TECHNOLOGY TRANSFER FROM ACCELERATOR LABORATORIES

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Abstract

By using empirical examples this paper presents several practical mechanisms on how to catalyst technology transfer from big-science laboratories to a particular member state and its industry. The underlying case is that of Finland and CERN. Special focus is on development projects between industry, especially with small and medium sized companies, which have introduced prototype products to CERN, and further developed them into fully commercialised goods.

1 MOTIVATION

In Europe [7, 11], worth some 20 b$ of public money is annually spent on purchasing technology-oriented equipment from industry of which 2b$ are for inter-governmental, scientific research projects. In all the amount of contributions poured into experimental scientific research is much greater as participating nations channel through their own research and industrial structures funding which eventually contributes basic research. To better exploit this massive investment the paper shows through couple cases how the intangible benefits obtained from big-science collaboration outperform the direct money-driven assessment metrics of technology transfer. It is shown that the benefits stemming from well-concerted development projects between industry and science laboratory generate multiple benefits, not all of them being measurable, but serving the objectives of science, public sector and commerce.

The focus of this paper is on cases with strong development thrust. The main case concerns a software development project, which after several twists ended up to a spin-off company [4]. This is followed with two shorter cases of which the first one describes how to develop new skills through high-tech collaboration between a small and medium sized company (SME) and big-science laboratory. The second one deals with the introduction of a novel technology by a SME and how a joint project with CERN boosted it. A summary is presented on the incentives for industry big-science collaboration.

2 CASES

2.1 Software spin-off

The development of the TuoviWDM (Web Data Management) system was based on the profound work, which was carried out at CERN during the 1980's and early 1990's and which eventually resulted in the World Wide Web. Many of the articles on the birth of the WWW [5, 9, 13] emphasise the unique CERN environment and the character of the exceptional individual behind the original invention [2, 3]. At CERN, one initiative was to use the Web to manage and exchange engineering data and other information between remotely located design teams [12]. To test the underlying idea of Web project management, a small pilot was started in one of the experimental collaborations to use the WWW for structured and disciplined engineering data management.

The original idea was to develop a comprehensive WWW software package to monitor the data communication between the thousands of computers around the world at the institutes participating in the LHC construction. In the spring 1995, software development work was initiated under the heading Tuovi, an acronym for the Finnish translation of product process visualisation. The initial activity focused on the analysis of communication logs around files stored in the busy WWW servers used by the global HEP community. At the same time an experimental installation was set up to test the use of the WWW for distributing market survey related information to industry. This proved that the technology was available, but resistance to apply them was high.

In the spring 1996, CERN recognised clearly the need for a CERN-wide engineering data management system [6]. A commercial system was being selected during summer 1996. At the same time the Tuovi system evolved towards its first real application within CERN, namely the CMS-B1 prototype. This small project within CMS was a natural choice because it had strong Finnish participation. Initial specifications for this first Web-EDMS was three lines of text. The system was to provide the project WWW-based access to documentation through the following functionality:

- Navigation within the document base through the project breakdown structure
- Searching documents through definite metadata attributes attached to each document
- Controlled loading and retrieval of documents to and from the system

It was relatively easy to accomplish this out of what had been developed during 1995. After the summer 1996 the system was already widely adopted among several projects at CERN. A Finnish government-financed technology project was started in Finland in order to transmit the acquired know-how to the Finnish industry. One action was to let a few industrial companies in Finland to test the software. In all three major collaboration projects were initiated and executed with Finnish and Scandinavian industry.

The year 1998 marked a significant expansion in the use of the TuoviWDM system. The system entered production use in several European high-energy physics laboratories. The present big science users are CERN (LHC accelerator, LHC experiments and CERN administrative division), DESY (Tesla and Hera projects), and the Max-Planck Institute (Wendelstein stellarator project, by now using the commercial version). These institutes use the system to interface and manage documents in their distributed engineering and design projects (Figure 1). These sites involve over 15.000 registered users, not counting 'guest' users in collaborating institutes who outnumber registered users roughly by a factor of two. At the end of 1998, the TuoviWDM serves users in more than 30 countries. A commercial version of the Tuovi system was developed and a spin-off company started operations in Helsinki by the beginning of 2000, now employing 15 people.

Figure 1. Some interfaces based on the developed technology.

During the five years altogether 41 people were involved in the research and development activities. The project produced 14 master's theses and contributed to 2 dissertations, in addition numerous academic papers were published. A significant educational contribution was also related to the 18 short-term students that were received, trained in the international environment, and employed in research and software development. Following their mission in the project, about 80% of them ended up in industry in similar software development positions. This flexible exchange of students and researchers, which could be co-ordinated with the changing needs of the development work, is a unique and highly positive feature of research institutes and big-science laboratories.

An agreement was signed between HIP and CERN by the end of 1996. It recognised the fact that the Tuovi software development had been and would in the future be fully financed by HIP, while CERN had provided the motivation, environment and various types of infrastructure support for the development work. CERN was granted a non-exclusive, permanent and irrevocable license to use the TuoviWDM free of charge. A modest measure of support was promised during the period while TuoviWDM was under development. The ownership, rights of use and intellectual property rights of the software remained at HIP. The question of serious customer support remained open, because HIP is a research organisation and cannot commit itself to long-term support obligations. It was agreed that a commercial software company should be found to give credible support for the foreseeable long period of TuoviWDM utilisation. Negotiations between CERN and the spin-off company have already been initiated.

2.2 Gateway to international markets

Know-how and partners involved in the building of technologically forefront scientific instrumentation come from global community of academics, industrialists and public authorities. Entering this kind of collaboration may not be easy for a small and medium sized (SME) company with no proven international competence. This sets the challenge for various people occupying themselves with technology transfer activities. The following case highlights the enormous possibilities to use big-science as a gateway to international markets for small and medium sized companies. Yet, it also emphasises the importance of active technology brokerage activity to make the ends meet between the industrial know-how and technological problems residing at the big-science laboratory.

A European small engineering and design company had been operating mainly in the domestic market. A strategic decision was taken to pursue growth abroad. It was thought that by exploiting their special competence in designing and engineering high precision vacuum components, the company could enter the European market through a scientific collaboration. Contacts to big-science were initiated through a technology liaison officer who scanned and mapped the skills of the company with possibilities to contribute to the construction of scientific instrumentation. A match was found and because of the lack of resources to take the technological leap the collaboration could only start when financial aid was granted from the national funding agency. To meet the stringent quality and documentation procedures involved in the high-tech co-operation, it became obvious that a significant leverage in the quality procedures of the company was needed. To reach the right level was not easy, and in practice made the deal financially unprofitable. The company had gained an asset which made it to distinguish from the others, it had reached the world class level in quality processes, which opened an avenue to enter completely new global marketplace. When in business for the design and engineering of top class components for sophisticated instrumentation demanding first-rate traceability, documentation and quality assurance the company turned out to increase its profits gradually.

The company contributed an important component of a larger system for exploring deeper layers of matter. Through the participation the company tied several relationships with major global players, which later on turned into fruitful business projects, thus breaking the barriers to enter international markets. The case shows nicely the initial thresholds that SMEs face when trying to enter in business with big-science and high-tech projects. These obstacles and the means to tackle them are:

- *To find the right contact*. Big-science laboratories are large and complex organisational structures, with collaborations and informal networks of expertise. It is simply difficult to find right contact surface upon which to develop an active technology transfer project. It is vital to have middleman in the process who knows the laboratory and is able to perform systematic mapping of expertise between the company and experimental science community.
- *To have an access to external funding agencies*. To qualify into real collaboration requires time and money. Science projects are usually lengthy, specifications keep changing, and financial support from an accelerator laboratory is scarce, which all make the collaboration for a SME hard to justify financially. Good access to various funding agencies are vital to back up the joint development effort. Cases where external funding had not been granted are few, if the initiative had been seen prospective both for the accelerator laboratory and the company.
- *To have the strategy to qualify to world-class level.* Big-science collaboration is characterised by projects with long duration and high contingencies when it comes to SME collaboration. Entering such research work must be a strategic decision and must be backed with management support and adequate resources.

2.3 Pushing a new technology

A company with a unique technology and no references has usually a hard time to negotiate with commercial and financial partners. The company lacks credentials and faces the known problem of proof on competence and delivery. From the technology transfer point of view this kind of start-ups bears the most risk, but also the highest commercial potential. The following case represents how unprejudiced big-science centre with technology driven objectives may be of catalyst for this kind of new technology intensive company [10].

The company had developed a unique way to measure very low temperatures accurately and without calibration procedures. Finding commercial partners had been difficult because of the relatively rare application area and lack on fully operational prototype, which could be integrated with some test environment. A contact with big-science centre was established through a technology incubator, which invited interested parties to share their knowledge. At that time the product was at laboratory stage which prevented direct testing, yet the novel approach was immediately seen to be very interesting by engineers at the accelerator laboratory. Communication channel was opened and the company continued to develop their first real prototypes. Despite the lengthy prototype construction phase the very first prototypes were severely tested by the accelerator laboratory. The feedback from these tests was most valuable for the small company. By further developing the prototypes along the lines given by the testers the process of making finally a commercial product was reduced significantly.

The case shows that big-science is willing to study novel ways to tackle their own challenges. They are ready to do it even on their on expenses. The neutral and demanding third party evaluation of the technology concerned boosted the new product development process in the company and paved the ground for becoming a serious alternative for conventional methods to measure low temperatures.

3 PARTNERING INCENTIVES

The benefits stemming from industry and big-science collaboration are many and the ones with true impact in technological development are often not related to direct business-to-business incentives (Figure 2).

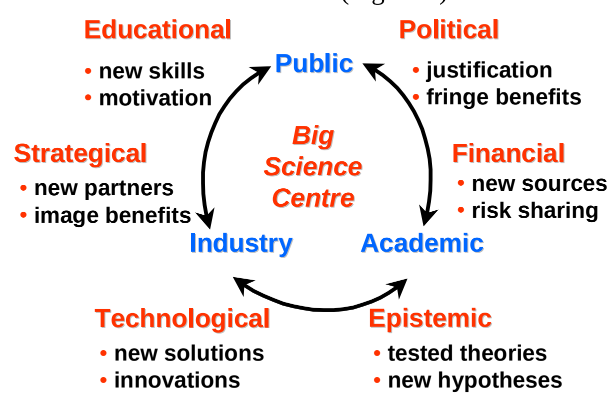

Figure 2. Collaboration motivations for big-science collaboration [1].

In addition to direct profit-making companies may, or perhaps should, seek for pure technological advantages in terms of new solutions and catalysed product development processes. Also it might be lucrative to pursue strategic goals in the form of new partners and market channels through an accelerator centre. Also when collaborating with big-science laboratories new sources for funding technological development may turn out. Especially for SMEs all of these possibilities should be sought further. Public sector benefits from better exploitation of science policy and educationally the science laboratories are the forefront educational units for bright young people. Finally, the scientific community may thrive more smoothly towards their scientific goals through the better integration of knowledge intensive companies.

Together with earlier studies and the cases discussed here shows that SMEs, and not to mentions spin-offs, the role of a middleman or a technology broker [9] is crucial to achieve success. Larger companies are capable to manage their own direct contacts with an accelerator laboratory, although they also need assistance. Major companies might even have their own man on the site to search for new projects and to maintain contacts with scientists and engineers.

At CERN several countries have their industrial liaison officers maintaining relations between the laboratory and respective member state's industry. For some the main task is to target market surveys and tenders to right companies, some go further than that and put significant emphasis on establishing R&D projects between engineers in companies and the ones developing scientific instrumentation. The ones aiming for higher level of technological collaboration require lean, but dynamic organisation that seamlessly interacts across geographical distances. Despite the political flavour of some purchase decisions, significant results are waiting those companies willing to probe new technological solutions and to take controlled risks that are always present in innovative processes.

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