METHODS FOR SUCCESSFUL TECHNOLOGY TRANSFER IN PHYSICS

K.N. Hill, Qi3, Cambridge, United Kingdom

ABSTRACT

The development of accelerators for scientific research generates significant technologies of interest to industry. As physicists and technologists we also require strong partnerships with industry in order that it may supply us with the instrumentation and systems we require for new apparatus. We discuss the methods developed for the UK Particle Physics and Astronomy Research Council (PPARC) and applied on behalf of CERN to encourage successful knowledge transfer into industry. Case studies illustrate the hurdles that must be surmounted and effective methods to build successful partnerships, licensing opportunities and spinout companies. Factors considered will include assessment of the commercial potential of technologies, personal motivations for academic/industrial collaboration, sources of funding, and effects on the academic groups involved in knowledge transfer activity.

INTRODUCTION

This article is intended for physicists and engineers engaged in accelerator research and development and for others who would like an insight into some of the fundamentals of successful technology transfer. No paper in this area can be comprehensive; our approach is to provide some simple underpinning principles followed by examples of their application. Although the initial concepts are rudimentary, they form the elements from which successful technology transfer is built.

DEFINING TECHNOLOGY TRANSFER

The nomenclature applied in the field is confusing. We refer to 'technology transfer' as a process through which resources are transferred between organisations, the effect of which is to transfer technology and the capability of applying the technology in the development of products and services between the organisations. The 'organisations' are typically academic research groups, industrial companies and consultancies or product development companies.

WHY SHOULD PHYSICISTS ENGAGE IN TECHNOLOGY TRANSFER?

It is not at first evident that technology transfer should constitute a part of the remit of academic institutes. Time and resources expended in working with industry could perhaps be better focused on single-minded pursuit of the institute's science goals. Nevertheless we live in an environment where governments and funding agencies increasingly emphasise the interconnectedness of the research base and industry.

There is considerable evidence for the link between investment in research and development in science, industry and defence and the performance of the economy. Politicians thus expect to see a return for taxpayers' investment alongside scientific advance. This is especially the case in multinational collaborations where benefit for contributing nations' industry has become a condition of funding in many experiments.

In addition to this reasoning, we have a role to benefit society through multidisciplinary academic and industry partnerships. There is a distinguished heritage of technologies that have found their way from physics into industry and these technologies underpin many aspects of our society.

Furthermore, we need industry to build parts of our scientific infrastructure. As the nature of our experiments demands ever more extreme technology we must thus learn how to interact with industry in a way that encourages it to participate in supply, often with no obvious or immediate application beyond our community.

Together, these three factors support a continued change in our level of engagement with industry at all levels.

RESOURCES AND VECTORS OF TECHNOLOGY TRANSFER

A sensible approach to the subject is to consider technology transfer as an exchange of resources through a variety of vectors:

Resources

There are four key resources capable of transfer; skills, facilities and intellectual property are exchanged, with money providing payment for resources.

The first resource of value in technology transfer is the skill resident in scientists, engineers and technicians. The human element of technology transfer is often overlooked and our listing of it as the first resource is a measure of our view of its significance.

Physical facilities and infrastructure provide the second resource. These may establish a particular organisation with a specific strength through the utilisation of prior investment in equipment for development, manufacture or test of the technology in question.

Inventions and methods for their realisation are known as Intellectual Property. This may be codified in the form of patents, trade marks, copyright, design rights or kept confidential as trade secrets. We refer to all of these as

Intellectual Property Rights (IPR) and those elements not published as 'knowhow'.

Money provides payment for resources, both as recognition for prior investment and support for future expenditure. The money provides access to skills, IPR and facilities.

Vectors of Transfer

There are numerous means by which the resources listed above may be exchanged to facilitate the transfer of technologies between parties. We describe six of the most common here.

- Consultancy is the exchange of money for skills and perhaps use of facilities on a transitory basis
- Employment implies the long term transfer of skills in return for payment
- Procurement is the vector whereby money is exchanged for goods and services. This type of transfer builds skills and capabilities in the supplying organisation
- Partnership is a complex form of exchange whereby all of the resources may be exchanged amongst partners over time in pursuit of a common goal such as collaborative development.
- Licensing is the exchange of Intellectual Property Rights for money
- Spinout is transfer of skills, facilities and Intellectual Property to a new entity formed for the purpose of commercialising the technology. The originating organisation may retain a shareholding or expect royalty payments from the spinout company.

REQUIREMENTS FOR SUCCESSFUL TRANSFER

We have investigated the factors sought by venture finance providers in their assessment of technologies for funding. The credibility of a technology proposition appears to depend upon five requirements:

- A global, growing market
- The potential of the technology to disrupt the market
- A strong management team
- Strong Intellectual Property Rights
- A clear business model through which revenue and profit can be generated

Whilst these assessment criteria are only directly applicable to the spinout vector of transfer, it is clear that the presence of these factors should support any type of resource exchange. It is well to note that practical technology transfer can be built upon minimising the impact where the factors are weak or absent from a technology proposition and maximising the prominence of the factors where they are present.

GOLDEN RULES OF PARTNERSHIP

Whilst the discussion so far may seem quite theoretical, the simplicity of the factors described is helpful in providing some 'golden rules' for building partnerships:

- People are the key to success – it is important to build relationships and trust, respecting the differing motivations of the partners
- The project requirements should be the focus of attention, rather than the source of funding
- Effort is required to ensure that all partners have strong motivation – for commercial partners, this should be based upon real market needs
- Project management is essential in order to manage the expectations of all partners throughout the lifetime of a collaboration

THE PROCESS OF TECHNOLOGY TRANSFER

We have developed a number of operating methodologies to support the process of technology transfer. In all cases, practitioners must take account of the maturity of the technology and the application for which development is foreseen.

In the accelerator community, one can envisage several stages of development; namely conception, underpinning technology development, development for accelerator applications, pre-competitive collaboration, application in other market areas and product development. At each stage, there is a need to:

- Identify and assess potential markets, competitors and substitutes
- Assess IP status and the technology / product development route
- Develop strategy and select an appropriate business model
- Secure resources for market, technology and IP protection
- Implement the exploitation program

We use a phased process with directed resources applied to understanding the technology, IP, market and business model at each stage before moving on to further technology development.

CASE STUDIES

We now move to consider some examples of technologies in the process of commercialisation by CERN and / or PPARC.

The openlab for DataGrid Applications

Conscious of the need for partnership in Grid deployment, CERN's IT Department has established the CERN openlab for DataGrid applications, a partnership with five major IT companies, HP, Intel, IBM, Oracle and Enterasys Networks. Each partner is sponsoring cutting edge hardware and software to the partnership, as well as funding young researchers who test and validate the software in the Large Hadron Collider Computing Grid (LCG) environment. CERN openlab recently announced that the CERN opencluster, which involves some 40 HP servers equipped with Intel Itanium 2 processors, has been successfully integrated into the LCG, which already involves computing and storage capacity at over 60 computing centres around the globe. Membership of the openlab is now open to companies at a "contributor" level, and a recent visit by eight leading UK companies and academic organisations confirmed further interest in partnerships with CERN to deploy its skills and infrastructure in industrial and bioinformatics applications.

In this example, CERN's skills and infrastructure developed in pursuit of Grids for Particle Physics research has yielded an open environment of sharing intellectual property and transferring technologies to potential suppliers and users in other communities.

The method used for transfer in this example is the formation of an open laboratory 'openlab', in which CERN and its industrial partners may exchange skills and share infrastructure. This has been facilitated by promotion from CERN's IT department.

ChemicalVias

The capital and running costs of microvia production can be reduced by a factor of ten with a CERN "ChemicalVia" process now available for transfer to industry. Engineers in the microelectronics group at CERN developed the process initially to enable efficient manufacture of the GEM (Gas Electron Multiplier) detectors used in particle physics. They then realised that this could also be used to reduce the cost of via production.

The current choices available to PCB manufacturers are to invest hundreds of thousands of pounds in the capital and running costs of laser, plasma or photo imaging equipment, or to subcontract the process to a company with those facilities. The CERN ChemicalVias process requires an order of magnitude less investment in wet etch baths and standard chemicals. The process is compatible with standard assembly lines for printed circuits with simple implementation, allowing any manufacturer to produce High Density Integrated (HDI) Circuits.

This technology is protected by a patent and low cost licences are now being offered to industry and academic groups. This is an example of the development of intellectual property and skills in the manufacturing process. These resources may then be transferred through the exchange of funds for access to the intellectual property and consultancy.

The method for transfer of this technology has included a series of technical seminars for companies in the electronics manufacturing industry, the contribution of articles to industry journals and the offer of processing evaluation samples for companies that show interest in the process.

Detectors for Intensity Modulated Radiotherapy (IMRT)

Cancer affects around 30% of the population; the development of treatment services is one of the key areas of health policy. One of the principle ways of treating cancer is to kill cancerous cells using radiation: X-rays, electrons or in some cases protons. However, the radiation will kill cancerous and healthy tissue indiscriminately and so it is crucial that the geometry of the radiation beams is accurately understood and optimised to have sharp edges so that cancers near critical parts of the body can be treated. The development of intensity modulated radiotherapy has provided a major advance in this area, the beam being dynamically shaped to treat cancers in critical parts of the body. There are difficulties in characterising the radiation dose as it requires mapping of the development of the dose in space and time. Particle physicists have used silicon based microstrip detectors for many years to provide high spatial resolution measurements.

The collaboration involves two particle physics groups, medical researchers and two companies. The partners will develop a system based on silicon microstrip detectors and read out by an integrated circuit developed for X-ray imaging. This will be used to map the dose distribution of a radiotherapy system in Weston Park hospital, a major UK centre for cancer treatment.

This is an example of a partnership, in which the skills, resources, infrastructure, intellectual property and funds from a number of partners are brought together for a common goal.

The method used to build this partnership was the identification of the problem at a medical engineering conference, followed by the organisation and sponsoring of a workshop attended by physicists, engineers, medical researchers and companies with interests in the area. It is well to observe that technology transfer from physics to healthcare seems to work most effectively when there is a strong clinical driver for the result of the project.

CONCLUSIONS

We have discussed the arguments for integration of technology transfer as a legitimate objective for academic institutes alongside their primary research goals. We have described 'resources' and vectors' as simple concepts underlying the units and means of exchange in technology transfer. This led us to understand the criteria used by venture finance providers in assessing technologies for investment and to develop some ‘golden rules’ for success in collaborative development partnerships. These goals are achieved through a developed and phased methodology for evaluation of opportunities. This operating methodology creates the circumstances through which opportunities may be selected and developed for successful technology transfer.

Although the models presented are simple, our experience indicates that they form a sensible basis for action in the majority of situations. The three examples show a variety of forms of resource exchange and methods employed in pursuit of technology transfer from particle physics to information technology, electronics manufacturing and cancer treatment. These methods are as applicable in the accelerator community as in other areas of technology endeavour.

ACKNOWLEDGEMENTS

I am grateful to the UK Particle Physics and Astronomy Research Council (PPARC) www.pparc.ac.uk, the UK Office of Science and Technology (OST) www.ost.gov.uk, the UK Department of Trade and Industry (DTI) www.dti.gov.uk, CERN www.cern.ch and my colleagues at Qi3 www.qi3.co.uk for their support in developing the material for this article and their ongoing positive attitude to technology transfer.

Nathan Hill
Managing Director Qi3
PPARC Industry Coordinator and UK Technology Transfer Coordinator for CERN.
nathan.hill@qi3.co.uk
Tel: +44 (1223) 422405