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Spin-offs from CERN and the case of TuoviWDM

Eero Byckling [a], Ari-Pekka Hameri [a,b,*], Thomas Pettersson [b], Horst Wenninger [c]

[a] *Helsinki Institute of Physics, P.O. Box 9, FIN-00014 University of Helsinki, Helsinki, Finland*
[b] *CERN, EST-Division, CH-1211 Geneva 23, Switzerland*
[c] *CERN, Directorate, CH-1211 Geneva 23, Switzerland*

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Abstract

Projects in big science generate technology that may have considerable impact on industry. Technology transfer is widely regarded as valuable in creating new products and companies, but the most effective modes of operation for this activity are rarely understood. This paper documents the catalyzing events, key obstacles and other influences at CERN during the 4-year journey of the TuoviWDM software project from its initiation in 1995 to the launching of a spin-off company in late 1998. The description proceeds in chronological order and focuses on the technological and organizational factors that have affected the innovation process. 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. The goal of technology transfer activity should be to fertilize the industries of the participating countries rather than to try to obtain additional finance for the research organization. Policy makers need to compare the weight of these two aspects when technology transfer policies are formulated for big science organizations.

Keywords: Engineering data management; World Wide Web; Technology transfer; Big science; Software development; Spin-off company; Intellectual property right

1. A short history

The development of the TuoviWDM (Web Data Management) system was based on the profound work which was carried out at CERN[1] during the 1980s and early 1990s and which eventually resulted in the World Wide Web. Many of the articles on the birth of the WWW (Cailliau, 1998; White, 1998; Hameri and Nordberg, 1998) emphasize the unique CERN environment and the character of the exceptional individual behind the original invention (Berners-Lee, 1987). The WWW was first adapted by the high-energy physics (HEP) community, but after it spread to general use an explosion of applications and ideas for further exploitation occurred. At CERN, one initiative was to use the Web to manage and exchange engineering data and other information between remotely located design teams, who had the immense task to design and construct the new LHC (Large Hadron Collider) accelerator for CERN (Høimyr et al., 1993). The LHC is a project worth more than US$3 billion, and almost all of its aspects involve pioneering technology which is not available commercially. 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

* Corresponding author. CERN, EST-Division, 1211 Geneva, Switzerland. Tel.: +41-22-767-9596; fax: +41-22-767-8890.
E-mail address: ari-pekka.hameri@cern.ch (A.-P. Hameri)

[1] CERN, the European Laboratory for Particle Physics, has its headquarters in Geneva. At present, its member states are: Austria, Belgium, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Italy, the Netherlands, Norway, Poland, Portugal, the Slovak Republic, Spain, Sweden, Switzerland and the United Kingdom. Israel, the Russian Federation, Turkey, Yugoslavia (status suspended after the UN embargo, June 1992), the European Commission and Unesco have observer status.

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and disciplined engineering data management. At the same time actions were taken to manage CAD drawings through an in-house drawing directory. Other repositories were also established to manage the vast amount of design information, some 2.5 million documents, needed to build the new accelerator.

Actually, the Tuovi project had not started as a software project. The Institute of Particle Physics Technology at the Helsinki University of Technology was the responsible body for the Finnish technical participation in the CERN LHC project. The institute surveyed what relevant know-how would be available in Finland to complement that already existing at CERN. At the Institute of Industrial Automation at HUT there was a large research group studying the development of business processes in large international companies. The director and gradually also many of the other key persons were attracted to relocate at CERN in order to apply established project management practices to the LHC.

Parallel to this new effort, Finland participated in other 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 of 1995, software development work was initiated under the heading Tuovi. The female 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. 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.

By the end of 1995 the system had become essentially a VRML-based product navigator. This provided the user with access to product component information. All the activity around an LHC subsystem, which produced an activity log, could be viewed via a 3D-visualisation module. This revealed, through the access of documents, what was the communication network and access frequency among the collaborating parties (Fig. 1; Puittinen, 1996). The system was tested in a group designing the ATLAS experiment, and demonstrations were given to several key people in LHC experiments and the accelerator. The response was cautious, yet supportive, but did not lead to real testing of the software system. 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 (Sipilä, 1995). 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.

In the spring of 1996, CERN recognized clearly the need for a CERN-wide engineering data management system (EDMS). A commercial system was being selected during the summer of 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; and
- 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 Fig. 2). After the summer of 1996 the system had already been widely adopted among several projects at CERN (Hameri et al., 1996). A Finnish government-financed technology project was started in Finland in order to transmit the acquired know-how to Finnish industry. One action was to let a few industrial companies in Finland test the software.

In autumn 1996, the Institute of Particle Physics Technology and two other institutes were merged into the new national Helsinki Institute of Physics (HIP). The Tuovi development work was enlarged to become the Technology Program of the new institute. At this time the name TuoviWDM was coined. Some Finnish Tuovi persons participated in the selection of the commercial EDMS for CERN. This paved new paths for the future of the TuoviWDM, because an interface between the EDMS system and Tuovi was implemented for both of the two commercial systems that were tested by CERN. After a lengthy acquisition period, the selected commercial EDMS entered production use at CERN in the summer of 1997. This TuoviWDM integration work opened up a whole new perspective to the development of the Tuovi system, because it was realized that TuoviWDM could be used as a universal WWW interface to all documentation related to a distributed project. The kernel of the system was constantly being developed, but at the same time the integration work during 1997 and 1998 linked the system to the repositories in the library and