Cooperation between Industry and Science – the Evaluation of Coordination of Operations

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Cooperating with universities is complementary to other innovation activities such as performing own R&D, sourcing public information and cooperating with other partners. Poland will have to focus more strongly on developing capacities in innovation and business sophistication. Stronger clusters, more R&D orientation of companies, and intensified collaboration between universities and the private sector. The article presents research other and own study.
Keywords: industry, science, coordination.

International experience demonstrates that cooperation of scientific circles and representatives of business is more than advantageous. The advantages are of a mutual nature. In the paper, the author shall present selected indices facilitating the comparison of Poland against the background of other selected countries. The paper also includes selected results of the research reflecting the state of cooperation of the scientific and business circles in Poland while the author lists the barriers, of key importance in her opinion, related to the commencement of cooperation of both the circles. She also points out that one of the most frequent problems in striking up this cooperation is the lack of activities related to coordination and manifested in the different perception of the problem. In her work, the author omits a substantial barrier-generating factor connected to outlays on research and development activities which, when compared against more advanced countries – Member States of the European Union, is seven-fold lower[1] .

1. POLAND IN STATISTICS

Taking a look at the statistics comparing Poland with other countries does not allow for much optimism. Poland is in the transition stage of its development – between the "increased capacity" phase and the "innovation" phase[2] . Next to Poland, also other countries are in this phase. This group includes among others Croatia, Estonia, Hungary, Lithuania, and Slovakia[3]. Taking the Global Competitiveness Index into account, Poland presently ranks 41st whereas in the year 2010/2011 it occupied 39th position while back in 2007 it held 21st rank. One of the reasons for ever decreasing standing in the index comes as a relatively weak cooperation of circles of science and business as well as deficiency in terms of innovative solutions in education and business.

It is worth taking a closer look at the indices of the selected criteria. For the purposes of the comparison, three countries from the above-mentioned group, which includes Poland, were selected as well as Switzerland and Germany which rank first and sixth respectively in the Index. It is proper to mention that Switzerland and Germany were included in the comparison exclusively for the purposes of demonstration of

[1] Gabryś A. (Ed.), *Najlepsze praktyki w zakresie współpracy ośrodków naukowych i biznesu przy wykorzystaniu środków z UE*, Warszawa, 2008.

[2] Schwab K., *The Global Competitiveness Report 2011–2012*, World Economic Forum, Switzerland 2011, p. 11.

[3] EU Member States have been listed here.

model countries. Table 1 presents the basic information on the selected countries.

Table 1. Selected data

Index rank	Country	Develop-ment phase	Total popu-lation in	Total areas in km²	Density of population	Gross do-mestic
1	**Switzer-land**	Innovation phase	7.6	41 290	177,25	523.8
6	**Germany**		82.1	357 114	230,73	3 315.6
33	**Estonia**	Transition phase	1.3	45 226	31,14	19.8
41	**Poland**		38.0	312 685	123,52	468.5
44	**Lithuania**		3.3	65 200	55,10	36.4

Despite the highest GDP among the selected countries in the transitional phase, Poland does not rank high in the comparison (Table 2). The data describing Switzerland and Germany and included in the table are to serve the purpose of presentation of indices of the leading countries. Table 2 presents the selected criteria and their indices.

Estonia and the Czech Republic remain the best performers within Eastern Europe, ranking 33rd and 38th, respectively. As in previous years, the countries' competitive strengths are based on a number of common features. They rely on excellent education and highly efficient and well-developed goods, labour, and financial markets, as well as their strong commitment to advancing technological readiness, particularly in the case of Estonia. In addition, Estonia's 33rd rank reflects solid institutions and well-managed public finances[4].

Table 2 Selected indices, based on: Schwab K., *The Global Competitiveness Report 2011–2012*, World Economic Forum, Switzerland 2011

Index **Rank/142** **Score**	**Estonia**	**Poland**	**Lithuania**	**Switzer-land**	**Germany**
Global Com-petitiveness Index Rank/142 Score	33 Score: 4.62	41 Score: 4.46	**44** Score: **4.41**	1 Score: 5.74	6 Score: 5.41
Capacity for innova-tion Rank/142 Score	34 Score: 3.7	**49** Score: 3.3	48 Score: 3.3	2 Score: 5.8	3 Score: 5.7
The impact of sustain-ability on competitive-ness Rank/142 Sustainability impact	26 ⇘	31 ⇙	33 ⇙	1 ⇓	6 ⇓
Higher (by 10 or more positions): ⇑ Slightly higher (by 3 to 9 positions): ⇗ Stable (higher or lower by 2 or fewer positions): ⇒ Slightly lower (by 3 to 9 positions): ⇘ Lower (by 10 or more positions): ⇓					
Higher educa-tion and training Rank/142 Score	23 Score: 5.2	**31** Score: 4.9	26 Score: 5.1	3 Score: 5.8	7 Score: 5.7
Quality of the educa-tional system Rank/142 Score	42 Score: 4.3	**77** Score: 3.7	64 Score: 3.8	1 Score: 5.9	17 Score: 4.9
Quality of sci-entific research institutions Rank/142 Score	27 Score: 4.8	**44** Score: 4.1	37 Score: 4.4	2 Score: 6.3	10 Score: 5.6
University-industry collabo-ration in R&D Rank/142 Score	34 Score: 4.3	**65** Score: 3.6	31 Score: 4.4	1 Score: 5.8	13 Score: 5.2
Availability of scientists and engineers Rank/142 Score	62 Score: 4.2	**67** Score: 4.1	57 Score: 4.2	15 Score: 5.1	41 Score: 4.5

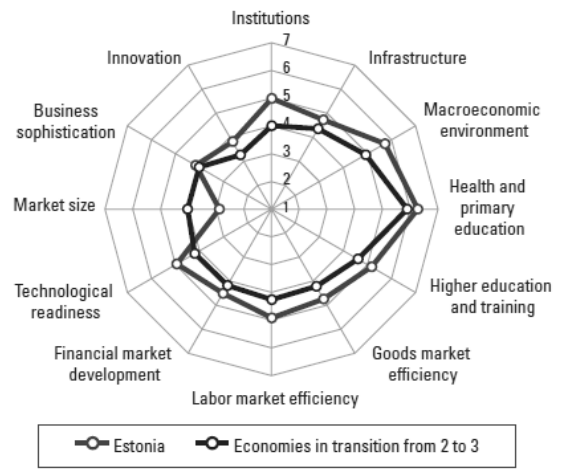
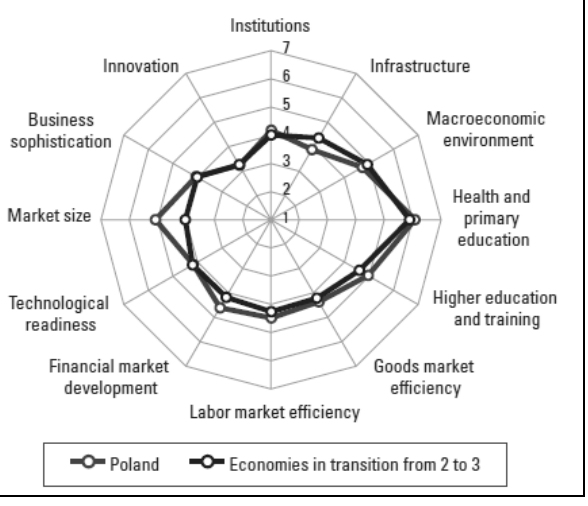
[4] Schwab K., *The Global Competitiveness Report 2011–2012*, World Economic Forum, Switzerland 2011, p. 26.

The indices above indicate that among the transition phase countries subject to the comparison, Poland does not rank among those with the high innovativeness level. It is a result of the unsatisfactory condition of higher education, the quality of education systems, the quality of R&D institutions as well as the low level of cooperation of scientific circles and industry. **Lithuania**, despite a lower rank in the Global Competitiveness Index, comes ahead of Poland as regards all the aspects mentioned above[5]. Lithuania and Estonia are also ahead of Poland in terms of cooperation of science and business. "Industry's small participation in the financing of R&D works (less than 40%) is a Polish specificity. The fundamental indicator of the increase in financing of the R&D activities is, therefore, the share of outlays for science in the Gross Domestic Product"[6]. As **Poland** transitions to the innovation-driven stage of development, it will have to focus more strongly on developing capacities in innovation and business sophistication. Stronger clusters, more R&D orientation of companies, and intensified collaboration between universities and the private sector[7].

Switzerland retains its 1st place position again this year as a result of its continuing strong performance across the board. The country's most notable strengths are related to innovation, technological readiness, and labour market efficiency, where it tops the GCI rankings. Switzerland's scientific research institutions are among the world's best, and the strong collaboration between its academic and business sectors, combined with high company spending on R&D, ensures that much of this research is translated into marketable products and processes that are reinforced by strong intellectual property protection[8].

Germany is ranked 6th this year, a decline of one place. Germany's business sector is highly sophisticated, especially when it comes to production processes and distribution channels, and German companies are among the most innovative in the world, spending heavily on R&D and displaying a strong capacity for innovation – traits that are complemented by the country's well-developed ability to absorb the latest technologies at the firm level. At the same time, the deteriorating availability of scientists and engineers (down from 27th to 41st this year) may erode the country's major competitive advantage in innovation if it remains unaddressed[9] (Table 3).

Table 3 Stage of development selected country, based on: Schwab K., *The Global Competitiveness Report 2011–2012*, World Economic Forum, Switzerland 2011, pp. 172, 184, 238, 296, 334

Country



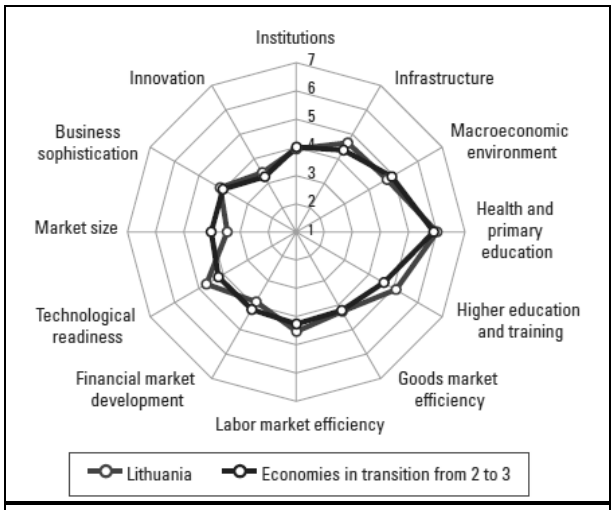
[5] Global Competitiveness Index takes into consideration other criteria than these mentioned here.

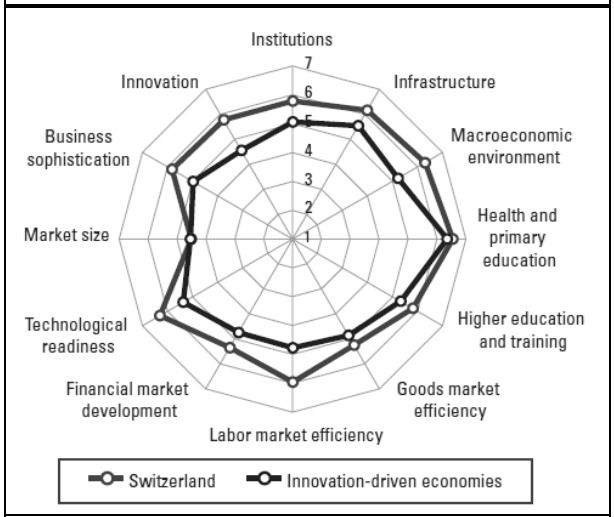
[6] Santarek K. (Ed.), *Transfer technologii z uczelni do biznesu. Tworzenie mechanizmów transferu technologii*, Polish Agency for Enterprise Development, Warszawa, 2008, p. 32

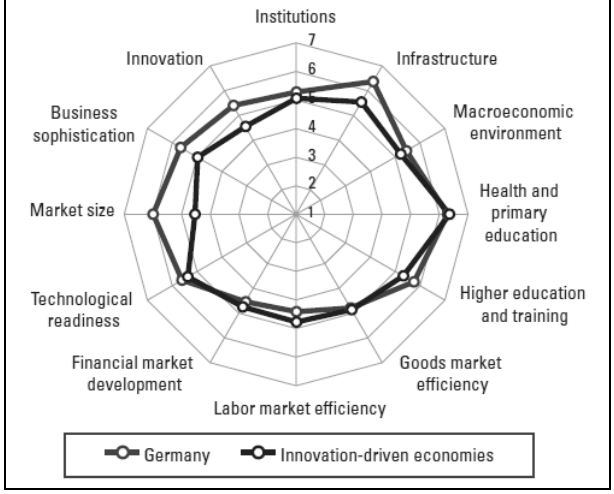
[7] Schwab K., *The Global Competitiveness Report 2011–2012*, World Economic Forum, Switzerland 2011, p. 26.

[8] Schwab K., *The Global Competitiveness Report 2011–2012*, World Economic Forum, Switzerland 2011, p. 11.

[9] Schwab K., *The Global Competitiveness Report 2011–2012*, World Economic Forum, Switzerland 2011, p. 24.







Therefore, the question arises how to create innovative economy in such a case if these two circles are incapable of cooperation? Entering into cooperation by the scientific circles and business has a direct impact on the application of the potential of both these groups in the scope of increasing innovativeness and competitiveness. This is the very reason why this issue requires closer attention.

The report which the author refers to indicates that Poland's main asset is the size of its market. However, for the country to go on to the higher level of development, honing skills in the scope of innovativeness, development of clusters, and increased **cooperation between scientific circles and industry** is a must.

2. RESULTS OF THE RESEARCH INTO COOPERATION BETWEEN SCIENCE AND INDUSTRY

The quality and the strength of relations occurring between companies and R&D institutions is of particular importance in the context of increasing competitiveness. Strong corporate systems of both the circles facilitate the improvement in the quality of life of residents, support entrepreneurship, and reinforce the image of scientific centres and of the given region. The lack thereof or weak cooperation relations between both the circles results in the scientific centres and regions' shift to the peripheries and in their marginalisation.

Observing the models of cooperation of science with industry, the following models can be distinguished[10]:

- Hierarchical – characterised by the domination of a strong centre cooperating with multiple organisations,
- Network – characterised by the intensity and comprehensive nature of interconnections between many organisations of various nature,
- Multicentric – connected with the existence of several loosely connected and cooperating organisations,
- Atomistic – occurs in case of connections between a small number of organisations and lack of cooperation between them.

[10] Górzyński M., Pander W., Koć P., Tworzenie związków kooperacyjnych między MSP oraz MSP i instytucjami otoczenia biznesu, Polish Agency For Enterprise Development, Warszawa, 2006, p. 8

Table 4. The offer of scientific centres addressed at the industry and that of the industry for the science,

source: Knop L., *Kształtowanie współpracy w triadzie: biznes-nauka-administracja*, (available at: www.dlafirmyinfo.pl), access date: Aug. 15th 2011

Offer for the scientific circles	Offer for the business
Indication of the development trends in the region and in the sector	Preparation of specialist Human Resources
Commissions (financing) for specific services – technological solutions	Creation of new technologies
Creation of job opportunities (employment of graduates)	Transfer of knowledge, research, attestation, certificates, expert opinions
Experience (know-how)	Prestige through obtention of testing and product credibility
Publishing scientific achievements	Provision of access to infrastructure
Sponsoring	Informing on market tendencies (expert level)
Implementation of research results (transfer of knowledge to the business)	Providing access to international contacts

Browsing through the science's offers for the business and those of the business for the science, certain discrepancies can be seen. They are included in Table 4.

In the first order, entrepreneurs look for a possibility of finding "a new road" for their sector and enterprise with the view of gaining competition advantage in relation to other enterprises. They also seek technological solutions allowing to fill in the market gap or to introduce a new product or a product expanded by new functionalities.

The scientific circles set priorities in other areas. In the first order, they focus on realisation of activities they are well familiar with – and so – educating and preparing the human resources to meet new challenges related to the global market. This is the reason for the offer where the main priority focuses on preparation of specialist HR (post-graduate courses and business trainings for senior management). Also preparation of expert opinions with the view of evaluation of operation of economic organisations and presenting recommendations for companies enjoys popularity.

Table 5. Traditional forms of cooperation universities – industry, source: Santarek K. (Ed.), Transfer technologii z uczelni do biznesu. Tworzenie mechanizmów transferu technologii, Polish Agency for Enterprise Development [Pl: PARP], Warszawa, 2008, p. 33; Responsible Partnering. Joining forces in a word of open innovation. A guide to better practices for collaborative research between science and industry, European Commission – EIRMA – EUA – EARTO – ProTon Europe, January 2005

		Industrial enterprises	
		individual	**institutional**
R&D organisations	**institutional**	– visiting professors – studies / scientific internships – participation in scientific councils – additional employment	– cooperation agreements – R&D consortia – joint R&D programmes (external financing) – commissioned R&D projects
	individual	– personal contacts – conference participation – guest lectures – participation in scientific teams (project teams)	– student work placements and internships – work placements / PhD research – consulting – additional employment

The traditional model of cooperation (Table 5) of science and industry is afflicted with a number of defects. The selected ones follow below[11]:

- Unused potential (human, R&D and scientific apparatus),
- Low effectiveness of research-dedicated outlays – too low effects (no returns from outlays),

[11] Santarek K. (Ed.), Transfer technologii z uczelni do biznesu. Tworzenie mechanizmów transferu technologii, Polish Agency for Enterprise Development, Warszawa, 2008, p. 33

- Deterioration of quality of education, excessively theoretical programmes of education, not useful for the needs of practice,
- Limited possibilities for development of universities due to the barriers in the level of financing of universities and research (budget limitations),
- Pauperisation of the environment and pathological phenomena (e.g. multiple jobs).

Table 6. Selected barriers for cooperation between science and business, based on: Bariery współpracy przedsiębiorców i ośrodków naukowych – Raport, the Ministry of Science and Higher Education, Department of Implementation and Innovation, November 2006, p. 5; Gabryś A. (Ed.), Najlepsze praktyki w zakresie współpracy ośrodków naukowych i biznesu przy wykorzystaniu środków z UE, Warszawa, Dec. 20th, 2008

Barriers indicated by scientific circles	**Barriers indicated by business circles**
Lack of sponsors	Lack of sufficient incentives (e.g. fiscal) on the part of authorities
Lack of interest on the part of entrepreneurs	Excessive price of cooperation offered by scientists/scientific centres
Lack of competent middlemen in cooperation of science and business	Lack of cooperation offers for companies
Lack of know-how in terms of practice	Lack of information regarding specific possibilities of cooperation and advantages resultant therefrom
Insufficient institutionalisation of cooperation	Scientists/scientific centres' ignorance of business realities (low competence of scientists or excessively theoretical approach)
Lack of finances	Red tape – excessively slow tempo of cooperation with scientists/scientific centres
	Lack of interest in cooperation on the part of scientific centres
	Insufficient applicability of solutions offered by scientific centres

Also a visible hermetisation of the scientific circles can be seen. It is a result of realisation of research within one's own scientific unit and the low level of cooperation with other scientific centres, and with the business circles in particular. The scientific circles are also oriented towards the dissemination of research results first and foremost through scientific publications and reports complying with the monograph requirements[12].

In distinguishing the barriers indicated by the individual circles, one can see that they feel numerous, however differing, barriers preventing them from establishing first contacts and later cooperation (Table 6).

It is certainly necessary to take up many activities with the view of improving the present state of affairs. The following can be mentioned among others[13]:

- Raising entrepreneurs' awareness regarding possibilities of cooperation with R&D centres,
- Propagation of advantages resulting from cooperation with scientific centres,
- Activation of scientists, providing them with encouragement to come forth to meet the needs of business, encouragement for autopromotion,
- Creation of internet platform for exchange of contacts, flow of information, and transfer of knowledge,
- Commercialisation of research works results,
- Entering into cooperation in networks and clusters.

However, it must be borne in mind that even if cooperation between science and business comes into effect, the communication and insufficient information flow present further obstacles. The research conducted by A. Gabryś indicates that the main barrier rendering the entering of science and business into cooperation is nothing else, but the insufficient flow of information between them. He indicates that in relation to the scientific circles it is 35% of respondents' answers while in case of

[12] Santarek K. (Ed.), Transfer technologii z uczelni do biznesu. Tworzenie mechanizmów transferu technologii, Polish Agency for Enterprise Development, Warszawa, 2008, p. 33

[13] Machnik-Słomka J., *Uwarunkowania współpracy między nauką a gospodarką w procesie transferu technologii i komercjalizacji wiedzy*, in: Budowa współpracy nauki z biznesem, Warszawa, 2010, pp. 14-15

the business environment – 45%[14]. Another substantial barrier-generating factor in the cooperation of science and business is the lack of common goals.

3. PROBLEM WITH COMMUNICATION AND LACK OF COORDINATION OF OPERATIONS – SYSTEMATISATION OF KNOWLEDGE

The author is of the opinion that the effective and harmonious cooperation comes as a result of constant communication exchange. The flow of messages facilitates coordination of works within the group e.g. working on a completion of a project. Before entering into any form of cooperation, the scientific and business circles should transfer to each other all sorts of information and should be involved in the exchange of knowledge-related resources.

It is obvious that prior to entering into cooperation, each of the parties holds a set of more or less relevant information. Such information is known to both parties before they embark on a joint realisation of a project. It is possible to find that it is common knowledge related to a certain code (e.g. issues and notions of logistics), related to the sector's specificity and even cultural conditions. This common set of information in a given field (the common code) enables mutual understanding and, in effect, commencement of effective cooperation of circles so differing as science and business. It comes as a result of accumulation of similar experience, observation of data and facts as well as of arriving at the same conclusions and of learning, too. The common code is a symbolic description of reality.

However, the estrangement of both the circles has this effect that communication in seemingly "trivial" matters becomes extremely difficult. The reason for this state of affairs lies in the lack of understanding, discrepancies in terms of notions and definitions, and in following a different code of values. Also differing perception or interpretation of facts contributes to the problems in communication and, as a result, to the failure in striking up cooperation[15].

Also the discrepancy related to the personal characteristics following from the pursued profession and acquired experience poses an obstacle in effective communication between science and business. Table 7 presents this very dissonance.

In such a case, entering into sustainable cooperation of science and industry becomes nigh on impossible. Not a small part of their time is dedicated by the parties to the bilateral explanation of their objectives and establishment of the required and sufficient plane of understanding. Prolonged problems related to the explanation of notions and, in many a case, the unwillingness to come to understanding result in the cessation of contacts and termination of negotiations which, after all, constitute only the overture to entering into cooperation.

Table 7. Characteristics of a scientist vs. Characteristics of an entrepreneur, source: Kubiński P., Kwieciński L., Żurawowicz L., *Naukowiec przedsiębiorcą. Własność intelektualna*, Wrocław 2010, p. 6.

Characteristics of a scientist	Characteristics of an entrepreneur
• Creation of intellectual property	• Economic success
• Long-term operation horizon	• Long- or short-term operation horizon (depending on the needs)
• Insight and precision	• Effectiveness
• Mission-oriented	• Market-oriented
• Deductive or analytical style of operation	• Inductive or synthetic style of operation
• Disciplinary	• Goal-/problem-oriented
• Inventiveness /inquisitiveness	• Obligation in terms of plans
• No time limitations	• Private (company) good
• Common good	• Objective: strengthening of the company's market position
• Objective: scientific rank	

Let us present the above in the form of two net (diagram) models. Among others, they are used to

[14] Gabryś A. (Ed.), *Najlepsze praktyki w zakresie współpracy ośrodków naukowych i biznesu przy wykorzystaniu środków z UE*, Warszawa, 2008

[15] Compare: Jochemczyk Ł., Ziembowicz M., *Sieci wiedzy. Perspektywa dynamiczna*, in: Układy złożone w naukach społecznych, A. Nowak, W Borkowski, K. Winkowska-Nowak (Eds.) , Wydawnictwo Naukowe Scholar, Warszawa, 2009, p. 42.

illustrate reality. For reality may be illustrated with the use of a structure consisting of nodes and links between them[16]. Notions, facts, or events are presented with the use of nodes in the net. The connections, in turn, demonstrate the relations occurring between the elements of reality. Relations reflect the dependencies and associations between the facts on the base of knowledge[17]. Diagram models of this type are labelled with the name of semantic nets.

The semantic nets as models for representation of reality may possess a varied structure. The structure can range from the hierarchical (classical) one in the form of a tree and developed by Collins and Quillian, to nets rejecting the hierarchical structure and called the spreading activation model, developed by Collins and Loftus[18]. In case of this second model, the template of links is created in keeping with an individual experience. The spreading activation model "consists in transmitting an impulse activating selected net elements to further elements connected thereto"[19]. If the activation has adequate strength, it is transmitted to further adjacent elements of the net.

For this reason, in the further part of the paper, the spreading activation model is used. It allows to indicate the different perception of the same issue, i.e. the cooperation of science and business and the their representatives knowledge resources. The model has also this advantage that the objects are not ordered hierarchically according to the set criteria, but they refer to the to-date experience and knowledge of representatives of both the circles.

The scientific and business circles have different reality imaging which renders the communication difficult. Figure 1 and 2 present spreading activation models pertaining to the premises of cooperation of science with industry (Fig.1) and pertaining to the premises of cooperation of industry with the scientific circles (Fig. 2).

Fig. 1 The spreading activation model: Premises of cooperation of science with business, own study

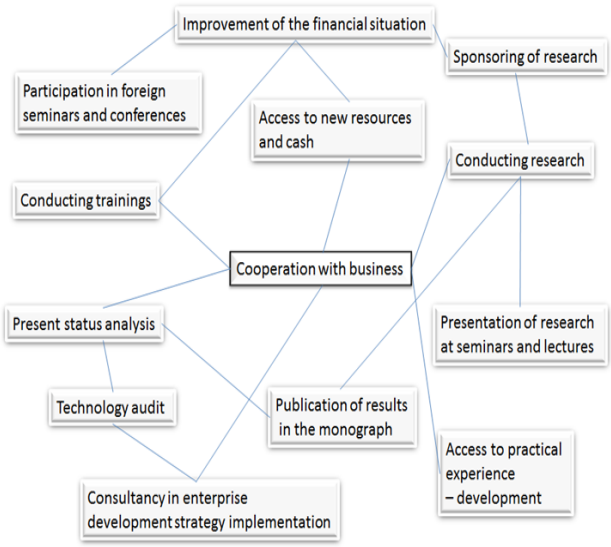
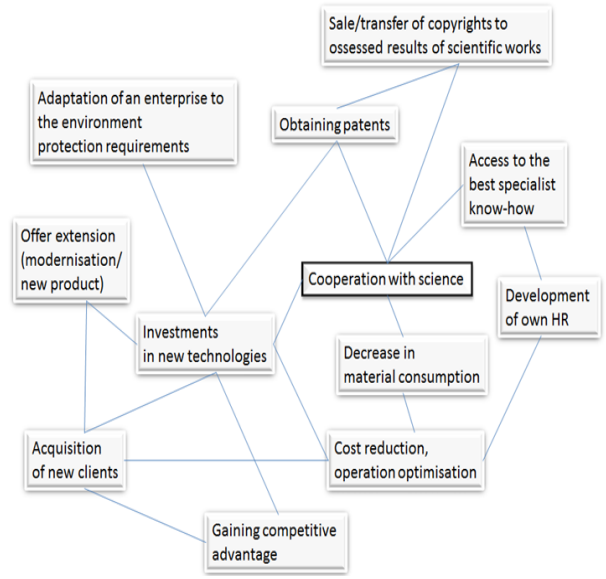


Fig. 2 The spreading activation model: Premises of cooperation of industry with science, own study



The models demonstrate that there are areas which do not require to be arranged at the beginning of the freshly commenced cooperation.

[16] Jochemczyk Ł.W., *Sieci Wiedzy*, in: Modelowanie matematyczne i symulacje komputerowe w naukach społecznych, Warszawa, 2007.

[17] Mulawka J.J. *Systemy ekspertowe*. Wydawnictwo Naukowo-Techniczne, Warszawa, 1996

[18] Collins A. M., Quiliqn M. R., *Retrieval time from semantic memory*, in: Journal of Experimental of Verbal Learning and Verbal Behavior, t. 8, 1969, pp. 240-247; Collins A. M., Loftus E. F., *A spreading activation theory of semantic priming*, in: Psychological Review, 1975, Vol. 82, pp. 407-428.

[19] Szymański J., *Wyszukiwanie kontekstowe w pamięci semantycznej*, a PhD thesis, Gdańsk, 2009, p.19

Conducting trainings (cooperation on the part of science) as well as access to the latest specialist knowledge and, in effect, development of personnel (on the part of an enterprise) is a joint representation of reality and expectations of both sides.

To a small degree, the similarity pertains also to expert opinions, audits, and consultancy services offered by the scientific circles. Nevertheless, next to the above, the industry expects also the research and investment in new technologies which would facilitate the competitive development of enterprises and would expand the number of consumers.

A serious discrepancy appears in relation to the financing of cooperation. The scientific circles expect financial support which could be allocated to the improvement of their financial standing and the possibility to publish research and present the material at seminars and conferences sponsored by business. Undoubtedly, it is a result of the manner in which universities and scientific centres settle accounts for conducted works ("pursuit" for individual credits and credits of specific units (e.g. faculties)). Entrepreneurs, if they decide to sponsor research, attempt to take over the results and use them solely for their own commercial purposes – the profit from market sales.

4. CONCLUSIONS

The above-described disharmony related to the personal features of a scientific and business personality, knowledge resources, and experience has this result that the cooperation between the scientific circles and industry does not reach the sufficient level. Examining the statistics presented in the first part of the work, one can conclude that it is outright unsatisfactory.

In many cases, the dissonance and the visible contrast of the premises, expectations, and objectives render the understanding, coordination, and, in consequence, the cooperation between science and business impossible. Hence, as a result of the constant flow of information, it is necessary to identify in the occurring models the reality of the differences to later eliminate or minimise them. These actions shall cause the shift in the representation of the world of each of the parties[20].

Bilateral communication shall allow for the development of similar structures in models or in their fragments. As a result of the mutual transfer of information and listening to the counterparty, the parties arrive at a compromise and understand their intentions. The structures of individual models of spreading activation undergo changes and modifications. These changes may, however, take place in a longer time perspective. Regardless of time, it is the highest time some actions were embarked on since in the contemporary society and under the global economy conditions, science is closely connected to economy.

If such actions are not taken up, the weakness of R&D institutions, the weakness of the higher education system and of the system of education and cooperation between science and business will shift Poland towards the peripheries and marginalisation. Hence, it is necessary to strive for the higher level of economic development through cooperation of science and industry since it has been proven that it facilitates the shaping of a network of inter-relations between organisations and enables the establishment of partnership between enterprises[21].

LITERATURE

[1] Bariery współpracy przedsiębiorców i ośrodków naukowych – Raport, the Ministry of Science and Higher Education, Department of Implementation and Innovation, November 2006

[2] Collins A. M., Quiliqn M. R., Retrieval time from semantic memory, Journal of Experimental of Verbal Learning and Verbal Behavior, t. 8, 1969, pp. 240-247.

[3] Collins A. M., Loftus E. F., A spreading activation theory of semantic priming, in: Psychological Review, 1975, Vol. 82, pp. 407-428.

[4] Jochemczyk Ł., Ziembowicz M., Sieci wiedzy. Perspektywa dynamiczna, A. Nowak, W Borkowski, K. Winkowska-Nowak (Eds.) , Układy złożone

[20] Compare: *Układy złożone w naukach społecznych*, A. Nowak, W Borkowski, K. Winkowska-Nowak (Eds.), Wydawnictwo Naukowe Scholar, Warszawa, p. 42.

[21] Compare: Górzyński M., Pander W., Koć P., *Tworzenie związków kooperacyjnych między MSP oraz MSP i instytucjami otoczenia biznesu*, Polish Agency For Enterprise Development, Warszawa, 2006, p. 8

w naukach społecznych, Wydawnictwo Naukowe Scholar, Warszawa, 2009.
[5] Gabryś A. (Ed.), Najlepsze praktyki w zakresie współpracy ośrodków naukowych i biznesu przy wyko-rzystaniu środków z UE, Warszawa, 2008.
[6] Górzyński M., Pander W., Koć P., Tworzenie związków kooperacyjnych między MSP oraz MSP i instytucjami otoczenia biznesu, Polish Agency For Enterprise Development, Warszawa, 2006.
[7] Jochemczyk Ł.W., Sieci Wiedzy, Modelowanie matematyczne i symulacje komputerowe w naukach społecznych, Warszawa, 2007.
[8] Knop L., *Kształtowanie współpracy w triadzie: biznes-nauka-administracja*, (available at: www.dlafirmyinfo.pl), access date: Aug. 15th 2011
[9] Kubiński P., Kwieciński L., Żurawowicz L., Naukowiec przedsiębiorcą. Własność intelektualna, Wrocław 2010.
[10] Machnik-Słomka J., Uwarunkowania współpracy między nauką a gospodarką w procesie transferu tech-nologii i komercjalizacji wiedzy, Budowa współpracy nauki z biznesem, Warszawa, 2010, pp. 14-15.
[11] Mulawka J.J. Systemy ekspertowe. Wydawnictwo Naukowo-Techniczne, Warszawa, 1996.
[12] Responsible Partnering. Joining forces in a word of open innovation. A guide to better practices for collaborative research between science and industry, European Commission – EIRMA – EUA – EARTO – ProTon Europe, January 2005
[13] Santarek K. (Ed.), Transfer technologii z uczelni do biznesu. Tworzenie mechanizmów transferu technologii, Polish Agency for Enterprise Development, Warszawa, 2008.
[14] Schwab K., The Global Competitiveness Report 2011–2012, World Economic Forum, Switzerland 2011.
[15] Szymański J., Wyszukiwanie kontekstowe w pamięci semantycznej, a PhD thesis, Gdańsk, 2009.
[16] A. Nowak, W Borkowski, K. Winkowska-Nowak (Eds.) Układy złożone w naukach społecznych, Wydawnictwo Naukowe Scholar, Warszawa, 2009.

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