DEMONSTRATOR+
NCBR

SUPPORT OF RESEARCH AND DEVELOPMENT WORKS

IN THE DEMONSTRATION SCALE

Information and promotional brochure

The National Centre
for Research and Development

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INNOVATIVE ECONOMY
NATIONAL COHESION STRATEGY

The National Centre for Research and Development

EUROPEAN UNION
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Dear Sir or Madam,

It is my great pleasure to present you the publication dedicated to the pilot project developed by the NCRD and called Demonstrator+ - Support for scientific research and development work at the demonstration level, in which we show the results of the review of projects carried out under the program.

Demonstrator + is an undertaking dedicated to projects characterized by relatively advanced work on the final product or technology. They have reached 6th to 9th Technology Readiness Level. Therefore, these are projects for which the market effects can be expected quite quickly. We have already spent PLN 423 million to support them, including the test phase carried out as part of pilot or demonstration installations. What is important, the entrepreneurs have spent as much as PLN 330 million on these projects.

But the implementation of new technologies is not only about the amount of expenditure, the quality of research teams or cooperation between science and industry, but also about the practice of commercialization. In this publication, we present several examples of specific projects undertaken by our beneficiaries in this context. I hope they will get your attention. With this belief, I invite you to read our publication.

Prof. Krzysztof Jan Kurzydłowski
DIRECTOR OF THE NATIONAL CENTRE
FOR RESEARCH AND DEVELOPMENT

What is Demonstrator+?

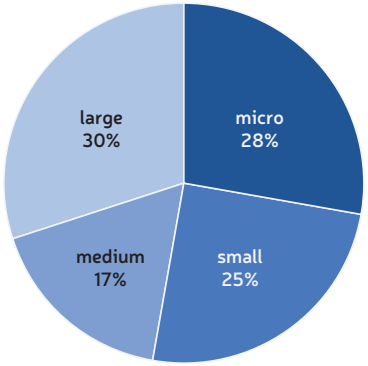
Demonstrator+ pilot project is carried out in the form of two thematic components - BIO-INFO and TECH - and aims at strengthening the transfer of research results to the economy by supporting projects whose important element is the phase of tests conducted within pilot or demonstration installations. The reason behind such support is the assumption that high costs of demonstration or pilot phase at the determined level of risk aversion of entrepreneurs and limited funds may be significant obstacles to the implementation of innovations to the economy. The task of Demonstrator+ is to reduce the financial barrier (by providing cash) and to make the public institutions assume some of the risk related to R&D works, which may encourage to increase the scale and range of research (reduction of risk aversion).

Specific objectives of Demonstrator+ include:

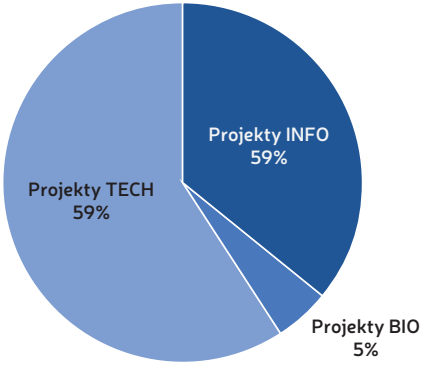
- prompting entrepreneurs to invest in research and development operations,
- increasing the efficient use of results of research and development financed from public funds in the economy,
- stimulating long-lasting cooperation between research units and entrepreneurs aimed at the utilization of research results in the economy.

45 projects have been given support so far under the Program, including 22 projects in the TECH area, four projects in the BIO area and 19 software projects (INFO). The total amount of the supported projects (total costs) is PLN 753 million (eligible costs of PLN 738 million), and the amount of funding by the NCRD within the Operational Programmes Innovative Economy system projects is PLN 423 million. Own funds contributed by the entrepreneurs to co-financing projects amounted to PLN 330 million. The major part of supported projects was carried out by large (18 projects) and medium (11 projects) enterprises. The total costs of the smallest and the largest project were PLN 5.5 million and 97 million, respectively.

Amount of funding provided the NRDC according to the thematic area



Amount of funding provided the NRDC according to the size of the beneficiary



Good practices — role models

Good practice may be defined as a manner of behaviour, action or organization (e.g. work)

- which is not required by regulations (laws, contracts),
- which is intentional (i.e. not accidental),
- which is desirable from the point of view of achieving social and/or economic objectives (or other - e.g. research),
- which does not involve any violation of the interests or rights of third parties,
- which could be a model (standard) for others in the general opinion.

It is difficult to clearly identify one specific model of good practice, which can be applied in every Demonstrator+ project. This document contains guidance, solutions and good ideas as a result of past experience that has worked in the implementation of R&D projects focused on the purposes of the economy and market.

Firstly, the procedure for selection of good practices has included the review of project documentations and interviews with people responsible for implementation of projects. Secondly, it has been determined whether the manner of behavior/conduct does not result from a legal obligation e.g. under a contract with the NCRD or other regulations. Thirdly, experts have assessed the manner of behavior/conduct from the point of view of its significance and usefulness as a standard, guided by the assumption whether and what benefits can be brought to the beneficiary (applying a good practice) and other stakeholders.

Projects carried out under Demonstrator+ to indicate good practice have been reviewed from the point of view of three operational areas: the method of selection (identification, formulation), project technical issues, the method of project organization and management, including the protection of industrial property rights and the way partnerships are established (creation of consortia).

The basic criteria for selection of good practices included:

- evaluation of the project status,
- identification of risk in terms of the project indicators,
- the innovation level of projects,
- credibility and reliability of implementation capacity,
- economic efficiency,
- quality of project management,
- quality of the consortium that carries out the project,
- prospects for cooperation between partners after completion of the project.

Demonstrator+ and good practices

Based on the results of analyses and examination of projects supported under the Demonstrator+ program, four good practices recommended as a standard type of conduct have been selected. The practices have been included in general recommendations, and their functioning has been indicated on the example of six projects where their use is most visible.

1. The selection method (identification, formulation) for the project technical issues

Each of the projects carried out under Demonstrator+ has its own history and justification. In many cases such justification is a desire to continue the previous research, the need to extend the range of products (signals from customers, actions of competition), anticipating changes in the market (e.g. patent expiry), following the trend in the sector or copying (importing) foreign solutions that are not yet available in the country. Although each of the themes is individually rational, only systematic and multivariate analysis of possible paths of conduct (in respect of R&D) can be effective from the point of view of the entire enterprise. A good example of such multivariate approach to

determination of the research subject is the project carried out by Champion Dorota Piotrowska.

Transition from the problem raised by the manufacturers, through the analysis of variants of its solution and research status can lead to defining of the project subject in a way that maximizes the chance of success of the commercialization process.

2. Evaluation of the chances of implementation and economic effects of projects

In addition to a risk that is strictly related to research, the R&D projects also involve a significant business risk. At the end of the research process it may turn out that, despite the creation of a very innovative solution, its implementation is not viable (e.g. because of too small a size of the market). It may also turn out that the solution created infringes the intellectual property rights of third parties. In this situation commercialization is difficult or even impossible. Lipid Systems company based in Wrocław, FINN from Łódź and Modertrans Poznań are excellent examples of due diligence in the management of such risk. Even before the beginning of the project, Lipid Systems carried out a professional valuation of the developed technology. This made it possible to recognize the economic rationality of the entire project, to learn the value of the target market and the project valuation, which is particularly important in possible negotiations with investors (whose participation is necessary in later phases of the project). FINN and TELE-FONIKA Kable determined the so-called closest prior art at an early stage of the project. Review of patent databases made it possible to check whether the potential effects of the project would not infringe any intellectual property rights of third parties. This test - which is relatively simple and does not require many funds - is a basic way to reduce the risk of inability to use the project results due to the constraints of the patent law. This type of test also enables better preparation of the R&D project itself by indicating the solutions that have already been blocked, determining the direction of research of competitors and identifying potential market niches.

In the case of Modertrans based in Poznań an analysis of demand for the target product - low-floor city tram - was prepared at the application preparation stage. Due to the nature of the market the analysis involved a review of European databases of tender procedures. In addition, the company prepared a financial forecast of the effects of project implementation and estimated the project performance indicators.

Reliable valuation of the project (i.e. technology and market) as well as determination of the closest prior art at an early stage of project may provide valuable research clues and help to avoid business failure of investment in R&D.

3. Project organisation and management

Management of a project worth several million PLN, especially when its implementation involves a consortium (created for the particular project) consisting of several entities of various profiles (e.g. an entrepreneur and a research unit), is a particularly difficult task. The problem is not only to keep the schedule and the budget, but also to reconcile different styles of operation, organisational cultures and interests. The basis for coordination of such consortium projects must be a precise agreement. However, the letter of the law is not enough as more efficient method of team work is also required.

In many cases, project management was understood only from the angle of division of tasks and the system of communications between partners. In addition, there were elements of project management methodology where appointment of specific individuals responsible for the project control was indicated. Many beneficiaries have already carried out joint research and development projects and the method of project management was the result of experiences in this respect. The use of a recognised management methodology is undoubtedly a good practice

arising directly from management of investment projects. This type of methodology includes PRINCE2 (Projects In Controlled Environments,), PMBOK (Project Management Body of Knowledge - Methodology of the Project Management Institute) and SCRUM (a set of simple holistic methods used mainly in IT projects). Eight entities among the beneficiaries of Demonstrator+ program have declared the use of Prince2 method (Finn, Robotics Inventions, Qumak, CTT Emag, AMZ-Kutno, PESA Bydgoszcz), PMI method (Adamed and Poczta Polska Usługi Cyfrowe), IPMA method in the case of AIUT and the project management system (PMS) in the case of Prevac. The project management methods indicated by the beneficiaries were not associated with the size of the project leader or the value of projects, but resulted from previous experience in implementation of both R&D and investment projects.

The basis for coordination of consortium projects must be a precise agreement. The use of a recognised management methodology is undoubtedly a good practice arising directly from management of investment projects.

4. Establishing partnerships (creating consortia)

Apart from a few exceptions, most of the projects under Demonstrator+ program were carried out in consortia with research units. Consortia were established to support one of the specific objectives of the program - stimulating long-lasting cooperation between research units and entrepreneurs aimed at the utilization of research results in the economy. From the point of view of project management there is a risk that in the case of poorly addressed project objectives the cooperation may proceed with some difficulties, thus affecting the results of the work. The key is to determine the long-term objective of the project (implementation of research results in the economy) as well as the project development after the completion of the pilot phase (which entity will develop the project and how). Synchronisation of these operations may help avoid many problems between entrepreneurs and research units (including the date of introducing the product to the market and the date of publication of the research results). In this field, it is also important to define the stage of work and determine the initial (laboratory) results of previous research. An ideal situation would be a prior collaboration of consortium members, although this may not be a prerequisite for providing support. The CATI survey for current beneficiaries indicates that such cooperation has already occurred in the case 17 projects.

The alternative perceived as a good practice is to analyse the current development of research by the members of the consortium and to validate the assumptions in terms of future implementation of research results. This makes it possible to clearly determine the ultimate objective of the project (pilot or implementation) and the role of each partner in the course of work (carrying out research, implementation and improvement of product or technology).

Another risk for consortia is the excessive dominance of a research team focused primarily on examining the project results, without taking into account the market factors. In order to minimize such problems, on one hand, the entrepreneur should carry out a reliable valuation of technology and estimate the economic effects of the project, so that the benefits of implementation are higher than the costs. On the other hand, the implementation of the project should significantly affect the entrepreneur's competitive position and bring measurable results. Therefore, the project should be associated with the current business of the company or result in entering into perspective niche diagnosed in the course of the company's operations. This occurred in the case of collaboration between Abraxas and research institutions. Although the project was created in the course of work at the Institute of Electronic Materials Technology, the entrepreneur had the idea to use it in business. The entrepreneur's involvement in the implementation process, i.e. the transition from laboratory scale to industrial scale, the construction of the demonstration line and division of revenues from commercialization agreed with research units enabled joint execution of the project at the stage of preparation for implementation. On the other hand, in the case of WSK „PZL Rzeszów" the cooperation with the research unit is long-term and systematic. As part of an ongoing

project within Demonstrator+ program, in addition to the regular cooperation with the Materials Research Laboratory for Aviation Industry at the University of Technology in Rzeszów, the project is carried out by a dedicated team that monitors the status of its implementation. The laboratory is focused on the aviation industry and has certificates that enable collaboration with entrepreneurs participating in innovative and very demanding processes (both in terms of safety and technology) for creating components for aircraft engines, which is of particular importance from the point of view of the project subject and the company's business profile. In addition to the above-mentioned research and development aspects a number of business works are carried out in the Laboratory, and the contract signed with WSK PZL Rzeszów contains provisions governing the purchase of research equipment, so as not overlap hardware in cooperating entities.

The key is to determine the long-term objective of the project (implementation of research results in the economy) as well as the project development after the completion of the pilot phase (which entity will develop the project and how). In this field, it is also important to define the stage of work and determine the initial (laboratory) results of previous research. The project can be associated with the current business of the company or result in entering into perspective niche diagnosed in the course of the company's operations.

SELECTED PROJECTS AND GOOD PRACTICES

From problem to solution

Accurate diagnosis of the market problem and consideration of all possible variants of procedure makes it possible to accurately determine the direction of investment in R&D

Beneficiary: Champion Dorota Piotrowska

Project title: Mushroom farm thermal system based on energy obtained from processed mushroom compost

Project value: PLN 14.5 million

Funding: PLN 5.2 million

Poland is the largest producer of mushrooms in the EU market and the third producer in the world. Practically every fourth mushroom on European tables comes from our country. Culinary and business advantages of growing mushrooms are well known by a small enterprise - Champion of Dorota Piotrowska from Grudziądz. For years, she has been involved in the production of equipment for mushroom farms, including in particular the delivery of entire „turnkey" production halls with equipment. With a regular contact with a large group of mushrooms producers, it was not hard for Champion to figure out that the major challenge is not only to ensure proper conditions and biological parameters. Mushrooms grow on a special base that becomes useless and require replacement after about 6-8 weeks period. The problem with the worn base would not be large, if not for the fact that as many as 1.25 million tonnes are produced in Poland every year. „What should we do with this?" the producers asked.

Mushrooms base can be a source of green energy

The only direction intensively studied with scientific methods so far has been the use of worn base as a fertilizer for further agricultural production. This reasoning seemed obvious as wastes are rich in minerals. However, its chemical composition (nitrogen, phosphorus, potassium) has to be balanced to form a proper fertilizer. An additional problem is that the base is formed throughout the entire year, and fertilization can be carried out only in periods of early spring and later autumn (in the absence of the option of efficient storage of waste due to microbiological hazard). Therefore, this line of research did not indicate any cost-effective solution for the „accumulating" problem.

What actually happened to the base could hard be called an effective solution to the problem. The easiest solution is to store the base in waste treatment plants. However, this process generates only costs (approx. 150 PLN/t), which would put into question the viability of cultivation. To avoid these costs, most mushroom producers decide to give base to farmers who use it as a fertilizer. The agricultural use of waste is limited by the need to distribute them at approx. 50 thousand hectares of agricultural crops while concentrating mushroom cultivation in the regions without such acreage (e.g. around Siedlce).

Paradoxically, despite the lack of scientific hints, a solution to the waste problem presented itself. Thanks to contacts with mushroom producers, Champion managed to learn that the largest item in the cultivation cost was heat and cooling energy. The detailed analysis carried out on three mushroom farms showed that the average farm with an area of about 7 thousand m2 spends about PLN 560 thousand per annum to buy energy. So why not use the large amounts of post-production waste to satisfy the huge demand for energy? The annual costs of purchase of energy for the entire industry is approx. PLN 150 million.

After the problem had been diagnosed, to achieve the expected solution it was necessary to develop a combustion technology that would consider the specificity of the base (low calorific value, high content of chlorine resulting in furnace corrosion, high content of sulphur, phosphorus and potassium resulting in formation of deposits, possible formation of significant amounts of nitrogen oxides, etc.). After two unsuccessful attempts to develop the technology, a customized solution was proposed by scientists from the Department of Energy Engineering at the University of Technology in Częstochowa. They found out that in order to make the whole process efficient and cost-effective it is necessary to prepare the base by drying, and afterwards to incinerate the resulting carbon char. The idea was tested in laboratories of the University of Technology in Częstochowa.

The success of the research phase and laboratory tests meant the need to move to the next phase - testing in real conditions.

Support for carrying out this costly phase of research was obtained from Demonstrator+ program managed by the NCRD. At this stage Champion Dorota Piotrowska began the construction of the pilot line to verify the current state of knowledge in industrial conditions, optimize the base combustion processes, calculate the ecological effect, develop an ergonomic solution for the new technology with diverse cultivation cycles. The preliminary test results show that the solution development solution will allow a standard mushroom producer to satisfy approx. 80% of the energy demand by himself, thus saving up to several dozens of thousands PLN per year on purchase of energy.

Good practice:

The choice of the subject of the research and development project is an important decision for the company's management, especially when it requires selection from among several options of action. Selecting the right direction of research should not be limited only to a variant analysis of cost, effects and risks. At this initial stage (before the project is started) the essence of the right choice is the correct diagnosis of the problem that must be solved, i.e. what is expected by the customer, the recipient and the market (new product, new functionality).

Therefore, the basis of the R&D project selection process should be a systematised diagnosis of the issue carried out in close dialogue with the interested manufacturers, customers, taking into account the role and interests (in the context of the problem) of key stakeholders, the current trends and the state of research, the costs and benefits associated with the chosen variant, legal restrictions, etc.

The diagnosis should thus result in a matrix of variants of solution to the given problem. Such systematised and multi-aspect indication of the actual market demand and the relevant solution allows to minimize the risk of wrong choice of the subject of the R&D project.

Valuation of technology — valuation of opportunities

Valuation of the developed technology makes it possible to determine the effectiveness of investments in R&D

Beneficiary: Lipid Systems Sp. z o.o.

Members of the consortium: Poznań University of Technology (Faculty of Mechanical Engineering and Management, Institute of Applied Mechanics), Wrocław University of Technology (Faculty of Fundamental Problems of Technology, Institute of Biomedical and Measurement Engineering), Regional Specialist Hospital in Wrocław, Research and Development Centre, Wrocław Technology Park

Project title: Innovative liposome technologies for use in cancer therapy

Project value: PLN 8.5 million

Funding: PLN 6.6 million

Neoplastic diseases are now the leading cause of death in industrialized countries, and the number of ill people is increasing. Research centres around the world are working on an effective and safe drug against this disease. Cytostatic pharmaceuticals currently used in cancer therapy are highly effective, but they are characterised by extremely high toxicity effects on the cardiac muscle and kidneys. Therefore, in many cases their use is very limited. Physical and pharmacological properties of such drugs may be improved by preparation of complex pharmaceutical formulations such as liposomal carriers. Antineoplastic agents which, due to the lack of selective effect on tumor cells, are characterized by low therapeutic effectiveness are a class of drugs particularly recommended in combination with liposomes.

The advantages and importance of liposomes used in drug carriers for the modern pharmaceutical market is well-known to Prof. Langner from Wrocław University of Technology, the founder of a spin-out company Novasome, and the current co-owner of Lipid Systems[1]. For many years Professor Marek Langner has been involved in research on liposome drug carriers, biophysics of lipid membranes and biosensors. With the knowledge of liposome technologies and understanding of the pharmaceutical market, the owners of Lipid Systems quickly realised that there is a significant shortage of modern anticancer drug, which is *doksorubicin* (the cost of the original product is approx. PLN 5 thousand per one ampoule, and the therapy requires approx. 50 ampoules), in the market. An additional argument in favour of the subject was the fact that all protection rights for the drug expire in 2014. The result of this diagnosis was the launch of a research and implementation project (in consortium with the Poznań University of Technology, the Wrocław University of Technology, the Regional Specialist Hospital in Wrocław and Wrocław Technology Park) which received support from the NCRD (Demonstrator+). The purpose of the project is to develop a liposomal form of *doksorubicin*, which will make it possible to introduce technologically advanced and reasonably priced drug based on a well-known active substance to the Polish and European markets. The ongoing works are aimed at optimizing the manufacture of liposomal formulation of the drug, starting the technological process of production of liposome preparations on semi-technical scale, then extension of the technological process to the stage of full production and validation of newly developed analytical methods. The technical effect of the project is a pilot line to manufacture liposome preparations, including their active closing in accordance with the GMP.

Although it might seem that because of the situation on the market the risk of commercialization of the developed technology of enclosing of *doksorubicin* in liposomes is small, Lipid Systems decided to make a professional valuation of the technology (valuation was commissioned to a consulting company specializing in the biopharmaceutical market). This move made it possible to determine whether

1 Lipid Systems sp. z o.o. was founded in 2011 and employs approx. 10 employees. The company's operations are focused on conducting research and development work in the field of medical sciences and pharmacy.

and at what point the work performed becomes profitable, what ranges should be taken into account when negotiating the sale of the product at various stages of development, or how to appraise in-kind contribution while negotiating support for the project with investors.

The starting point of the valuation was the size of the potential market for the drug with active pharmaceutical form of *doksorubicin*, however, considering only those types of disease (breast cancer, ovarian cancer) which have a major influence on the size. The valuation was based on three potential scenarios of market expansion assuming various the combination of target markets. The scenarios specify the time of introduction to the market, the period of presence (of the drug) on the market and the expected maximum percentage market share. The valuation was carried out according to the discounted cash flow method, taking into account the risks for the various stages of clinical phases and drug registration (it is assumed that the chances of success for biotechnological drug is 10% for preclinical trials, 20% for phase I clinical trials, 30% for phase II clinical trials, 67% for phase III clinical trials, and 81% at the registration stage). Finally, after analysing the progress of work on the technology, it was decided to assume that the chance of success is 70%. With the above-mentioned underlying assumptions, the valuation allowed to estimate the range of commercial value of the project and its expected profitability.

Good practice:

Each R&D project undertaken by an entrepreneur individually or in consortium is essentially the same investment as a purchase of fixed assets or equity investment, for example. It requires own financial resources as well as additional funding (loan, public support, investors), involvement of a group of employees, and provision of instruments and equipment. It can be determined with high precision what is necessary to carry out the project, but it is much more difficult to estimate the effects. It becomes even more difficult when the project is large, more complex and extended over time. In addition to the business risks associated with the situation on the market at the end of the research part and the start of implementation (e.g. macroeconomic situation), there may be risks arising directly from the essence of the research process. The most important problem is the limitation of the ability to benefit from the effects of the project as a result of violation of industrial property rights of third parties.

Good practice in implementation of research and development projects should be considered as estimate of both the above-mentioned risks before starting the project or at its initial stage. *This is done by determining the closest prior art, appraising the technology and/or preparation of a business plan for implementation when the subject of the project is a new service or product.*

Determination of the closest prior art allows checking whether the expected results of the project (e.g. invention, utility model) are already protected. This will also make it possible to learn the current state of knowledge, recognise the competition and market niches. Valuation of technology (DCF or comparative method) helps to determine the economic efficiency of the R&D project, indicates the time when profitability is achieved and the range of price negotiations in the case of sale of the technology itself. The preparation of the business plan allows to activate the company and start work e.g. with an equity investor.

The risk of collision under control

Determination of the closest prior art can significantly reduce the risk of commercialization

Beneficiary: FINN Sp. z o.o.

Members of the consortium: Isyrius Foundation, Institute of Science and Technology Stipendium, OPEN-RnD Sp. z o.o., Łódź University of Technology, Faculty of Electrical, Electronic, Computer and Control Engineering

Project title: Stereoscopic imaging

Project value: PLN 11.5 million

Amount of funding: PLN 9.7 million

Synchronization of mechanical components under way

Taking pictures and making videos in three dimensions (3D) is an extremely advanced technology, used more and more widely by the creative industry. But this new trend is still heavily underdeveloped, which significantly affects the costs of application of this technology and its popularity. Filming in stereoscopic technology requires expensive and modern equipment as well as skilled professionals. Work on the film set involves simultaneous recording of two images, separately for each eye. After shooting one scene it is necessary to reset the cameras and many various parameters. All this takes time. Therefore, it is costly (remuneration for many extra specialists) and does not guarantee the quality of image (the loss of image increases the intensity of image defects; the viewer experiences dysfunctions, from unnoticeable overload of the visual system, through slight discomfort, to significant eye strain resulting in a complete loss of depth perception and information provided in this way may no longer be acquired).

Aware of strong demand for 3D stereoscopy (commercials, documentaries, feature films and private productions) and the technical problems with the application of this technology, FINN, a micro-company from Łódź operating in the ICT sector since 1994 and responsible for a number of IT projects, has developed a system for synchronization of mechanical components of the film set and optimization of on-line parameters of image. This system includes both adjustable guides with cameras (the so-called stereoscopic carrier) and software synchronising image parameters (focus, shutter, focal length, stereoscopic base, convergence).

Despite the development of 3D technology the specialized hardware and software for support of stereoscopic technologies is fully available only in the US (in some European countries to a limited extent, e.g. the United Kingdom, France, the Netherlands). In Poland, comprehensive rental of specialized equipment for production of films in stereoscopic technology is still incommon, whereas specialists and experts in 3D technology are few in number and provide expensive services. So the competition in Poland is still relatively small, with a significant market potential considering the degree of use of the Internet and mobile technologies.

It was necessary to create demo versions of the entire system and to test it in a real environment in order to refine the idea. The value of this undertaking was estimated at approx.

PLN 11.5 million. For this purpose, the established research and implementation consortium (with the participation of the Łódź University of Technology, the Institute of Science and Technology Stipendium, the Isyrius Foundation and Open-RnD sp. z o.o.) obtained support from Demonstrator+ program carried out by the NCRD (the financed project will include industrial research on the methods of analysis and processing of stereoscopic image, research and development work in the field of film accessories, IT algorithms and tools that automate imaging, as well as production of demonstrators of the new equipment).

Despite good market prospects and weak competition, the consortium also decided to determine the closest prior art to minimise the project risk and avoid any claims from entities whose interests could be affected by the project. Therefore, a detailed review of the databases of inventions kept by the Patent Office of the Republic of Poland was performed. The process consisted of:

- Defining all possible entries related to the subject of the project (3D imaging),
- Verification of new solutions available in the databases,
- Analysis of the databases for consistency with the subject of the project and selecting the databases to be verified,
- Searching the databases for occurrence of inventions corresponding to the thematic entry.

A set of 15 keywords (e.g. "3D", "stereography", "film", "image", etc.) including their inflections was prepared for the purposes of the analysis. The database search returned 143 inventions corresponding to the specified queries (entries). After a detailed analysis of all items we determined that the extent of the planned project does not infringe any exclusive rights of third parties.

Good practice:

The problem that may occur at the implementation stage is the limitation of the ability to benefit from the effects of the project as a result of violation of industrial property rights of third parties. ***Estimation of risks of collision before the start of the project should be considered a good practice for research and development projects.*** *Determination of the closest prior art is used for this purpose. It allows to check whether any expected results of the project (e.g. invention, utility model) are no longer a subject of another solution protected by law. This will also make it possible to find out about the current state of knowledge, recognise the competition and market niches.*

From idea to product — the common objective of every project

Joint research carried out by the consortium members at earlier stages significantly reduces the risk of implementation, and also organizes the role of various entities in the commercialization process.

Beneficiary: Abraxas Olgierd Jeremiesz

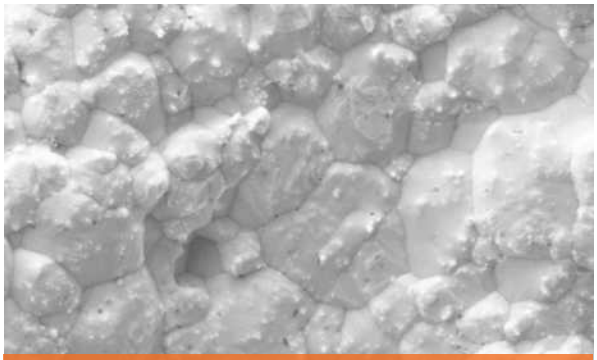
Members of the consortium: Helioenergia Sp. z o.o., Institute of Electronic Materials Technology, Warsaw University of Technology, Faculty of Mechatronics

Project title: Pastes based on silver nanoparticles for application in electronic engineering and electrical power engineering

Project value: PLN 5.6 million

Amount of funding: PLN 4.9 million

The initiator of the project was the Institute of Electronic Materials Technology which came across a problem with obtaining silver nanoparticles. The problem was solved by scientists who made a successful attempt to obtain nanoparticles from their own resources in laboratory conditions. The next step was the completion of the statutory project titled "Development of technology for obtaining silver nanoparticles." Due to very optimistic results which led to three patent applications in Poland and two applications in other European countries, another development project funded by the NCRD titled "The new generation of pastes based on silver nanoparticles for electronics" was carried out. Industrial and development work was performed by the consortium established for this purpose, consisting of ITME, PW - the Faculty of Mechatronics at the Institute of Metrology and Biomedical Engineering, and the company Abraxas who had the idea to implement the technology. Abraxas Olgierd Jeremiesz is a micro enterprise operating in the energy sector, and its main revenues come from exports. The company has a small but experienced team of people and has practice in the field of R&D work (e.g. it is the author of a patent in the area of photovoltaics).



Silver nanopowder under electronic microscope

Silver nanoparticles have a wide range of applications, from the electronics industry to power engineering. The developed technology is innovative and its implementation will provide the consortium with a number of competitive advantages in both local and global market. As a result of completion of the project, the silver paste production technology will be characterised by a lower sintering temperature, higher electrical and thermal conductivity, and the ability to achieve layers with a thickness of 0.5-5 μm after burnout. This will allow to use it in preparation of layers in printed and flexible electronics, i.e. on films, paper or fabrics. Pastes can be applied in various technologies e.g. silkscreen or template, and the designers do not preclude a possible use of other methods, e.g. offset printing or stamp. This technology can be used in many areas, e.g. in the dynamically growing wearable technology market or photovoltaics. Another application of this technology is silver coating of aluminium contacts for power engineering. The ability to apply the technology in the field without specialized equipment will have a significant effect on the reduction of production costs and, at the same time, on protection of the environment. The technology will replace the outdated, expensive and environmentally unfriendly technology based on galvanic processes. The paste created in an innovative technology is also characterised by

easy application, which allows the customer to apply coats on elements in his or her facility without any assistance.

Given the ease of application and low costs, the product will attract small and medium-sized enterprises, which has been confirmed by preliminary talks at the project concept preparation stage. The project leader and partners are currently clarifying the financial terms of commercialization, while carrying out marketing activities to begin sales. The members of the consortium plan to participate in two international trade fairs in 2015 to help to sign sales contracts. However, there are also regulatory risks which may limit the effect of implementation; they are related to the safety of use and trade in hazardous materials. At present, the risk is estimated at an average level.

Good practice:

Completion of a research project in a consortium is an organizational challenge, but the greatest risk is to achieve the common objective. The objective becomes easier to understood with the progress of the project, whereas the cooperation of entities was also needed at earlier phases of research. In the case of this project, the result of work was to develop the technology on a laboratory scale. The results of previous work determined the transition to the next phase of development, i.e. increasing the amount of produced silver paste from the laboratory scale to the demonstration scale, and then to the industrial scale. Although the project is only halfway there, the main problem, i.e. the transition to production on an industrial scale, has now been resolved and the members of the consortium are no longer worried about the final outcome of the project.

A good practice in this case is to perform research work in the earlier stages, so that the implementation process does not generate risks associated with technological assumptions. *The cooperation between entrepreneurs and research units has a clearly defined goal and specified rules of implementation.*

Detailed analysis of the market through effective implementation

Preparation for implementation at the project planning stage through an analysis of demand and economic efficiency increases the chances of achieving the assumed results

Beneficiary: Modertrans Poznań Sp. z o.o.,

Members of the consortium: Poznań University of Technology, Faculty of Machines and Transportation

Project title: Innovative city tram

Project value: PLN 14.1 million

Amount of funding: PLN 5.6 million

New tram ready for tests

Modertrans Poznan is engaged in production of trams and trolleys trams, repair and modernization of rail vehicles and buses. The company currently offers: high-floor trams and partly low-floor trams as well as bogies. The idea of a low-floor tram was a result of market demand and Modertrans' development plans. Work on the preparation of low-floor trams had already been carried out for several years, and Demonstrator+ program enabled the completion of the project in cooperation with the Poznań University of Technology, connected with the company by previous projects. The prototype of the Moderus Gamma low-floor tram carried out under the current project will have the approval and will allow the company to present it on fairs and to participate in tenders. According to the assumptions of the company's business strategy, the new tram should be significantly better than products offered by the competition, and therefore an experienced research unit was invited to cooperation - the Poznań University of Technology which has extensive research facilities. The analysis of the competition's range of products and the market demand made it possible to design a tram with the following specifications:

- low and flat floor and smooth tram height adjustment,
- low noise level – 75 dB,
- comfort (smooth height adjustment, quietness of movement)
- competitive price.

In addition, if the project assumptions are confirmed, supercapacitors storing the energy recovered when the vehicle brakes and used when it starts will be installed in the tram. In the implementation process the company plans not only to sell trams, but also bogies (for 1000, 1435 and 1520 mm tracks), and the vehicle itself can be equipped with a wireless passenger information system. The company also plans to analyse the option of using the design to build tram-train vehicles. These vehicles may move

on both tram and railway tracks. The above-mentioned elements will strengthen the new model of tram and increase the chances of implementation and subsequent sale. However, we cannot forget that the sale will be carried out in a tender procedure, so the elements of tender specifications will also be important to determine the ability to participate in tenders. On the other hand, the eastern markets which were taken into account in the sales forecasts may prove to be much less promising due to the current political situation. Those are significant risks associated with the implementation of the project, but their significance will be assessed after completion of the project.

Good practice:

The implementation of an innovative project whose final objective is to produce results requires accuracy in planning and execution of an analysis of investment profitability. The implementation of projects entails a significant risk consisting of the entrepreneur's funds and the competitive position. Preparation for implementation already at the stage of pre-project analyses should be associated with an analysis of demand for the product or technology that is supposed to be the result of the project and a financial analysis that allows to forecast the future financial flows and to make the implementation decision based on financial indicators.

Modertrans Poznań carried out a demand analysis as well as prepared a financial forecast with the valuation of the project. *The demand analysis was performed for both the Polish market and Eastern European markets which could be a perspective direction of development for the company. Databases of tendering procedures throughout the European Union were used to analyse the demand.*

The demand analysis was used as a basis for a financial forecast of sales of trams in the period of five years after the completion of the project. Taking into account the capital expenditure incurred in the project and financial forecasts, the company prepared a detailed analysis of investment profitability by calculating popular economic performance indicators such as NPV (net present value) and IRR (internal rate of return). The next step after the completion of the project will be to contribute the results of the projects as intangible assets to the company's assets.

Long-term cooperation and joint development of the R&D Centre

Cooperation of the members of the consortium should be in the form of long-term contracts, which will allow to consolidate it and increase its effectiveness also in the areas outside the current ongoing project

Beneficiary: WSK „PZL Rzeszów" SA,

Members of the consortium: Rzeszów University of Technology, Materials Research Laboratory for Aviation Industry at the Rzeszów University of Technology

Project title: Testing of critical aircraft engine elements with higher performance characteristics

Project value: PLN 24.2 million

Amount of funding: PLN 18.6 million

Engine components tests under way

Production of aircraft engines is a very complex process in which the safety of the final product is very important and entails a long process of validation tests. On the other hand, it is a market where new technologies determine the company's competitiveness. For many years, WSK "PZL-Rzeszów" SA has been a supplier of aircraft engine modules and has been approved as a supplier of GTF engine components which will come into operation in 2016/2017. The new GTF engines are green technologies since, according to the specific objectives, they are to consume less fuel (by 16%), have CO2 and NOx emissions reduced by 50% and noise emission reduced by 15dB. However, for WSK "PZL-Rzeszów" SA is to be able to meet these requirements it is necessary to develop new technological solutions and verify them in a static ground test. The construction of test stands will significantly shorten the duration of testing of new solutions as well as reduce the costs of research necessary to put the solution into operation. Therefore, the main objective for the leader is to achieve the ability to test advanced components of modern aircraft engines in conditions similar to real conditions, and then to deliver them. For WSK "PZL Rzeszów" SA the supply of components for modern engines which will be offered by business partners means a considerable increase in revenues and the more importance in the global aviation market.

Development of new technologies allows the company to participate in the development of the global aviation market, mainly through the companies of the main

investor - United Technology Corporation - which is also a shareholder in Pratt & Whitney Canada and America. These companies are leading manufacturers of aircraft engines in the world and, at the same time, the major contractors of WSK "PZL-Rzeszów" SA. With the support for sales, the modern engine components from WSK "PZL-Rzeszów" SA will be included in their ranges of products, which will increase the value of contracts. Due to the nature of the airline industry, in the case of positive test results, WSK "PZL-Rzeszów" SA will become a supplier of components and meet all the indicators associated with the implementation.

Cooperation with research units is a permanent part of the company's strategy and should guarantee competitiveness and increase of share in the global aviation market. WSK "PZL-Rzeszów" SA is an initiator and an active member of the Centre of Advanced Technology "AERONET - Aviation Valley". The beneficiary has been collaborating with the Materials Research Laboratory for Aviation Industry at the Rzeszów University of Technology in a wide range of projects where it is both a leader and a consortium member in several research and development projects worth over PLN 150 million. Additionally, WSK "PZL-Rzeszów" SA is creating the Research and Development Centre for Aircraft Engines, which will consist of the design and technological office, facilities equipped with engine test house, the prototype section and material testing laboratory. In addition to the major research and development support for WSK "PZL-Rzeszów" SA the project will contribute to the strengthening of companies associated with the "Aviation Valley", mainly through the access to technologies at a level comparable with centres operating in Western Europe and the US. WSK "PZL-Rzeszów" SA and the Rzeszów University of Technology are one of the most active entities in the implementation of projects in the field of applied research (targeted projects, applied research projects) as well as their commercialization and implementation (technology initiative, Innotech I and II and Innolot) . Their cooperation in both R&D projects and investment projects was initiated in 2004.

Good practice:

The Aviation market is one where technological advantage defines the competitive position; this is why WSK has been cooperating with the Materials Research Laboratory for Aviation Industry at the Rzeszów University of Technology in the area of research and development work as well as investment projects. A cooperation agreement was signed between the Laboratory and WSK, and significantly goes beyond the current R&D projects and governs cooperation also in the business field. For example, purchases of instruments and equipment are synchronized between the parties so that their offers do not overlap. On the other hand, the Laboratory has a number of certificates and standards that enable collaboration with enterprises operating in the innovative, but also demanding, aviation market. ***Thus, a good practice is the long-term nature of cooperation between the consortium members, who, in addition to the implementation of the current project, are involved in continued cooperation in terms of current activities and the project development.*** *Such cooperation may be in the form of framework agreements, letters of intent, or more detailed arrangements between the parties.*

Due to the fact that the objective of the project is a response to an actual demand of the aviation industry, i.e. efficient and economical GTF engines, the financial aspect was crucial here. Before the project was started the investment profitability had been accurately estimated, including calculation of the costs associated with the implementation. Although the analysis of demand was carried out by Pratt & Whitney due to the nature of the market and the ability to sell through companies within the Capital Group of the owner of WSK, the forecast of production of small and medium aircraft engines was done based on orders from existing customers. This information made it possible to calculate the investment profitability for the next 5 and 10 years, and to plan the project budget so as to minimize the risk of project implementation. Just as in the previously described projects (Modertrans Poznań and Lipid Systems) good practice here is associated with the analysis of economic efficiency of implementation and guaranteed sales after the project period.

What can be used in other projects?

The proposed areas of good practices can also be used in other projects, both in those carried out with public funding and those strictly private. All or only selected practices will apply here, according to the phase of the project.

Considering the fact that the long-term objective of each R&D project is its use in the economy, it is particularly important to become prepared for its implementation. In this field, a number of good practices have been identified; they should precede the implementation of project, de facto even its planning, and then should be used in the course of its implementation:

1. Determination of the closest prior art will allow to eliminate the risk of infringement of intellectual property rights, and, on the other hand, will give rise to preparation of a patent application to enable a realistic valuation of the technology and proper protection of the idea.
2. Beginning of work on the project is a good time to start verifying the idea on the market. The verification can be done by direct contact with entrepreneurs who could potentially be interested in the implementation, or by analysing the demand and market. If the initiator of the project is an entrepreneur, the verification should address the current state of knowledge in research units. Depending on the nature of the project, such research can be carried out by using tools such as inquiries, analysis of industry reports, or access to specialized databases. Those actions should result in estimation of the target market after the implementation of the project.
3. Research and verification of the assumptions of the project directly at the entrepreneur's location (or verification of the state of knowledge by the entrepreneur at the research unit) also allow to reduce technological risks associated with the pilot and implementation phases. Analysis of technological assumptions at the project preparation stage will allow to minimize risks associated with the planned parameters of the product or technology as well as to eliminate the risks associated with materials or technologies used.
4. The beginning of cooperation at the implementation stage is the last moment to appraise the project (its results in the form of technology or product). Valuations at this stage are based on forecasts and estimates of the target market, which means that they are subject to a high risk of uncertainty. At this stage, it is advisable to prepare a complete business plan, including calculation of the costs of implementation of the project into production. This document provides a complete image of the economic efficiency of the planned project.
5. At the project implementation stage it is recommended to use a project management methodology. In the case of high-value projects that involve various types of partners the methodology should be recognized and widely used in project, management (e.g. PRINCE2, PMI). For smaller projects the methodology applied may use elements of various patterns or be based on previous experience. However, all the stages of the management process should be described in detail and followed when the project is being carried out (division of tasks and responsibilities, reporting, management of emergencies, evaluation).

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