio of the Federal Ministry of Justice. It was founded as Reichspatentamt in Berlin and looks back on 130 years of history. It has focused on the protection of intellectual property (DPMA, 2012, p. the office).

In Germany, in the end of 1950s the number of patent applications from universities was very low. This situation was characterized by the privilege of the HEIs professors to exploit, for their private benefit, inventions created during their research at the university, whereas the industry researchers had to report their inventions. This situation was quite contradictory: the inventions could be created in the frames of universities but not be patented whereas the enterprises could decide on inventions and patent them. The university professors had to pay the patent application fees at their own risk and had to invest considerable time to find an appropriate industrial enterprise. Therefore many inventions made in universities were not patented. Still, according to Becher et al. (1996), about 40% of patents of academic origin were applied for by professors privately and 60% by industrial partners (Becher et al., 1996, p. 28). Due to this legal framework, only a few transfer units at German universities were actively engaged in patenting and licensing. At the
beginning of the 1970s, however, the patent applications from universities reached a significant level. At the beginning of 2002, the so-called privilege of university inventors was abolished: like all other workers, they had to report their inventions to the university. Thereafter, the university could claim the invention (Schmoch, 2006, pp. 56-57; Schmoch 2007, p. 1).

The Russian IPR are regulated by the Russian Federal Service for Intellectual Property, Patents and Trademarks (Rospatent) (OECD, 2011a, p. 92). After the collapse of the Soviet Union, the Russian Federation became a party to a number of international treaties such as the World Intellectual Property Organisation (WIPO) and Convention and the Patent Cooperation Treaty (PCT). Lately in 1992, the Russian Federation began negotiations towards the WTO which demanded certain IPR-related disciplines (OECD, 2011a, p. 92). For investors, the question of IPR in Russia is one of the key issues as far as the most of science organizations are state-owned which are mainly funded from the budget and industry cooperation, and investments on the controversial legal basis are barely possible. According to experts, by 2003, nearly 90% of the existing intellectual property registered in Russia was funded from the state budget and considered as state property (Dezhina & Leonov, 2003, p. 2). In the Soviet Union, the concept of 'intellectual property' as an element of market economy and inventions were not considered as commodity: no one had exclusive rights to IP and the invention was automatically assigned in the public domain. Since then, Russia adopted a set of laws, decrees and regulations on IP; the Patent Law of the Russian Federation (1992) is among them. This Law, however, passed when the privatization process was not open yet, so many research institutes, industrial enterprises and innovative firms, which have become the owners of IP, were still in state ownership. Thus, regardless of whether IPR have been transferred to the Ministry, enterprises or institutions, the state directly and indirectly was the owner of IP created at the expense of budget funds (Dezhina & Leonov, 2003, p. 6). Lately in 1998, the Presidential Decree "On legal protection of research results, experimental design and technological work of the military, special and dual purpose" and its execution as well as the later Government Resolution (2.09.1999 № 982) "On the use of scientific and technical activities" transferred the exclusive rights to any of the results of scientific and technological activities, obtained from the federal budget (if they were not objects of exclusive rights of individuals and entities) to the federal body (Dezhina & Leonov, 2003, p. 10).

Part IV of the Civil Code, voted in December 2006 and came into force on 1 January 2008 replaced all previous IPR legislation and combined all previous IP laws into a single legal instrument with a number of improvements (OECD, 2011a, p. 92). This law proclaimed the author of created IP as its primary owner (Spiesberger, 2008, p. 13). It was an effort to raise it to the WTO and EU standards (European Commission

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24 www.rupto.ru
25 Presidential Decree of the RF on 14.05.98 No.556
26 Resolution of the Russian Government on 29.09.98 No. 1132
IPR infringements on April 2007 were moved into category of "grave" crimes. Amendments in the Criminal law (Articles 146 and 180) have had a positive effect previously copyright and trademark crimes fell under the category of "medium gravity crimes". The adopted amendment now classifies these crimes under the category of "serious gravity crimes" (European Commission Trade, 2009, p. 5).

Patents, according to the Eurostat (Eurostat official website, 2012), reflect part of a country's inventive activity and show country's capacity to exploit knowledge and translate it into potential economic gains. According to this logic, indicators based on patent statistics are widely used to assess the inventive performance of countries because patents represent novelty, utility and inventiveness. Patents belong to indicators of R&D outputs (Eurostat official website, 2012, p. 1).

In 2009, Germany submitted the largest number of patent applications to the EPO among EU-27 countries (Eurostat, 2012, p. 80). In 2010, according to the Eurostat, Germany submitted more than 100 times more patent applications to the EPO than Russia. In 2008, the EPO granted Germany 80 times more patents than Russia.

Table 16: Patent applications to the EPO at the national level, total

<table>
<thead>
<tr>
<th></th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>total (no breakdown)</td>
<td>22 655.19</td>
<td>22 253.01</td>
<td>21 724.39</td>
</tr>
<tr>
<td>per million of inhabitants</td>
<td>275.55</td>
<td>271.37 (e)</td>
<td>265.57 (e)</td>
</tr>
<tr>
<td>Russia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>total (no breakdown)</td>
<td>245.25</td>
<td>226.17</td>
<td>211.33</td>
</tr>
<tr>
<td>per million of inhabitants</td>
<td>1.73</td>
<td>1.59 (e)</td>
<td>1.49 (e)</td>
</tr>
</tbody>
</table>

Source: composed from Eurostat 14.06.2012

Table 17: Patent applications to the EPO, inventor's country of residence, total

<table>
<thead>
<tr>
<th></th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24 116.8</td>
<td>22 797.0</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Russia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>251.4</td>
<td>246.4</td>
<td>0.0</td>
<td></td>
</tr>
</tbody>
</table>

Source: composed from OECD.Stat 12.08.2012

Table 18: Patent grants at the EPO, inventor's country of residence, total

<table>
<thead>
<tr>
<th></th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 796.1</td>
<td>18 992.4</td>
<td>n.a.</td>
<td></td>
</tr>
<tr>
<td>Russia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>166.6</td>
<td>237.7</td>
<td>n.a.</td>
<td></td>
</tr>
</tbody>
</table>

Source: composed from OECD.Stat 12.08.2012

The EPO is one of several world patenting offices. Apart from EPO, the USPTO comparative data are also available for both countries. The USPTO granted in 2008 1 803.6 patents to Germany whereas Russia obtained 80.2 of them.
Table 19: Patent grants at the USPTO, inventor's country of residence, total patents

<table>
<thead>
<tr>
<th></th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>3 964.4</td>
<td>1 803.6</td>
</tr>
<tr>
<td>Russia</td>
<td>111.4</td>
<td>80.2</td>
</tr>
</tbody>
</table>

Source: composed from OECD.Stat 12.08.2012

Inventors seek protection not only in Europe and the USA but in other IP offices e.g., applying to the Japanese Patent Office, Eurasian Patent Office, and many others. Thus, the results are not necessarily representative in relation to global trends. Therefore it is important to introduce the notion of patent families. Patent families are counted according to the earliest priority date (first patent application worldwide) and the inventor's country of residence. By 2008, Germany had 55,952 patent families which are 2.7 times higher than Russia with 20,234 patent families.

Table 20: Patent families by country of origin, total

<table>
<thead>
<tr>
<th></th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>56,082</td>
<td>55,952</td>
</tr>
<tr>
<td>Russia</td>
<td>21,033</td>
<td>20,234</td>
</tr>
</tbody>
</table>

Source: composed from World Intellectual Property Indicators, 2011 edition

'Triadic' patent families refer to patents filed at the EPO, the Japan Patent Office (JPO) and the USPTO which protect the same invention. These patent families are very expensive and provide a very high level of IP protection.

Table 21: Triadic patent families, total and number per million inhabitants, 2009

<table>
<thead>
<tr>
<th></th>
<th>Total patents</th>
<th>Number per million inhabitants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>5 764</td>
<td>70,37</td>
</tr>
<tr>
<td>Russia</td>
<td>63</td>
<td>0,43</td>
</tr>
</tbody>
</table>

Source: composed from OECD Factbook 2011: Economic, Environmental and Social Statistics OECD 2011

It is possible to identify trends in inventions in both countries by observing classifications of patent applications. The International Patent Classification (IPC) facilitates searching for invention trends. Data only of the applications in the EPO were available.

28 [http://dx.doi.org/10.1787/888932505906](http://dx.doi.org/10.1787/888932505906)
29 [http://dx.doi.org/10.1787/888932505925](http://dx.doi.org/10.1787/888932505925)
Table 22: Patent applications to the EPO by section IPC as % of total, 2007

<table>
<thead>
<tr>
<th>Section of Invention</th>
<th>Germany</th>
<th>Russia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human necessities</td>
<td>14.5</td>
<td>24.3</td>
</tr>
<tr>
<td>Performing, operations, transporting</td>
<td>23.7</td>
<td>13.4</td>
</tr>
<tr>
<td>Chemistry, metallurgy</td>
<td>11.6</td>
<td>17.4</td>
</tr>
<tr>
<td>Textiles, paper</td>
<td>2.1</td>
<td>1.6</td>
</tr>
<tr>
<td>Fixed constructions</td>
<td>4.3</td>
<td>1.4</td>
</tr>
<tr>
<td>Mechanical engineering, lighting, heating, weapons, blasting</td>
<td>14.9</td>
<td>13.1</td>
</tr>
<tr>
<td>Physics</td>
<td>13.6</td>
<td>15.6</td>
</tr>
<tr>
<td>Electricity</td>
<td>15.2</td>
<td>13.2</td>
</tr>
</tbody>
</table>

Source: composed from Eurostat 14.06.2012

Regarding the breakdown of patent applications at the EPO into fields it is possible to state that the German priority patenting fields and invention dimensions are "performing, operations, transporting" whereas in Russia those are "human necessities". "Chemistry and metallurgy" take 2nd position in Russian invention preferences, whereas in Germany that is "electricity". Both in Germany and Russia the biggest amount of inventions was made in the business enterprise sectors. Higher education sector in Germany fulfilled more patent applications than the government sector, whereas in Russia this situation is the opposite. German HEIs submitted 320,865 patents vs. 1.2 of those in Russia in 2008. In 2007, however, Germany and Russia had 314,718 vs. 4.033 patent applications to the EPO. Surprisingly, after the legislation reforms, Russian HE sector reduced the patent applications from 4.033 in 2007 to 1.2 in 2008. According to Ulrich Schmoch (2006), patents originating from universities represent a reasonable investment (considering high costs of patent applications) because university aims to make commercial exploitation in an industrial enterprise. Therefore, university patents signal already existing or intended contacts between universities and industrial partners (Schmoch, 2006, p. 53).

Table 23: Patent applications EPO by priority year at the national level by sectors

<table>
<thead>
<tr>
<th></th>
<th>Germany</th>
<th>Russia</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2007</td>
<td>2008</td>
</tr>
<tr>
<td>Government sector</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>282.48</td>
<td>268.921</td>
</tr>
<tr>
<td>(p)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Per million of</td>
<td>3.432</td>
<td>3.271</td>
</tr>
<tr>
<td>inhabitants</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Business enterprise sector</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>21</td>
<td>18</td>
</tr>
<tr>
<td>(p)</td>
<td>501.822</td>
<td>148.238</td>
</tr>
<tr>
<td>Per million of</td>
<td>261.214</td>
<td>220.734</td>
</tr>
<tr>
<td>inhabitants</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 24: Trademarks abroad, average number per million population, 2007-09

<table>
<thead>
<tr>
<th>Higher education sector</th>
<th>Total</th>
<th>314.718</th>
<th>320.865</th>
<th>166.041</th>
<th>4.033</th>
<th>1.2</th>
<th>n.a.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per million of inhabitants</td>
<td></td>
<td>3.823</td>
<td>3.903</td>
<td>2.025</td>
<td>0.028</td>
<td>0.008</td>
<td>n.a.</td>
</tr>
</tbody>
</table>

Source: composed from Eurostat 14.06.2012
n.a. – not available
p – provisional

Indicators based on trademarks are a new measure that reflects innovations in the service sector and confirm that firms perform both technological and non-R&D-based innovation. Trademarks abroad refer to the average number of trademark applications filed at the USPTO, Office of Harmonization of the Internal Market and JPO. According to the OECD, countries with a large services sector tend to engage more in trademark protection whereas countries with a large manufacturing sector have a greater tendency to patent than to trademark (OECD, 2011d, p. 12). Regarding the German-Russian statistics on trademarks it is possible to conclude that the services sector is more developed in Germany than in Russia: 28 trademarks abroad per million population in Germany against 1 trademark in Russia.

According to the OECD (2011d), rising patenting activity has been accompanied by an average 20% decline in patent quality over the past two decades. Therefore some patents are more valuable than others (OECD, 2011d, p. 6). Patent quality indicators try to capture both the technological and the economic value of innovations, and are normally based on patent citations, claims, patent renewals and patent family size. They are considered to be meaningful measures of research productivity (OECD, 2011b, p. 73). The quality of innovations protected in Europe in the past decade was highest in renewable energy technologies, nanotechnologies and information technologies. Germany is the country with the maximum patent quality index in solar energy. Russia is not leading in patent quality index in any of selected technologies (OECD, 2011b, p. 73; OECD, 2011d, p. 6).

Costs of filling patent play an important role in the patent statistics especially for the SMEs. For example, at the EPO the patent filling was about five times higher than in the US (OECD, 2004, p. 118). The Commission estimated that the overall fee of a European patent is around EUR 49 900, Japanese and US patents cost on average

EUR 16 450 and EUR 10 330 respectively (Eurostat official website, 2012, p. 1). It is obvious that patent applications are only possible when suitable financial support for inventions' commercialisation is available.

3.3.3 Collaborative Research

"The production of scientific knowledge is shifting from individuals to groups, from single to multiple institutions, and from a national to an international level". Researchers and research institutes build networks across national and organisational borders. OECD suggests that that international scientific collaboration among institutions results in research with high impact (as measured by normalised citations) – and the broader the collaboration, the higher the impact of the research (OECD, 2011b, p. 27; OECD, 2011d, pp. 9-10).

According to the OECD (2009b), co-authorship of research publications provides a direct measure of collaboration in science. Co-authorship may involve researchers in the same institution, in the same country, or in two or more countries. Collaboration among researchers in a single institution was the major form of collaborative research until the end of the 1990s; nowadays it has been decreasing. Co-authorship, both domestic and international, has grown in importance over the past decade. International co-authorship measures scientific articles with two or more authors from different countries (OECD, 2009b, p. 114).

Over 50% of publications in Germany by 2007 were made in international co-authorship whereas in Russia this index was close to 39%\(^{31}\). According to the OECD (2009b), bigger countries tend to less international collaboration than the smaller ones (OECD, 2009b, p. 114). Table below presents the impact of scientific production and the extent of international scientific collaboration in Germany and Russia. Germany has produced in 2003-2009 three times more international articles than Russia. The normalised impact for Germany is almost 3 times higher than the Russian one. The normalised impact is the ratio between the average number of citations received by the documents published by a specific unit (country, institution, and author) and the world average of citations of the same time period, document type and subject area (OECD, 2011d, p. 13). International collaboration among institutions differs between the countries in 10%.

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\(^{31}\) Source: National Institute of Science and Technology Policy in Japan, Science and Technology Indicators - Data updated in 2008 for 5th edition, July 2008. The data is based on scientific articles of natural and medical sciences and engineering, [http://dx.doi.org/10.1787/745766770745](http://dx.doi.org/10.1787/745766770745)
Technology Transfer Systems and University-Industry Relations in Germany and Russia: 
Comparative Study

Table 25: Impact of scientific production and international collaboration, 2003-09

<table>
<thead>
<tr>
<th>International collaboration among institutions, %</th>
<th>Normalised impact</th>
<th>Number of articles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>42,2</td>
<td>1,3</td>
</tr>
<tr>
<td>Russia</td>
<td>32,0</td>
<td>0,5</td>
</tr>
</tbody>
</table>

Source: composed from OECD and SCImago Research Group (CSIC), Report on Scientific Production, based on Scopus Custom Data, Elsevier, June 201132.

A new indicator of research impact 'university hotspots' (geographical distribution / location of top-50 universities by main subject areas), measured by normalised citations to academic publications across all disciplines shows that German universities belong to the top 50 universities of the world leading in such disciplines as agricultural and biological sciences, chemistry, environmental science, immunology and microbiology, neuroscience, physics and astronomy. None of Russian universities belong to this listing (OECD, 2011d, p. 8).

Table 26: Quantity and quality of scientific publications, per 1000 inhabitants, 2009

<table>
<thead>
<tr>
<th>In top-quartile journals</th>
<th>In other journals</th>
<th>Absolute number of publications (thousands)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>0,738</td>
<td>0,722</td>
</tr>
<tr>
<td>Russia</td>
<td>0,045</td>
<td>0,198</td>
</tr>
</tbody>
</table>

Source: composed from OECD and SCImago Research Group (CSIC) (forthcoming), Report on Scientific Production, based on Scopus Custom Data, Elsevier, June 201133.

Quality adjusted research output is measured by the publications in top journals. So-called 'high quality publications "are defined as publications in the reference period by authors affiliated to an institution in a given country published in the most influential 25% of the world's scholarly journals in their category on the basis of citation data"34 (OECD, 2011b, p. 27). Concerning the total publications, regardless of quality, Germany is leading with 119,500 against Russian 34,300. The German index in top-quality journals is more than 16 times higher than the Russian one. International collaboration denotes publications co-authored with institutions in another countries. National collaboration considers publications co-authored with institutions within the same country (OECD, 2011b, p. 27). Germany has a high impact with national and international institutions which is indicated as 2.10 whereas Russia has medium impact with the 1.04 index. Russia has a low impact concerning

32 [http://dx.doi.org/10.1787/888932485424](http://dx.doi.org/10.1787/888932485424)
33 [http://dx.doi.org/10.1787/888932486260](http://dx.doi.org/10.1787/888932486260)
34 as ranked by the SCImago Journal Rank, [www.scimagoir.com](http://www.scimagoir.com)
international institutions only with the index 0.97 whereas Germany has medium 1.66 when dealing with international institutions\textsuperscript{35}. Collaborations within the same institutions and single-author articles in Germany have medium impact whereas Russia has the low one. Collaboration within national institutions in Russia has low impact as well whereas Germany keeps the medium position\textsuperscript{36}.

It was not possible to find the latest data concerning the co-authorships between the sectors of performance in the statistical databanks. However, Loet Leydesdorff (2009) made a research on this issue in 2009. He stated that by 2000, out of 61017 German publications there were 1028 university-industry publications and 14003 university-government ones. For Russia those were 76 and 6315 accordingly (Leydesdorff, 2009, p. 23).

Collaboration is also an important part of the TT activities of many firms. It involves "active participation in joint innovation projects with other organisations but excludes pure contracting out of work". General amount of firms collaborating on innovation activities shows the readiness of firms for innovativeness. Both in Germany and Russia collaborating innovative firms are mostly large enterprises which make over 40% of innovative firms. SMEs in Russia are 5% more involved into collaboration on innovative activities than the German counterparts.

Table 27: Firms collaborating on innovation, by size as % of innovative firms, 2006-08

<table>
<thead>
<tr>
<th></th>
<th>SMEs</th>
<th>Large firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Russian Federation (manufacturing)</td>
<td>23,6</td>
<td>41,2</td>
</tr>
<tr>
<td>Germany</td>
<td>18,8</td>
<td>46,0</td>
</tr>
</tbody>
</table>

Source: composed from OECD, based on Eurostat (CIS-2008) and national data sources, June 2011\textsuperscript{37}.

"Collaboration with public research organisations (higher education or government research institutes) can be an important source of technology transfer for the innovation activities of firms [HE and government]" (OECD, 2009c, p. 80; OECD, 2011b, p. 31). Here again, large enterprises are more active than SMEs. But, in contrast to previous comparison, in case of collaborating on innovation with HE or government research institutions Germany is much more successful than Russia: 33.2% vs. 9.3% by large firms and 10.3% vs. 3.4% by SMEs. However, according to the OECD, the data indicate "only the existence of some sort of collaboration, not its type or intensity" (OECD, 2009c, p. 80). According to Ulrich Schmoch, "the most

\textsuperscript{35} Source: composed from OECD and SCImago Research Group (CSIC) (forthcoming), Report on Scientific Production, based on Scopus Custom Data, Elsevier, June 2011, http://dx.doi.org/10.1787/888932486279

\textsuperscript{36} Source: composed from OECD and SCImago Research Group (CSIC) (forthcoming), Report on Scientific Production, based on Scopus Custom Data, Elsevier, June 2011, http://dx.doi.org/10.1787/888932486298

\textsuperscript{37} http://dx.doi.org/10.1787/888932486507

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important framework for collaborative research in Germany is joint university-industry projects within programmes of the BMBF" (Schmoch, 2006, p. 57). In Russia, according to the OECD (2011a), improvement of the framework conditions in the public-private sector enterprises would be most significant contribution (OECD, 2011a, p. 21).

Table 28: Firms collaborating on innovation with HE or government, 2006-08

<table>
<thead>
<tr>
<th></th>
<th>SMEs</th>
<th>Large firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>10.3</td>
<td>33.2</td>
</tr>
<tr>
<td>Russian Federation (manufacturing)</td>
<td>3.4</td>
<td>9.3</td>
</tr>
</tbody>
</table>

Source: composed from OECD, based on Eurostat (CIS-2008) and national data sources, June 2011\(^{38}\).

3.3.4 Institutional arrangements

Technology transfer and licensing offices may be integrated into a research institution. These offices ensure closer links between commercialisation and research activities. On-site departments benefit from low expenditures as the fixed costs for staff and operations are "absorbed" by the main institutions. There is a risk, however, that TT offices concentrate mainly on existing relationships and neglect new opportunities. Another risk is that smaller universities often lack the resources and skills to effectively work on TT activities such as e.g., patent portfolios (OECD, 2002b, p.64).

In the 1980s, many German experts suggested the establishment of transfer units at universities in order to improve the TT to industry. Transfer units were established at almost all German universities. According to Stefan Kuhlmann (1991) and Ulrich Schmoch (2006), in practice, the transfer units had their major function in public relations and less in the mediation of TT (Kuhlmann, 1991, p. 117; Schmoch, 2006, p. 60). The experts explain that "for a typical transfer unit with a staff of about five persons it is […], difficult to follow the research activities of a university with 30,000 students, 3,500 scientists, and 250 research centres …" and that "most enterprises organize their contacts to research institutions themselves without the mediation of transfer units" (Reinhard & Schmalholz, 1996, p. 32; Schmoch, 2006, p. 60). The experience of last years showed that long-term research and education sometimes come into conflict with research topics relevant for industrial exploitation. Therefore special institutional arrangements outside universities have been established. In Germany, the so-called An-Institutes (Institut an der Universität) operate under a co-operation agreement with a university and receive about one-third of their budget as institutional funds from the relevant federal state, one-third from contract research for industrial clients, and one-third from projects for

\(^{38}\) \url{http://dx.doi.org/10.1787/888932486488}
public clients (Abramson et al., 1997, p. 287). A successful example of this type of organisation is German Research Centre for Artificial Intelligence (Deutsches Forschungszentrum für Künstliche Intelligenz) which is now the world's largest among the most recognized 'Centers of Excellence' and currently is the largest research centre worldwide in the area of artificial intelligence and its application.\(^{39}\) Already mentioned above Fraunhofer Institutes and An-Institutes apply their own academic research activities into practical needs whereas TT units primarily do not have their own research activities but transfer those of universities. Start-ups may also be seen as institutional arrangements that support the knowledge transfer from academic research to industrial application (Schmöch, 2006, p. 61). In Germany, universities have public non-profit status so they can only improve the general framework for supporting spin-out companies but not making business.

In Russia the TT units are quite a new phenomenon. In last years a number of TT centres have been established at RAS and universities in order to facilitate the commercialisation of their inventions. By 2011, there were over 100 such centres in Russia. In addition, around 30 'collective use centres' were established where innovators can conduct testing, measuring, modelling, etc. (OECD, 2011a, p. 232). Science parks, including those that are university-related, carry an environment-creating function playing an incubator role, nurturing the development and growth of new technology firms and encouraging the development of university-based spin-offs, products, and processes. Science parks do not just promote innovation and entrepreneurialism but are also seen as transferors of technology from university to local economy environment (Felsenstein, 1994, pp. 93, 97). The first technology parks in Russia were created in the late 1980s – early 1990s. Most of them were organized as structural units of HEIs and were not active in supporting businesses. Rare cases, industrial parks were established in the form of limited companies. Russian technology parks, with rare exceptions, do not perform functions of an incubator, but are primarily a kind of 'security grounds', enclosing small companies from aggressive environment. Duration of stay of such companies in technology parks are in average of 10 years (with the international standards in 2-3 years) (EXPERT RA, 2011, pp. 1-10). By 2008, Russia had 83 registered technology parks; incubators are among them (OECD, 2011a, p. 232). Nowadays, Germany has at least 150 technology centres. The institution specialised in initiating, supporting and overseeing enterprise start-ups in the form of organised innovation centres is the Federal German Association of Innovation, Technology and Business Incubation Centres (ADT, Bundesverband Deutscher Innovations-, Technologie- und  

\(^{39}\) [www.dfki.de](http://www.dfki.de)
Gründerzentren) created in 1988 which supports its member centres by initiating and overseeing innovative technology-oriented start-ups.  

3.4 Discussion / Portfolios

The research intensity in Germany is roughly two times higher than in Russia by volume of R&D spending as % of GDP. R&D spending in relation to the population in Germany is over 10 times higher than in Russia. This difference, however, may be partly explained by different economies, partly by different national policies and institutional structures. The larger scale of R&D expenditures in Germany has certain advantages for R&D outputs e.g. patents granted.

3.4.1 Major Differences in National TT Systems

Higher Education Portfolio

The difference in R&D expenditures in HE sector may not be explained by economic but by policy reasons. The GERD in HEIs in Germany is more than five and half times higher than in Russia. This indicates that research activities in Russian HEIs are hardly possible with poor financing policy. This is reflected on the stocks of the R&D personnel and researchers in the Russian HE: they are almost six times lower than in Germany. Several programmes were developed by the Russian government in order to support R&D in the HE sector. However, the statistical data for assessing the situation are not available yet and the reforms need some time to give fruitful results. HE sector in Germany is research-oriented and receives government and business support for these needs. Russian HE sector is less research-oriented and does not practice research as much as German one. Therewith HE as research performer is stronger in Germany than in Russia.

Business Sector Portfolio

There are great differences in the industrial portfolios of both countries. Business sector expenditures as % of GDP in Russia is almost two and half times lower than in Germany. Over 57% of R&D in the business sector is financed directly by the government of the Russian Federation which makes Russia the OECD leader on government-financed R&D in business sector. German government finances directly about 4.5% of business R&D. This difference may be explained by the fact that German business sector body is more diversified and financially autonomous than the Russian one where the forms of ownerships of major business enterprises (enterprises are mostly state-owned corporations/companies) indicate less private decision-making and financial autonomy. State-owned enterprises create

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150 are German members of the German Association of Innovation, Technology and Business Incubation Centres, [www.adt-online.de/mitglieder.html](http://www.adt-online.de/mitglieder.html)
monopolies, roughly speaking: majority of the business sector, including research activities, belongs to the state. This phenomenon may be identified as nationalised business sector. Moreover, OECD (2011a), defines Russia as "poor business environment" and "anti-competitive" (OECD, 2011a, p. 5). Compared to the Russian counterpart, the research performers in Germany have more autonomy as well as opportunities for research competition. These differences may be the reasons for different research outputs including patent portfolios and publications.

GOVERNMENTAL RESEARCH PORTFOLIO

The governmental R&D policies in Russia are difficult to define for the reason of missing data. Generally speaking, data on the Russian Federation are less available in the international databanks of OECD and Eurostat than those of German counterpart. The governmental sector in Russia has more than twice higher amount of R&D personnel and researchers comparing to Germany. The index of patent applications is lower than in Germany though. The reasons for poorer technological performance may reveal the differences in the institutional structures in two countries.

INSTITUTIONAL PORTFOLIO

Despite many significant differences between the German and Russia R&D systems, many individual elements of the two national systems may be functionally compared.

Table 29: Functional Similarities between R&D Institutions in Germany and Russia

<table>
<thead>
<tr>
<th></th>
<th>Germany</th>
<th>Russia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education, research</td>
<td>Universities</td>
<td>Universities:</td>
</tr>
<tr>
<td></td>
<td>universities of applied sciences</td>
<td>2 National Universities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9 Federal Universities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>29 National Research Universities</td>
</tr>
<tr>
<td>Basic research</td>
<td>Helmholtz Centres</td>
<td>Russian Academy of Sciences</td>
</tr>
<tr>
<td></td>
<td>Max Planck Institutes</td>
<td>Russian Academy of Education</td>
</tr>
<tr>
<td></td>
<td>Leibniz Association*</td>
<td>Russian Academy of Art</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Russian Academy of Agricultural sciences*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Russian Academy of Medical Sciences*</td>
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<tr>
<td></td>
<td></td>
<td>Russian Academy of Architecture and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Construction Sciences*</td>
</tr>
<tr>
<td>Public mission,</td>
<td>Helmholtz Centres</td>
<td>Russian Academies of Sciences</td>
</tr>
<tr>
<td>public interest</td>
<td>German Academies of Science</td>
<td>Institutes of the Ministries</td>
</tr>
<tr>
<td></td>
<td>Departmental Research Institutes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Federal States research organisations</td>
<td></td>
</tr>
<tr>
<td>Applied research,</td>
<td>Fraunhofer Society</td>
<td>State Research Centres</td>
</tr>
<tr>
<td>Technology transfer</td>
<td>Leibniz Association*</td>
<td>Federal Research and Production Centres</td>
</tr>
<tr>
<td></td>
<td>Federal States research organisations</td>
<td>Russian Academy of Agricultural sciences*</td>
</tr>
</tbody>
</table>
Technology Transfer Systems and University-Industry Relations in Germany and Russia: Comparative Study

<table>
<thead>
<tr>
<th>An-Institutes</th>
<th>Russian Academy of Medical Sciences*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technological and science parks</td>
<td>Russian Academy of Architecture and Construction Sciences*</td>
</tr>
<tr>
<td></td>
<td>National Research Centres (Kurchatov Institute)</td>
</tr>
<tr>
<td>Russian Academy of Medical Sciences*</td>
<td>Technological and science parks</td>
</tr>
</tbody>
</table>

Applied research, development

| Research by German Federation of Industrial Research Associations | Networks and Clusters |
| Research by German Federation of Industrial Research Associations | Industrial Research Networks and Clusters |

* both basic and applied research


The German R&D institutional infrastructure is more diverse than the Russian one. In Germany, the operational responsibility between the public R&D institutions and their TT activity as well is wider than in Russia. The major and biggest player in the Russian research is the RAS focused on basic research. Other academies of sciences participate both in applied and basic research. Helmholtz Centres and Max Planck Institutes as well as the RAS and some other Russian academies are characterised by their public base funding and basic research orientation. German Fraunhofer Institutes conduct primarily applied research with the mission of TT to industry. Russia does not have similar to Fraunhofer structure. German and Russian universities have as functions education and research with focus on basic research. Nevertheless, Russian HEIs are primarily focused on education. Russian HEIs perform less research outputs than German counterparts: traditionally in Russia the universities were not seen as research performers; poor financing is also the reason for low technological performance. Recent reforms on Federal and National Research Universities have not shown tangible results yet. It is difficult to assess them for the shortage of statistical data. Generally speaking, according to the OECD classification of national research systems, Germany may be characterised as country with an average share of government R&D funding and performance with broad-based system (OECD, 2002b, p. 31) (both universities and institutes involved into R&D), whereas Russia is a country with a very high share of government R&D funding and performance with institute-based system.

UNIVERSITY-INDUSTRY RELATIONS PORTFOLIO

The R&D expenditures in the HE sector of Germany and Russia are very contrasting. The R&D in the Russian HE sector is less enabled for poor financing, thus the

\(^{41}\) [http://mon-ru.livejournal.com/21227.html](http://mon-ru.livejournal.com/21227.html)

creation of technology is hampered. The government sector in Russia receives a greater financial support than the HE sector. In Germany, on contrary, the HE sector receives more means than the governmental sector for the R&D. The expenditures influence the research environment and therewith the R&D personnel. The stocks of R&D personnel in Russian HE sector are six times lower than in Germany. The government sector in Russia possesses twice more researchers than the German one. The financial university-industry relations on R&D are as follows: Russian industry supports R&D in HE sector more than the German one, the difference makes 8%. This indicator, according to Ulrich Schmoch (2006) may represent contract and collaborative research (Schmoch, 2006, p. 53). There are no available data helping to assess HE support of the business sector, but, in both countries, large innovative firms tend to benefit more from the public sector than SMEs.

The R&D HE outcomes in Germany are much higher than in Russia which shows more intense university-industry relations in Germany. Even though legal basis in IPR is positive in both countries in the sense of creation of spin-offs out of universities and patent applications by the universities' inventors, the patent applications to the EPO showed that in 2008 there were 3.903 patent applications per million inhabitants from German HE sector comparing to Russia with 0.008 applications per million inhabitants. According to Ulrich Schmoch (2006), patents originating from universities represent existing or intended contacts between universities and industrial partners (Schmoch, 2006, p. 53) which means that the Russian HE sector has fewer contracts with the industry than the German one. Statistical data show that after the legislation reforms on patents in 2008, Russian HE sector reduced the patent applications to the EPO. Considering poor financing of the HE research sector, it is hard to believe that the situation on patenting will be positively improved by legislative reforms only. Higher education sector in Germany fulfilled more patent applications than the government sector whereas in Russia this situation is the opposite. The co-authored publications between industry and HE sector were more frequent in Germany than in Russia in 2000. In both countries government-industry relations in sense of publications were more intense.

The research interface in Germany is more favourable for university-industry relations than in Russia, it is more turbulent and the transfer connections are deeper, according to research outputs. In Russia, the government is the most engaged into research. In Russian industrial sector, the research activities are concentrated in state corporations and state-owned enterprises. The business environment for spin-offs is more favourable in Germany than in Russia: in Germany the amount of days to start a business is twice lower than in Russia; the culture of spin-offs in Germany is more developed, in Russia, spin-offs from universities are a rare and new phenomenon; administrative burdens on start-ups and barriers to competition are much higher in Russia than in Germany.
3.4.2 Major Similarities in National TT Systems

R&D expenditures as % of GDP in the government sector are similar in both countries. That indicates similar public R&D policies in both countries when it is the matter of allocation preferences. In business-funded R&D in the public sector, Germany and Russia stay literally next to each other in the OECD statistics. Generally speaking, the amount of R&D personnel in physical persons in Germany and Russia is alike. Both in Germany and Russia the biggest amount of inventions was made in the business enterprise sectors. In both countries, large innovative firms tend to benefit more from the public sector than SMEs and tend to do more regular training activities than SMEs. Both in Germany and Russia collaborating innovative firms are mostly large enterprises which make over 40% of innovative firms. In both countries, governmental impact on national TT system is significant.

4. Conclusion

The technological performance of national science and technology systems as well as their transfer processes may be assessed due a set of comparative indicators split into inputs (research orientation) such as expenditures and human capital and outputs (technological performance) indicators such as patent applications or scientific collaboration indexes. The institutional structure is also important for the reason that is works as 'converter' of inputs into outputs. The comparison of national technology transfer systems allows seeing countries' research and development orientation and technological effectiveness in general perspective. The comparative study showed that the research and development orientation in Germany and Russia is different because the resources are allocated differently in sectors of performance: Germany sets more on research in higher education whereas Russia does it in the government sector. The research institutions in Germany and Russia have different sets of tasks, financial possibilities and decision-making abilities. Thus, the research activities are concentrated differently in the research systems of compared countries. German HE sector is much stronger than the Russian one as research performer. However, in both countries, business enterprise sector performs more technology transfer outputs, according to patent statistics. The comparison of TT systems in both countries was successful. The mechanisms of TT between HE and industry were defined. However, the comparison based on available indicators did not allow deeper assessing of relationships between the sectors including business enterprise and higher education relationships. Existing indicators were not sufficient to look deeper into the TT channels (e.g., to assess mobility of researchers between the sectors). However, it became possible to make general conclusions about the university-industry relations and define some differences and similarities between the two countries. In Germany, the university-industry relationships are more developed than in Russia. German HEIs are more involved into transfer activities because the research interface in more
favourable for university-industry connections (e.g., barriers for doing business, etc.).

Although the relation of universities and industrial enterprises are an important topic, only a limited number of studies on the linking mechanisms have been undertaken. This point may be also supported by the fact that a few comparable international statistical data were found concerning the whole range of university-industry relations in the two compared counties. The statistical reflections on mechanisms of interaction between industry and universities (e.g., patenting, spin-offs, co-publications, etc.) are not likely to find in the international databanks. The research literature carries more descriptive than tangible character, data are not in comparable form, and figures are rarely consistent.

Future research challenges would be to find out the orientation of the research between the sectors including the HE and business sectors (short-term or long term research); traditional areas of cooperation between the sectors; the effectiveness of TT units within universities, or types of university-industry interactions according to disciplinary fields. From the statistical perspective of the current study, researchers belong to different sectors, which might not always be accurate. The mobility of scientists between the sectors would be challenging to discover. These relations are possible to discover due to empirical investigations. Public employment legislation as well as regulations governing temporary mobility and secondary employment would be necessary to observe in order to define legislative barriers for university-industry relations.

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The German-Russian academic year 2012/2013 offered an outstanding opportunity to discuss overarching themes of German-Russian academic collaboration, to exchange experiences on both sides and to develop prospects – also for further bilateral collaboration. 120 participants from Germany and Russia met in April 2012 at the University of Kassel for the German-Russian Symposium on “Knowledge transfer – the new core task of Higher Education Institutions”.

The contributions in this volume document the aspects of knowledge transfer presented and discussed at the conference. They cover the economic relevance of the Higher Education Institutions for the regional innovation process as well as the strategic role of knowledge transfer back from economy and society to the universities. Best practice examples of innovative concepts and models of knowledge transfer are given by university representatives from Russia and Germany.

The second subject priority sheds light on the bilateral relationships between Germany and Russia in the reciprocal “Knowledge transfer” – the bilateral collaboration in research, teaching and technology.