

# MAXIMIZING TECHNOLOGY TRANSFER BENEFITS TO SOCIETY

A. Peters, Heidelberg Ion beam Therapy Centre (HIT), Germany

## Abstract

What is ‘technology transfer’? Is it just the movement of knowledge or is it a more interactive process? The speaker will present definitions of technology transfer and discuss the linked challenges. Furthermore some technology transfer examples from industry will be given to derive step by step feasible strategies for successful collaboration. Problems like ‘different cultures’ in science institutes and industry will also be discussed as well as other key factors, e.g. the ability and willingness of scientists to move from public institutes to industry.

## WHAT IS “TECHNOLOGY TRANSFER”?

Technology transfer is a topic which arose with the enormous scientific progress and the Industrial Revolution in 19<sup>th</sup> century. This can be seen in a historic review: “A popular story goes that, following a demonstration of the new miracle of electricity in 1831, Faraday was asked ‘What use is it?’ He responded, ‘Sir, of what use is a newborn babe?’ Llewellyn Smith (1997) gives another example of Faraday’s foresight, in describing another incident, when Faraday, ‘in reply to Gladstone’s\* question “What use is electricity?” replied “One day Sir you may tax it”’. [1]

Thus it is obvious that technology transfer has to do with science, inventions and also economics. In literature one can find a lot of attempts to define the expression more precisely, one short version of these reads as follows: “The process of promoting technical innovation through the transfer of ideas, knowledge, devices and artefacts from leading edge companies, R&D organizations and academic research to more general and effective application in industry and commerce.” [2]

A lot of authors see technology transfer as a linear activity, where scientific research leads to technological developments and then to commercial applications in industry. This so-called ‘linear model’ simplifies the process between all actors, seeing technology transfer as a one-way street [Sandström et al., quoted in 1]. Other authors distinguish between two different kinds of technology transfer, called vertical and horizontal. Vertical transfer refers to dissemination of technological knowledge along the line from the more general to the more specific, whereas horizontal transfer occurs through the adaption of technology along one application to another, possibly wholly unrelated to the first. [3, 4]

Besides these more theoretical approaches to technology transfer many companies, universities and governmental organizations now have an “Office of

Technology Transfer”, dedicated to identifying research which has potential commercial interest and strategies for how to exploit it. For instance, a research result may be of scientific and commercial interest, but patents are normally only issued for practical processes, and so someone – not necessarily the researchers – must come up with a specific practical process.

The process to commercially exploit research varies widely. It can involve licensing agreements or setting up joint ventures and partnerships to share both the risks and rewards of bringing new technologies to market. Other corporate vehicles, e.g. spin-offs, are used where the host organization does not have the necessary will, resources or skills to develop a new technology [5].

## CHALLENGES FOR SUCCESSFUL TECHNOLOGY TRANSFER

Mostly all (accelerator) scientists have experiences with collaborations between institutes to exchange know-how or to bundle their power to realize common projects. What is the difference to technology transfer if commercial companies are involved? Do different “cultures” or working styles play an important role? Or is it simply the influence of economical aspects on both sides?

Other challenges have to be overcome: Is technology transfer just some sort of knowledge movement or does it need an interactive process between the included partners [1]? Does the linear model describe the process in accordance with the facts or are the interdependencies between all involved partners more complex?

To answer these questions the author drew up a questionnaire with the following (shortened) inquiries:

- Can you provide examples of technology transfer between institutes or universities, who actively do accelerator research and development, with your company?
- What were / are the advantages and disadvantages in such technology transfer projects concerning technical problem-solving, efficiency, creativity, etc.?
- How do you “synchronize” the (possibly) different working styles in an institute / university with the working methods in your company?
- How do you see and judge the possibility of technology transfer by exchanging personnel, from time to time or longer-lasting? Do you have examples for this, which you can describe briefly?
- Are there any problems in your country concerning legal issues, career and social status when changing from science institutes to industry?

Different company managers or leading employees were contacted and the following chapter contains a selection of answers giving spotlights from experiences in industry.

\* William Ewart Gladstone (1809-1898) was a British Liberal Party statesman and Prime Minister (1868-1874, 1880-1885, 1886 and 1892-1894). He was a notable political reformer, and was for many years the main political rival of Benjamin Disraeli.

## EXPERIENCES IN INDUSTRY

### *Instrumentation Technologies*

Rok Uršič, CEO of Instrumentation Technologies, a beam diagnostics supplier from Slovenia, reports on an example of successful technology transfer: “We developed a family of products that are sold under Libera brand name. They are building on an open platform. Among the first customers was also Diamond Light Source (DLS) in GB. They took advantage of Libera openness and developed a specific communication controller that is used to connect many (>100) of Libera Electron products (beam position monitoring electronics) in to a big fast global orbit feedback. The communication controller is actually an intellectual property (IP) module in a form of FPGA code that can be installed on the Libera FPGA, see Fig. 1. We offer the so called ‘Diamond Communication Controller – DCC’ functionality side by side with our in-house developed fast feedback building blocks solution. Laboratories therefore have more choices when deciding how to implement their feedback system. We offer DCC together with our system integration and support services to help laboratories implement such functionality. Since we used DLS IP for commercial purpose we agreed on a royalty based model with Diamond Light Source. [6]”



Figure 1: Libera BPM electronics with RocketIO used to implement the ‘Diamond Communication Controller’ [7]

Thus, open software and also hardware platforms provide a good basis for an interactive cooperation of institutes and companies. The outcome is an enhancement of performance and functionality options for the product portfolio, which leads to additional selling points.

Based on the own experience of Rok Uršič, who spent 8 years ‘on the other side of the fence’ and constantly working closely with research institutes gave Instrumentation Technologies the experience how to deal with this challenge and turn it into opportunity. “We exchange personnel with institutes in both directions for a restricted period, examples are DESY or the Brazilian light source. We consider this to be our competitive advantage.”

### *Sigmaphi*

Sigmaphi, a magnet manufacturer in France, benefited from a technology transfer by SOLEIL, initiated in 2007 and lasting for three years, see Fig. 2. The objects of this

transfer were complete pulsed magnetic systems, which were asked for delivery by ALBA, the Spanish light source [8, 9]. SOLEIL trained an accelerator physicist hired by Sigmaphi on the specialities of such magnets including power supplies and vacuum technology and was involved in the development of the single parts. Jean- Luc Lancelot, CEO of Sigmaphi states: “The lab is mostly involved in one of a kind products; it has the advantage of deep expertise and time. The company brings industrial approach, cost reduction, and also sometimes a broader view as exposed to many different views from different labs.” Concerning the collaboration style he complements: “Bringing together two different approaches is very productive, providing that each party comes very open minded.”

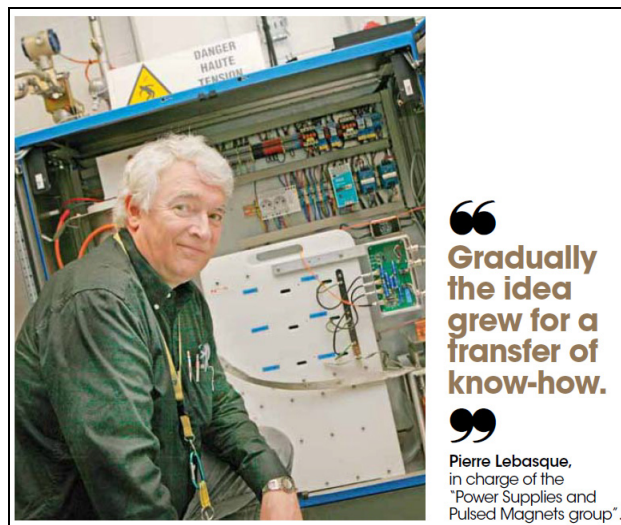


Figure 2: Pierre Lebasque in front of the pulsed magnet power supply developed in close collaboration with Sigmaphi [8]

Pierre Lebasque from SOLEIL adds: “Sigmaphi has competent engineers with whom exchanges are always instructive. Besides, collaboration has made my group think about new concepts. ... Until now, our group has only designed pulsed magnetic systems for electrons, not heavy particles. By working with Sigmaphi to answer a call for tenders concerning a proton and ion ring, we came up with completely new solutions that resulted in Sigmaphi’s tender being accepted.” [8] This shows again, that an interactive way of technology transfer can open the perspectives on both sides, leading to better results also in the institutes.

### *Bergoz Instrumentation*

Julien Bergoz, CEO of Bergoz Instrumentation, situated in France near CERN, addresses two other aspects of technology transfer, ‘industrialization’ of products and the monetary facet, giving the following example: In the HERA project at DESY a BLM system was necessary to monitor Hera-p loss in the presence of Hera-e synchrotron light. A detector based on two PIN-diodes working in coincidence scheme was chosen because of its largely

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insensitivity to X background photons hence, the high radiation tolerance and an excellent linearity over 8 orders of magnitude, see Fig. 3.

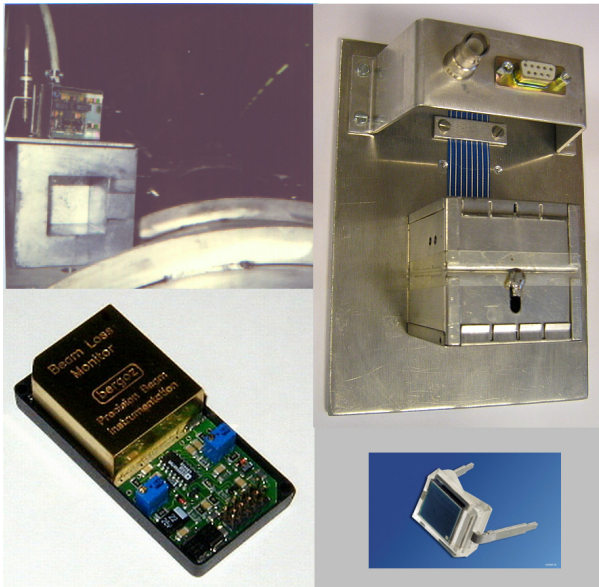


Figure 3: Beam Loss Monitor (BLM) mounted in the DESY HERA tunnel with shielding opened (upper left); upper right: DESY prototype (Courtesy of Kay Wittenburg, DESY); lower right: PIN-diode used in the BLM; lower left: BLM product of Bergoz Instrumentation

Julien Bergoz reports [10]: “Desy proposed that we industrialize it, more compact and less expensive. In view of the exceptional specifications of this BLM, we accepted with pleasure. A formal TT contract was signed with a provision for 5% royalties on BLM sales to be paid to DESY. The BLM instrument was redesigned by us. Kay Wittenburg at DESY tested it on beam and intense radiations, which resulted in further improvements.” The combination of creating a series product with industrial methods on one side and the expertise and beam test possibilities of an institute like DESY on the other side lead to a successful product. An initial delivery went to DESY and sales to other institutes started thereafter, more than 3000 units are used on most electron synchrotrons. In addition, BLM custom versions were developed e.g. for LEP’s high energy case, again with guidance of Kay Wittenburg in close collaboration.

### Danfysik

Danfysik has been working on accelerator technology for more than 45 years now, from magnets, power supplies and insertion devices to whole accelerator systems like booster synchrotrons and ion implanters. During this time Danfysik made sufficient experiences in collaboration with institutes and other companies and therefore technology transfer. Bjarne Roger Nielsen, CEO of Danfysik, says: “It requires a good understanding from both sides. Make written technology transfer and/or

collaboration agreements. Make sure to involve the scientist’s superior (ex. dean or institute director) in the agreement so that there is an understanding for the time needed for the project. It is easier to ‘bridge the culture gap’ if you have people in the company organisation that has previously worked in a university environment.” [11]

In 2007 Danfysik initiated a collaboration named InnovAcc with university and industrial partners on development of new technologies for particle therapy machines e.g. new types of thin walled vacuum chambers, which was supported by the Danish Advanced Technology Foundation. Together with the Engineering College of Aarhus, the Institute for Storage Ring Facilities Aarhus and the company B-Rustfrit Stål A/S new designs with corrugated surfaces were successfully tested and manufactured, see Fig. 4. Still implementing enforcement of the sides a remarkable cost price reduction could be achieved. Lars Erik Bräuner (Engineering College of Aarhus) summarizes the benefits of participating in this technology initiative: “Finite Element Analysis of thin walled pressure vessels with complex surfaces under external pressure lead to increased knowledge in this field in the institute. Many of the students involved are now employed in good jobs in R&D departments.” [12] And Bjarne Roger Nielsen adds: “Advantages of such collaborations are that the institutes often have a higher level of theoretical/technical competency than the companies, that company staff is trained during the technology transfer and hence the company competency is ‘lifted’”.

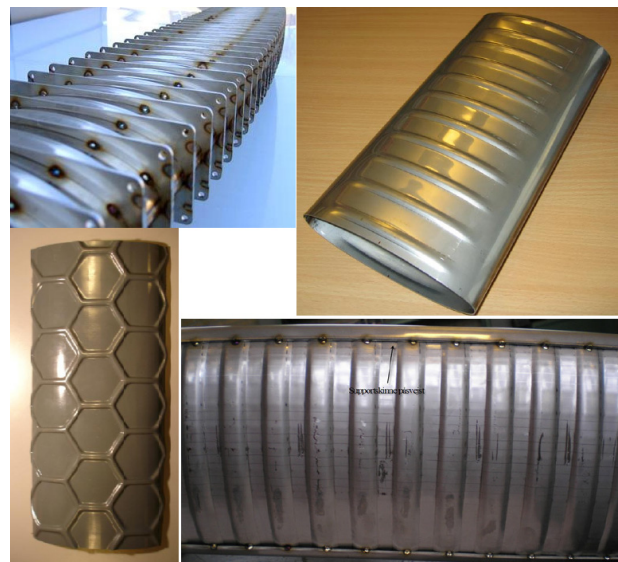


Figure 4: Thin-walled vacuum chambers for ramped dipoles; upper left: previous version with welded lamellae; upper right: prototype with corrugated surface; lower left: alternative idea for corrugating; lower right: production version with lateral enforcements [12]

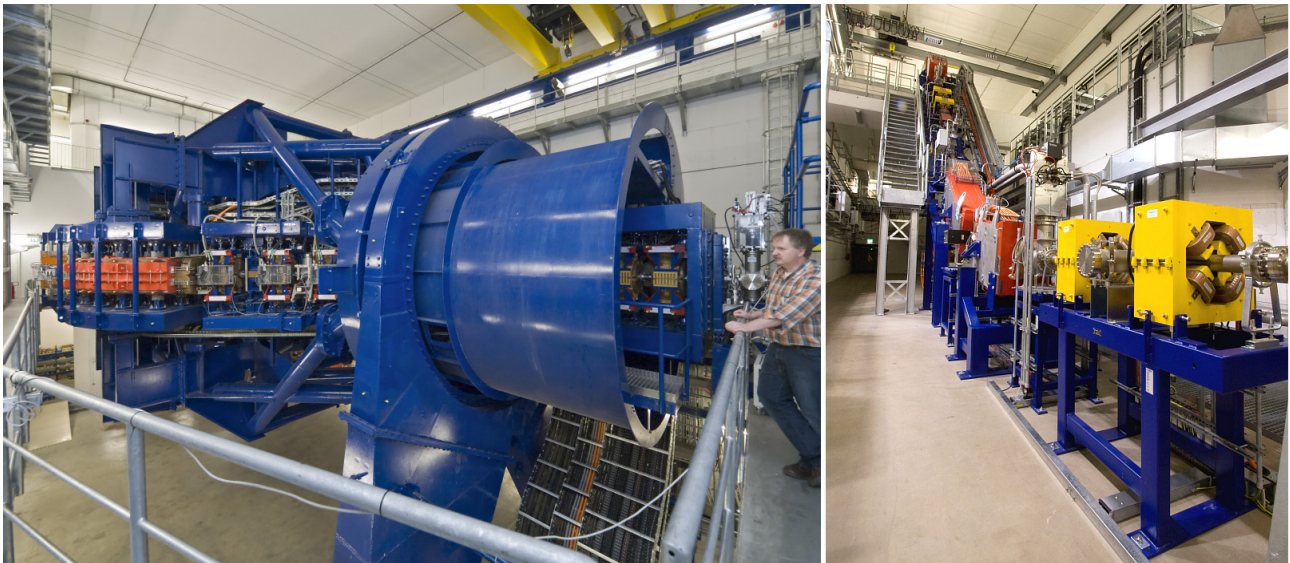


Figure 5: The first ion gantry worldwide installed at HIT (left); right: a part of the high energy beam transport line to the 45° treatment room in the first Siemens project in Marburg (Courtesy of Siemens AG, Healthcare Sector).

### GSI – HIT – Siemens

Triggered by GSI's biophysics group that studied the radiobiological effects of heavy charged particles on various in-vitro systems already in the 70ies an experimental carbon ion therapy programme was initiated at GSI in 1993. A collaboration of GSI, the Heidelberg University Hospital in, the German Cancer Research Centre (DKFZ) and the Research Centre in Rossendorf successfully established a pilot project linked to the GSI accelerator facility that allowed the treatment of about 440 patients from 1997 till 2008 with carbon ion beams. Parallel to the running clinical programme at GSI a proposal for the first hospital-based proton-ion therapy centre at Heidelberg was prepared and submitted to Germany's research funding agency. In the next step the building up of the HIT centre, directly located at the university hospital in Heidelberg, was decided and GSI developed not only the accelerator technology [13] from the beam optics up to the fully detailed tender documents but also the dose delivery (raster-scanning), the beam monitors, the control and safety system as well as the treatment planning code. Due to the lack of a general contractor for the accelerator part GSI took over the guidance of all component suppliers and the responsibility for the beam diagnostics equipment [14], the installation on site and the commissioning.

The responsibility for the HIT facility operation and further commissioning was stepwise transferred to the HIT Company, a 100% daughter company of the university hospital in Heidelberg, where today a team of around 20 physicists, engineers and technicians are responsible for running the accelerator and the maintenance of most of the systems. Still a close connection to GSI exists. All these activities lead to a Technology Transfer contract between GSI (and indirectly IAP Frankfurt) and Siemens Healthcare Particle Therapy

on Particle Therapy Accelerators and Raster-Scanning treatment techniques, which gave Siemens access to the concept and design documents produced at GSI for the HIT project and the previous GSI pilot project on radiation therapy with carbon ions. Based on the technology and know-how transferred to Siemens a product portfolio was developed and Siemens delivered the treatment planning system, treatment control system and dose monitors for HIT, and is executing three customer projects for turnkey combined carbon and proton therapy facilities including the accelerator [15]. Siemens took over the general design layout for these facilities from the HIT project, but some parts were modified or replaced, see Fig. 5. Further co-operation between Siemens and GSI (and later on HIT) was extended to:

- Procurement of certain components (e.g. beam diagnostics) or services (e.g. copper plating) from GSI used within the Siemens Projects.
- Co-operation on further development and tests of components (e.g. RFQ).
- Consulting on technical issues on an "as-needed" basis.
- On-the-job training during commissioning of the HIT accelerator by GSI.
- Later also a commissioning team out of GSI personnel supported temporarily the Siemens team in their first project in Marburg, Germany.
- Exchange on spare parts strategies and their storage.

Although this description is far away from any completeness it can be clearly stated that this was and is still a highly non-linear technology transfer process with complex interdependencies and (partly) closed feedback loops. To bridge the gap between industry and science institutes it is valuable to have staff with science background hired in industry – also the opposite way would be of merit, but is seldom done. The different

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working styles can be a benefit, as science institutes with a less regulated environment offer flexibility and support creativity, whereas in industry the focus is on arriving at results within a given timeline and budget. In addition, a mismatch between expertise and experience (between the partners and in the different hierarchy levels) as well as mutual expectations are challenging and may easily cause friction at working level. As an example, the level of documentation caused a lot of discussions between GSI and Siemens; in particular the demands for general comprehensive manuals and complete life-cycle recordings in the healthcare industry are extremely high, whereas in science institutes the documentation is made by experts for experts, thus being brief and to the point, not written for non-experts. Furthermore, corporate compliance regulations make it increasingly difficult and complex to execute co-operations between industry and publically-funded institutes.

A transfer of knowledge and technology with the enormous scope mentioned above seems not to be possible without the transfer of personnel. A few experts from the GSI accelerator division changed over to HIT as well as a larger group of people from the biophysics section; also a nucleus of physicist involved in the GSI therapy project were hired by Siemens, for the treatment application aspects mainly.

## SUMMARY AND CONCLUSIONS

What do we learn from these experiences done in industry and the involved science institutes? As a result the following positive influences for technology transfer can clearly be listed:

- All partners including all persons involved in the technology transfer should 'know' each other including their background as good as possible; especially the hierarchies of the partners, the decision-making processes and also restrictions within the institutes or companies must be aware to all persons concerned.
- The interaction of all partners should take place 'at eye level', although different 'cultures' in science institutes and industry are mostly obvious.
- An atmosphere of openness should be found on both sides of the technology transfer, which should create the background for an interactive process.
- An interactive process opens new perspectives not only for the technology recipient, but also for the donor.
- As in most economic and interhuman relations the willingness for compromises is very important to overcome deadlock situations.
- One of the most essential prerequisites for a successful technology transfer, especially when it concerns complex systems, is a temporary or long-lasting exchange of personnel.
- As technology transfer is an additional task for scientists, which sometimes causes drawbacks in

their scientific work, a (monetary) compensation is necessary as a motivation.

- Initiatives for technology transfer can and should be started from both sides, public scientific or technical institutes as well as industry companies. One should not rely on the 'linear model' only.
- Young scientists should have contact to industry as early as possible by traineeship during their university time or by taking part in networks, DITANET [16] is such an example. This avoids wrong impressions, e.g. that research is only done in science and creates experiences how the industry works.

If these insights would be realized by all partners and implemented in the common processes, much more success in the technology transfer could be realized resulting in more benefit to society.

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## REFERENCES

- [1] S. Åberg, "An Interactive View on Technology Transfer", Proceedings from the 16th Nordic Workshop on Interorganisational Research
- [2] R. A. F. Seaton, M. Cordey-Hayes, "The development and application of interactive models of industrial technology transfer", *Technovation*, Vol. 13, No. 1, pp. 45-53.
- [3] W. A. Fischer, "Empirical approach to understanding technology transfer", *R & D Management* 6, 1976
- [4] H. Brooks, "National science policy and technology transfer", *Technology Transfer and Innovation*, NSF67-5, Washington, D.C., USA
- [5] [http://en.wikipedia.org/wiki/Technology\\_transfer](http://en.wikipedia.org/wiki/Technology_transfer)
- [6] Rok Uršič, Instrumentation Technologies, priv. comm.
- [7] G. Rehm, "Digital EBPMs at Diamond: Operational Experience and Integration into a Fast Global Orbit Feedback", DIPAC 2007, Mestre, Italy
- [8] P. Lebasque, "It pulses between SOLEIL and Sigmaphi", *INNOVATIONS*, The magazine of the SOLEIL Synchrotron, No. 19, June 2010
- [9] Jean-Luc Lancelot, Sigmaphi, priv. comm..
- [10] Julien Bergoz, Bergoz Instrumentation, priv. comm.
- [11] Bjarne Roger Nielsen, Danfysik, priv. comm.
- [12] <http://www.innovacc.dk/projektet/vakuumkamre.html>
- [13] T. Haberer et al., "The Heidelberg Ion Therapy Centre", *Rad. & Onc.*, 73 (Suppl. 2), 186-190, (2004)
- [14] A. Peters et al., "Beam diagnostic devices and data acquisition for the HICAT facility", DIPAC'05, Lyon
- [15] Heiko Rohdjess, Siemens AG, Healthcare Sector, priv. comm.
- [16] <http://www.liv.ac.uk/ditanet/>