System Research Institute
Polish Academy of Sciences

INTERNATIONAL KNOWLEDGE AND INNOVATION NETWORKS FOR EUROPEAN INTEGRATION, COHESION AND ENLARGMENT

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Innovation Networks and Clustering Process in the Silesia Voivodeship

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1. Introduction

Recent forecasts clearly demonstrate that coal is and will still be one of important sources of energy. Such developed and developing countries as USA, Russia, China, India, Australia, Republic of South Africa, Indonesia and South Korea are predicting raise in their coal consumption in the coming years. Coal consumption in the EU "15" is stable and predicted to be stable on the level of 250 million tonnes, of which 170 million tonnes are imported. Poland, a new member of the UE, produced 102,9 million tonnes of coal in 2003 with the lowest unit cost of excavation per tonne of 32 €, compared to 130-140 € in Germany and Spain and 170 € in France. In 1970s Poland produced more than 200 million tonnes of coal and was ranked the 5th producer and exporter in the world. Poland has been also known as a leading producer of machines and equipment for underground mining.

The sector of "mining machines and equipment" was selected for the IKINET project studies because it is an interesting example of successful restructuring process based on existing competence, experiences and intensive interaction with the knowledge infrastructure. Almost all Polish industrial firms from the sector are located in Silesia, one of 16 voivodeships in Poland, where almost all coalmines are located too. According to the IKINET methodology we selected 15 industrial firms and called them a "cluster", although it is rather a network of formal and informal cooperation centered around the KOMAG Mining Mechanization Centre, a sectorial research institute.

The market of the mining machines and equipment has changed dramatically in last 15-20 years and today is a typical high-tech products market, operating on a global scale, and dominated by a few key actors as JOY Global INC. All products of the market can be grouped in four main lines:

- longwall shearers and road headers,
- powered roof supports,
- transportation systems for underground and vertical transport,
- coal preparation systems.

The market is under constant increasing pressure from work safety and environment protection requirements. As a result of the global competition and safety/environment protection requirements, the products became more and more complex, using the up to date achievements of:

- automatization,
- information technology,
- nanotechnology.

Also, the customer-producer relationships are now more complex and covers all activities from designing a required system customized to the client's mining and geological conditions and requirements through maintenance, service and substitution of the old systems.

The 15 selected industrial firms' production is sold both domestically and abroad. The Polish market for mining machines an equipment is too small for the cluster, therefore the selected firms are explicitly aiming to a greater diversification of products and markets. Foreign markets are considered as key areas for their future growth. In the last 2-3 years, when the demand for coal increased substantially, one can observe more investment in the mining industry, including new mining machine and equipment. Such changes are also observed in Poland: many coalmines had a profits for the first time in more then 10 years and put part of them for replacement of used machines. In common opinion such situation will last next 3-6 years. For instance „Kopex" S.A. – leading Polish exporter of mining machines and equipment has increased his turnover by 60% in 2004. One of its biggest investments consists in supply longwall shearers to „Tabas Coal Mine" in Iran, where beside Polish firms, some companies from Germany and Great Britain are participated. Formation of international consortia for realization of export projects is considered as an example of new activities of Polish firms. Leading firms have increased their turnover by 50% in 2003 and export by 30-50%.

2. Regional background

2.1 General description of the region

Silesia is NUTS II region and one of 16 voivodeships in Poland, with the highest population density (382 persons per km^2). On the area of 12.300 km^2 (4% of the area of Poland), live 4.8 mln inhabitants, which correspond to the second position behind Mazowieckie Voivodeship. As far as 17,4% of the total employment in Poland is located in Silesia and its GRP per capita amounts to 6000 euro (110.4% of the Polish average and only 28,9 of the EU average).

Through almost all the 20th century, Silesia due to its heavy industry was considered as one of the most industrial region in Europe. Such industrial monoculture was even strengthen after the second world war. At the begging of the 1990s the large and complex programme of reindustrialization of Silesia has been started with the main aim at change the regional industrial profile to more diversified one. In 2003 the structure of the regional economy looks like:

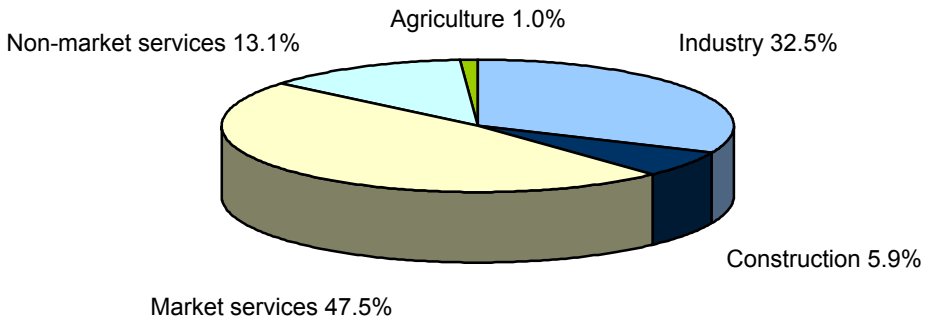


Fig. 1. The structure of the Silesian economy

The vast (94.6%) majority of all entities in the regional economy are small enterprises employing up to nine persons, next medium firms with the employment up to 49 persons amount up to 4.4%, while the large firms share only 1% of the number of all firms in Silesia. The large firms are mostly from steel and mining industry.

In particular the problem o the mining and steel industry in Silesia turned out to be the major bottleneck for economy development of the region in the time of transformation from the

central planned to market oriented economy [1]. Large steelworks and mines were and still are state owned, highly vertically integrated companies, often subsidized from the state budget. They were completely unprepared to the market economy and only recently some steelworks were re-privatized and down-sized while the mining industry still waits for a complete, sound and realistic plan of restructurization of this sector.

Changes observed in the economic structure of the Silesia Voivodeship confirm that the service sector is more and more important in generating gross added value. Between 1995 and 2000 share of units of the market and non-market services sector in generating gross added value increased by 9%. In 2002, more than half of gross added value (61.0%) was generated in the service sector. Despite its growing importance, the share of industry in generating gross added value is still important. Industry and construction generated 38% of gross added value in 2002, half of which was generated in the industrial processing sector. The most significant industries are: mechanic vehicles, trailers and semi-trailers production with growing importance of automotive sector, metal production, food and beverages industry, metal goods production and machines and equipment production.

To evaluate perspectives for economic development in developed countries, one often applies the OECD classification of the industrial processing section according to technology level based on “R&D content”. Taking into account the indicators “sold production”, “level of employment”, “share of the largest enterprises” and “share of the most important goods in the processing industry”, one could state that the medium-high-tech and high-tech sectors are poorly developed in the Silesia Voivodeship.

	SOLD PRODUCTION		NUMBER OF EMPLOYED		LARGEST ENTERPRISES**	MOST IMPORTANT GOODS**
	250 employed or more	10-249 employed	250 employed or more	10-249 employed		
High-tech sector	-	0,2%	-	0,3%	no enterprises	no goods
Medium-high-tech sector	21,0%	14,2%	10,1%	10,6%	27,8%	18 %
Medium-low-tech sector	7,5%	16,2%	6,5%	12,2%	27,8%	36%
Low-tech sector	22,8%	17,1%	11,4%	17,4%	44,4%	46%

Source: Regional Innovation Strategy of Silesia Voivodeship 2003-2004

* *Data of the Office of Statistics in Katowice and Statistical Yearbook 2002, the Office of Statistics in Katowice, ISSN 1640-0097*

** Based on the list of 500 largest companies in 2001, prepared by „Rzeczpospolita"

2.2. Research and development sector

An important part of the national potential of the R&D sector is situated in the Silesia Voivodeship. According to data of the Main Office of Statistics, this sector included at the end of 2001:

- 113 units (12.6% of units in Poland) including: 6 institutes of the Polish Academy of Science, 32 R&D, 64 development units, 11 institutes of higher education;
- 11670 employed in the R&D sector (9,5% of employment in Poland) including: 654 professors, 809 assistant professors and 3760 PhDs;
- 3,8 persons full-time employed in R&D activities per 1000 employees (national average: 4,5 persons);
- Internal expenditures of the R&D sector in the Silesia Voivodeship represented 8,34% of total expenditures for R&D in Poland (the Mazowieckie Voivodeship 44,07%, the Małopolskie 9.49%, the Dolnośląskie 7,03%);

- Internal expenditures for the R&D sector per 1 inhabitant of the Silesia Voivodeship represent 83,89 PLN (7th position in Poland) whereas the average is 125,72 PLN. These expenditures represent in Mazowieckie 422 PLN, in Małopolskie 142 PLN, in Dolnośląskie 115 PLN, in Łódzkie 113 PLN;
- Total internal expenditures of the R&D sector represent 0,41% of GDP whereas the national average is 0,70% (9th position in Poland); These expenditures represent in the Mazowieckie Voivodeship 1,59%, in Małopolskie 0,96% and in Dolnośląskie 0,57%.

The regional system of permanent education in the Silesia Voivodeship relies on a wide education base including 33 institutes of higher education, of which 23 are non-public schools. In 33 institutes and 11 branches, distant-learning departments and advisory points there are 186 400 students. The Silesia Voivodeship is placed second, after the Mazowieckie Voivodeship as for number of students. In 2001, the number of students per 1000 inhabitants was equal to the domestic average and amounted to 40 persons per 1000 inhabitants. A positive trend may be observed however, that the number of students in higher education has leveled off on the level achieved in the late 90s and in some fields it has even grown. Numerous graduates represent nowadays the most entrepreneurial and flexible layer of society, which is capable of absorbing and developing innovations. This factor may be decisive in terms of investment attractiveness of the region in the near future.

2.3. Small and medium enterprises in the Silesia Voivodeship

In the Silesia Voivodeship in 3 088 out of 403 400 registered companies were companies with foreign capital (data December 2001). Among national companies operating in the region 356 100 were entities of natural persons and non-trading companies which equals to 88,3%. It represents a growth of 31% in comparison with 1995 (271 200). This number may serve as an indicator of a level of entrepreneurship in the region. The number of companies acting by virtue of commercial law at the same time has increased by 3,9%, from 11 900 in 1995 to 19 600 in 2001.

A survey carried out among SME in the Silesia Voivodeship has indicated that they can be divided into 3 groups as for their innovativeness.

SME innovativeness in the Silesia Voivodeship		
Very innovative companies	**Medium innovative companies**	**Low innovative companies**
Modern, open for innovation and active. Innovative solutions are new on the domestic and international market. Supralocal nature of sale structure (domestic and foreign market dominate). High dynamics of changes in employment (rise).	They have limited and less stable contacts with a small group of partners. Lack of a determined development strategy. Innovation is new only for the company itself, on the local and domestic market. Medium dynamics of changes in employment (rise and fall).	Focus on surviving. Low interest in innovation. Innovative solutions are new only to the company itself. Local nature of sale structure (local sale markets dominate). Stagnation in employment.
Approx. 10% SME	**Approx. 60% SME**	**Approx. 30% SME**

Source: Regional Innovation Strategy of the Silesia Voivodeship

At the end of the description of the region we present the Silesia at glance table and the map of the region.

Silesia at glance

BASIC CHARACTERICS	NUMBERS
Area	12.3 thousand sq. km (4% of Poland's area) (ranked 14th in Poland)
Population	4,8 mln inhabitants (12.9% of Poland's population) (ranked 2nd in Poland)
Population density	393 inhabitants/sq. km (ranked 1st in Poland)
Degree of urbanization	79.3% (ranked 1st in Poland)
Migration per 1000 population	-2.1 (ranked 15th in Poland)
Gross Domestic Product (GDP) per capita	110.1% on average
Gross value added per employed person	115.9% on average
Gross value added in agriculture	1.7%
Gross value added in industry and construction	40.9%
Gross value added in services	46.7%
Employment in agriculture	12.6% of population
Employment in industry and construction	36.6% of population
Employment in services	34.4% of population
State owned enterprise	294 (ranked 2nd in Poland)
Companies with foreign capital	3880 (ranked 4th in Poland)
Number of SMS *	412115 (ranked 2nd in Poland)
Share in Poland's export *	16,5% (ranked 2nd in Poland)
Rate of unemployment **	16.5%
Population with higher education ***	7,0%
Innovation spending	17.0% of national spending for innovation in industry
R&D spending	8.3% of national spending for R&D
Employment in R&D	9.62% of total employment in R&D in Poland

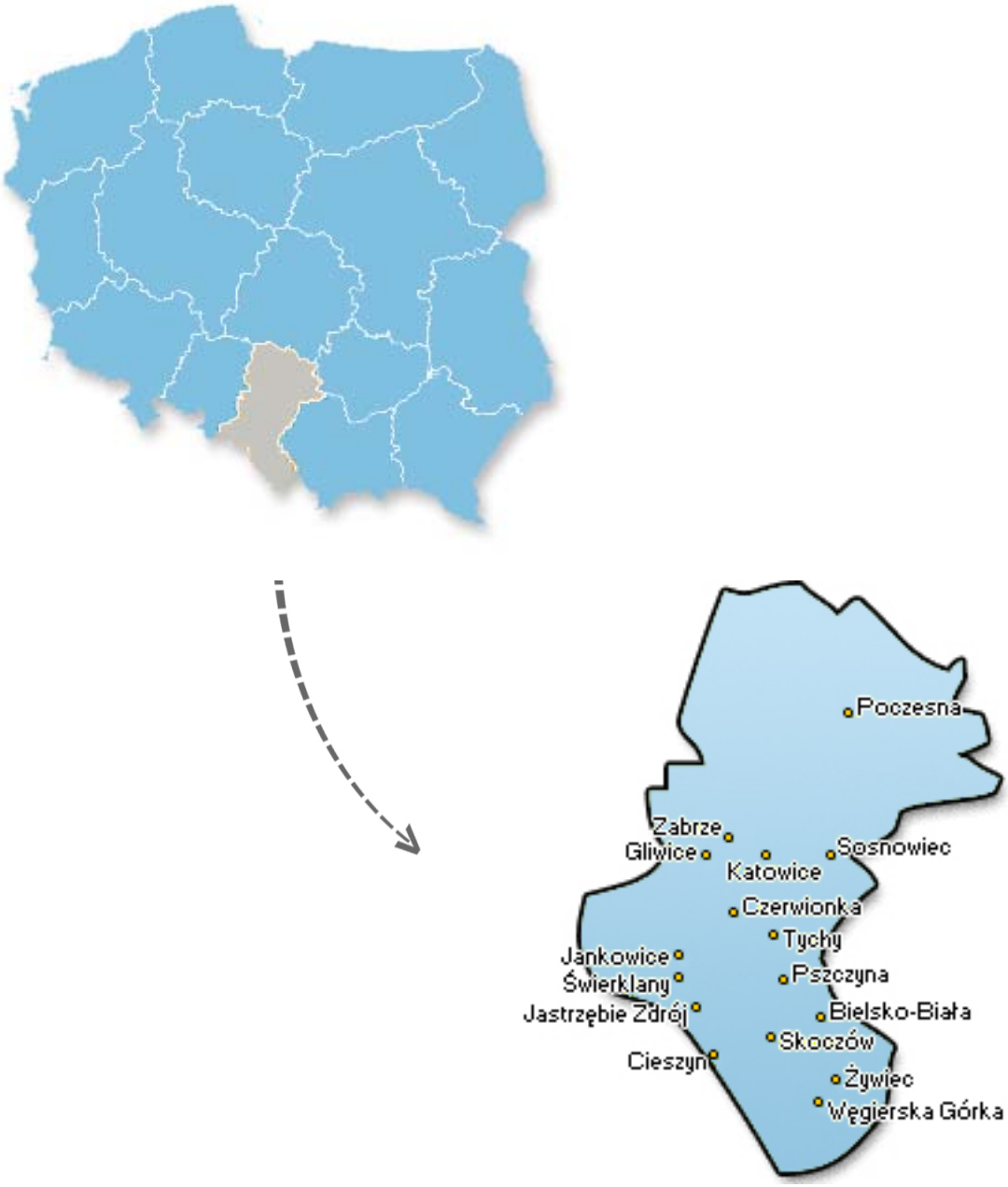
Source of data: "Statistical yearbook of regions – Poland" Central Statistical Office, 2002
** Source of data: PARP, Statistics http://www.parp.gov.pl/statregiony.php*
*** Source of data: Bezrobocie online (on August, 2003 the average rate of unemployment in Poland was 17.6%)*
**** „Development strategy of the Śląskie voivodeship 2000-2015", Parliament of Śląskie Voivodeship, Katowice, September 2000*

Innovation performance of Poland relative to EU25 in 2004 *

HUMAN RESOURCES	
S&E graduates/20-29	71
Population with tertiary education	65
Participation in life-long learning	56
Employment in high-tech manufacturing	-
Employment in high-tech services	-
KNOWLEDGE CREATION	
Public R&D/ GDP	69
Business R&D / GDP	10
High-tech EPO patents / population	2
High-tech USPTO patents / population	1
TRANSMISSION AND APPLICATION OF KNOWLEDGE	
SMEs innovating in-house	39
SMEs innovating co-operation	71
Innovation expenditure	85
INNOVATION FINANCE, OUTPUT AND MARKETS	
High-tech venture capital investment / GDP	13
Early stage venture capital / GDP	28
Sales of “new market” products	-
Home internet access	68
ICT expenditure / GDP	123
High-tech manufacturing value added	43

**Source: 2004 European Innovation Scoreboard Country Pages EU25 + Candidate Countries*
http://trendchart.cordis.lu/scoreboards/scoreboard2004/pdf/eis_2004_annex2.pdf

Map Poland and Silesia region



3. Empirical study of mining machines and equipment sector

3.1. Description of the sector

The sector of "mining machines and equipment" was selected because it is an interesting example of successful restructuring process, based on exiting competence and intensive interaction with the knowledge-infrastructure, which can, up to some extend, be repeated with the whole Polish machinery sector. As the result of the restructuring process one can observed the formation of the "mining machines and equipment" cluster, although it should be noted that clusters in Polish economy are not as developed and not so popular as they are in the EU.

3.1.1. Name of the sector

"mining machines and equipment"

3.1.2. Code in NACE classification

29 Manufacture of machinery and equipment n.e.c.

291 Manufacture and machinery for the production and use of mechanical power, except aircraft, vehicle and cycle engine

3.1.3. Relevance for the region

After the second world war till 1980s Poland was one of the main coal producer (the 5th in the world ranking) and exporter, also kwon in the world for its mining machines and equipment. For instance the mining industry of India, People Republic of China and Republic of South Africa were based on Polish machines for underground mining. Since the beginning of 1990s the sector was confronted with many considerable problems caused by the change of economic system: almost all business ties both domestic and international were broken, almost all companies in the sector were down-sized and many of them even closed. In 10 years the output of the mining industry dropped more then 2 times. In the face of the crisis of the mining industry the domestic market for mining machines and equipment was reduced substantially [1].

Only in the last 3-5 years some signals of a recovery of the mining industry can be observed, some mines brought profit and begun to invest in new technology. A recovery in the mining machines and equipment sector are faster as the companies in the sector are smaller and almost all private and trade unions are not as strong as they are in the mining industry.

The “mining machines and equipment” sector has 120 firms in Silesia and employs about 15,000 workers. Its output in 2003 was close to 500 millions euro with more than half of it exported. The companies form the sector keeps working contact with such research institutes as GIG – Central Mining Institute, EMAG – Centre for Mining Electrification and Automation, as well as with the AGH – University of Science and Technology in Cracov and many others. The sector shows a relatively high knowledge intensity and strong inter linkages with the knowledge infrastructure.

3.1.4. Industrial firms considered in the empirical analysis

- DOZUT - KOMAG Ltd.
- ENEL Ltd.
- FAMUR, Joint-Stock Company
- FAZOS, Joint Stock Company
- GRAMA Ltd.
- JOY Maszyny Górnicze Ltd.
- Jastrzębskie Zakłady Remontowe Ltd.
- OPA-ROW Ltd.
- REMAG, State-owned enterprise
- RYFAMA, Joint-Stock Company
- TAGOR, Joint-Stock Company
- POWEN, Joint-Stock Company
- VOEST – ALPINE Technika Górnicza i Tunelowa Ltd.
- Zabrzańskie Mechanical Works, Joint-Stock Company
- ZBMD-KOMAG Ltd.

3.2. Empirical study

3.2.1. Innovation history

The majority of selected firms have passed very deep transformation from central planned economy to the market economy. The transformation has been hindered by a big crisis in mining sector which lasted for 10 years, when the coal production was reduced two times, workforce 3 times and investments were reduced to almost zero. After the transformation the majority of the selected firms have modern, more efficient organization, with new departments such as R&D, marketing etc. They use modern managerial techniques (TQM, teamwork, project management, profit centres) and have obtained ISO 9000 certificates. Such organizational innovations are considered as a big success of the transformation.

The selected firms have a workforce form 30 to 700 workers. After privatisation all of them, except one called REMAG, are became private enterprises. Two of them are foreign owned: one by JOY Global INC. and one by Voest Alpine INC.

Although the privatisation process is almost completed, such structural changes as formation of capital groups and companies merging are still quite often in the sector. In coming years one can predict more foreign companies transferring their companies to Silesia, as the mining machines and equipment are designed and produced in close proximity to coalmines. We had such a situation in the past when German mining industry was reduced and closed then many producers moved their factories close to mines in USA or Australia.

As result of global competition the selected firms are aiming to a greater diversification of products and markets as well as to grater vertical integration of all production phases. Their motivation to innovate is mainly related to adept to the requirements of actual orders of clients or potential ones. Their short term strategies consist in the production growth with stable employment.

When types of innovation are considered new products and markets are also important forms of innovation for all selected firms. Their motivation to innovate consists mainly in decreasing the production costs and improvement of production/service quality. Their short term strategies have been related to rather implicit process of ex post learning then explicate decision of innovation design by the firm. The lack of adequate internal financial resources

was the main reason that some important innovation opportunities have explicitly not been exploited by the most of selected firms. Financial factor and the above mentioned crisis in coal production are the two main obstacles to innovation. When sources of innovation are considered then in majority of selected firms innovation have been pushed by a gradual process of accumulation of „tacit" knowledge leading to incremental improvement in products/service. Also product/service improvements have been favoured by contacts with regular clients in the framework of subcontracting relationships.

In conclusion, in all selected firms the process of search for innovation solutions has been guided mainly be the need to improve the economic performance of the firm. Organizational innovation were most popular and as a result Polish firms are more prepared to compete on global market [2-4].

3.2.2. Management and human resources

The management style in majority selected firms has been changed form centralized one into open, consensus based and horizontally integrated. Modern management techniques such as project management, innovation teams, TQM, profit centres, etc. are often used, while „contract engineers" or „job shoppers" as well as junior staff from local university are not often hired in the selected firms because of lack of sufficient financial resources [5].

The process of learning and process of knowledge creation is coordinated by R&D department in the majority of selected firms. The acquisition of R&D via external research project or via intellectual property rights is not often used. The majority of firms use cumulated „tacit knowledge" and prefer „informal" process of knowledge creation mostly based on interactive learning. They more often use the deep knowledge of specific technology so called specialized knowledge than combine originally existent technologies from other sectors. They also believe that relationships with clients are more proinnovative that the relations with suppliers. For majority of them the observation of the competitors is a mayor source of information and innovation and, in general, their level of information on the technologies of the competitors is very high. They mostly concentrate their research effort in a specific filed through the exploitation o their traditional competitive advantages.

3.2.3. Relationship with local organizations

As it as already mentioned, the 15 selected firms form rather a network of cooperation than a cluster as it is described in the literature. The main obstacles to cooperation are the following:

- Lack of the trust, which is very common in Polish economy at present.
- Lack of identification of common aims.
- Lack of identification of joint projects.
- Lack of leadership and organization capabilities.

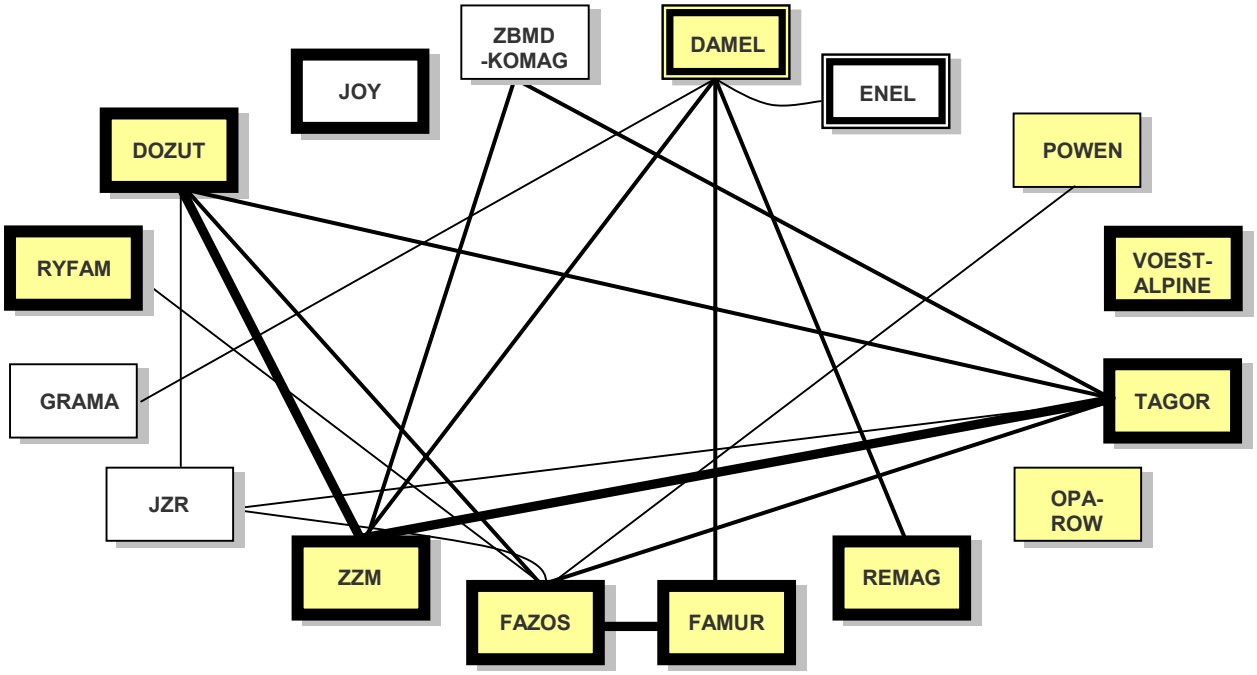


Fig. 2. The Silesian mining machines and equipment cluster

The sector mining machines and equipment is very specific and the close proximity of it to mining industry plays a very important role in its development. Therefore they recruit their new staff mostly form local universities or polytechnics as well as from the local research institutes. Only foreign firms such as Vest Alpine or JOY are able to recruit specialist form abroad.

When we consider the definition of the collaboration within the cluster, the selected firms have the following advantages:

- Existence of common know–how and even culture different form that in other sector.

- Perceived complementary or difference of respective knowledge and technical capabilities.
- Continuity of the relationships over various years.

The advantages can be considered as a good starting base for setting up a real cluster as an informal egalitarian system based on consensus. Such a system should be developed in the future. Recently one can observe that two groups of machine and equipment producers are under organization, one in Katowice and one in Zabrze. The main purpose of such groups is to compete with foreign firms entering Polish market.

Two research institutes: KOMAG-Mining Mechanization Centre and GIG – Central Mining Institute are the main partner for the selected firms in R&D. They organize periodic information and promotion seminars for representatives of the firms and organize international conferences of scientific and technical character. These conferences are an important forum of the experience exchange among scientists, designers, producers and users of technical solutions. They enable the participants to get acquainted with the latest achievements in the domain of mechanical systems, mineral engineering, environmental protection.

3.2.4. Relationship with national and international actors

Almost all Polish mining industry is located in Silesia, therefore interregional relationships in the cluster play less important role. All selected firms have started international business as exporters, mostly to the neighbouring countries such as Ukraine or Russia. At present the relationships are more complex e.g. REMAG has production in Spain, managed from Poland and close cooperation with coalmines in Spain, Vietnam, Germany and Sweden. The investment project coordinated by Kopex in Iran is a positive example of collaboration of Polish firms. One may expect more such examples in coming years.

4. Conclusions

1. Innovation in medium technology sectors is driven much more by customers than by suppliers. As a result the trend of increasing customisation of products, services and processes is widely observed in these sectors.
2. The markets, on witch the above sectors operate, are under increasing pressure form safety and environment protection regulations. These regulations combined with standardisation are main drivers of innovations.
3. The customer – producer/service provider relationship are now more complex and cover all activities form designing a require product/service customized to all client's requirements through maintenance service and substitution of all products. Due to such complex relationship the customers' loyalty is of vital importance for companies in the medium technology sector.
4. Organizational innovations are of grate importance, particularly, in the countries – new members of the EU. They have brought to companies new more – efficient organization, managerial techniques (TQM, project management, profit centres etc.) and ISO 9000 certification.
5. Innovations in medium technology sectors have mostly gradual character and consist mainly in improvement of existent products, services and processes. They are very dependant on individual skills, professional codes of communication and tacit knowledge.
6. Cooperation between the research institutions and companies in the medium technology sector is not as well developed as it is in the case of high technology sector. Also setting up spin-offs is too risky and not so popular. Knowledge base in these sectors becomes increasingly interdisciplinary and inter-sectoral. Recently organized technological platforms are looking as promising solutions to the above obstacles. They are promored within the sector by KOMAG.

5. References

1. Stachowicz J.K, (2001), Zarządzanie procesami reorientacji strategicznej w przedsiębiorstwach przemysłowych tradycyjnych, Warszawa 2001
2. Szymoniuk B., Walukiewicz S. (2004), Klaster „plastikowa Dolina" w Tarnowie, Raport Instytutu Badań nad Gospodarką Rynkowa, Gdańsk
3. Walukiewicz S. (2004), Sieci proinnowacyjne i klastry, w Walukiewicz S. (red.) Współczesne zarządzanie: Teoria i Praktyka, Centrum Badań Przedsiębiorczości i zarządzania PAN, Warszawa, 31-41
4. Walukiewicz S. (2005), Wstęp do systemowej analizy innowacyjności, Raport badawczy IBS PAN, RB/67/2005
5. Winch S. (2005), Kultura organizacyjna a zarządzanie wiedzą, Raport Badawczy, IBS PAN RB/69/2005