# STRUCTURAL OPTION FOR FOSTERING INNOVATION IN THE AEROSPACE AND AVIATION INDUSTRIES

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## Abstract

*The main goal of the research performed was to foster an innovation climate, improve efficiency and effectiveness of the innovation process in aviation industries through the development of a multidisciplinary research network model, by optimal use of different tools and techniques to achieve a structure for better collaboration between innovation partners.*

## 1 Introduction

Aviation is constantly changing. Two factors driving this change are the demands of the market and push of new technologies for continuous development of new solutions. At present, this happens mainly through the gradual improvement of something which already exists. However, circumstances for aviation services may change (e.g. global warming, fuel availability) and this would require a number of new concepts to be available.

The design, development and manufacture of an aircraft requires complex multidisciplinary process optimisation. To respond to the present challenges, the aerospace and aviation industries require an environment where the best scientists and engineers could use their knowledge and skills in the most effective way – creating and acquiring new ideas and developing them until the desired results are achieved.

The Vision 2020 Report, followed by the establishment of the Advisory Council for Aeronautics Research in Europe, which had the task of publishing the first and second Strategic Research Agendas and the 'Out of the Box' (Ideas about the future of air transport) project report to identify potential new concepts and technologies for future air transport and present a variety of possibilities for the future development of the aeronautics sector.

The 'Out of the Box' project report [1] also recommends:

"…7.3.4 There is a general consensus that some sort of European incubator mechanism needs to exist where novel ideas can mature and implementing this concept is recommended. Such a European initiative would not by definition require a new organisation. It is quite feasible that better joint directions and **an improved organisational setup for cooperation in innovative research would yield a good results**…".

It should be noted that recommendation 7.3.3 draws attention to the current trend in the programming of research:

"It has been observed that there are limited possibilities and a lack of money for high-risk, long-term research at European universities and research organisations. The current trend in the technological infrastructure is to give priority to short-term research and technology development that will generate money on short notice".

The above indicates that we are facing urgent challenges to cope with:

- air transport, aviation industries have to develop quickly (market demand, new circumstances for aviation services),
- lack of financial resources for long term research,
- policy giving priority to short-term research and technology development that will generate money at short notice,
- creation and management of large scale multidisciplinary and multicultural network structures.

This paper focuses on the last of the challenges mentioned above: creation and management of large scale multidisciplinary and multicultural network structures and in particular on two elements which play a very important role in making a step forward in innovative development in aeronautic industry:

- network structure formation and functioning,
- communication.

The main goal of the research performed was to foster an innovation climate, improve efficiency and effectiveness of the innovation process in aviation industries through the development of a multidisciplinary research network model, by optimal use of different tools and techniques to achieve a structure for better collaboration between innovation partners.

Issues related to the creation and management of multidisciplinary research networks are very similar in all industries but in aeronautical industry this type of networks have a particular importance due to a variety of competences required in development of any aeronautic construction

The present paper reviews and develops work performed by the TECHNOLOGY PARTNERS Foundation during 2006-2008 within the research projects:

- *Conceptual Development and Model Implementation of Various R&D Structures, and*
- *Multidisciplinary Research Centres as an effective Tool for Improving Research Effectiveness,*

in the context of the Open Innovation approach and of the experience achieved in performing R&D activities in the framework of the AIRBUS-TECHNOLOGY PARTNERS Foundation agreement.

The paper consists of the following sections:

- the 'Open Innovation' approach,
- the model structure,
- the process of forming a structure for fostering innovation,
- the role of communication issues in the creation and functioning of networked research structures.

## 2 The 'Open Innovation' approach

Presently, the research capacities of many innovative organisations – even leaders, with many promising ideas and concepts – are frequently insufficient to ensure that these ideas are implemented. This is the case with organisations and firms operating alone and believing this to be the only correct way to perform R&D.

Both research/innovation activity and the implementation of new products and solutions require an entirely new approach, i.e. the innovation process must undergo radical

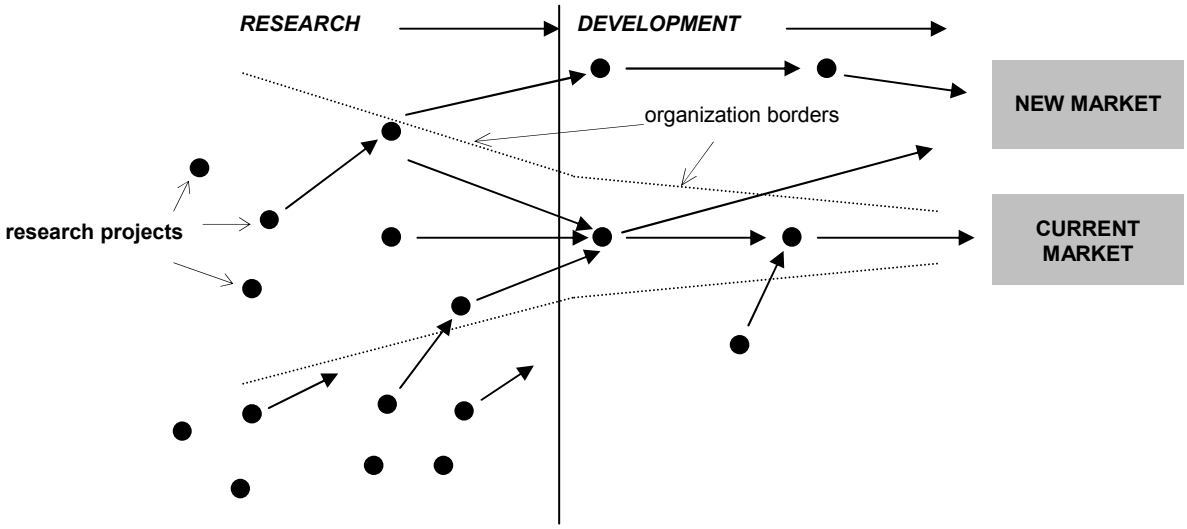


Fig.1. Industrial R&D management – the Open Innovation approach. *source: [2]*.

change: from the Closed Innovation to the Open Innovation approach.

Fig. 1 illustrates this two-way flow of ideas into and out of the organisation (the lines signifying the boundaries are dotted – the boundaries are more open).

| CLOSED INNOVATION | OPEN INNOVATION |
|---|---|
| The best people in our sector work for us. | Not all the best people work for us. We have to cooperate with the best from both inside and outside our organisation. |
| In order to achieve a profit from R&D, we have to invent, develop and implement everything ourselves. | External R&D can be a significant source of value. Internal R&D is needed to make use of part of that value. |
| If we are the first to invent something, we are also the first to bring it onto the market. | We don't have to do the research ourselves in order to profit from it. |
| The organisation that is the first to bring a product or service to market wins. | Creating a good business model is more important than being the first to introduce a product or service on the market. |
| If we create the most good ideas in our sector, we win. | We win if we're the best at using both our own and external ideas. |
| We have to maintain control over our intellectual property to prevent our competitors from profiting from it. | We should profit from the use of our intellectual property by others, as well as make use of others' intellectual property, if it allows us to develop our business model. |

Tab.1. The most characteristic differences between Closed and Open Innovation.
*source: [2].*

Under the Open Innovation [2] approach, organisations may and should use external ideas together with the ones they develop themselves, and use both internal and external routes to market. This factor is key to satisfying its technical challenges and demands. Ideas are still formulated within the research process conducted in the organisation (the left side of the diagram) but some may "leak out" of it at either the research or development stage and flow out onto the market (the right side of the diagram). These "leaks" are usually borne by start-ups which frequently employ the workers of the organisation in which the idea originated. Another mechanism are licenses granted to outside organisations. Ideas can also originate outside an organisation's research labs and "flow into" it.

## 3 The model structure

It is necessary to realise that R&D results are always implemented within complex structures, not simple closed systems limited to single organisations.

**Innovation itself cannot proceed without a structure. The effectiveness of the process requires a structure, which should serve as its catalyst.**

The structures within which R&D takes place can be networks or chains, or be combination chain-network structures. The network or chain consists of a research unit (e.g. university), an enterprise, support organisations (government and non-government agencies, central and local government offices, etc.).

The model structure should:

- possess the critical mass necessary for the performance of its tasks.
- Possess effective management and market, technology and operating effectiveness

### 3.1 Critical mass

The effective implementation of R&D results requires the appropriate "critical mass" whose achievement is possible through cooperation – within a formal or informal multidisciplinary

research structure – of several S&T organisations and enterprises.

The critical mass thus achieved should enable the performance of work currently or potentially in demand, and the implementation of its results.

A structure that possesses critical mass is one that can perform the full cycle of activities involved in R&D activity, consisting of:

- Development of initial project idea and scope,
- Development and performance of research process,
- Development of project documentation and presentation of the results,
- Economic analysis and result implementation rationale,
- Development of IPR documentation,
- Development of financial and legal documentation and other materials relating to the contractual aspects of result implementation,
- Appropriate contacts with complementary organisations possessing infrastructure appropriate for ensuring quick technology implementation.

### 3.2 Market, technology and operating effectiveness, effective management

Within the model structure exists three levels which ensure market, technology and operating effectiveness. This requires R&D management excellence, gained through use of appropriate techniques and tools.

Different methods, tools and techniques are used at each level:

- operating activity level – project management; HR, equipment, and fixed asset management; audit (self-evaluation) tools and techniques;
- technology level – technology intelligence, road-mapping, technology evaluation methods, technology and technology alliance potential evaluation;
- market level – marketing analysis (classical approach), specifically sector analysis, market alliance analysis and drafting commercialisation scenarios.

Fig. 2 shows the tools and techniques relating to these three levels.

These techniques, used properly, i.e. with the correct procedures at the correct moment (i.e. technology development stage) and applied to the correct subject, allow for effective commercialisation of developed technologies. The same tools can be used at various technology development stages.

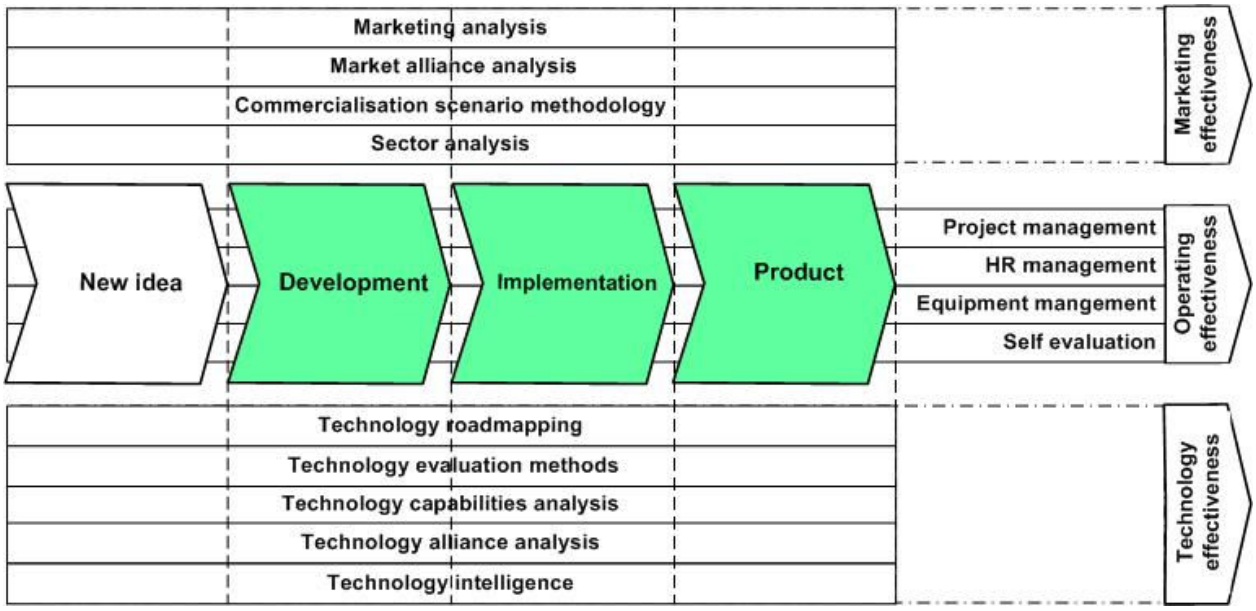


Fig.2. Innovation process carried out by research structures aimed at maximising effectiveness. *source: TECHNOLOGY PARTNERS Foundation.*

## 4 The process of forming a structure for fostering innovation

After 2000, R&D activity gained a new development impulse thanks to a change in enterprises' approach to issues of technology transfer and an acceptance of new innovation activity management concepts.

In the new situation, the model R&D structure that maximises effectiveness while minimising risk is the technology network or alliance. Multidisciplinary research consortia (centres) (including Technology Platforms), that possess critical mass that enables them to conduct the full range of R&D activities are examples.

The shape of the organisational structure of the Multidisciplinary Research Centre (Consortium) is largely the result of several organisations' undertaking an R&D project. Joint project performance is the most common and effective form of initial formation of a Research Consortium.

Fig. 3 shows a model of project performance by three R&D organisations, leading to the launching of joint projects.

Successful performance of a project is a strong motivation for further cooperation and supports initiation of new projects, and hence the creation of Multidisciplinary Research Centres.

The development of the Multidisciplinary Research Centre is a complex process. Achieving operating effectiveness requires attaining a position to carry out actions relating to R&D management: the use of appropriate tools to increase knowledge and communication to ensure correct cooperation between the partners.

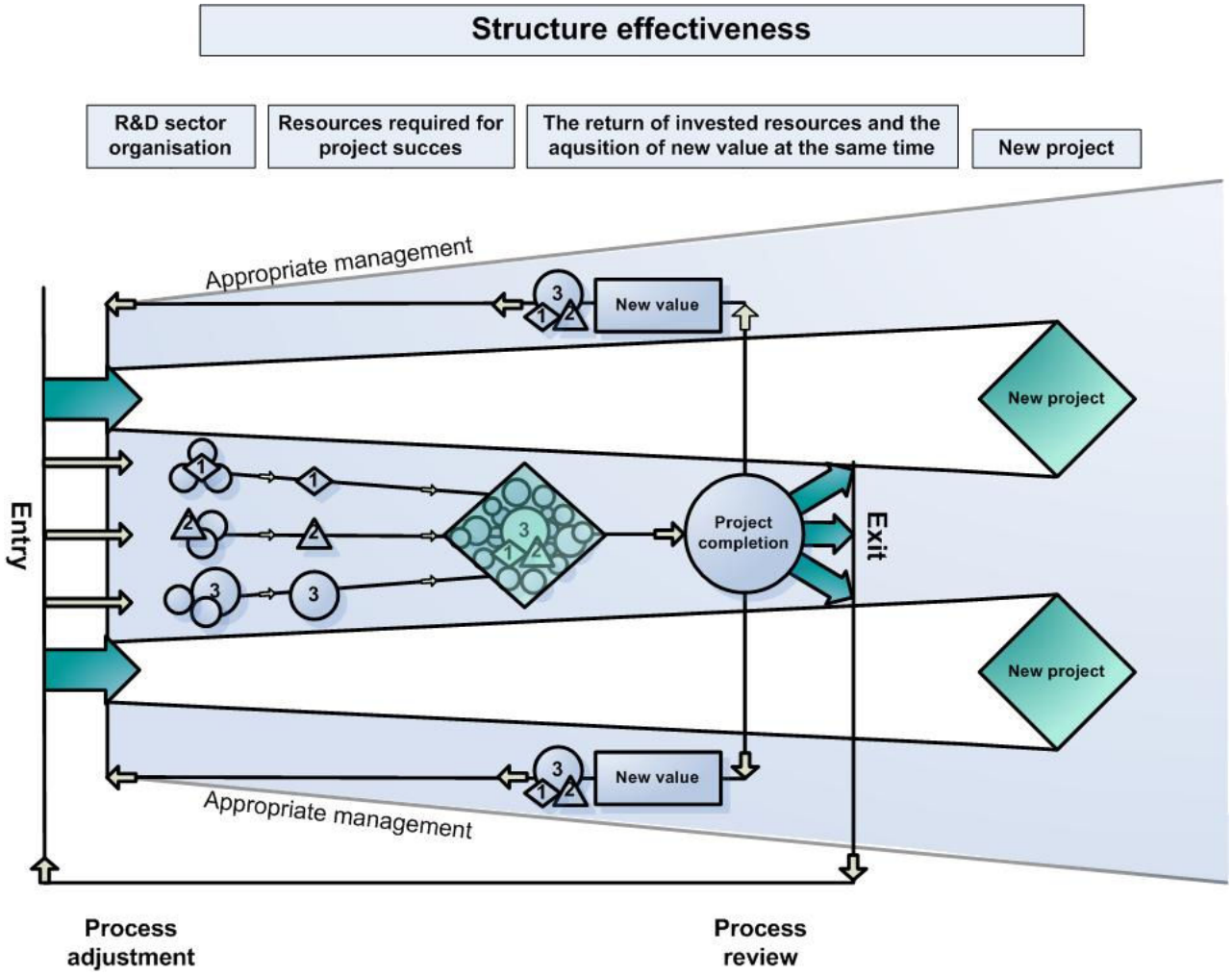


Fig.3. Model of project performance by R&D Institute consortium.
*source: TECHNOLOGY PARTNERS Foundation.*

The model structure should enable achieving market, technology and operating effectiveness through effective management of its constituent units and the whole Centre with appropriate tools and techniques (Fig. 4).

Fig. 5 presents two paths toward an Multidisciplinary Research Centre.

The upper part shows development of the structure with the same partners, whose cooperation generates new resources

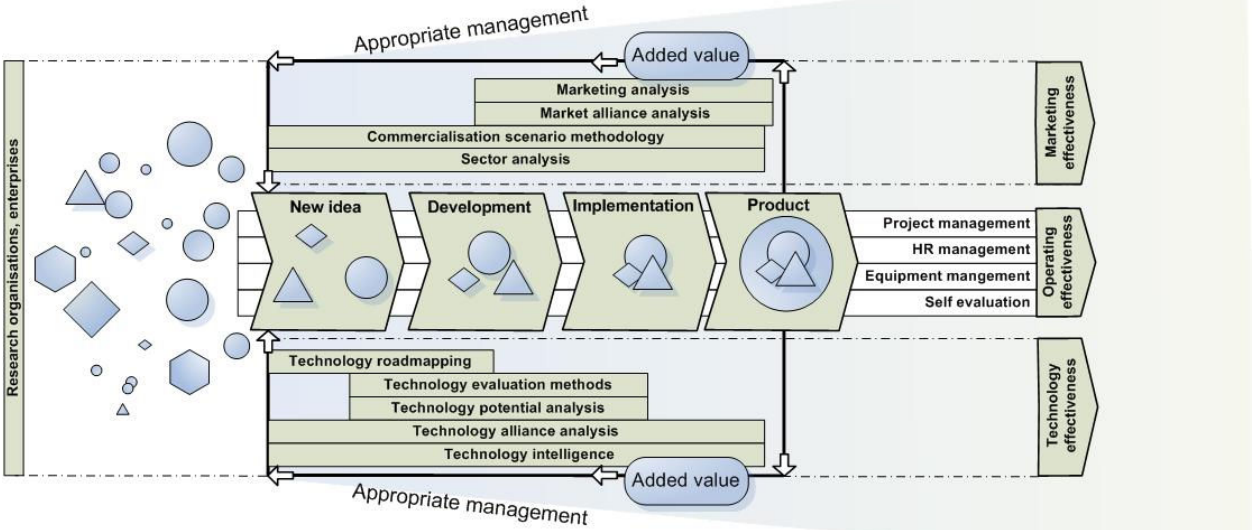


Fig.4. Origins of Multidisciplinary Research Centre.
*source: TECHNOLOGY PARTNERS Foundation.*

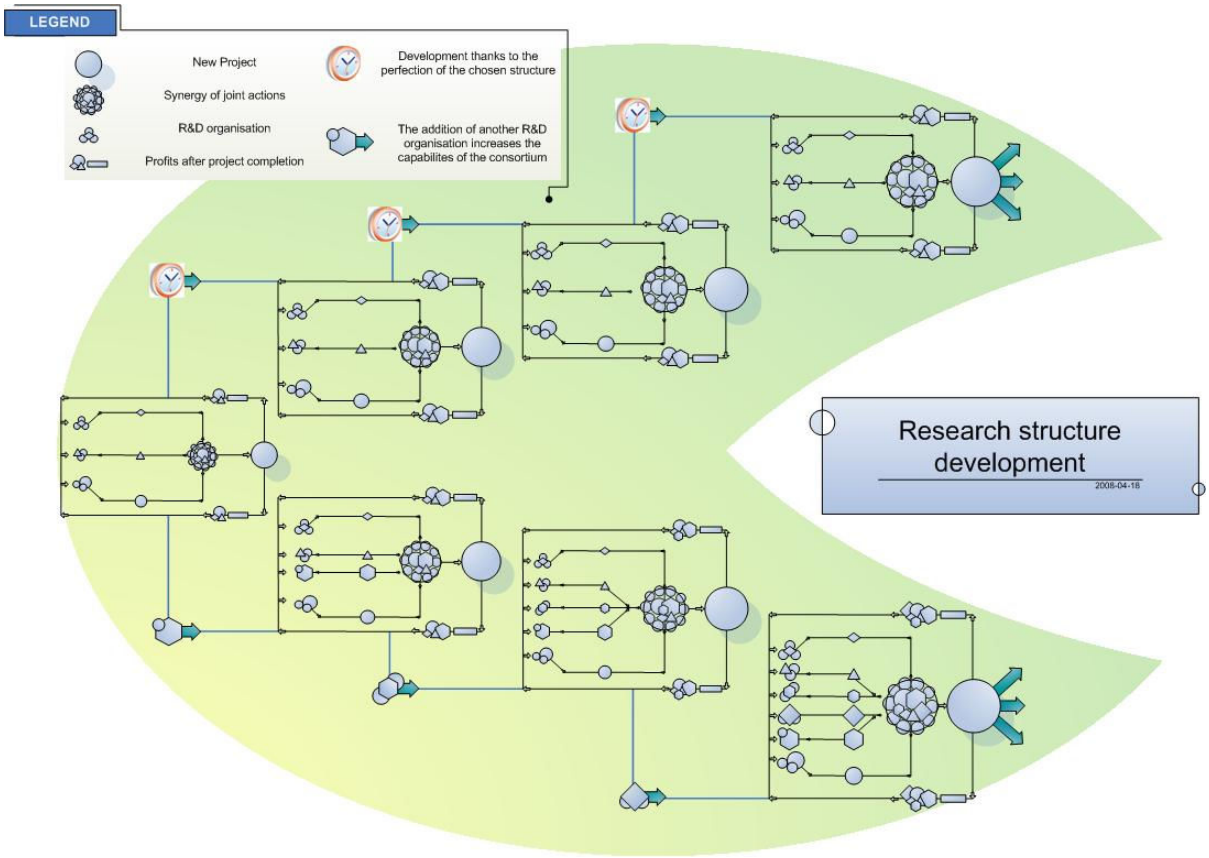


Fig.5. Multidisciplinary Research Centre development.
*source: TECHNOLOGY PARTNERS Foundation.*

(knowledge, finances, contacts, management skills); the lower part shows the growth of quantitative potential, necessary to undertake new tasks.

### 4.1 Organisational activity (management best practice)

Successful establishment of the Multidisciplinary Research Centre (MRC) requires interest from industry and active involvement of future members in shaping the MRC.

A MRC is organised in three main stages. At each stage, the factors that have the greatest influence on the Centre's future success must be considered.

*Stage 1: Formation*

The first step is collecting interested partners, who meet to prepare a general layout of activity. The vision of progress is defined, as are the mission and strategy (strategic objectives). The Centre is formed through signing the appropriate agreement and its members develop a detailed Strategic Programme (stage 2).

*Stage 2: Development of Strategic Programme*

At this point the partners define the joint activity programme in detail. The objectives included in the programme should be practical, focused on research in connection with enterprises and covering the full product and service development cycle to implementation of S&T results.

*Stage 3: Implementation of Strategic Programme*

Actions undertaken by the Centre (research projects etc.) and the general cooperation should be ensured in the long term – many tasks require extended cooperation for implementation of results, others require initiation of additional work resulting directly from previous activity.

### 4.2 Supplementary and corrective actions in line with 'Responsible Partnering'

Creating an environment for long-term cooperation is an important element of establishing Multidisciplinary Research Centres.

The 'Responsible Partnering' initiative is a guide to cooperation principles, available to all interested organisations. Its main elements are presented below, since many should be included in the Centre's Strategic Programme.

Four European organisations: European University Association (EUA), Pro Ton Europe, European Association of Research and Technology Organisations (EARTO) and the European Industrial Research Management Association (EIRMA), with support from the EU Commission, created the 'Responsible Partnering' [3] initiative to increase the effectiveness of joint research and knowledge transfer. The TECHNOLOGY PARTNERS Foundation, as a member of EARTO and EIRMA, took part in creating the initiative.

'Responsible Partnering' is based on two principles:

- Maximum Beneficial Use of Public Research;
- Responsible Use of Public Research.

These principles are developed further in the following ten guidelines for undertaking action that should gradually be included in the partners' activities:

1. Foster strong institutions
2. Align interests
3. Treat collaboration strategically
4. Organise for lasting relationships
5. Provide the right professional skills
6. Establish clear intent
7. Use standard practices and communicate regularly
8. Achieve effective Intellectual Property
9. Provide relevant training
10. View innovation as a trans-disciplinary activity

## 5 The role of communication issues in the creation and functioning of networked research structures

Experience shows that the existing patterns of communications and relationships between RTD organisations across Europe are far from perfect [4].

Improved communication requires something more than just tools. It is necessary to understand and consider the unquantifiable issues that influence the way in which people use the tools available to form and maintain

mutually beneficial relationships. An issue of primary importance in Europe are cultural differences. These include differences between the Anglo-Saxon and Mediterranean traditions, between northern and southern Europe, and between "new" and "old" Member States, as well as between universities, research organisations, large enterprises and SMEs.

There are also large differences in the level of organisations' understanding of research management processes and their use of best practice, as well as a low level of understanding of the behaviours that promote good cooperation.

Communication is a process, i.e. a finite sequence of activities related to the transfer of information between people and groups (organisations). The classic communication model emphasises actions relating to the transfer of information between the source and the recipient, communication within organisational structures, communication within formal and informal communication networks etc.

The model of communication within network structures is characterised by the following traits:

- it reflects communication within network structures, i.e. between multiple organisations and their representatives cooperating in the innovation development and transfer process,
- it reflects intra- and inter-organisational communication processes,
- it focuses on the actions that make up the value chain and are hence directly related to innovation development and transfer [5].

The network communication model is based on the VCOR (Value Chain Operations Reference) model.

Improvement of communication processes aimed at increasing the effectiveness and efficiency of innovative solution development and transfer requires the measurement and evaluation of processes in order to ascertain the current condition, as well as a diagnosis of the existing problems with an indication of improvement directions. Communication processes are measured and evaluated with the use of two methods:

- internal evaluation by team members,
- external evaluation.

The internal evaluation of communication processes is based on personal opinions on the level of employee satisfaction, acquisition of new skills and increase of the level of knowledge, barriers and factors facilitating access to information, as well as complaints, comments and negative opinions. The internal evaluation of communication processes is based on the personal opinions of participants of the communication process within the organisation. It is intended to answer the question of whether and to what extent communication processes (in reality, access to information) make it easier for the employees to perform their innovation development and transfer tasks. The internal evaluation is performed using a questionnaire and a scoring scale. In order to limit the impact of subjective evaluations, the individual employees' opinions are aggregated (averaged).

The external evaluation of communication processes, on the other hand, concerns the entire innovation development and transfer system and the final results of the system's functioning, i.e. the development and transfer of innovation. It considers factors including:

- results achieved (% tasks completed, % tasks completed on schedule and under budget etc.),
- quality to tasks performed,
- level of customer satisfaction, etc.

The external evaluation is performed by the project leader, the managers of the organisations taking part in the project, external experts and others. It takes into account both qualitative and quantitative criteria.

Communication processes are improved using the process approach. This concerns the management of a network of innovation development and transfer process participants focused on management of communication processes. The management actions consist of the following main steps:

1. Identification of innovative solution recipients (customers) and their needs,

2. Identification of the communication processes that directly or indirectly fulfil the customers' needs,
3. Measurement of the degree of fulfilment of customers' needs (communication process evaluation),
4. Communication process analysis and improvement,
5. Result measurement,
6. Team motivation.

In the approach adopted by us, improvement of communication processes is connected with the formalisation of actions and provision of appropriate tools

Analysis of the software solutions available on the market has shown that they do not meet all the requirements of the network's members.

## 6 Case study: the TECHNOLOGY PARTNERS Foundation (TPF)

Below is a short case study on the cooperation of an interdisciplinary research centre with strong ties to industry with aviation industry (AIRBUS).

The TECHNOLOGY PARTNERS Foundation (TPF) is a scientific research organisation founded in 2003 and possessing (since 2004) the status of Advanced Technology Centre. The structure of TPF was gradually developed with an objective to create a strong S&T organisation with a leading position in the area of producing and implementing R&D results and develop mutually beneficial and profitable cooperation with national and foreign organisations and institutions.

In its current form, TPF is an example of a network virtual scientific research institute with significant research potential. The core of the network is the TECHNOLOGY PARTNERS Consortium, consisting of 10 industrial research (R&D) institutes, and two SMEs. It consists of approximately 1,550 research staff. The important asset of this network is the ability to undertake large interdisciplinary projects concerning various scientific disciplines and industrial sectors.

Research projects initiated by Consortium members or external organisations are carried out within ad-hoc networks which are dissolved upon a project's conclusion. Each consortium member may take part in several projects simultaneously, becoming an element of various networks. The consortium's activity led to a further tightening of connections and served as a stimulus to search for new forms of cooperation.

TPF promotes and carries out the Open Innovation concept. The adopted innovation activity model requires ability to deal with many problems. The main ones concern areas such as management of large, interdisciplinary research projects, including work coordination and project control, flexibility of operations and quick response to market signals, making use of market opportunities, quick preparation of proposals, team formation and selection of appropriate persons to perform the work.

The scientific potential, organisational structure and approach adopted by TPF facilitated first contacts in 2005 with AIRBUS on research cooperation possibilities. In 2006 cooperation agreements were signed.

AIRBUS has been cooperating with Poland, both in the area of research (for around 4 years) and production (for over 10 years).

Both research and production cooperation have proved that there exist valuable and cost-effective capabilities in Poland which would be worth exploiting to a greater extent through AIRBUS' supply chain either directly or indirectly.

The research cooperation with Poland has provided AIRBUS with a virtual interdisciplinary research centre in the form of a number of Research Institutes' research teams, managed by the TECHNOLOGY PARTNERS Foundation, whose actions in this area are based on the relevant agreements with AIRBUS and on a consortium agreement between the Research Institutes. To date, the research cooperation has achieved the following results:

- 8 completed research projects ordered directly by AIRBUS,
- 2 joint FP 7 projects (being performed in large consortiums), and
- 5 feasibility studies of new research projects, positively evaluated by AIRBUS as being within the scope of its interest and of high technological competence.

In the production sector, however, there exists a technological gap which is limiting the industry's ability to capture higher value work from AIRBUS. Polish manufacturers and research institutions should work together on raising the technological standard in those areas in which their offering could be the most attractive, and on developing innovative concepts that could be transformed into new products.

**Ideally, in the long term, this would enable AIRBUS to acquire very competitive products manufactured in Poland based on research performed by Polish providers**.

Fig. 6 summarises AIRBUS' approach to cooperation with Poland in the area of R&D.

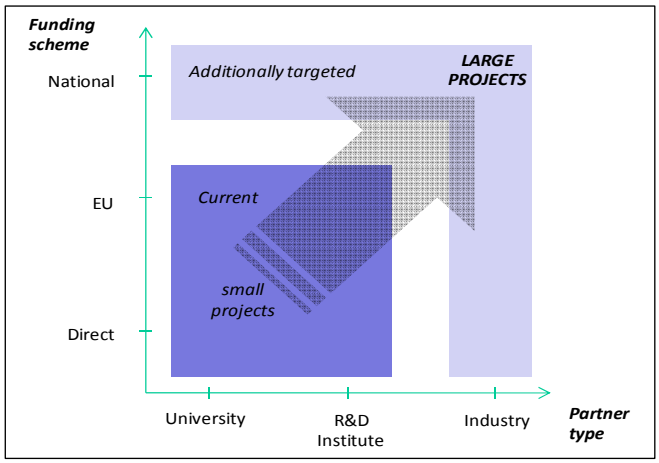


Fig.6. AIRBUS' approach to cooperation with Poland in the area of R&D.
*source: TECHNOLOGY PARTNERS Foundation.*

One of the main challenges confronting TPF is the need to improve communication. The member-institutes' existing mutually differing, individually designed information and software systems constitute a barrier to effective network cooperation in line with the Open Innovation approach. This is true both of cooperation between research partners and their cooperation with industry. Increasing the effectiveness of cooperation required appropriate system support – the creation of a shared work environment and information resources. TPF initiated and is performing a project intended to create a software tool (platform) supporting communication within network structures. The project is intended to increase the competitiveness of research organisations cooperating within a network structure. This will be achieved through the development and implementation of a dedicated software and information tool.

The system will allow users to:

- consolidate their knowledge, human, and infrastructure resources, and thereby achieve synergy – benefits of scale;
- improve communication effectiveness and ensure quick access to information of the required quality, both by members of the project consortium and by potential external research and industrial partners;
- increase the efficiency of R&D project performance and their quality thanks to a shared project management environment;
- overcome differences between the institutes in their level of understanding and application of research management processes and best practices.

## 6 Final remarks

- The business, research and technology transfer scene changed after 2000. The new drivers are New Business Models (Strategic Business Development in pre 2000); the new methods, Technology Networks (Core Competences in pre 2000); new relationship, Alliances (Programmes in pre 2000). This is a reminder that R&D management it is not project (or programme) management only.
- The R&D model structure that ensures maximum operating effectiveness while minimising risk can be presented as a technology network and alliance. The multidisciplinary research consortia that achieve the critical mass enabling them to perform the whole range of activities involved in performance of R&D are a representative type of such a structure.

- Particular focus in R&D management should be placed on communication issues. Differences amongst collaboration partners in their understanding of the research and innovation process, in their cultural preferences for 'top-down' versus 'bottom-up' management and in their maturity in terms of their skills in research management, can get in the way of effective partnering, just as much as differences in language or culture.

## References

[1] *Out of the Box (Ideas about the future of air transport)*, European Commission, DG Research, ACARE, November 2007.

[2] Chesbrough H. *The Logic of Open Innovation: Managing Intellectual Property*, California Management Review 45(3), 2003.

[3] *Responsible Partnering: Joining forces in a world of open innovation – A guide to better practices for collaborative research between science and industry*, EIRMA, EARTO, EUA, ProTon Europe, January 2005.

[4] *Boosting European Private R&D: Final Report*, European Research Advisory Board (EURAB), EURAB 05.036, October 2005.

[5] Robbins S.P. *Essential of Organizational Behavior*, Prentice Hall, 1996.

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