

Cooperative Research Networks in Engineering - A New Format of Interaction with Industry

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Abstract: The increasing connectivity brought about by the communication revolution has opened new ways for interaction among research groups, strengthening the possibilities of collaboration among long distant partners. One concrete example is the formation of networks, where complementary and geographically distributed competencies can be joined to develop cooperative research. Such arrangement results in a clear optimization of human resources and infrastructure, allowing the constitution of strong teams that may address problems of large complexity or multidisciplinary nature, usually extrapolating the capacity of isolated groups. This format of collaboration is well established in the scientific community, where long term interaction involving international teams is quite common. In the last decades, changes in the regulations and policies of different countries have opened the way for a similar trend in the very delicate realm of University - Industry interaction, resulting in the establishment of several programs of joint cooperation. In Brazil, a new experience has been recently introduced, involving the formation of cooperative research networks. In this program, called RECOPE, Universities and Research Centers constitute a network and, in agreement with one or several Industries, develop research in a topic previously defined. The aim of the program is to focus on emerging technologies, so that even competitors can take part in the funding of the project. One of the networks deals with Advanced Processes in Metal/Mechanics and has been under development during the past three years. Several cases of successful interaction have been established, although different problems have been diagnosed in the implementation of such network. The paper presents the results so far obtained by the Metal/Mechanics network and the plans for its future evolution.

Keywords: cooperative networks, Industry-University interaction

1. Introduction

The constant and progressive advent of new technologies, most of them displaying a substantial amount of scientific content, has produced a completely different pattern for the sustaining of markets and development of new products. Coupled to the continuing decrease of the product life cycle, the situation is such that even well managed firms can experience failure when confronted with disruptive changes in technology and market structures [1]. Several examples can be given in different sectors of industry, from electronics to steelmaking, where solid and mature technologies have been displaced and taken over by more efficient and, in some cases, revolutionary new products or processes. On the other hand, the generation of scientifically based technologies requires a continuous investment in research, experimental development and engineering. When a system succeeds in promoting a broad knowledge basis and has available the managerial capacity to produce high quality goods and services, the result is a concentration of power in all levels. In fact, the observed shortening of the time necessary to transform a scientific breakthrough into an innovated product has been used to explain the success of several industrialized countries [2]. As a result, in the productive sector, it has been observed the formation of technological complexes as well as the fusion of companies. To a certain extent, the same pattern seems to be occurring among countries, with formation of political, economic and military blocks around few countries with technological leadership [3].

Being the engineers the ones, which enable the majority of scientific knowledge and inventions to reach the consumer markets as innovations, the competence in engineering is essential for commercial success even for the countries with less scientific development [4]. The PRODENGE program was established in Brazil to promote the

development of engineering through two actions: the reengineering of the educational programs (REENGE) and the formation of cooperative research networks (RECOPE). One of these networks deals with Advanced Processes in Metal/Mechanics and has been under development during the past three years. Several cases of successful interaction have been established, although different problems have been diagnosed in the implementation of such network. At the moment, several projects are under way and different activities are being offered to the industry such as: workshops, courses, state of the art information and consulting. In a large and heterogeneous country like Brazil, the possibility of remotely accessing high tech information from remote areas may provide a substantial impact for the development of regions located outside the relatively few largely industrialized centers. In the next few years, with the incorporation of new forms of on-line communication, other possibilities of interaction and training, such as tele-education and video-conference, will be considered. The paper describes some aspects of the traditional cooperative research, the results so far obtained by the Metal/Mechanics network, and the plans for its future evolution.

2. Cooperative Research and Networks

During the last decades, the industrialized countries have tried several arrangements to stimulate innovation, the reduction of R&D costs, and the optimization of their technical and scientific potentials [5,6]. Particularly important arrangements are the Pan European research and development program EUREKA, the European Framework Programs for Research and Technology Development (RTD), the North American Advanced Technological Program (ATP), and National Science Foundation programs such as the Industry-University Cooperative Research Centers (I-U CRC), Engineering Research Centers (ERC), Small Business Innovation Research (SBIR), and The Grant Opportunities for Academic Liason with Industry (GOALI). These attempts led to joint efforts for technological development, involving the conception and implementation of cooperative R&D projects, developed by partnership arrangements of enterprises, research institutions and universities. For that matter, the partners involved agree to commit financial and human resources in exchange for access to project results and information produced. In general, this kind of arrangement aims at the development of technologies in their pre-commercial stages [4].

These cooperative arrangements were mostly motivated by possible reduction in costs and risks, but the increasing connectivity brought about by the communication revolution has opened new ways for interaction among research groups, strengthening the possibilities of collaboration among long distant partners. One concrete example is the formation of networks, where complementary and geographically distributed competencies can be joined to develop cooperative research. Such arrangement results in a clear optimization of human resources and infrastructure, allowing the constitution of strong teams that may address problems of large complexity or multidisciplinary nature, usually extrapolating the capacity of isolated groups. The format of collaboration in networks is well established in the scientific community, where long term interaction involving international teams is quite common. However, in the near future, due to the increasing availability and speed of communication systems, the concept of networking will evolve as one of the most important tools for technological development [7], and will be a significant asset in the realm of the University-Industry interaction.

Characteristically, networks do not necessarily consist of buildings, corporate shells or an organization. Networks may be no more than a discussion list, a web-site or a sequence of seminars. Moreover, networks rely heavily on communication systems, as institutions or individuals that are geographically apart may join efforts on common interest projects, making use of the increasing speed of communication for transmitting bigger masses of data, or real time distance processing. Networks also tend to depend on multiple sponsors. Contrarily to traditional institutions that have one main source of funding, different agencies or clients may fund networks. Finally, networks have a limited life span, as they are not expected to live beyond their mission. Once their objectives are attained, as long as there are no other aims, they are adjourned. Thus, networks do not risk becoming outdated.

Variations in overall social, economic, political and especially technological conditions require deep changes in the paradigms that have ruled human activities. The process of technological innovation and the way technological production is organized has been no exception. The possibilities of single organizations were outpaced. Networking has been one response to those changes.

There are both economic and strategic motivations that drive participants into networking. Strategic objectives are important even though investors more easily grasp financial or economical reasons. One strategic motive is sharing uncertainty. Technology is a long term and high-risk investment. Network participants, however, share risks. Furthermore, the overall risk is reduced by the fact that different approaches contribute to enhance the chances of success. Another strategic purpose for joining networks is reducing time to market: The fact that many participants

join efforts in common interest projects results in shorter time to obtain commercial results. Besides, business participants put pressure on academia to reduce time in solving a problem, whereas theoretical results from academic participation help closing in towards a solution. Another reason for taking part of networks is cross-fertilization. The main frontier for technological innovation is the combination of different fields of knowledge or technologies. Many breakthroughs occur when different technologies are combined. Networks are a mechanism for bringing organizations with differing areas of interest to collaborate in joint efforts. Sharing expertise is another strategic result from networking. As technology becomes increasingly, more complex and interdisciplinary, one single organization is seldom able to tackle technological problems or opportunities by itself. Networks congregate organizations with differing capabilities and facilities.

One more strategic result from networking is the possibility for monitoring environmental changes, as a network is a sample of the universe in which an organization thrives. Suppliers, customers, competitors, academia and other partners collaborate on common interest projects within a network. Therefore, a network provides the means for an organization to monitor changes in its business environment, and to be aware of opportunities that arise. One immediate outcome of the possibility of monitoring the business environment is market access and positioning. Since networks are a sample of the business environment of an organization, they help them to plan their market strategies.

3. The RECOPE program

In the RECOPE program, networks consist of several universities joining one or more companies or other client-users for the technologies to be generated. Those participants collaborate in jointly defining and carrying out innovation projects of common interest. RECOPE has promoted, since 1997, the establishment of 87 networks in various sizes and subjects. There were three entries in RECOPE for submitting proposals: priority issues, specific-theme networks, and statewide coalitions.

Seven priority issues resulted from a broad consultation. Such priority issues were defined as the outcome of a sequence of seminars in addition to a Delphi consultation for technological forecasting and assessment applied to around four hundred respondents [8]. Participants from the business community, as well as from academia and government, contributed in defining priority issues. The RECOPE priority issues suit a twofold rationale: one of competitiveness and one of social demands. Seven priority issues were selected:

- industrial automation
- advanced processes for metal-mechanics transformation
- computer science as applied to engineering
- transportation engineering for urban mass transportation and infrastructure for exportation
- agro-industrial production
- planning, management and engineering of water resources
- basic sanitation

The eighth issue was technological education for competitiveness, meant to recycle engineers who were already active in the marketplace. It became one of the three components of PRODENGE. Networks in priority issues were meant to tackle pre-competitive technologies. Each priority issue resulted into three to six networks. A call for proposals invited proponent to state their interest and preparedness to join efforts in networks on those priority issues. Selected proponents were then invited to meet and define the projects and networks within each issue. A coordinator for each priority issue was elected. Each network then elected a coordinator, defined and formulated its project, defined the responsibilities and the budget for each participating organization, and submitted it for funding.

Specific networks did not necessarily fit into the seven priority issues shown above but had to be submitted in the form of a previously established network with the participation of several universities, industry or some other end-user, and a project comprising objectives, scope, methodology, a time-chart, and a budget. Examples of specific networks are: deep-water off-shore oil drilling; the recovery of oil spill and their use in structural ceramics; the recovery of mining waste and their use in industrial processes or as construction material; the development of highly sensitive blood pressure sensors for surgical equipment; knowledge management for business; automatic monitoring system for hollows in underground mining; supervision, analysis, and management of heavy electric power systems; and catalysis.

Statewide coalitions were also established as one part of RECOPE for the support of networks tackling priority issues from a state-level standpoint. Four statewide RECOPE initiatives have been launched so far involving a partnership between FINEP, state-level governments, and the local Federations of Industry.

4. Advanced Processes for Metal/Mechanics Transformation Network

The Metal/Mechanics (MM) network was established with a total of 172 researchers (including students and technical staff) from 17 research institutions spread along 5 states of Brazil. The selection of research topics resulted in a total of 18 projects involving 32 industries.

The following 5 sub-networks have been implemented:

- innovation on the reduction of iron ores;
- steel: new products and processes;
- near net shape manufacturing;
- improvement in the surface properties of metals;
- advanced machining processes.

After long negotiation of the projects, contracts were signed and the first payments occurred in late 1997. After two and half years, the network has achieved several important marks. All projects are under way and a survey of the infrastructure and human resources of the network has been completed. The interaction between groups has increased continuously and new potential partners have been identified both in the industry and participating universities and research centers. Since the networks are open, new partners can be included at any time. The connectivity among the members of the network is quite high, and is heavily based on the use of e-mail system and Internet. A dynamic site is under construction and will be used as an additional working media of the network. One concrete benefit of the RECOPE project has been the establishment of very broad and complementary research teams in the Metal/Mechanics sector. In some areas, all relevant research groups and industries of the country are engaged, suggesting a solid route for the future of the network.

Due to differences in the sectors covered by the MM network, the degree of industrial interaction is not uniform among the five sub-networks. Some cases of success in this interaction are quite evident. The sub-network on Advanced Machining has managed to establish a very strong interaction with the industrial sector of automakers and manufacturers. It has already introduced a membership system to keep interested enterprises linked to the network and it is programming a series of activities, such as courses, publications and meetings to fulfill the needs of its partners. The sub-network on Surface Properties has promoted a series of workshops with heavy participation of the industry and it is constantly being pressed to produce new ones. In both cases, the number of industries involved in their sector is large and there is still room for increasing interaction. The division of Powder Technology in the Near Net Shape sub-network managed to include all important research groups in the subject, and is directing the planning of activities for the segment. Some of the other sub-networks have their activity in sectors dominated by few very large industries, such as the iron ore producers and steel makers. In such case, the possibility to attract concurrent companies for a joint project is quite small and depends on a very good selection of a pre-competitive theme. Even though, some successful projects have been developed along each sub-network.

The rigorous selection of a pre-competitive topic for research has been the main difficulty faced so far by the Metal/Mechanics network. The lack of definition of pre-competitive themes has kept some potential industrial partners out of the network due to fear of leakage of information to its competitors. This kind of problem has no easy solution and will demand time to be solved. It is expected that, as the interaction proceeds and successful cases are registered, there will be a natural increase in confidence among the partners, resulting in a consistent and long term research program, capped with a selection of adequate pre-competitive themes for investigation.

At the end of each year, the MM network realizes a workshop for evaluation of the activities and the planning of the following year. During these workshops, a series of talks and short courses has been offered to the participants of the network, with very good response. Talks on Quality Control and Marketing were given in the first workshop, realized in November 1998. Strategic Planning, Goal Quantification and Uses of Internet were given last December, during the second workshop. Two short courses were also offered last year: How to Lead Technical and Scientific Teams, and Management of Projects. The reaction to these talks and courses has been quite favorable, mostly from the academic personnel, usually not exposed to such training in their universities. During the first half of 2000, the strategic planning for the network and for each sub-network have been developed. Among the long list of actions to

be pursued, the consolidation of the network, through a system of membership affiliation and the offer of a variety of services to industry (courses, training, consulting, etc.) have been given prior attention. A more subtle, but also important issue is the handling of intellectual property in the network. This seems to be a very touchy field, needing a careful approach to avoid disagreement and internal dispute. A recent study has been published on this subject[9], suggesting that there are no clear-cut rules. Different situations require different solutions, opening the question for negotiation.

Regarding the problems that have hindered the consolidation of the network, the most obvious is the delay in grant disbursement to participating universities. Because it affects directly the development of the projects, this lag also hurts the delicate relationship between universities and industries. Taking into account that industry-university cooperation is still quite fragile, any additional disturbance, such as delay in reports due to lack of funds, can damage substantially the establishment of a long term association.

Another source of difficulties, had to do with the attempt by some research groups to elect their own topics of interest as the relevant ones to the network. Gradually, after several meetings, this kind of behavior was minimized. However, there is still a gap on the industrial side, regarding the participation in the networks. In the majority of the cases, the industry brings their last minute problems to consideration, making difficult the proposal of a long term project on a pre-competitive theme. In some cases, after few months of enthusiastic interaction, the industry loses interest in the topic, as well as in the network participation. For this reason, a careful approach has to be exercised when dealing with large companies, since more than friendly, the contact has to be done at the appropriate level, where the long term goals of the enterprise are set.

5. Conclusions

The constant and progressive advent of new technologies, most of them displaying a substantial amount of scientific content, has produced a completely different pattern for the sustaining of markets and development of new products.

Since the generation of scientifically based technologies requires a continuous investment in research, experimental development and engineering, cooperative research has been used in the last decades by industrialized countries to stimulate innovation, the reduction of R&D costs, and the optimization of their technical and scientific potentials.

Although these cooperative arrangements were mostly motivated by possible reduction in costs and risks, the increasing connectivity brought about by the communication revolution has opened new ways for interaction among research groups, strengthening the possibilities of collaboration even for long distant partners.

One concrete example is the formation of networks, where complementary and geographically distributed competencies can be joined to develop cooperative research. Such arrangement results in a clear optimization of human resources and infrastructure, allowing the constitution of strong teams that may address problems of large complexity or multidisciplinary nature, usually extrapolating the capacity of isolated groups.

In Brazil, a cooperative research network program (RECOPE) was established, consisting of several universities joining one or more companies or other client-users. Those participants collaborate in jointly defining and carrying out innovation projects of common interest.

One of the networks, focussing on Advanced Processes for Metal/Mechanics Transformation was established with a total of 172 researchers from 17 research institutions and it is developing a total of 18 projects involving 32 industries.

The results obtained so far suggest that this new format of University-Industry interaction will become progressively more important, as the evolution of telecommunications proceeds.

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