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**BUILDING A PLATFORM FOR SCIENTIFIC-RESEARCH
COOPERATION UNDER CIRCUMSTANCES
OF REALIZED ASYMMETRY OF POTENTIAL**



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BUILDING A PLATFORM FOR SCIENTIFIC-RESEARCH COOPERATION UNDER CIRCUMSTANCES OF REALIZED ASYMMETRY OF POTENTIAL

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Summary

Growing complexity of the environment arising both from the processes of globalization in world economy and from the development processes in Poland has become a strategic challenge for the Institute of Aviation. Significant disproportions of the potential of Poland, compared to Germany, United States, or China (especially in terms of the economic dimension and the adopted model for financing scientific research), as well as distant position of Polish universities on the scientific map of the world lead to the necessity to create a model for managing the Institute of Aviation based on internationalization of research and cooperation with leading scientific and (Ohio State University — OSU) technological centres (General Electric — GE). The experiences of the Institute of Aviation show that what should be the basis of international competitiveness of research institutes is well educated scientific personnel, modern research infrastructure and competences of cooperation. A proof of this is 16-year-long strategic alliance (private-public partnership) of the Institute and GE, cooperation with OSU and activities in European research consortia. The innovative dimension of scientific cooperation with OSU (2+2 formula, research internships, commission for predicting new directions of scientific research) and other foreign partners allows the Institute of Aviation to achieve success in competition of international character.

Keywords: platform for scientific-research cooperation, realized asymmetry of potential, internationalization of research, co-financing of research

Introduction

In times of advanced globalization processes and intensified competition (with symptoms of hypercompetition) in global economy more and more often the issues of cooperation of research centres as platforms for creating states' competitive advantages on an international scale are more and more often discussed [1] [2] [3]. Observations show that scientific centres more and more often build their intellectual strength on the basis of so-called open innovations [4] [5]. Thus, what emerges is the issue of building cooperative associations within not just one state, but in the supranational dimension [6].

The goal of this article is presenting the possibilities of building a scientific-research platform with realized asymmetry of potentials. This work is on the one hand a case study concerning international cooperation pursued by the Institute of Aviation in Warsaw and on the other hand it is an attempt to make generalizations and draw constructive conclusions.

Institute of Aviation has for dozens of years been conducting scientific research and research-development works for and together with the representatives of the Polish Aviation Industry. In the first half of 1990's cooperation and joint activity in this sector ceased to exist. After the first insight into the phenomenon it was concluded that the main reason for it is that new, foreign owners of the industry have their own research-development institutions and are not interested in cooperation. What was highlighted then were the differences in potential of international corporations and Institute of Aviation hit by the crisis.

New owners introduced their quality systems and management systems. They launched production of components and parts for their assembly lines, to some extent they continued the production of already existing products.

The reason for the collapse of cooperation in research and development between the Institute of Aviation and the aviation industry was yet another, perhaps the most important cause. By the 1990's the development of new products in Poland was financed under so-called "Knot Programmes". In course of such programmes such aircraft as: PZL-Sokół helicopter, PZL Skydruck cargo airplane, training-combat airplane I-22 Iryda. When knot programmes ceased to exist, the money for both factory research and development units, as well as Institute of Aviation ran out.

After over twenty years a new form of co-financing for joint activities of industry and science called "Strategic Programmes" was introduced. These programmes constitute financial support for the development of technologies and new products carried out by the industry. Foreign owners quickly accepted government's sponsoring. Thanks to strategic programmes, cooperation with Polish R&D industry started recovering slowly.

A common feature of former knot programmes and current strategic programmes was (and is) the fact that the state finances industrial orders for research-development works at the Institute of Aviation. What the above deliberations show is that when the state pays for the research, national industry is more likely to notice the opportunities and benefits in cooperation with national scientific centres, including the Institute of Aviation.

A research institute, to be able to serve its purpose, has to achieve a certain "critical mass" of the number and qualifications of personnel and research infrastructure. In case of the Institute of Aviation the critical minimum of the number of employees ranges between 800 and 1000 people. Annual investments, which are necessary to maintain and develop the competitiveness of research infrastructure amount to an average of about PLN50m. The Institute wouldn't be able to achieve such a multitude of research projects and necessary income on the national market even with the support of strategic programmes. For this reason the Institute made the decision to look for clients on the global market [7]. The Institute formulated the challenge in such strategic slogans as "Internationalization of scientific research" and "Providing services on the international scientific research market", which follows international trends.

1. Areas of possible asymmetry of potential

The Institute of Aviation operates in the area of scientific research and creation of new technologies (demonstrators of technology). It is known that activity of this kind is conducted efficiently in countries with high economic potential, in big centres of concerns and state institutes. The differences in potential between the Institute of Aviation and Polish economy and the leading foreign centres and foreign economies is presented in the following points.

1.1. Polish universities in the Shanghai ranking

Academic Ranking of World Universities is a ranking of universities prepared and compiled by the Institute of Higher Education at Jiao Tong University in Shanghai. This document analyses over 1,200 universities in the world, which excel in the area of globally renowned scientific papers, their high quotation rate, winners of international scientific awards and in terms of quality of education. Polish universities in this ranking placed around the 500th position. In table 1 a more detailed comparison is presented. The comparison includes Warsaw University of Technology (PW), American Massachusetts Institute of Technology (MIT), Chinese university of technology Tsinghua (Tsinghua), German university of technology in Munich (TU Munich), American Ohio State University (OSU) and the Chinese Nonking University Science and Technology (NUST).

Table 1. Comparison of statistical data of some universities of technology

	PW	MIT	Tsinghua	TUM	OSU	NUST
Position in the Shanghai Ranking	522	5	58	49	79	500
Number of students (thousands)	37	11.3	45.2	37	64.9	30
Number of scientific employees (thousands)	2.4	5.5			5.2	
Number of doctoral students (thousands)	1.3	5.5				11

Source: [8] <http://www.shanghairanking.com/Search.html#>

The data presented in table 1 show that the leader of this ranking — MIT — has the same number of doctoral students and scientific employees. Warsaw University of Technology has a comparably low number of doctoral students and a high number of students, compared to the number of scientific employees. It seems that what determines these relations is university's budget, demand for particular categories of education and the university's profile (research, didactic).

1.2. Access to well-educated graduates

Institute of Aviation employs mainly the graduates of Warsaw University of Technology. Candidates for students of this university have the most points on their final high school exams. The students take part in some courses abroad (mainly in renowned universities around the world) and gain experience in students' scientific associations. According to the ranking of technical universities in Poland, Warsaw University of Technology placed first in 2016 [9]. Thus, it is possible to claim that the Institute of Aviation relies on well-educated graduates. It is possible to work on doctoral theses during work at the Institute.

1.3. National income

Level of national income and its derivatives, including the percentage of income spent on scientific research are among the determinants of the asymmetry of potential .

Table 2 presents a comparison of statistics for Poland, USA, China and Germany.

Table 2. Comparison of economic indicators for Poland, USA, China and Germany (2015)

	Indicator	Poland	USA	China	Germany
1.	GDP [trillions of US Dollars]	0.474	17.947	10.866	3.355
2.	GDP per capita [thousands USD] (ppp)	25.825	56.066	13.171	47.221
3.	Percentage of GDP spent on science	0.87	2.73	2.1	2.85
4.	Amount of GDP spent on science [billions of US Dollars]	7.428	433.380	317.848	96.069
5.	Position of the best technical university in global ranking	PW 500	MIT 5	Tsinghua 58	TUM 47
6.*	Position in international innovativeness ranking	23	8	21	2

*wg. Bloomberg Innovation Index

Source: [10] OECD (2016) Expenditure on R&D. In: OECD Factbook 2015-2016 Economic, Environmental and Social Statistics, OECD, Paris. [11]

http://databank.worldbank.org/data/views/reports/ReportWidgetCustom.aspx?Report_Name=CountryProfile&Id=b450fd57

Looking at the comparison of asymmetry of national incomes and percentages of GDP allocated to science, it is possible to notice that the ratio of GDP and GDP spent on science further deepen the discussed asymmetry. This leads to an important conclusion about the necessity of developing internationalization of research and development of the exports of research services, with concentration of state spending and economic freedom.

1.4. Model of financing scientific research

Model of financing scientific research in Poland should be considered from the point of view of wishes and facts. The desired model is the one in which the economy and the state provide equal contributions to financing research and all actions lead to that. However, the still common model is the one in which the academics decide what to research, who is supposed to conduct research and how much can be spent on research. Due to lack of other requirements, this leads to fragmentation and contributory research in pursuit of grants (and not reliable results) and to purchases of mediocre-class research equipment, which doesn't guarantee the competitiveness of a scientific venture on an international scale. This leads to two conclusions, which have been used at the Institute of Aviation. The first one is the necessity of concentrating strengths and assets. The second is strong focus on internationalization of research and exports of results.

2. Actions aimed at minimization of the influence of asymmetry of potential

The offer of the Institute is determined by two main internal factors, namely, the competences of employees and competitiveness of research infrastructure. Such a formula of the offer corresponds with the policies of providing services, including participation Polish and international grants. Orders most often take the form of outsourcing, which means that the client orders what would be too expensive if he did it himself. Pioneering research is conducted in prestigious scientific centres usually in secret. High requirements from clients and cooperation in the area of

shaping the technical conditions for future products is a source of inspiration for own research. The Institute doesn't get such knowledge from the clients. That's why the Institute increasingly spends own funds allocated to research on the development of scientific teams closely associated with foreign teams. Temporary research services, or temporary participation in grant teams is the first step towards the establishment of durable relations between the Institute and foreign clients. The developed relations have to be based on trust resulting from high quality of services and punctuality of provision.

The strategic cooperation of the Institute of Aviation relies on the partnership with General Electric (GE) corporation and Ohio State University. Thanks to cooperation with scientific and industrial partners, competences developed during the implementation of joint ventures become a source of competitiveness of the Institute of Aviation not just in Poland, but also on the international arena.

3. Science and Technology Conference" formula and cooperation of the Institute of Aviation with Ohio State University

Public-private partnership is cooperation between units of public administration and private entities. The foundation of this definition is the community of activities of the public and private sectors created so that partners are able to serve their purposes as well as possible. In case of the Institute of Aviation this means developing competences in the area of research on new technologies, acquiring new skills enabling the transformation into a partner for carrying out global projects. One of the goals of General Electric is ordering advanced research from a competent partners at competitive prices and expanding the position of the global leader in technology.

Cooperation of the Institute of Aviation with General Electric called by both partners public-private cooperation, goes beyond the boundaries of the classic definition as its purpose is not any kind of privatization and from the point of view of the Institute of Aviation it is a form of internationalization of research and building competitiveness.

4. "Science and Technology Conference" formula and cooperation of the Institute of Aviation with Ohio State University

A big research institute working in the area of "advanced technologies" needs a constant influx of major funds.

The condition for gaining such significant and stable revenues in current reality may only be lasting strategic partnership on a global scale. However, maintaining the research-scientific character of the Institute of Aviation requires carrying out scientific tasks in a proportion appropriate for the whole research-development activity. An area concerning scientific activity is, among others, conference activity and the activity of research teams working on doctoral theses. That's why the Institute organizes in the United States scientific conferences under the common title "Polish — American Science and Technology Conference", which are co-organized by Ohio State University, one of key universities cooperating with General Electric.

By now, in the years 2000–2016 the Institute organized 16 such conferences. The participants of the conference are outstanding specialists from GE, NASA, Boeing, United Technology, Sikorski, Air Force. Among the participants from Poland are ministers responsible for economy and science, university professors, entrepreneurs (mainly the presidents of companies operating in Poland) and naturally specialists from the Institute of Aviation. "Science and Technology" conferences keep up the "scientific tension" in relations of the Institute with OSU and GE.

Institute of Aviation has a trilateral agreement signed by OSU, Warsaw University of Technology and the Institute of Aviation. Under this contract since 2013 the following programmes have been conducted: exchange of 3-month-long scientific internships, joint scientific care over doctoral theses and cooperation of the so-called commission for predicting new directions of scientific research.

5. Doctoral theses in the 2+2 formula

Institute of Aviation has the rights to award doctoral titles in the area of construction and exploitation of machines. Based on these rights of the Institute of Aviation and competences of Ohio State University in 2015 an agreement on joint implementation of doctoral works in the 2+2 formula was signed. 2+2 formula means joint conduct of doctoral works at the Institute and at OSU within joint research teams. Research teams are supposed to be specialized in leading research creating and supporting promising research-development-innovative projects. These research projects are supposed to be conducted by doctoral students. The subjects and directions of research are defined by a Polish-American mixed team. The first area of cooperation is "More electric plane". Within this direction the first doctoral thesis titled "Analysis of the possibility of using full-electric, hybrid and turbo-electric technologies for future aircraft propulsion systems, in terms of mission energy consumption, NO_x/CO₂ emission and noise reduction" under management of prof. dr Meyer Jacques Benzakein from OSU, and dr. hab. Inż. Witold Wiśniowski from the Institute of Aviation is being developed.

Joint doctoral works conducted within OSU-ILot research teams in the innovative 2+2 formula constitute an original platform for scientific cooperation of the Institute of Aviation with the American partner — Ohio State University.

6. Cooperation in programmes financed by the European Union

Scientific-research centres of EU countries are a natural research partner for the Institute of Aviation. Building mutual relations takes place under conditions of codified rules including: participation in the works of lobbying-initiating organizations like European Research Establishment of Aeronautics, the establishment of consortia and submitting grant applications. The Institute is participating in the implementation of about a dozen projects and in case of some of them is acting as the leader. Entities

financing grants in European projects actually hire, pay for and supervise the employees of the Institute of Aviation who carry out tasks assigned to employees by the project leader.

European cooperation platform is a system integrating researchers from various countries and centres, it creates the ties and relations between them. In an extreme case the system leaves to the Institute just the task of taking care of financing employees in breaks between projects and in case of lack of projects.

Work in the system of European grants is possible in case when teams, thanks to their efforts receive grants in a continuous way, or when there is a possibility to order these teams to carry out other tasks during the breaks. The length of breaks between grants is hard to predict and it depends on the management of the Institute only to a small extent.

In order to keep a significant position on the market of grants financed by the EU, it is necessary to constantly participate in the life of the society, that is, participate in meetings, seminars and conferences. The goal is to build the image of a credible partner by carrying out the assigned tasks in a diligent manner.

7. Conclusions

When it decided to internationalize its activity, the Institute of Aviation had to take into consideration the issue of asymmetry of potential, in comparison to foreign partners.

Over 16 years of experiences in the implementation of the strategy of internationalization, possibilities of limiting the influence of the above-mentioned factors of the asymmetry of potential have been observed. The factors limiting the influence of the asymmetry of potential are direct cooperation with strategic partners and conducting own leading scientific research projects in close cooperation with Warsaw University of Technology, other Polish universities of technology and OSU.

For the purpose of implementing the strategy, within the platform of cooperation, two models have been built in the Institute. The first one of them is the complex model including continuous cooperation in R&D with

the strategic partner, organization of annual conferences in the "Science and Technology" formula and conducting doctoral works in the "2+2" formula. The second one is the model based on applying for and implementing grants, according to the rules binding in the system of the European Union. The Institute attaches exceptional importance to European cooperation, counting on that this cooperation will be developing dynamically in the nearest future.

In case of both models what determines success are personnel, competitiveness of the research infrastructure and organization of research. Also in these cases the aid of the state plays an important role in purchases of latest research equipment, in financing leading research (including the financing of doctoral works in the 2+2 formula) and financial support for the preparation of new concepts for European grants.

It is necessary to emphasize that the key factor for the success of the Institute of Aviation is complex approach and assigning the appropriate rank to all areas of activity of the Institute of Aviation, where their international competitiveness is regarded as the necessary condition.

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