Spin-offs from CERN and the Case of TuoviWDM

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Abstract

This presentation outlines the catalyzing events, key obstacles and other influences at CERN during the four-year journey of the TuoviWDM software project from its initiation in 1995 to the launching of a spin-off company in late 1998. The TuoviWDM software is a WWW-based extended enterprise interface to product data management systems and to data vaults residing in proprietary information systems. A group of organizations uses this integrated whole to store and access information and to manage operational processes. The large projects and global user base at CERN provided the development team with an extremely flexible, occasionally surprisingly benign, and always challenging environment to develop the system. The opportunities to exploit the diversity hidden in the world's largest particle physics laboratory are immense. However, this case has again demonstrated that in a public sector organization the climate, the procedures, and the decision-making bodies, which are related to creation of technology and to technology transfer, may be supportive, irrelevant or even counter-productive.

keywords engineering data management, World Wide Web, technology transfer

1. A short history[1]

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[1][2][3] emphasize the unique CERN environment and the character of the exceptional individual behind the original invention[4]. At CERN, one initiative was to use the Web to manage and exchange engineering data and other information between remotely located design teams[5]. 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.

Finland participated in several activities related to the LHC, including development of superconducting magnets, detector system mechanical structures, and data analysis software. Common features of these discrete projects came to be appreciated when the computer center at CERN demonstrated three-dimensional visualization software for engineering design. This generated the idea of developing 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. The female's name *Tuovi* is a nice acronym for the Finnish translation of *product process visualization*. The initial activity focused on the analysis of communication logs around files stored in the busy WWW servers used by the global HEP community (Figure 1)[6]. The early VRML (virtual reality modeling language) and other 3D-visualization experiments at CERN were partially the inspiration for the emergence of this novel aspect of project management. At the same time an experimental installation was set up to test

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the use of the WWW for distributing market survey related information to industry[7]. This proved that the technology was available, but resistance to this application was high. However, at the end of 1995, one pilot was established to test a system for managing and distributing sales support material to industry through a WWW browser and a VRML model of the product.

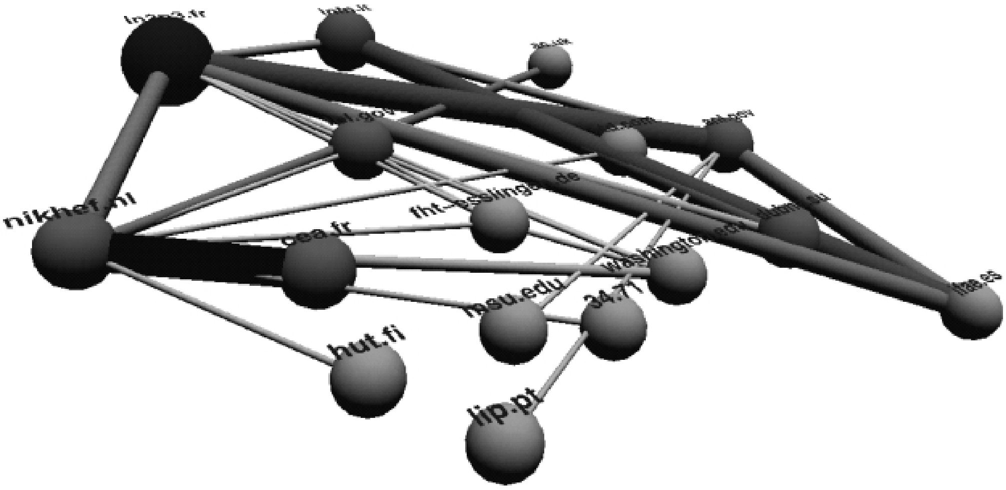

Figure 1. Communication between partners around project related documentation. The diameter of the nodes and connecting lines indicates the density of communication activity.

In the spring 1996, CERN recognized clearly the need for a CERN-wide engineering data management system[8]. 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 in the world 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 (see Figure 2). 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 industry.

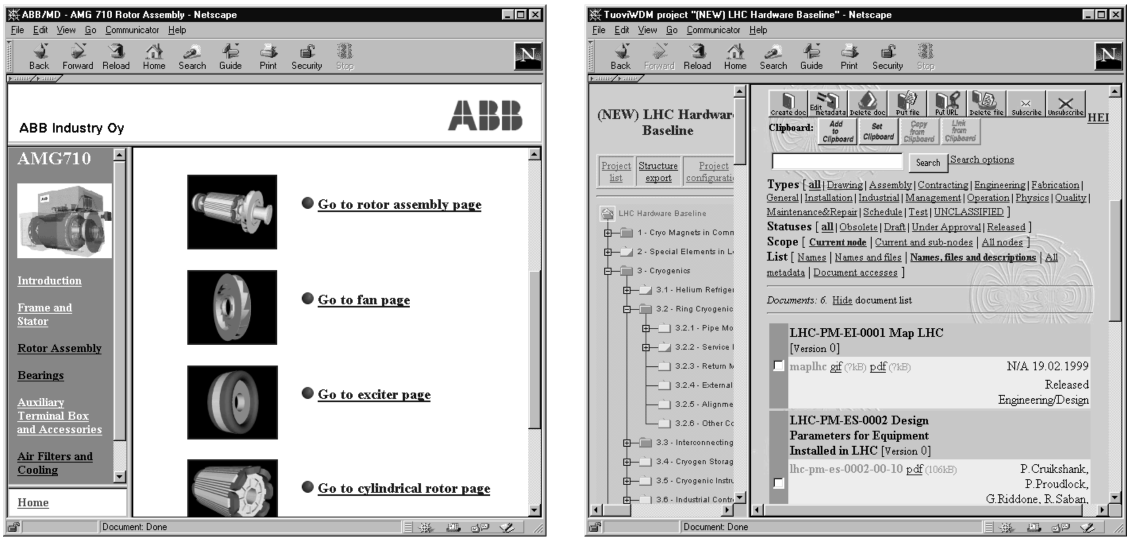

Figure 2. The first version of the system as part of an industrial pilot in spring 1996 (left), and the system as it was in the 1998 production version at CERN (right).

The year 1998 marked a significant expansion in the use of the TuoviWDM system. The system entered production use in all major 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). These institutes use the system to interface and manage documents in their distributed engineering and design projects. These sites involve over 10.000 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 towards the end of 1998.

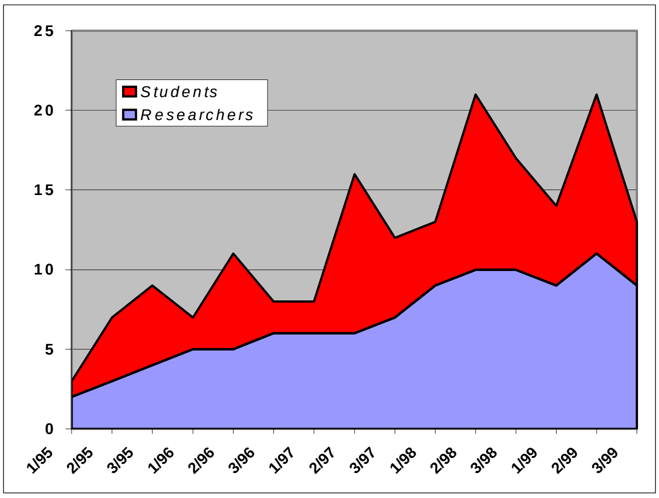

Figure 3. Average number of employed personnel in Tuovi-activities during the years 1995-1998 (data presented in four-month intervals). Peaks in the number of students are due to summer training programs.

During the four years altogether 38 people were involved in the research and development activities (Figure 3). Apart from minor exceptions, all of them were financed from Finland, mainly by the Helsinki Institute of Physics. In line with the educational responsibilities of HIP and CERN, the project produced eleven master's theses and contributed to two dissertations. 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 coordinated with the changing needs of the development work, is a unique and highly positive feature of research institutes. Significant flexibility existed also at the universities in Finland. Several researchers spent periods at their home institute with the industrial pilots and studies, while the kernel of the development team has stayed for the whole duration at CERN as members of HIP staff. The flexibility of human mobility in highly skilled environment of the leading high-energy physics laboratory should be exploited more widely also by other development teams.

An agreement was signed between HIP and CERN by the end of 1996. It recognized 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 organization 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 utilization.

2. Conclusions

In Europe, some 20 billion USD of public funding is annually spent on purchasing technology-oriented equipment from industry and about 2 billion USD of this is for inter-governmental, scientific research projects[9]. If in-kind contributions from participating institutes and financed by local governments are included, the sum probably doubles. The innovation potential hidden in these large-scale technological projects could be more systematically exploited. CERN has a role in this arena especially now when it is in the prototyping and assembly phase of the largest particle accelerator in history. Compared to the purchase volume and technological development expenditure at CERN generally, the story of the TuoviWDM is a minor episode. However, this story illustrates many of the ingredients a successful CERN-based innovation will have. To crystallize the main lessons learned, we first list some observations:

- Creation of revolutionary new technology is a common characteristic of big science projects. This stems from the need to build pioneering facilities, but also from the concentration of a large group of exceptional individuals.
- The large scale and flexible environment of science facilities motivates creative persons to carry to fruition revolutionary ideas which in industrial companies rarely would have a chance to grow.

- The tradition of supporting free flow of technology to existing industry and to emerging spin-off companies is a most important source of new high technology business in the countries participating in the science facilities.

Experience from CERN tends to support the following concluding guidelines:

- Many scientists and administrators in science organizations are not supportive and often even adverse towards industrial applications and the business world. Strong input from industry and a wise management are needed to avoid that the majority view stifles applicable innovations.
- Attempts to obtain funding to the research organization from technology undermines the transfer of technology to industry and must be avoided. The so-called technology transfer functions should direct their initiatives and resources to establishing contacts with companies and to finding mechanisms to create and support the growth of spin-off companies in the member countries.

Many cases have shown that best yield from big-science collaboration emerges through intangible profits, i.e. through education, new skills and products, unforeseen markets and partners, and so on.

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