

Collaboration between Universities and Industry Based on Experience of the Silesian University of Technology

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Abstract — This study discusses a theory of industrial-academic cooperation involving the technical university. Paper focuses on Silesian University of Technology (SUT) background. This study also describes the policies and models of collaboration between the Silesian University of Technology and Industry that are used to establish a lasting relationship. This study hopes to provide a good example to local or overseas technical industry institutions to provide background, experiences, methods and results that can assist in developing future cooperation plans.

Index Terms — collaboration, cooperation, university, industry, technology transfer, consortium, industrial partnership

INTRODUCTION

The collaboration defined by [1] is:

“A mutually beneficial and well-defined relationship entered into by two or more entities to achieve results they are more likely to achieve together than alone.”

Successful collaboration includes several key elements. Collaboration should [1]:

- be mutually beneficial—Successful collaboration usually includes a “win-win” situation,
- be a well-defined relationship—Successful collaboration usually includes congruent expectations of all participants in terms of roles, guiding values and end-in-mind,
- include multiple entities—A successful collaboration recognizes the value of different perspectives and the importance of allowing for those differences,
- achieve results together that would not likely be achieved alone—Collaboration is work in and of itself. For it to be worthwhile, collaboration needs to result in greater benefits than costs. Remember, the whole is greater than the sum of the parts.

Historically, university researchers have collaborated with industrial scientists on marketable projects. News coverage at the turn of the twenty-first century might lead one to believe that this is a current phenomenon. However, science historians have traced collaborations between European companies and university researchers back to the 1800s.

Traditionally, industry sought partnerships with universities as a means to identify and train future employees. As global economies shifted, companies wanted access to faculty who created the cutting edge knowledge and technology central to university research. Knowledge creation and technology development require considerable capital investments, historically provided by governments [2].

The interdependent research relationships between universities and companies enable both entities to sustain growth in their areas. While companies rely on university researchers for product innovations, faculty gain prestige through increased external research funds. Just as industry needs innovative ideas to ensure profits, researchers need additional research dollars to sustain faculty productivity [3].

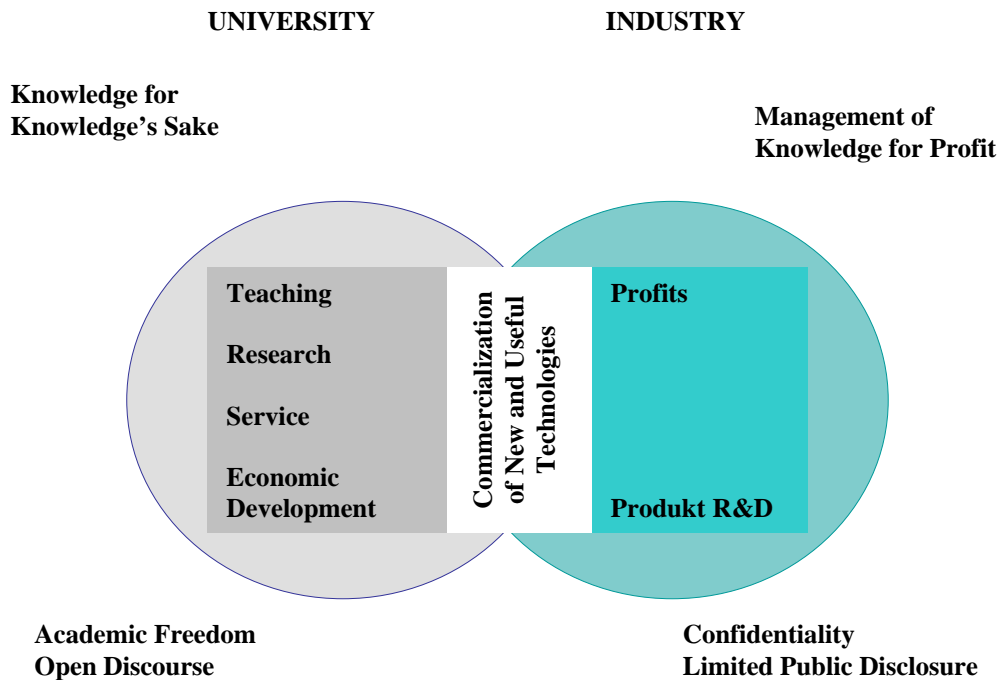


FIGURE 1
BRIDGING CULTURES [4]

Advantages of the Collaborative Relationships

There are numerous benefits that derive from university-industry relationships, including benefits to society, universities, and companies.

Social benefits. Society benefits from university-industry research relationships through innovative products and technologies. Industry-sponsored university research is often developed into practical applications that benefit society.

University benefits. Interactions with industry are clearly thought out with attention paid to the benefits that will accrue to the university. Some universities seek industrial partnerships because of the potential financial rewards of patents and licenses that result from the commercialization of academic research. This provides the means by which universities can decrease the governmental funding gap. Patents generated through industry-sponsored research are sometimes shared between companies and universities. The intent is that the university will use patent revenues to support activities that are not market oriented, such as the teaching mission of institutions.

Company benefits. University-industry collaborations can stimulate companies' internal research and development programs. University researchers help industrial scientists identify current research that might be useful for the design and development of innovative processes and potential products. This first look at cutting-edge research gives companies a competitive edge because it decreases the time it takes to move a potential product from the laboratory to the market, which strengthens international economic competition [5]-[7].

ABOUT SILESIAN UNIVERSITY OF TECHNOLOGY

A brief history

The Silesian University of Technology is one of the biggest technical universities in Poland. Its rich, over 65-year-old, tradition makes it the oldest in Upper Silesia and one of the oldest in the country.

The university was founded on May 24, 1945 and Gliwice was chosen for its seat despite initial plans to locate it in Katowice. What made the city stand out from other places in Upper Silesia was the space potential it offered.

The foundation of the Silesian University of Technology fulfilled the idea which had been present in the consciousness of the Silesian community for a long time. Since research development and didactic activities were essential to support this highly industrialized and having great prospects area, the first actions to set up a technical university in this region were taken as early as in the late 1920s.

The inauguration ceremony of the first academic year was held in Gliwice on October 29, 1945. At the time the University had a student population of 2750.

It used educational curricula taken from the Technical University in Lvov at four faculties: Chemical, Electrical, Mechanical and Civil Engineering and employed nearly 200 academics. The outstanding teaching staff, made up mainly of professors of the former Technical University in Lvov, were one of the strongest assets of the University since its foundation.

Today we are incorporating 13 faculties and numerous R&D and teaching units, educating about 30 000 students at all levels and study types, employing over 1900 academic teachers [8].

Goals of the Silesian University of Technology

The main goals of the Silesian University of Technology are:

- support of the academic entrepreneurship and proinnovative attitudes,
- support for applying for funds for R&D activities, advice in projects' preparation and partner search,
- information and promotion services for academic staff regarding innovation, scientific cooperation possibilities, technology transfer and intellectual property rights,
- information and promotion of the University resources,
- international and national research projects' participation
- modernisation of teaching process, internationalisation of education, introduction of modern teaching methods and new technologies,
- introduction of further improvements in the University management practices,
- industrial and scientific partnerships.

Faculties and its main fields of scientific, research and application activities

At the moment there are thirteen faculties at the Silesian University of Technology and they cover the whole range of engineering disciplines, as well as elements of management, sociology and administration. They are:

- Faculty of Architecture,
- Faculty of Automatic Control, Electronics and Computer Science,
- Faculty of Civil Engineering,
- Faculty of Chemistry,
- Faculty of Electrical Engineering,
- Faculty of Mining and Geology,
- Faculty of Energy and Environmental Engineering,
- Faculty of Materials Engineering and Metallurgy,
- Faculty of Mathematics and Physics,
- Faculty of Mechanical Engineering,
- Faculty of Organisation and Management,
- Faculty of Transport,
- Faculty of Biomedical Engineering.

A brief information about all of the faculties can be found in workbook [8].

Faculty of Architecture

Fruitful collaboration of the Faculty with creative professional organizations is being developed, among others with Union of Polish Architects, Society of Polish Town Planners, Chamber of Polish Architects, Chamber of Polish Town Planners, local self-governments, and the Silesian Voivodeship's self-government.

The Faculty implements projects and scientific researches concerning modern problems and difficulties in architectural and urban designing, spatial planning, history and theory of architecture, problems of sustainable development in urban and architectural revitalization of municipal areas, restoration and conservation of monumental and historic buildings, environmental aesthetics, building quality assessment and facilities management.

The faculty is a member of the European Association for Architectural Education (EAAE) and of European Council of Landscape Architecture Schools (Le Notre); it also cooperates with organizations and institutions in several countries e.g. with IAPS – International Association for People Environmental Behaviour Studies, Internationale Bauausstellung

(IBA) Fürst-Pückler-Land in Germany, Del Bianco Foundation in Italy and National Reservation of Cultural Heritage Old Halich in Ukraine.

Faculty of Automatic Control, Electronics and Computer Science

The Faculty collaborates with companies operating in different fields of industry. As a result, numerous projects of our researchers have been successfully implemented and different companies participate in the education process through student industrial placements as well as supervising the students' theses and organizing training courses where certificates of competence are conferred.

The Faculty carries out research into automation, robotics, system analysis, signal conversion, analysis, synthesis and system design, electronic and telecommunications systems, microelectronic technologies, digital signal conversion, theoretical and applied computer science, software, databases, design and construction of computer equipment, basis and techniques of creating computer networks.

The Faculty has had outstanding achievements in scientific research, both theoretical and practical, as well as research and development projects. These include:

- the formulation of new steering algorithms (adaptive, predictive and changeable), significant contribution to the creation and modification of the existing methods of adjuster design,
- the opening of the Signal Process Laboratory, the Specialized Integrated Circuit Design Laboratory, the creation of the FUZZY-FLOU system, which is used in the decision making process, drawing up and implementation of the steering system for the sheet metal etching process at Columbus Steelworks in the RSA,
- the creation of program modules which guarantee the safety of information in computer systems, modules for hospital computer systems, systems of vocal communication with the computer for the blind user, an algorithm visualization system, the computerization of town councils.

Faculty of Civil Engineering

The Research and Development activity of the Faculty comprises all fields connected with civil structure designing, building materials and technologies, transportation engineering and infrastructure: development of the theory of structures, reinforced-concrete, prestressed-concrete steel and timber structures, framework building, particularly those exposed to the effects of mining subsidence, testing of soil, foundations and structures, solid body mechanics and mechanical system dynamics in a non-classical approach, scientific basis for exploitation, renovation and conservation, new techniques in bridge construction, exploitation of bridge structures in areas exposed to mining subsidence, transportation infrastructure design and construction, including the development of the theory of pavements and soil improvement techniques in mining subsidence areas, design, construction and exploitation of town infrastructure including the infrastructure subjected to mining subsidence, testing of durability of materials and structures, ecological buildings, management, information, organization, computer and decision-making systems for building companies, techniques and testing of building materials and products.

The Faculty is a member of AECEF (Association of European Civil Engineering Faculties) and an active participant of EUCEET (European Civil Engineering Education and Training) assembling over 130 partners including 101 Faculties of Civil Engineering from 29 European countries.

Faculty of Chemistry

Research activity of the Faculty is focused on: transformation of hydrocarbons; synthesis, structure and reactivity of five- and six-element heterocyclic systems; chemistry of carbohydrates; metal complexes in organic synthesis; oxidation and chemistry of peroxy compounds; physical chemistry and technology of polymers synthesis and modification of polymers; gas and ion transportation in polymers and polymer membranes; catalytic processes in technology and in environmental protection; thermal and chemical technology of coal treatment; technologies of treating coal-derivative resources; utilization of selected heavy industry wastes; new technologies and the theory of inorganic and electrochemical processes; optimization of technical and apparatus solutions of industrial processes; static analysis and macro kinetics of inorganic processes; phase transformations and interface processes in multi-component systems; substances of special purity and properties; utilization and industrial waste disposal; corrosion and protection against it; industrial chemical analysis; eco-analysis, analysis of biological materials; new reactions and analytic reagents; the selected problems of bioprocess engineering and separation processes; crystallization; dynamics of chemical reactors; gas cleaning, nanostructured materials and biocatalysts, nanofluids.

Faculty of Electrical Engineering

Scientific research carried out at the Faculty includes the following subjects: informatics and telecommunication systems in the field of production, transmission and distribution of electric energy, the diagnosis of electric power devices, electric metrology, calibration and electric quantity comparators, automatics and control, digital-circuit and microprocessor engineering, the rudiments of Electronics, electromagnetic compatibility, projects of electric and electronic systems, signal processing methods, projects of comutator engines admission systems, electric and hybrid cars, the analysis of electromagnetic fields of electric machines, the application of signal processing in control systems,

the modernization of the construction of electric engines, power electronics electric drives, electrothermal systems, microprocessor control of drive systems, energy generation in wind and solar power stations, mobile, walking and industrial robots, mechatronics, informatics in electric systems.

Faculty of Mining and Geology

The Faculty runs the scope of researches concerning modern mining which covers appropriate geological identification of mineral deposits, economically effective extraction of raw materials, use of energy-saving and fail-safe machines, meeting requirements of safety and environmental protection. Scientific and research achievements of the Faculty concern among other things: automation and control of working processes, application of fuzzy sets in modelling and simulation researches, monitoring injury risk and fire precautions, control of dangers of stray currents, construction of modern mining machinery, experimental and computer research of dynamic and tribological phenomena in mining machines, rationalization of structure and organization of mining companies, earth surface protection at mining sites, removal of mining damage and revitalization of postindustrial areas, mining below facilities on the surface of the area or in the conditions of bounce danger, ventilation and air-conditioning of mines, fire fighting, control of dust and gas explosions, industrial safety in mining, control and determination of preventive treatment of water dangers in active and liquidated mines, flood hazard assessment, examination of coal quality and protection of coal resources in a deposit and assurance of energy safety of the country, designing of digital mining maps, application of clean coal technologies, estimation of utilization possibility of mineral wastes, crisis management, new technologies using gravity and other physical methods, research on physical chemistry of mineral processing principles and use of results in new technology development and modification of existing methods of coal flotation processes with focus on steam coals, analysis of water-coal slurry fuels properties and its production, industrial testing of new flocculants in water-sludge circuits of mineral processing plants.

Faculty of Energy and Environmental Engineering

The research work carried out at the Faculty covers the following fields: air, water and soil protection, environmental management, heat engineering in the building industry and municipal management, protection against environmental contamination, identification and spread of contaminants, application of membrane techniques in wastewater and water treatment, use of microbiological processes in environmental protection and engineering, optimization of installations and facilities in water supply stations and wastewater treatment plants, operation and diagnostics of power machinery and facilities, investigation of complex processes of heat flow, use of renewable sources of energy; gas, heat and nuclear power engineering, heat engineering and industrial air-conditioning, construction and operation of combustion engines, design of machinery and facilities for waste utilization, design of machinery and facilities for chemical processes.

The staff of the Faculty are members and sit on the boards of numerous European scientific organizations, such as European Research Community on Flow, Turbulence and Combustion, European Membrane Society, European Biotechnology Federation

Faculty of Materials Engineering and Metallurgy

The research carried out at the Faculty involves materials engineering and metallurgy, focusing on the following branches: waste-free technologies, development and utilization of waste materials, mathematical modelling and optimization of metallurgic processes, environment management, electric heating engineering, computer aided design processes, theory and technology of metallic materials, cracking mechanics, biomechanics, modelling of heat flow processes, kinetics of welding processes, kinetics of waste formation and destruction, technologies of composite formation, surface engineering, founding, structure analysis and properties, designing of chemical composition and technologies of materials subjected to complex mechanical and thermal load and corrosion environment, ceramics technologies of special properties, stereological methods, new biomedical materials.

Faculty of Mathematics and Physics

At the Faculty the scientific research are realized in the following disciplines: solid state acoustics, acousto-electronics and optoelectronics, solid state physics, semiconductor nanotechnology, applied nuclear physics, mathematical and functional analysis, algebra and group theory, simulation and modeling in management, theory of stochastic processes, applications of mathematics, mathematical analysis, electronic storage documentation, design of internet applications, multimedia and cryptographic systems.

Faculty of Mechanical Engineering

The Faculty carries research in the following disciplines: material science of steel, special and construction alloys, tool steels and sintered materials used for tools; material processes technologies, mechanics, robotics, mechatronics, fluid mechanics, biomechanics, mechanical vibrations, dynamics, drive systems, virtual models in designing, operation and maintenance of machinery, computer aided design, construction and machinery operation and maintenance, technical diagnostics and methods and techniques of noise and machinery vibrations reduction.

Current co-operation with industry embraces among others the following assignments:

- carrying out mutual research and development works, developmental and goal oriented projects,
- participation of firms in delivering equipment and fitting out the research and didactic laboratories at the Faculty,
- transfer of new technologies from science to industry and from industry to didactics,
- organizing postgraduate studies for all candidates to raise their professional qualifications,
- giving expertise and doing researches in the laboratories at the Faculty and giving opinions concerning the innovative character of undertakings carried out by business enterprises.

Faculty of Organisation and Management

The Faculty carries out research in the following fields: strategic management in companies and economic regions, values in contemporary company management, HR management, personnel marketing theory and practice, financial services marketing, company assets management, international expansion of companies, urban logistics, international logistics, project management, product technology and quality management, processes of change and strategies of company development, computer – aided engineering tasks, Virtual Working Environment, Human Body Modeling and Computer Aided ergonomics analysis, creation and exploitation of acoustic maps, political and legal problems of Upper Silesia Region, promotion of employment in local government, public safety, rescue systems, emergency management, quality management in manufacturing, service and administrative companies, management of environmentally friendly processes.

Faculty of Transport

The Faculty conducts scientific research in the following areas: transport nets optimization, transport logistics, microprocessor technique and simulation tests in transport, mathematical modelling of combustion processes in engines, alternative fuels usage, wearing out of transport machines' elements, supporting computer designing transport machines' units, vibroacoustic diagnosis of machines and vehicles, dynamics of vehicles' suspensions, applying numerical methods in designing and optimizing wheel units and wheel-rail system, telematics and transport safety.

Faculty of Biomedical Engineering

Faculty of Biomedical Engineering debuts in 2010. Biomedical Engineering is one of the most important directions of research in Europe and the United States. The proposed course of study is in line with the latest courses of leading universities in the world and offers interdisciplinary knowledge of computer science, electronics, automatic control and robotics, mechanics and foundations of medical science. Biomedical Engineering is gaining in importance of national economy. According to the World Health Organization it can be classified as major (in addition to genetic engineering), a critical factor in the progress of modern medicine [9].

MODELS OF UNIVERSITY- INDUSTRY COLLABORATION

There are a few models of University- Industry Collaboration developed in SUT based on our own experience and good practice of other universities, which are presented beneath.

Technology licensing

Intellectual Property Protection (Patent Attorney Office) providing services in relation to transfer of rights, commercialisation of inventions and patent policy strategy:

- national and international procedures of patent application,
- consultation on industrial property rights, inventions, patenting procedures and intellectual property rights for academic staff,
- preparation, negotiation, administrative service and management of all IPR contracts entering into force.
- examination of technological state-of-the-art, patent ability and new solutions at the University.

Technology transfer centre

Innovation and Technology Transfer Centre (CITT) at the Silesian University of Technology was founded in response to the need of creating a link between science, business and administration. Increasing market demand, rapid changes in entrepreneurs' environment and new perspectives gained by Polish membership in the European Union are main factors which determine current economic reality. Centre's goal is to actively participate in forthcoming changes. CITT's activity profile is a part of long term policy of government and University aiming to increase the role of technical universities in building economy based on knowledge through technology transfer and commercialization of research results. Our aim is to direct and locate intellectual assets strengthening the position of leading innovation transfer centre.

Innovation and Technology Transfer Centre's mission is to create effective cooperation network within science and industry to intensify the flow of innovative technologies and knowledge [9].

Incubators of Entrepreneurship

Academic Incubator of Entrepreneurship is a general unit of Silesian University of Technology, that primarily supports academic entrepreneurship, collaborating with the Student Career Office and the Scientific Technological Park "Technopark Gliwice". Incubator creates the conditions to use the knowledge and brand new ideas in business and life. Incubator help people from the university community, who either intend to start a economic activities or already run their own business, during the first period of development of their business. This initial stage of becoming the manager of own life is difficult and requires both the substantive and organizational support – for this purpose preincubation and incubation actions are taken [9].

Research collaboration agreements

In 2009 and 2010 SUT signed over 20 collaboration contracts with partners from the different branches of industry, among others:

- automotive industry,
- engineering industry,
- procurement industry,
- construction industry,
- maintenance industry,
- production industry,
- chemical industry,
- service industry and many more.

Consortium

There are plenty of consortium agreements signed by SUT and industrial partners established to implement research projects financed and co-financed by EC, Ministry of Science and Higher Education and others. The most important consortiums are established for the purposed of:

- strategic scientific research and experimental development programmes - high-budget programmes resulting from the country's science and innovation policy, designed to support the development of the Polish economy and the public sector,
- goal-orientated projects – undertaking scheduled for implementation within a fixed period of time and in specified terms, conducted by entrepreneurs including applied research, development work, industrial research or pre-competitive research.

High-level research and technology alliances

The aim of **Silesian Center of Advanced Technologies** is enforcement of cooperation between consolidated research-development sphere of the Silesian Region and industry. The effect of SCAT shall be a direct implementation of the generated new technologies, production of new workplaces and enrichment of Silesian firms competitiveness on the unified European market.

The following Common Research Programs has been founded within SCAT:

- CRP 1 Biocybernetics and biomedical engineering
- CRP 2 Synthesis of special chemical compounds, biotechnologies, waste utilization, environmental engineering
- CRP 3 Teleinformation infrastructure in the labour safety management, process safety and social safety in aspect of hazard controls and hazard reduction
- CRP 4 Material engineering and nanostructural materials for health and environment protection
- CRP 5 Technology of production and application of modern materials and composites and advanced Technologies of material connection
- CRP 6 New computer science services and data storage and data transfer techniques in computer and telecommunication nets
- CRP 7 Control of technical parameters of the systems and automate of technological processes [8].

The major task of the **Biomedical Engineering Center** is to coordinate the activities of the three main Silesian Universities – Silesian University of Technology, Medical University of Silesia and University of Silesia – through connecting their didactic, scientific and research groups as well as coordinating their interdisciplinary research activities combined with application, servicing, training and promoting activities within the field of biomedical engineering [9].

PROMOTION OF THE SILESIAN UNIVERSITY OF TECHNOLOGY'S RESOURCES

In 2009 Silesian of University of Technology implemented databases which allows to search and collect information on SUT's researchers and specialized research apparatus. Its purpose is to facilitate contact with persons and entities interested in using the scientific potential of the SUT, and in particular:

- ordering parties of scientific-research and industrial research service,
- the potential partners in research and development projects,
- and other institutions interested in common research and development projects.

Access to the university databases of academic staff (experts) and scientific equipment and laboratories is available via:

www.biznes.polsl.pl

<http://eksperci.polsl.pl>

<http://aparatura.polsl.pl>

<http://eksperci.polsl.pl/en/>

Publications

Bilingual publication issued in 2009, presenting a compendium of knowledge about the Silesian University of Technology with an emphasis on collaboration with industry. It focuses on presenting offers of the Silesian University of Technology units that may interest industrial partners, in terms of research and development (Faculties) as well as technology transfer, patent protection, entrepreneurship development (CIIT, AIP, CIB). It also presents the university administrative units, which task is to provide support for project management.

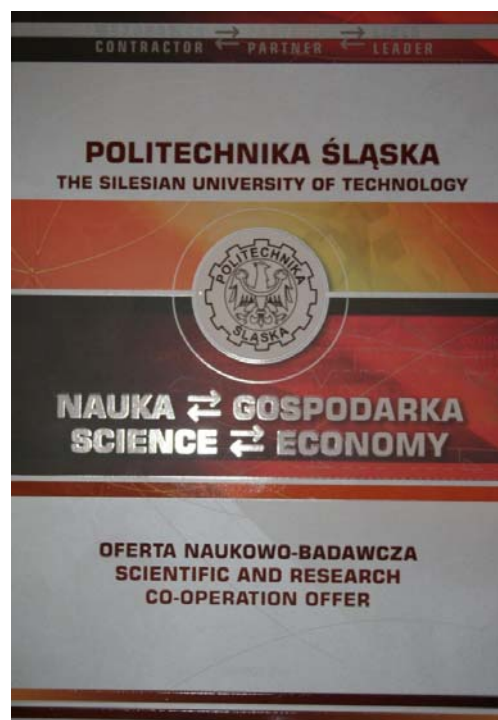


FIGURE 2
PUBLICATION – THE SUT Scientific and Research Co-operation Offer

Publication issued in 2009 is an effect of collaboration with GAPP and presents technological offers of research units of the Silesian voivodship, including a very extensive offer of the Silesian University of Technology. The publication was distributed to about 100 entrepreneurs from across Poland, who expressed its willingness and readiness to cooperate with scientific institutions in many ways. Currently it is planned to reissue of the publication in English in cooperation with Regional Contact Point.

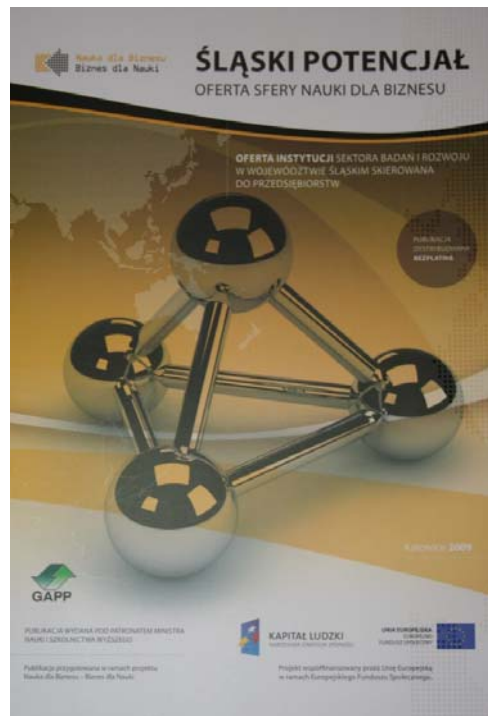


FIGURE 3
PUBLICATION – Silesian Potential

CONCLUSIONS

To support and strengthen cooperation between enterprises, industrial partners and research units, which would have a direct impact on the implementation of solutions of scientific research to the economic reality, it is required to maximize and intensify following activities:

- to form scientific and industrial consortiums for joint research and development projects leading to implementations and inventions which can be applicable on the market,
- to apply for funding of the projects from all possible sources in cooperation with industrial partners (European Community Funds, EU Structural Funds, State Budget Resources for Research),
- to create studies that reflect market needs and train personnel that is employed in companies operating in market conditions (studies requested by Ministry of Higher Education, scholarships, fellowships),
- to cooperate on international level (new directions for the development of science, global markets),
- to promote university resources via the internet, publications (such as publications presenting the offer of individual research units) and public databases (eg database of experts, database of scientific equipment, database of technological offers, catalogs of publications, patents and inventions) what may be equivalent to the trade offer,
- to support initiatives from academic staff, aimed at cooperation with industry and business development, disseminating results of scientific research,
- to enter into the general, frame agreements of cooperation between scientific units and industrial partners which can provide access to long-term cooperation.

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