European Laboratory for Particle Physics

BASIC SCIENCE and TECHNOLOGY TRANSFER
- MEANS AND METHODS IN THE CERN ENVIRONMENT -

GENEVA, 28 - 29 NOVEMBER 1997

Workshop Records
Editor: F. Bourgeois / CERN
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Disclaimer

This document contains a collection of the summaries and the personal views of those who spoke during the Workshop. It therefore does not anticipate nor preclude technology-transfer-related actions to be taken by the management of CERN in the future. In addition, and because of the lack of thorough editing, extracts from these Workshop Records cannot be used as a source for formal reference; however, reference may be made to the document as a whole.
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FOREWORD

As a result of the interest shown by a large number of people, in particular CERN Council Delegates, members of the CERN Finance Committee, the CERN Management, and numerous individuals, CERN decided to publish these records as a straightforward account of the talks and the discussions held in the course of the three sessions of this Workshop.

Every effort has been made to publish these records quickly at the expense of some imbalance in the wording, length, and style of the summaries. To this end, most summaries or handouts supplied by the participants have not been edited. A few talks and the round-table discussions have been summarized by the editor on the basis of tape recordings. These particular summaries were checked and approved by the speakers, the CERN Technology Advisory Board, and the Chairmen of the round-table discussions.

The editor is pleased to acknowledge the support given by Ms Sonia Escaffre and Ms Valeria Pietropaolo in the secretarial effort, Mr Daniel Boileau for tape-recording the whole event, Ms Marie-Pierre Destouet for the verbatim, Ms Pepi Dockheer for the summary of the round-table discussions, and the CERN Desk-Top Publishing Service for copy-editing and page layout.

The Editor
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1 INTRODUCTION

1.1 PARTNERSHIPS WITH PARTICLE PHYSICS

Basic science usually does not have immediate benefits for industry or the economic world in general, and delays in the return are often incompatible with the short-term expectations of market-driven activities. It is, however, a fact that instrumentation and technologies developed for the execution of fundamental research have often triggered new developments which would not necessarily have taken place otherwise.

Over the last forty years, partnerships between CERN, the world’s largest laboratory for particle physics, and research institutes, universities and industry, have been the fertilizer and source of a large number of technological innovations. A number of indicators show many cases of mutual benefit resulting from partnerships between industry, research organizations, and groups engaged in particle physics.

Unlike other institutes, CERN is an international host laboratory subject to special constraints in its technology transfer policy. In particular, this policy should not impair CERN’s prime mission, namely: the timely and resource-effective execution of particle physics experiments.

1.2 WORKSHOP OVERVIEW

The aim of this Workshop was to review technology transfer mechanisms in the environment of an international host laboratory and try to improve CERN’s policy in the light of:

- the outcome of a number of salient and completed examples;
- the views of the various partners; and
- the advice of external technology transfer experts.

In addition, the Workshop helped select a few new actions to be taken in the light of the recommended technology transfer policy.

Transfer of know-how or technology, in partnership with CERN, can be tentatively grouped under three headings:

- technology transfer through people;
- technology transfer through collaboration agreements;
- technology transfer through purchasing.

In order to maximize the outcome of the Workshop a half day was spent on each of the three aspects, each session being subdivided into three parts:

- Review of current practices by invited experts and consultants (three–four contributions).
- Report on the outcome of a number of completed actions as seen by one of the partners, whether industry, institute, or CERN (four–five contributions). This part comprised short contributions highlighting both benefits and problems encountered in the technology transfer process. These
partnership examples were introduced by a review talk to set the scene and help the participants identify the major aspects of each case.

- Round-table discussion to analyse the content of the session and establish a recommended policy in agreement with CERN regulations and duties. This essential part took place as a two-way process between the experts and the other participants. The round-table discussions were chaired by Mr R. Miège (technology transfer through people), Dr J.-P. Husson (technology transfer through collaboration agreements), and Dr M. Gigliarelli-Fiumi (technology transfer through Purchase).

Participants were welcomed on Friday 28 November by Professor C.H. Llewellyn Smith, CERN Director-General, who introduced the Workshop. Plenary talks were given by Professor J. Mariano Gago, Portuguese Minister of Science and Technology, and Professor J. Routti, Director-General at the Directorate General XII (Science, Research and Development) of the European Commission.
# Agenda

## 2 Technology transfer through people

Friday 28 November 1997 (Morning)

**Chairman:** F. Bourgeois

### 2.1 Agenda

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Note: in relation with this Workshop, Dr David Townsend / Univ. Pittsburgh Medical Center, gave a 'Career Seminar' on Friday 12 December 1997 at CERN

'Through Particle Tracking to Positron Tomography'

D.W. Townsend, University of Pittsburgh Medical Center

Abstract: The transfer of technology from basic research fields such as Particle Physics to more applied areas such as medical imaging, although often promising, is not always as straightforward as it may at first appear. The constraints imposed by the specific application in one field may complicate or even invalidate an approach that appears promising from the perspective of the other field. Careful attention must be paid to specific details. This talk discussed examples of particle physics techniques that have had an impact on medical imaging, and critically examined the procedure by which the transfer of such technology is accomplished between the two fields.
Mr Minister, Director-General, Ladies and Gentlemen,

It is a very great pleasure for me to welcome you to this first CERN Workshop on Basic Science and Technology Transfer.

CERN is a collaboration of 19 European Member States, including four ex-communist countries from Central Europe. In a sense, however, CERN has become a world organization, and one-third of the scientists who carry out research at CERN (the 'users') come from outside the Member States. Furthermore, we recently negotiated new agreements with, amongst others, Japan, US and Russia by which they contribute to the basic infrastructure of the Laboratory as well as, as always in the past, to the construction of experimental detectors. The number of CERN users has grown from about 1200 twenty years ago to 5500 today. We think the fact that so many people are attracted to come from all over the world to work here is objective evidence of the success of CERN.

CERN's success has been to a large extent based on excellent collaboration between our Member States. However, this tradition of collaboration also complicates the practice of efficient technology transfer. If a new technology is transferred to and developed in only one or a few of our Member States then the other countries can justifiably protest 'Just a minute, we also paid for this development.' How we should face this problem of fair distribution of the benefits of technological innovation between the Member States is a subject that could be discussed at this meeting.

A very quick word on the budget. Corrected for inflation, our budget, of approximately 900 MCHF every year, is less than 20 years ago, and whereas until the early 1980s it was shared by 12 Member States, now there are 19. About one-third of this budget is placed in industrial contracts. The value of CERN's contracts is therefore about 300 MCHF a year: this sets the scale of the subject of this workshop.

The primary role of CERN is to carry out research in particle physics, but there are secondary benefits. High-energy physics research at the frontiers of our understanding and technical ability generates a constant need for new devices and techniques which frequently turn out to have uses in other fields. These are spin-offs. One example is the World-Wide Web. The Web was invented at CERN because we have researchers in so many countries who wish to collaborate easily and efficiently using the Internet. To push our research forward there was a pressing need to invent something like the Web. Another example is the various particle detectors, silicon detectors, crystal detectors, also Charpak detectors, which have been developed at CERN and which are now in use in hundreds of hospitals for medical imaging. These are only two of many other such technological breakthroughs.

Another benefit is what I would call stimulation of industry. CERN's orders often push industry to the limit of its capabilities, and sometimes even a bit beyond. A company which collaborates with CERN has to learn new techniques and, by working with us, frequently ends up improving its own technology. Surveys of this effect in the 1970s and 80s showed that as a result of contracts with CERN, additional orders were generated. There was an amplification factor of 3. In other words, for every Swiss franc we placed in
an order, the companies later received 3 Swiss francs of orders which otherwise would not have existed. Of course, we are talking of turnover, not profits, but it is a significant effect.

The next benefit is training. CERN has a very specific role in training people in particle physics. We have our own fellowship programme and we estimate that worldwide, within and outside our Member States, more than 200 PhDs are awarded every year based on work at CERN. Some of these PhDs become academic research scientists, but at least half end up working in industry. The CERN experience of working on high-technology projects in an international environment, having to respect very tight deadlines whilst creating a world-wide network of friends and contacts, is a unique training.

We also carry out an important training role for applied physicists and engineers. Some Member States fund PhD students in engineering to spend a year at CERN. Special schemes have been set up with certain countries, for example Spain, Portugal, and Austria to send young engineers working in industry to CERN. The laboratory has great expertise in informatics, superconductivity, radio-frequency systems, electronics, high vacuum, etc., and these young people learn these technologies and transfer them later to industry in their own countries.

Finally particle physics, along with astronomy and some other sciences, plays a role as a flagship science, 'science-phare', in exciting young people and turning their attention towards science and technology.

A very brief word on the science we do here and our future programme. In the 1950s it was found that in high-energy collisions hundreds of different types of particles are created. From the catalogue of the new particles, some sort of Mendeleev table was made, and a working description called the Standard Model was created. But the Standard Model is only a sort of recipe which lays the foundations for asking more profound questions. We now believe we are moving from the question 'What?' to a more interesting question 'Why?' (e.g. Why is the proton 2000 times heavier than the electron?), and looking for the logic behind this model.

We believe that at CERN we have the best chance to find the answers, and the 5500 users who come from around the world to do their research here apparently agree with us. In this decade, the LEP accelerator, the large electron–positron collider which we are currently upgrading to higher energy, will provide the best chance, and from 2005 onwards the Large Hadron Collider (LHC), which will be a proton accelerator, will be CERN’s frontline facility. The LHC will take us into a domain where, if nothing new is added to the Standard Model, it gives non-sensical predictions. So with the LHC, we are more or less certain to make break-throughs concerning some of the major ‘why’ questions.

The LHC project is going to give rise to a lot of interesting technology and contracts. I am not going to describe how the LHC will work, except to say that there will be two beam pipes with protons going in opposite directions, in orbits controlled by superconducting magnets. To get the magnetic fields that we need, we will have to go down to superfluid helium temperatures (1.9 degrees kelvin), less than the temperature of outer space. Nobody has ever built such a big system — over 20 kilometres of superconducting magnets carrying about 12 000 amperes, working at 1.9 K with superfluid helium. I am sure that developing the technology and building the LHC will generate interesting spin-offs.

The LHC detectors also involve extremely challenging technology. Already there are about 3500 scientists based in 160 different institutions in 45 different countries involved in building these detectors, which will be in operation for 20 years or so after the machines starts up. Making sure that the
pieces that will be manufactured in those different countries will arrive on time and fit together is a fascinating management challenge.

To conclude, the purpose of CERN is to study the nature of matter and enlarge mankind’s knowledge of the Microcosmos. It is possible that this work will reveal new laws of nature which could have totally unforeseen consequences or applications. We can’t predict whether that will happen or not. It may even be unlikely. But what is certain is that if there are laws of nature which we do not know, then we cannot exploit them. The other thing that is certain, is that in pursuing this research, there will be technical advances and inventions of direct value, as spin-offs of the technology that we invent, which we must try to transfer to industry. The question for this workshop is how to do this better; how to make sure that the technological advances or inventions at CERN are recognized as being useful, and how to bring them to industry, which can then bring them to the market place.

From CERN’s point of view, we are here to listen to you from outside, to try to learn from your experience and see how we can improve the interface between CERN and industry. We have broken the subject down into three topics. The first is technology transfer through people, which personally I believe is the most efficient way, the second is through joint R&D projects, and finally the third is through contracts. These are all important topics and I am looking forward to hearing the outcome of these days. I hope you enjoy yourselves and I am sure that this meeting will be very profitable.
Professor José Mariano Gago, Portuguese Minister for Science and Technology

Professor Gago welcomed the initiative. He thought that the best way to contribute to the debate was to adopt a political point of view and to discuss how the subject was increasingly viewed by governments all over Europe, what were the trends, what were the challenges that large research laboratories, either national, but mainly international, would face in the future. He felt that all European governments would congratulate CERN as one of the many successful examples of science and technological international cooperation in the world. He also agreed that a critical review of technology transfer mechanisms in the light of present and future challenges faced by international laboratories was certainly useful.

It is increasingly seen that technology transfer is always embedded in a larger context of scientific and technological co-operation. In the past at CERN, technology transfer has been considered something marginal that could distract the organization from its main objectives. A second aspect is that technology transfer is essentially an organisational problem. CERN is an organization supportive of long-term strategies and that helps to transfer technology without much fear of losing something immediately that cannot be regained in the longer term. It is also an organization where the type of work, namely research, provides this naturally. Teamwork is widespread at every level of the organization and this gives a good setting for technology transfer through people.

CERN has never been under very intense political pressure. CERN staff and users imagine that they are subject to very strong political pressure. In fact much less so than any large national laboratory in large Member States. And that is not good, because the push for the transfer of technology derives essentially from outside pressure. CERN should welcome more political pressure upon it to encourage the organization to be more responsive to Europe and to the problems in Europe. A frequent question is: What does the organization deliver besides technical and scientific papers?

Technology transfer must be organized in a very professional way. Research organizations in physics tend to lag behind the general movement of research organizations in all other sciences, mainly in the life sciences: biology, biochemistry, etc. and this view must be taken very seriously. The budgets for very large organizations created after World War II will probably decrease in the future because there are other research areas competing for public funding. It is very difficult to expect in the next 20 years, a dramatic increase in the percentage of public expenditure devoted to research and one cannot expect a decrease in competition from others seeking public money. So the natural consequence is that the former very large organizations will have to fight for their budgets and the outcome of that battle will probably be a constant and a slow reduction of budgets in the next decades. To circumvent this situation the organization should be less isolated. If CERN was to integrate some of the new competitors, it would probably succeed. Technology transfer may be a way out if it is given the appropriate importance in the life of the organization.

A counter example is Astronomy and Astrophysics. Professional astronomers in the last few years have been extremely successful in linking the new media to astronomy. They have also changed the curricula in secondary education and in basic science in several countries in the last 30 years. That has not happened in particle physics. In the course of the LEP project CERN was extremely successful in a defensive way at a time when the environmental mood, the environmental fight came as a wave in Europe. But no one thinks about particle physics or CERN as a contributor to environmental issues.
Technology transfer through people

Invited talks

There is another problem which is the current ideology in particle physics. Popularization books tend to convey the idea that ‘scientists are doing that in the name of the quest for the ultimate unified theory of everything’. From a political point of view, that is bad propaganda. No one believes any more in uniqueness, everyone prefers complexity. Life sciences are now the new model for industry, for governments, for the political arena. CERN has not, and Member States have refused in the past to allow CERN to go into extensive non-accelerator physics. CERN should be a more complex organization and it should try to attract other areas of research.

Technology transfer is obviously part of the image of a research organization. It is not only a question of the success of the transfer but rather a problem of the image of the organization. It is obvious that the ability to transfer technology is one of the reasons that can be used in politics to ask governments and industrial organizations and political parties to support CERN. One of the political experiments that was successful in the case of Portugal and that could possibly be used in other countries was the organization of a CERN–Portugal Advisory Committee. Advisory committees are increasingly important in politics and in research politics. Technology transfer could be monitored in these advisory committees for a particular country.

Professor Routti will certainly say that CERN might better contribute to projects in technological areas, development projects in the European Union and in the European framework programmes. But no one will help CERN to do that. National organizations will be against it because they will see CERN as a new consumer of public funding. As present Chairman of the Eureka Initiative, Professor Gago strongly urged CERN and other international research organizations to participate in, to promote, and to develop Eureka projects in which of course technology transfer is an essential component.

In his conclusion, Professor Gago said that CERN was a great organization and that he would very much like it to overcome present difficulties and the present mood in the World politics. He considered it his duty to convey to colleagues in other European governments, the European Council and the Eureka Initiative the rich experience of CERN and its present efforts, in particular this seminar, to prepare itself for the next century. He wished the debate would help to build up a new sense of shared responsibility between international research laboratories, industry, and society at large.
Collaborative European research has a long and successful history on many fronts. Large facilities exist, such as CERN in Geneva for particle physics, the European Southern Observatory ESO in Chile for looking at southern skies, EMBL in Heidelberg for molecular biology, ESRF in Grenoble for synchrotron radiation and JET in Culham for fusion research; the necessity of working together is self-evident. Similar situations also exist in space studies of ESA and the more commercial aerospace activities of Arianespace and Airbus Industries. I would like to mention also the collaborative networks of Eureka for industrial research and the Cost activities involving countries also outside the European Union. But my principal topic today is the European Union Framework Programmes for Research and Technological Development, and in particular the plans for the Fifth Framework Programme starting in 1999.

In total some 14% of European public research funding is directed to the common activities referred to above. The EU research programmes account for about 4% of the total Member State funding of research. This is a much smaller fraction than that of federal research funding in the United States or the corresponding share in Japan. Thus the principle of subsidiarity must be kept in mind: only actions calling for joint efforts should be done at the European level.

Despite the fairly small share of the EU research funding, it represents a sizeable research investment, amounting to more than 13 billion Ecu for the current Fourth Framework Programme for the years 1994–98. Its impact on European research extends beyond this financial perspective. The funding goes to collaboration and coordination efforts and is also supplemented by national and industrial contributions. It is all project funding looking for the best ideas amongst highly competitive proposals.

The budget proposal around 16–17 billion Ecu for the next Framework Programme represents a modest but real increase in research funding at the European level. The share of research would probably also increase slightly from its current 4% share of the EU budget, where the large blocks are Common Agricultural Policy with about a 50% share and structural funds of some 32%. Some leverage to research funding is obtained from structural funds, of which today about 5% and in the future hopefully more are used for innovation-related tasks, such as science parks and technology villages, as well as fast telecommunication networks of special importance to peripheral regions.

More important than the budget development of the Framework Programmes is their structural evolution. Here we have major challenges ahead of us because of intensifying global competition and many complex policy issues facing European countries. It is fair to say that European research compares quite favourably with the United States and Japan when quality and quantity of results and higher degrees are compared. But our challenge is to be more successful in converting this scientific and technological excellence to economic and social benefits of our citizens, companies and societies, while at the same time maintaining and further strengthening the knowledge base.
The structure of the current Framework Programme follows classical science and technology disciplines. It has 18 thematic programme areas and three horizontal programmes for international collaboration beyond the EU, innovation systems and exploitation of results, and mobility and exchange programmes. More than 10,000 projects are running in parallel in these programmes.

These collaborations already bring significant added and strategic value. Mapping of human genomes, study of regional and global environmental problems, development of common standards for telecommunication, and many other areas require joint efforts. Pooling resources together helps to reach critical size otherwise difficult to reach especially in smaller countries, and provides access to much larger knowledge pools than working alone.

Still, a higher degree of focus and concentration is needed to better reach the strategic objectives of research programmes. Furthermore, more flexibility is needed to enable reorientation of programmes in a rapidly changing world. The heavy co-decision process between the European Parliament and the Ministerial Council also sets its own boundary conditions, and political priorities, as it should.

To reach the objectives of strategic importance the new Framework Programme is proposed to have a much smaller number of thematic programmes; discussions vary between three and five instead of the current eighteen. One reason for the limited number of programmes is the scientific integration of disciplines. For instance, life sciences today are all based on molecular biology and genetic information, computers and telecommunication are integrating to networks, and common requirements for industrial activities are competitiveness and sustainability. A smaller number of programmes also provides more flexibility within larger programme areas.

Furthermore, the limited number of programmes is also a requirement for the new modality called Key Action proposed as a principal instrument of research activities. Key actions are multidisciplinary efforts for finding solutions to major European challenges and call for an integrated approach including research in many disciplines and all the way from basic science to industrial and policy research. About 20 key action areas are proposed for topics such as Food, Environment and Health, Cell factory, Global change, Electronic trade, Multimedia technologies and content, Intermodality of Transport Systems, Aeronautics, and Sustainable Energy Systems. Many topics include also socio-economic research elements, which are often even more decisive than science and technology contributions. The concept of key action has been very favourably received and the co-decision process is advancing towards starting these programmes in the beginning of 1999.

Technology transfer is another challenge on the European level. It can be estimated that for every million ECUs invested in research one idea worth a careful business plan is born. With the total research investments of close to 100 billion ECUs annually in the European Union member countries we need to evaluate of the order of 100,000 ideas annually. This is a task calling for a decentralized approach close to the source of these ideas. However, common rules of intellectual property and its protection are needed, technology transfer organizations need to be set up, and integrated capital markets for risk investments need to be developed.

The new science-based companies operate in an environment very different from traditional industries. They have narrow time windows, immediate international markets, and large capital needs. The European Commission has been active in supporting the establishment of European risk capital markets both through the newly started Easdac and the European Investment Fund. They provide capital and
management support to science-based technology companies which will form an increasingly important part of the European industrial fabric.

It is appropriate that CERN as the leading particle physics laboratory in the world has taken an active interest in these matters. Of course, the large investments in particle physics research can and should be justified primarily for the search for fundamental structures of nature. However, since their study requires most advanced technologies, it is very useful to look at the most effective means of their use also outside particle physics. Achievements, such as the World-Wide Web have changed the information technology developments significantly. Medical imaging can benefit from particle physics detectors, superconducting technologies are finding their ways to many applications, massive computational needs necessitate advanced parallel computing with many other uses, and new energy technologies can be developed based on accelerator technologies.

I hope and trust that these objectives can be met while maintaining the excellence in particle physics and that the experience gained will benefit European science and societies on many fronts of common European interests.
2.3 Completed examples

‘Technology transfer through people at CERN, EC partnerships’
P. G. Innocenti / CERN

Technology transfer through people

- People at CERN
- Students and Fellows Programmes
- Other Programmes
- Collaboration with the European Commission

People at CERN

- Staff (2875)
- Fellows
- Paid Associates
- Doctoral and Technical Students
- Summer Students
- Users, including PhD Students (5500)
- Bilateral Agreements
- Industrial Trainees

>1000 young people in contact with CERN technology
Growth of doctoral student programme

Whereabouts of PhDs

Whereabouts of PhDs in industry

Fellows number plot

Field of work of CERN fellows

Bilateral agreements

- Signed by CERN with many countries or institutions bring young people for an extended stay in the Laboratory
- Established since many years with Austria, France, Israel, Italy (ASP, Piemonte), Switzerland, World Lab
- Recently with Japan, Portugal, Spain, Sweden

There is room for more.

Participation in EC programmes

- TMR
  Fellows (5/y)
  Networks (4 networks active)
  Access to large-scale facilities (ISOLDE)

- RTD projects
  Information technology (5 projects active)
  Telecommunications (3 projects active)
  Nuclear fission safety (1 project active)

- INTAS (4 collaborations active)

- ISTC (7 projects active)
Technology transfer through people

Completed examples

'Technology transfer in the field of laser processing of materials'
J. Santos / ISQ

The talk covered 10 years of co-operation between CERN and ISQ, a private Portuguese institute delivering services of technical inspections, research and development, namely in the areas of joining technologies, non-destructive testing of materials, and construction and maintenance engineering.

Examples of successful areas of co-operation with CERN were given. Particular attention was given to the laser processing of materials, an area where several industries/companies were created in Portugal, due to the existing co-operation between CERN and ISQ.

'Technology transfer through people: opportunities and challenges'
I. Ten Have / Philips

Technology transfer through people

People should be considered an important ‘product’ of CERN. Technology transfer through people is a very efficient route for technology transfer and as such trained people represent an important return-on-investment to the member countries and society in general. People who have been educated and trained at CERN carry valuable tacit knowledge which they can take with them and directly apply in industry.

A successful transfer, however, will require more than just that knowledge. The transferee should be able to communicate his/her ideas clearly, should be able to convince a new working environment of applicability, usefulness of the ideas, and give clear direction as to what to do and what not to do, etc. In other words a successful transfer will also require developed personal skills. As this is an issue barely addressed in science and technology training programmes, this is a point where CERN should consider training people.

I myself am an example of technology transfer through people. I left CERN in 1994 and am now working as a product manager on NMR imaging techniques for Philips Medical Systems in Holland. There are different elements from my CERN working experience that are extremely useful in my current position:

Technology transfer

- NMR is based on manipulation of particle spin
- The NMR technique like many CERN experiments uses superconducting magnets
Technology transfer through people

Completed examples

- Information technology plays a central role in NMR imaging and has elements similar to CERN experiments such as:
  - Fast data acquisition
  - Data processing
  - Data quality
  - Networking, etc.

- X-ray imaging uses semiconductor technology for detector arrays

Scientific Methodology

- Analytic thinking
  - Working with abstractions
  - Modelling
  - Systematic approach

- Ph.D., which in industry is interpreted as proof that the individual has produced a substantial, original contribution to knowledge

- Experience with designing and carrying out a project

International working experience

- Experiment being built across the globe and assembled with high-precision fit at CERN

- Working in international teams

- Cross-cultural management

- Expatriate life

After working at CERN for a number of years the word impossible is no longer part of your vocabulary:

IMPOSSIBLE.
Technology transfer through people

Completed examples

‘The EBI Industry Support Programme, Advanced Computing Technologies for Biopharmaceuticals’

P. Zanella / EBI

- The EBI is an Outstation of the EMBL
- 100 staff. Funding: EMBL + EU + industry contributions
- Database, information management, deposition, network servers
- Research in computational molecular biology
- The EBI serves academic and industrial research

Fast Data Growth

- No. of genome sequencing projects increasing
- Technological advances improve sequencing speed
- Biodata spread all over the world via the www + internet

Why is Bioinformatics so hot?

- Bioinformatics is about data which is growing exponentially
- Biosciences depend on it
- Dry research on data as complement to wet biology to cut time and cost
- Interdisciplinary skills required, experts are rare

Industry Partnership

Objectives: financial support, new role/image, applied orientation, extended competence + visibility, technology transfer, spinoffs, etc.

Pessimistic views of external consultants: our data are in the public domain, R&D sponsors want tangible benefits.

- Strategy? Assess the needs of potential partners and then propose joint developments
- BioStandards: a Pilot Project

Pharmaceutical perspective: Industry must cut costs & time to market, increase output. New drugs R&D + production takes 10 years. Bioinformatics, when integrated in the discovery process, will help identifying new targets faster.
First project: BioStandards funded by EMBL, EU and Industry Partners: Hoffmann La Roche, Novartis, Glaxo-Wellcome, Zeneca, SmithKline-Beecham, Pfizer, E. Merck, Rhone-Poulenc, British Biotech, Chiron, Novo Nordisk, Astra, Schering, Pharmacia-Upjohn, Hoechst, HMR, Boehringer-Ingelheim, Bender, Janssen, Monsanto, etc.

Three-tier approach: 'the Club' generates two types of projects: those of general interest, launched as part of its mission and those concerning a limited number of partners ready to provide separate financial support. Small companies (biotech, biomed) needing a loosely coupled and less expensive type of support are being offered an 'affiliate' package.

The financial model

The BioStandards Project has been financed so far by the three participating parties: EMBL-EBI, EU Commission DG III, Industry. Affiliate programme and special projects are mainly financed by the industrial partners.

Direct contributions of the industrial partners already represent 12% of the EBI budget. The intangible contributions are invaluable: we have established links with a new user community demanding commercial-level products & services.

Less than 2 years from kick-off the success is visible: we expected to attract 10–12 companies and we have now reached 20 and more wish to join. The EBI bio-industry relationship is a solution to a real problem & seen as model by other communities. The addition of a third leg (services, research, industry) has increased stability and morale and the Council has clearly appreciated this initiative.

Conclusions

We have built a cost-neutral, precompetitive TT engine aimed at 'raising the level of the sea'. Rival companies appreciate meeting at a neutral place and having the opportunity to talk to our scientists and engineers. This mutually stimulating learning process goes on and we are discovering new collaboration opportunities all the time. The new industrial dimension is turning out to be a unique competitive advantage for the EBI.
‘EPAC CONTRIBUTION TO TECHNOLOGY TRANSFER’
J.-M. LEFEVRE / ESRF

INTRODUCTION

The first European Particle Accelerator Conference (EPAC) was held in Rome, Italy in 1988 under the auspices of the European Physical Society (EPS) and the European Committee for Future Accelerators (ECFA).

Since then, the Conference has been held every two years in a different European country.

During the five days duration of the Conference, an intense flux of communication is established not only between European Universities, Institutes and Accelerator Laboratories, but also between these organizations and representatives of Industry.

- 700 to 800 physicists and engineers participate, mainly from European Institutions but also 30% from overseas.
- 40 to 60 companies are represented, they interact with the participants to the Conference through several means:
  - Industrial exhibition (40-60 stands)
  - Participation in the conference through talks, posters
  - Special half-day seminar devoted to relations with Industry
  - Informal contacts with participants during almost a week

REVIEW OF THE DIFFERENT CONFERENCE OUTPUTS

1988 IN ROME

29 exhibitors in the fields of optics, electronics, vacuum, computing, electro magnets, RF generators, accelerator hardware.

1990 IN NICE

44 exhibitors plus one stand rented by CERN and one rented by CEA with a view to demonstrating how such institutes interact with Industry.

1992 IN BERLIN

52 exhibitors, plus initially a special session for Industry chaired by Dieter Böhne (GSI).

Future projects were presented and remarks were addressed to industrial representatives on the need for turnkey contractors for medical accelerators, the interest in selecting a company with experience in electrical power plants as an architect for buildings and infrastructure, and on the difficulties in developing standard components for similar accelerator projects.
1994 in London

39 exhibitors. A seminar for Representatives of Industry was chaired by N. Marks (Daresbury) – 8 oral presentations described technology transfer policies at CERN, the ESRF and TRIUMF.

The experience of Industry in technology transfer from Institutes was described; Oxford Instruments for the HELIOS project, SCANDITRONIX for the SRRC, VALVO for klystron users, ION BEAM APPLICATION and AMERSHAM for the construction of cyclotrons.

1996 in Barcelona

34 exhibitors. The conference included a special session for Industry chaired by D. Lewis from AMERSHAM in which 11 papers described the participation of Industry in the construction of accelerators for medical applications, for inertial fusion programmes, for chemical bonding processing, and for fabrication of micro components.

The history of the EPAC actions to promote technology transfer from Research Laboratories to Industry clearly shows the progression of Industry capacity in producing equipment and technical assistance for accelerator projects.

A good example of this capacity is given by the licences granted by the ESRF to some industrial companies to produce accelerator and scientific research equipment based on the results of the ESRF Technical Development programmes.

Technology transfer between the ESRF and European Industry essentially operates through three channels.

The ESRF needs a special product thus Industry is invited to develop the corresponding equipment

One example of this method is the development of the Hydrostatic Levelling System (HLS) by the company Fogale Nanotech to meet ESRF requirements for the survey and alignment of the storage ring magnets.
Technology transfer through people

Completed examples

SEVERE OPERATING CONDITIONS REQUIRE STRINGENT SPECIFICATIONS WHICH ARE PRODUCED BY ESRF AND IMPLEMENTED BY INDUSTRY UNDER ESRF SUPERVISION

The ESRF Assurance Quality Manual consists of a compilation of technical specifications used in Call for Tender exercises for the attribution of manufacturing contracts for Industry. These specifications are written with the aim of satisfying constraining conditions of ultrahigh vacuum and/or mechanical precision. The correct application of these specifications is supervised by ESRF experts.

One example of this method is the production of five-metre long, 10 mm high undulator ultrahigh vacuum vessels made of stainless-steel bars electron-beam-welded to thin copper-plated stainless-steel sheets.

Another good example is the construction of Front End modules. The design layout of the modules including beam diagnostics, personnel safety and interlocks is produced by the ESRF. This design is used to place turnkey contracts with Industry for the production of the modules, including assembly, cabling, complete tests. Over forty of these modules have been delivered.

Licence agreements

In the period 1992–1996, eight licences were placed with Industry.

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<tr>
<th>SUPPLIER</th>
<th>SUBJECT OF LICENCES</th>
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<tr>
<td>NOVELEC</td>
<td>High precision electrometer</td>
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<td>DANFYSIK</td>
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<td>JOBIN YVON</td>
<td>Bimorph variable curvature mirrors</td>
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<td>OXFORD INSTRUMENTS</td>
<td>X–Ray beam position monitors</td>
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<tr>
<td>EURISYS</td>
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<tr>
<td>IRELEC</td>
<td>Mirror benders</td>
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<tr>
<td>CINEL</td>
<td>Diamond crystal monochromators</td>
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The transfer of technology is based on a period of training of the Industrial company for the technology concerned, then the ESRF experts remain available to support the company in the course of the manufacture.

Further subjects should soon become candidates for licences: electronics for detectors, CCD camera, cryogenic compounds.
Technology transfer through people

Round-table discussion

'BETEL, EC-funded collaboration with France Telecom'
O. Martin / CERN

The BETEL (Broadband Exchange over Trans-European Links) project was executed in 1993 following the DIVON (Demonstration of Interworking Via Optical Networks) Call for Proposals issued by the European Parliament during Summer 1992. The project was particularly well focused and had the ambitious goal of demonstrating, for the first time in Europe, international 34 Mb/s ATM links with genuine applications.

The project gathered a small number of partners under the leadership of France Telecom Expertel and was a very unique collaboration between information technology industry (Alcatel-CIT) providing advanced ATM cross-connects and ATM adaptors, telecom operators (France Telecom and Swiss Telecom) providing ATM 34 Mb/s links, and two user communities, High Energy Physics community (CERN, Switzerland and IN2P3, France), Higher Education community (EPFL, Switzerland and Eurecom Institute, France) providing high-speed distributed computing and teleteaching applications.

The BETEL project as well as other DIVON related projects were instrumental in what became the European ATM pilot in 1994–1995 and the JAMES project afterwards (pan-European advanced ATM applications testbed for use by the European Research community as a whole). TEN-34 (Trans-European Network – 34 Mb/s), the European Union co-funded backbone interconnecting National Academic and Research Networks that became available during the first half of 1997, also bears some relation with BETEL in the sense that its ATM sub-network is nearly identical.

2.4 Round-table discussion

(Summary prepared on the basis of the verbatim)

Mr. R. Miége: We have heard a very interesting series of presentations. But before starting the debate, let me introduce myself: I am not a physicist, I have been working for 13 years now in the European Commission dealing, since my arrival there, with the promotion of technology transfer and innovation at Union level starting with the Sprint Programme. Lately I have turned more towards policy formulation. Finally, I have been involved recently in the feasibility study of a technology transfer initiative at the Joint Research Centre JRC of the Commission.

Now for the debate: a lot has already been said. Technology transfer is unavoidable. Technology transfer cannot be left to its own devices, it does not occur naturally. It has to be organized, in a professional way and it has to be communicated. So my suggestion is that we focus this discussion on how to better organize technology transfer at CERN and how to better communicate it also to the outside world. Let us focus on technology transfer through people. Let's not go through the purchasing or the research collaboration. But even if we concentrate on technology transfer through people, from the various presentations which we have heard, we see that this may mean different things. While listening, I have identified four different routes for the transfer of technology through people:
Technology transfer through people

Round-table discussion

1) the students, PhD, the Research Fellows who are spending some time at CERN and then move outside;
2) the users, the research scientists, about 6,000 people using the facilities;
3) the staff in the sub-contracting firms;
4) the former staff of CERN.

Each one of these groups has got specific characteristics and needs. They have to be analysed and served each in an appropriate way.

The purpose of CERN is not technology transfer. It is basic research. Technology transfer in a basic research environment is not the same as technology transfer in a technical centre serving directly small and medium-sized enterprises. Now how do we organize technology transfer through people and how do we communicate it? Is there something to be done more systematically, more professionally at CERN in this area?

MR. J.-N. THALMANN: I am the Managing Director of the ‘Office de la Promotion et de l'Industrie Genevoise’. I have spent 25 years in industry and stopped six months ago. I took the office 3 months ago to identify what we should do in Geneva and the area. We are talking about transfer through people. I think you are right. It is the key, of course, to the whole question. Now let me first give you a small example of what I heard here not too long ago. There was one figure that was given to me. They have made a study at the University of San Diego, California: ‘What does a student want when he has finished his studies?’ The result was that 92% of the graduates wanted to create their own company, the ‘Bill Gates’ syndrome. The same was done in here in Switzerland, and the fantastic figure of 8% of students coming out of university wanted to create companies. Even with the best technology, if you don’t have entrepreneurship you don’t have any transfer of technology. Look at what is happening in the United States and you will understand why so many companies are being created there. And when talking about big companies, like Alcatel and Philips, new jobs, new values are not created by these companies. They are cutting down, restructuring, not creating values today. The new values are coming from small companies.

DR. P. ZANELLA: First of all when one talks about technology transfer, one should distinguish between the transfer of a particular technology or transfer of know-how.

If you transfer technology through young persons who happen to be among those 8% or so, who really want to start their own company, I think there should be a change of mentality, the Organization should accept and encourage it. I had the impression in the past that it was not done very pro-actively, to say the least. The Organisation should begin to feel that this is a winning point. Of course the Web was a very nice example of technology transfer, but it ended up in the wrong continent. The other point is transfer of know-how. CERN is a very special place where you get to learn how to face very complex things. When you get to a certain age, you know that you can solve big problems. And this is what I brought to the EBI.

MR. R. MIÈGE: This illustrates that the meaning of technology transfer differs very much depending on whether you are at the basic science end or close to regional development where starting spin off companies matters very much.

MR. J. ROOTES: John Rootes from the JRA technology Broker in the UK. The four groups mentioned include the student researchers, scientists, staff and former staff, lots of PhDs, lots of highly qualified people talking about transferring technology. Another aspect is spotting the applications for this technology, and that is where we get true technology transfer. Among these people, the people moving around, people
transferring, you need entrepreneurs. Now we support ESA in this activity of technology transfer. And we are judged by and large on physical transfers of technology in terms of licences to use and other things. But in fact, in going around between universities and companies all over Europe, and acting with European partners in the Network, we get messages across between companies and between sectors.

**Dr. H. Wenninger:** I want to stress that in the past we did encourage technology transfer through people. CERN is now going very much into a short-term contract policy, which of course means that people think they will not end their career at CERN. On the other hand, I think I remember one case, where someone tried to create a company, and the only help we gave was to say: 'You can come back to CERN when you fail'. On the other hand, how can we organize it? We need some feedback from you on what is reasonable.

**Dr. P. Zanella:** I think we need some brainstorming on that. I think CERN is in a completely different situation from what we have in EBI. In fact your technology transfer policy, as I read it recently at EMBL is orthogonal to the one that is being adopted through the same Council. And Council admits that the two organizations are so different that it would be ridiculous to have the same approach. To start with, the data that we created in that organization are immediately sellable to industry. Here no. You can't sell the data. But I could mention the idea they had at EMBL when they cleared our institute. We were part of an organization centralized in Heidelberg. When this part started growing a bit out of control, they sent it out to another country, to another Member State with the particular condition that they should contribute to the organization and gain some of their bread from other sources. I thought it was more or less virtual when I went there but that was not the case. I could not have paid the salaries unless a substantial fraction of the budget could be found from other sources (i.e. Industry, EU sponsored R&D projects, etc); this is the kind of pressure the Portuguese Minister Gago was referring to. It was applied. At CERN, one has to identify areas where this is possible. How to organize this is a management challenge.

**Dr. H. Wenninger:** Certainly locally we can do a lot and certainly we have thousands of students who can cooperate.

**Dr. C. Le Pair:** I would like to put a serious question to the management of CERN. CERN is a high-energy physics community with a very strong core culture. And knowledge transfer or external activities are not part of that culture. And so the question is: what incentives does CERN give to its people to be transfer-minded?

**Dr. H. Wenninger:** It is clear we have no specific policy to promote this. Our policy is rather: you have a job, it is tough, you'd better do your job, and if you do something additional it is on your free time.

**Dr. C. Le Pair:** This attitude is very healthy, I must admit, for high energy physics. But if you want to be active in transfer, then it is not enough.

**Mr. F. Bello:** I think that you have beautifully phrased the problem when you have said that it is necessary to force CERN to enter into technology transfer. That is not easy. Because the experience I have with the CERN culture is a very ambivalent attitude to transfer of technology. Because CERN is a science-oriented organization. People put the focus on their core business which is to produce new physics basically. Transfer of technology costs money and time. People have the perception when talking with people to transfer knowledge that they are deviating part of their time to a task which is not part of the core business.
of the organization. And the member countries have also a very ambivalent attitude. Why? Because, of course, my minister is in favour of technology transfer, as a politician he would like to force CERN to transfer a lot of technology to the Member States. But, on the other hand, he is very tough on the budget of CERN. CERN has incurred in the last years deep cuts in the budget and it will be extremely difficult for the administration to invest in new areas, such as technology transfer, which are not part of the core business of the Organization. The problem is cultural and organisational. There should be an independent unit, with a line in the budget. However, I don’t think that transfer of technology can be spread as a task for everybody at CERN.

**DR. J.-M. LEFÈBvre:** I think pretty well along the same lines. I would like to take the example of vacuum techniques. To my knowledge there is nowhere in Europe to gain a proper education concerning modern vacuum techniques. The essential of the know-how is transferred by CERN. There has been for a very long time, right from the creation of CERN, an excellent team of vacuum experts at CERN and they have taught their techniques and know-how to a lot of people, probably everywhere over Europe. This is probably due to the fact that in the 1950s, when CERN was created, it was a much different spirit where these ideas of promotion of technology were completely included. Resources are now going to decay slowly with the fact that the CERN budget will decrease.

**MR. F. BELLO:** A quick reaction. I think and I am absolutely convinced that when transfer of technology is through people, CERN is always brilliant. But when you have a piece of technology developed at CERN that can be moved from particle physics to a different area of application, the system fails.

**MR. R. MIEGE:** There is a lot of difference between the general transfer of know-how, ideas, or knowledge and the transfer of one specific piece of technology to a precise application. Here we come to the problem of financing which has been evoked here and there. Some say that money pressure pushes you to try and find solutions and then clients. Others say that one needs money in order to operate a good transfer of technology. Prof. Routti has got experience in venture capital and I think it would be a good opportunity to hear what he has to say.

**PROF. J. ROUTTI:** When we are talking of technology transfer we are talking also of creation of new science and technology based companies, which remains a major challenge in Europe. Firstly, there is the basic question of who has the right to capitalize publicly funded research and knowledge, which was not acceptable in earlier days. Secondly, it was thought that economic interests would contaminate science. Today we understand that these problems can be avoided and that access to the sources of knowledge is required for creation of new knowledge-based industries. It should also be emphasized that technology transfer is not collecting new technologies. According to Niels Reimers, the founder of Stanford University Licensing Office, technology transfer is firstly marketing, secondly marketing and thirdly marketing.

We are also short of competent people who can found and run new technology companies and convert knowledge to economic assets. Scientists are seldom good managers themselves, and they should rather convert on a fair basis their knowledge to equity in companies with a sound financial and management basis. There is no longer a shortage of capital, but the challenge is to make the transfer mechanisms work. We also need a stronger interface between financial and science worlds to increase the current small rate of less than 10% of European risk capital going to new technology companies, while in the United States they receive about 50% of such funds. New companies will also have an important positive impact on employment and competitiveness of our industries.
Dr. H. Wenninger: We have to find ways to make sure that we identify technology which we need. We see young people coming in with ideas that are market-oriented. If we can get out of this Workshop an encouragement for the young staff to continue in this direction this would already be a step forward.

Dr. K. Hubner: My experience is that the staff of CERN is very willing to transfer technology. Usually people are very happy and ready to work overtime to make that transfer of technology possible. But I think the difficulty is that we have an insufficient scanning of the outside needs, of the outside opportunities. And we share this with quite a number of European universities as for example the Ecole Polytechnique de Lausanne. How do you find your partner? And this is one of the difficulties.

Dr. P. Lecq: I am working at CERN in the field of detectors. I think we have to provoke a cultural revolution to CERN, because what was said by many people is quite true. The students who come at CERN and who are working with us are not educated in a way that the knowledge they have acquired at CERN may be used in other fields. I think we are not pushing enough in that direction. What has been done is far from being sufficient. For instance, about the Web which was invented at CERN: I think that everybody who connects to the Web should see the CERN logo appear somewhere, if we got one cent per connection, our financial problems would be solved.

Dr. P. Zanella: I just wanted to make some constructive remarks in answering H. Wenninger’s first question. How would you organize it? I think you have already got from here some synthetic advice. There must be an outfit separated from the rest which should contain help in marketing, legal advice, those types of things. People should get advice and they don’t find it at CERN. Also some kind of reward should exist. And some pressure should be put on the management to be pro-active in this area.

Dr. J.-P. Husson: I am dealing with R&D consultancy in a lot of European programmes. I would say that it is too easy to protect ones own niche behind the basic research mission. This is over, and for that an Organization like CERN and other big institutions need internal advice and legal services to help people, in the direction of what has been said, people realise that they will never finish their career in CERN. Solutions cannot come from outside, they have to come also from inside. And I strongly suggest that an internal service for industrial services at CERN should be created.

Dr. C. Lepair: I would like to suggest an answer to the question: how do you find people or companies who are interested? Everyone of us and everybody working in CERN knows about 1,000 people. You can start using your telephone, with five calls you have the whole world. So that can never be the problem. The problem is that the people have no incentive to start picking up the phone.

Mr. R. Mittge: We now have to bring this session to a close. I would like to mention, as a way of illustration, the proposal that the Commissioner is about to adopt for the Joint Research Centre. It contains five different elements.

- The first one is a re-structuring, a re-enforcing of the technology transfer function within the JRC, which would include providing incentives to staff, scanning the needs and setting up a sort of internal marketing and a technology watch unit.

- Second proposal, a technology incubator in order to help mature startup companies and also to host SMEs wanting to collaborate with the JRC.
Third a technology transfer fund which would be a venture capital vehicle privately funded and managed. This fund would have a first right of appraisal of the JRC Research results deemed fit for a transfer.

Fourth, an education initiative in order to introduce new curricula combining technology and entrepreneurship.

And fifth, a virtual technology park in order to build up on advanced telecommunication networks to promote research collaboration.

These are in a nutshell the different proposals which are on the table of the Commission. To a large extent they echo the debate which is going on here at CERN.
## Technology Transfer through Collaboration Agreements

**Friday 28 November 1997 (afternoon)**

**Chairman: R.F. Heyn**

### Agenda

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<td>P. Stoessel (ETHZ)</td>
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<td>工业 collaboration and technology transfer at the FZK GmbH</td>
<td>A. Kurz (FZK)</td>
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<td>Mechanisms for creating high technology companies</td>
<td>E. Byckling (Helsinki Inst. of Phy)</td>
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<td>Selling IPRs, trading exclusive rights and dealing with patents</td>
<td>C. le Pair (STW)</td>
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<td><strong>Break</strong></td>
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<td>Technology transfer at CERN (Collaboration agreements)</td>
<td>O. Barbalat (CERN)</td>
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<td>Spin-off from scintillator development at CERN</td>
<td>S. Tavernier (Univ. of Brussels)</td>
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<td>CAEN and CERN Collaboration</td>
<td>F. Vivaldi (CAEN)</td>
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<td>High performance computer interconnect development</td>
<td>K. Löchsen (Dolphin)</td>
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<td>QSW: an example of the European capabilities in the field of the high-end information technology</td>
<td>A. Orlandi (QSW)</td>
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<td>Experience from a technology transfer project on superconducting magnets technology</td>
<td>B. Nielsen (Danfysik)</td>
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**Intermission**

17.50–18.45: Round-Table Discussion

Chairman: J.-P. Husson (Essor Europe)
3.2 Review talks

Technology transfer and intellectual property rights at ETH Zürich
P. Stoessel / ETH Zürich

ETH Zürich, a technical university with 11,000 students, 3,000 scientific staff and 330 professors, closely collaborates with industry:
- bilateral agreements,
- Swiss Priority programmes,
- KTI Projects,
- Framework Programme of the EU,
- COST and EUREKA,
- sale of patent applications and licensing of software,
- yielding intellectual property rights,
- continuing education for scientists and engineers in industry,
- promotion of spin-off companies.

ETH TRANSFER, a unit with 2.5 positions, acts as a catalyst, mainly by:
- supporting collaboration between industry and research groups,
- ruling intellectual property rights,
- selling R&D results,
- supporting the formation of spin-off firms, and
- visiting industries in order to introduce new contacts and future collaborations.

ETH Zurich signs annually about 80 contracts for collaborations with industry and receives 40 MCHF, only 10% of it through mandates. Professors are provided with guidelines on topics such as support for spin-offs, conflict of interest or exploitation of know-how, with a guide to filing patent applications, with sample contracts in order to facilitate their administrative efforts etc.

ETH is interested in long term collaborations: Solving industry's problems of tomorrow. We collaborate with 'technology brokers'. Besides the electronically available Research Report of ETH Zurich (http://www.ethz.ch), we present applied research in the Innonet (http://www.innonet.ch/ethtransfer).
Technology transfer through collaboration agreements

Review talks

‘INDUSTRIAL CO-OPERATION AND TECHNOLOGY TRANSFER AT THE FORSCHUNGSZENTRUM KARLSRUHE GMBH (FZK)’

A. KURZ / FZK

The Forschungszentrum Karlsruhe is one of the largest non-commercial Science and Engineering Research Institutions in Germany. At present it employs approximately 3,700 persons and has an annual budget of 620 MDM; of this amount 120 MDM is self-generated income. Its Programme ‘Research for environmentally sustainable high technologies’ comprises: environment; energy; microsystems engineering and medical technologies; fundamental research.

The application-orientated activities of the Centre comprise all stages of research, from basic findings to pre-product development. The Centre has a wide experience in all aspects of technology transfer. A crucial element for success in this field is to have a framework which, at the FZK, consists of:

- TT as an objective of the company, defined in the Agreement among shareholders (Federal Republic of Germany and State of Baden-Wuerttemberg),
- defining and implementing internal policy and organizational structures for IPR and TT matters,
- effective organization and project management of technology transfer activities/projects.

The presentation will illustrate the channels of technology transfer used at the Forschungszentrum. Besides more ‘classical’ channels it will, in particular, describe the organization and management of technology transfer Projects in a narrow sense (SME-orientated TT) at FZK. Therefore, the speaker will present how FZK attempts to solve the most important challenges for successful TT, such as:

- identifying feasible and potentially successful results/ideas for TT (more internally-orientated)
- finding suitable partners in industry (externally-orientated),
- solving questions/problems to define and implement TT Projects (harmonization of science/business environment; feasibility; commercial aspects; scope; contributions of the partners; intellectual property rights issues; project management).

Finally empirical data will be presented.
Enhanced exploitation of CERN technology by member-country industries would support CERN's mission in basic physics research. Two efficient mechanisms for generating industrial products are: R&D collaboration with large or medium-sized companies and generation of spin-off companies. Here I discuss the latter.

The U.S. venture capital community provides a favourable climate to emerging high tech ventures. In Europe, venture capital does not support start-ups and technology as effectively. In spite of this, identifying promising new ideas at CERN and coupling these to professional venture capital financing would be an efficient procedure to exploit revolutionary new technology.

There are many obstacles in moving R&D from the academic and research community to industry. Doing business is often unfamiliar and even distasteful to scientists. Within CERN there are not many people with actual first-hand knowledge of industry and related competence. However, CERN possesses also remarkable advantages. The tradition of publishing results and providing them freely to the industry is crucial for attracting companies; patenting or other protection would almost certainly kill exploitation of promising ideas. Above all, CERN includes an enormous pool of talent in engineering and many cutting-edge technical projects.

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'STW and intellectual property'

C. Le Paër / STW

The paper deals with: STW in a nutshell; Users of research results & The Knowledge Trade (KT). Information on STW, its programmes, projects, people and users can be found on the Internet:

<http://www.stw.nl>

The research is done in universities. Users are mainly private firms. STW dealt with ~500 different companies in 1996. Selection is on the basis of:

Scientific quality & Utilization, i.e. the chance that the results of the research will be used outside the research community itself. A spin-off is the formation of user networks. User interrelation is often important.

Exclusive results are not transferred for free. The property of the research belongs jointly to STW and the university in which the research is carried out. In some cases the property is shared with a user.

A number of reasons for practising KT are discussed. The principle is generally accepted. KT appears on the agenda if one or more users ask for secrecy, a patent, or some other kind of exclusivity. Issues discussed include: right of first refusal/ option agreement/ licence agreement/ complete transfer of all rights.
Technology transfer through collaboration agreements

Completed examples

Conditions that play a role include: sharing the costs of the research/contribution to the research/reimbursement of the costs of patenting/lump sum/entrance fee/royalty agreement/prohibition of 'mothballing'/due diligence/minimum royalty/combinations of the above.

If the knowledge has no value, we encourage immediate publication of the research results. So, nobody can prevent others from using them. The revenues which we receive are in principle channelled back to the university group that did the research, to be used for further research or education.

3.3 Completed examples

'Technology transfer through R&D Collaboration Agreements'

O. Barbalat / CERN

(Handouts)

Introduction

- The CERN context
- Conditions for R&D Collaboration Agreements
- Collaboration Agreements Contracts
- Fields of application
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The CERN context

- Concept of R&D collaborations developed in mid 1980s.
- LEP construction. Few resources available for LHC R&D at CERN.
- Industrial character of major LHC supplies for collider and detectors.
- Awareness of the need to involve Industry and National Institutes in the development.
- Council concern to increase collaboration with industry in line with 1987 CERN Review Committee recommendations.
- R&D collaborations first launched for the LHC machine (SC Magnets). In the early 1990s, extended to LHC detectors following a 'Call for Technology' to industry.

Note: Close collaboration with computer suppliers since the 1960s.
Technology transfer through collaboration agreements

Conditions for R&D Collaboration Agreements

- Mutual interest.
- CERN needs components and systems beyond existing technology.
- Industry is interested in participating in the R&D because:
  - Expectation of later CERN orders.
  - Acquisition of improved manufacturing technology.
  - Prospect of new markets.
  - Gaining technological know-how for new products.

Collaboration Agreements Contracts

- Framework contract for collaborative R&D taking into account:
  - Each partner contributes its own personnel and material resources.
  - Minimum money flow.
- Safeguard of CERN interests:
  - Freedom to proceed to a competitive Call for tenders based on the R&D results.
  - Publication rights and free access to R&D results.
- Preservation of legitimate interests of the industrial partner:
  - Compensation if no follow-up order.
  - Confidentiality regarding proprietary technological contribution.
  - Licensing rights.
- Agreement on intellectual property resulting from the joint R&D:
  - Possibility to take patents.
  - Exclusive exploitation rights with royalty to CERN.
  - No CERN liability in case of industrial exploitation.
- Particular arrangements negotiated and adapted to each case to encourage industrial participation while preserving CERN interests.

Difficulties and Obstacles

- CERN's academic culture versus Industry.
  Need to reconcile:
  - Pursuit of knowledge versus short-term profitability.
  - Publication of results and free exchange of ideas versus confidentiality to preserve competitive advantage.
  - International cooperation versus concern for national or company self-interest.
- CERN financial rules:
  - Award of contracts to lowest bidder with balanced-return mechanism.
- Intellectual property rights.
Open Issues

- Interviews with firms indicate that the decision to enter in a collaborative R&D agreement is strongly related to the overall corporate strategy of the company. Hence wide range of attitudes.
- Difficult to evaluate the benefits to industry and in particular the achieved technology transfers. Need to develop a methodology. It is one of the objectives of this Workshop.
- Diffusion of results or protection for possible commercial exploitation?
- How to detect innovations with potential commercial interest?

'Spin-off from scintillator development at CERN’
S. Tavernier / Univ. Brussels and P. Lecoq / CERN

The Crystal Clear Collaboration was set up in 1990 with the aim of studying a possible use of heavy scintillating materials in an experiment at the new CERN accelerator LHC. For this task we attracted a number of experts from outside CERN who brought specific expertise in certain aspects of the study and use of scintillating materials. Probably in part because of the presence in Crystal Clear of a large number of non-high-energy physicists, this collaboration has always kept an active interest in non-high-energy physics applications of scintillators. This resulted in a number of developments and projects which were not formally part of the Crystal Clear programme, but which certainly greatly benefitted from the existence of Crystal Clear, and the resulting contacts with CERN and with technology developed at CERN.

Among these projects I should mention:
- Improved understanding of the scintillation mechanism in cerium, and praseodymium-doped oxides and fluorides, a promising class of fast luminous scintillators.
- Development of a small animal scanner using BaF2 and photosensitive wire chambers
- Development of a gamma camera using YAP and position-sensitive photomultiplier tubes.

Two new projects are currently emerging
- The use of avalanche photodiodes to design new and improved PET scanners
- Study of a possible use of a fast scintillator and a gas amplification device to build a true digital x-ray radiographic system.
CAEN was created in 1979 near Pisa (IT). It is a spin-off company of INFN and CAEN has been primarily working in the field of particle and nuclear physics until 1993. It is currently diversifying its activities in the fields of micro-electronics, space, environmental monitoring, biomedical instrumentation and computing.

CAEN is one of the leaders in nuclear instrumentation. A strong on-site support team keeping regular contacts with physicists is the key to efficient exchange of design ideas and early implementation by CAEN. Added features expand the market. This was the case for the well-known dual timer N2255, and the Charge Integrating ADC designed at CERN and transferred to CAEN in 1986. Each of these units brought more than 2.5 MCHF of business to CAEN.

Future designs will involve time-to-digital converter chips developed at CERN and continued participation in the FERMI project. CAEN is also participating in the EEC CRAFT project (Cardiac Imager).

The Norwegian SMB start-up from 1992 based on a leading position in computer interconnect technology has collaborated with CERN from its early days and before. The base technology of the company is the IEEE 1596 (1992) SCI – Scalable Coherent Interface technology developed in Norsk Data from 1987 and in Dolphin Server Technology from 1989.

Dolphin’s first customer was Convex in 1992 that built a new model of its Exemplar supercomputer using Dolphin’s technology. Today, Dolphin has a US head-quarters and 40 employees in Norway and 40 in the USA. Dolphin is the leading provider of SCI technology, components and sub-systems.

The main Dolphin Collaboration Projects with CERN have been the RD 24, ‘Application of the Scalable Coherent Interface to Data Acquisition at LHC’, the TOPSCI Eureka project, and the SISCI and ARCHES Esprit Projects. SCI related work in LHC experiments resulting from the collaborations above and especially from the RD24 collaboration includes ATLAS for second level trigger and DAQ, ALICE for DAQ (Prototyping), and LHC-B for DAQ (Evaluation).

The collaboration has brought high quality research on applications and improvements to SCI technology.
CERN has done benchmarking of SCI to demanding future data-processing applications and simulation of behaviour of optional technology improvements. The large number of research partners of CERN is a very valuable resource to Dolphin, and also to other researchers. In industry it is obvious that there is a very high visibility on CERN research in the interconnect and IT area.

Typical actions that have been taken on by CERN are the evaluation of the technology and of competing/alternative technology. The results from this work have a more long term perspective and value than feedback from standard customer relations.

CERN's strengthened objective to use standard products is positive to Dolphin and has made it easier for Dolphin to work with CERN in parallel with serving the mainline customer base in the shorter term.

Some of the results from the collaboration are: the Brookhaven STAR Experiment has selected SCI for DAQ; continued and expanded collaboration especially with the RD24 Partners; extensive spin-off to other European research partners, especially German Universities and often outside HEP community; improved understanding of the technology and the product's strong and weak points; and many good publications including reference works on SCI. CERN has also been a key element in creating new business around SCI in industry as in VMETRO's PMC, VME-related and RT-oriented work on SCI.

Partners like CERN is a strong necessary condition for the successful start-up of an SMB based on leading edge technology like Dolphin.

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‘QSW: AN EXAMPLE OF THE EUROPEAN CAPABILITIES IN THE FIELD OF THE HIGH-EN D INFORMATION TECHNOLOGY’

A. ORLANDI / QUADRICS SUPERCOMPUTERS WORLD LTD.

In this short talk, I shall explain how the work done in the GPMIMD 2 Esprit Project produced such great results at the technological level, and as a consequence in terms of European capabilities in the field of Highly Scalable Computing Systems. In order to do this, I shall spend a few minutes explaining the nature and the detailed results of the programme itself. I shall also try to show how the availability of the technology made it possible to take advantage of other important opportunities.

First of all I must explain that the QSW company was created by putting together the capabilities in scalable computers of the UK company called Meiko and the computing knowledge and experience developed in Alenia Spazio in cooperation with INFN. This was done in spite of the scepticism existing in Europe around Information technology in general and High-Performance Computing in particular. The result of the work done in collaboration with CERN has been the development of a powerful interconnection network to connect commodity processor units\(^1\) together in a massively parallel arrangement, providing the best performing supercomputers in the world. We are now receiving a lot of attention and consideration in

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\(^1\) SPARC architecture at present, but ALPHA architecture will be available during 1998.
the USA, where our technologies, both in MIMD and in the SIMD field, are recognised as the most powerful and challenging systems in various programmes supported by different governmental institutions.

Similarly at the industrial level, giant US companies are negotiating with QSW in order to continue the development of those products and to exploit jointly the market at a world-wide level.

Nevertheless, while taking pride in presenting such huge results with such a small financial contribution from European government sources, I believe that this effort will be wasted if in the future in Europe high-performance computing is not sustained, even at a fraction of the level of the government funding for similar efforts in the USA.

It is not understandable that, whilst space, aeronautic and nuclear activity and related industries are sustained in Europe at a level comparable with the level in America, the supercomputer is not perceived to be strategic. American and Japanese companies are engaged in a bitter war, sustained by their respective governments in order to win supremacy in this sector.

We are not requesting special protection from the European Community against other nations or companies, but only a comparable level of funding in order to be able to be considered as full partners and not as secondary colonies in the future.

In conclusion the co-operation with CERN has demonstrated that a small amount of money spent efficiently can create and sustain companies able to compete commercially and world-wide on the open market.

What we need for the future is:

- Limited resources for R&D activities, but with continuity and at the 100% level. As an order of magnitude, we suggest a few million ECU's as adequate. The Pathforward programme can be considered the reference of the comparable American effort.

- The funding of concentrated and focused activities in the field of supercomputing, discontinuing the policy of distributing financing to many different small projects. The ASCI/HPCC initiative can be considered an appropriate reference in the USA.

- A policy of coordinated acquisition in the field of procurement by European institutions that can stimulate and sustain European technologies.
Technology transfer through collaboration agreements

Completed examples

'Experience from a technology transfer project on Superconducting Magnet Technology'

B. R. Nielsen / Danfysik A/S

Danfysik A/S is a privately owned company specialized in providing equipment and systems for the particle accelerator market on a commercial basis. The core competences include the development, design and manufacture of magnets, magnet power supplies, and complete accelerator systems.

When – in 1995 – we decided to widen our range of capabilities to include the technology of superconducting magnets, we looked for a joint development project with an external partner rather than initiating an internal technology development project. For us CERN was the natural choice of partner because of its extensive expertise and high reputation within our core market.

The joint development agreement made concerns the 'Development of a Prototype Dipole Corrector Magnet, MCBX'. MCBX is a combined horizontal and vertical field corrector magnet. The project included training of Danfysik engineers and technicians at the CERN prototype laboratories, conceptual design work by CERN, detailed design and manufacturing by Danfysik.

Novel techniques were tried out in this magnet including a mechanical structure based on scissors type laminations, a new invention of making high-precision flat cables out of superconductor wire, and CAD/CAM data from the coil design program were used directly for CNC machining of 3-dimensional end pieces for the coils. This first prototype MCBX magnet has recently been tested at 4.2 K and 1.8 K and has proved to perform well within specifications.

Benefits as a result of this project include

for Danfysik:
- fast decision on contract
- guidance from experts within own field of applications
- synergy effects from collaboration
- qualification as a superconducting magnet manufacturer
- a good reference

for CERN:
- a new prototype magnet, 'free'
- a new potential supplier tested and qualified
- ideas and inventions from outside – synergy
- new techniques tested.

In general the collaboration has worked smoothly and the objectives set out for the project have been met.
3.4 Round-table discussion

(SUMMARY PREPARED ON THE BASIS OF THE VERBATIM)

Dr. J.-P. Husson: I have been a researcher for 15 years in nuclear physics, studied gold, by mischance it was radioactive gold, I have not succeeded in selling it too much, and I later became senior official in various European Commission committees. After this I decided with some friends to found a little R&D consultancy. So, I am in a very curious position. In this job, if we succeed too much, the know-how is given to the clients and we are out of the market. So we have not to succeed too much, we have to provide services which give good opportunities for R&D projects and not too much in order to give new opportunities to our clients. So today I would like to submit to you three or four ideas linked to CERN's preoccupation of transfer of technology.

I would like to underline three points. The first is partnership. What does partnership mean in the sense of collaboration, agreement, cooperation, and we see that these words don't mean the same thing for the different partners. Second, transfer of technology marketing: this is probably the thing that we all need to succeed in a job. After that, I would mention something which has not been directly mentioned, it is the follow-up of research-industry collaborations. Last but not least, I would say a word on the political level: even if it does not exist, you have an advantage as an institution to show a policy, even if it has not started yet.

Dr. L. Bellau: I am from the Fraunhofer organization in Germany, responsible for corporate planning and marketing. So, I pick up what you propose for discussion: what does cooperation mean? Fraunhofer as the biggest contract research organization in Europe does not yet have any cooperation with CERN. I am here to see how we can manage that. But we heard, let's say, more about the final end of the success and not much on the first seconds. I would have liked to learn how the first seconds happened and who really was the active partner. In the morning, we agreed that technology transfer is not a self-driven process but there has to be an active role, you have to implement activation energy, let's say. And we agreed, when we talked about transfers that there should be a driving force, be it a pulling force or be it a pushing force. So the pulling force, we agreed, is if we create a good environment for the scientists so that they go out, if we create a good spin-off environment, and so on; the pulling force tries to get them out of an institution. Or there is a pushing force for example if you offer them only limited contracts as we do in Fraunhofer. But, coming to cooperation and collaboration, there is of course a pulling force from CERN to be a partner for others if they look for solutions and they approach CERN if they want their competences, but there of course is a need to make a more active information policy to make more transparent what is available at CERN for others. But now coming to CERN as an active partner in that kind of collaboration with industry or with other research institutions, and there of course I agree that it is marketing as Mr. Routti said in the morning, but marketing not understood as, let's say, the conservative form of marketing that we have a final product for your purposes and then try to market it for other purposes, but more the modern definition of marketing, what is said to be marketing is adapting all internal business processes to the needs of the client. If you take technology transfer seriously, then of course you have to consider this during the development, and not at the final end. So I propose that we should use this approach for your developments, the so-called pro-active approach and not a reactive approach. And now my concern is how to get into CERN's developments at the very early stage together with our researchers and how we can install this kind of relationship to accompany your developments.
Technology transfer through collaboration agreements

*Round-table discussion*

**DR. J.-P. HUSSON:** Thank you for that. But I have to react to this comment. My question was: Who has to be the driving force? Is the driving force the research? Or is it the market? Are the driving forces the internal relationships or are they the external markets?

**DR. H. WENNINGER:** I see the examples reflect the way in which CERN proceeded. When we finished LEP, there was a physics programme ongoing but we saw a new project in 10–15 years. So CERN took the initiative and made a call for R&D collaboration with industry and other institutions. So we said we want to have a joint venture on not yet known solutions in the various fields of technology. That is how Crystal Clear started. We have had something like over 50 R&D programmes which went to peer review with international committees to judge the validity of the proposals and reject those which were not good. We now face the transition period: do we now know which technology was successfully developed in these five years, pick out those and drop the others because they are not in our main line of application. This creates problems with some partners in industry who tell us: you dropped us too early. This is a question of resources. What industry now wants is that we go independent from our own needs to see how we can help in more classical technology transfer issues. And this would be a new policy.

**DR. C. LE PAIR:** I would like to draw your attention to a set-up in the US which was designed for a totally different purpose. It was designed for stimulating small and medium-sized businesses to do their own research, it is called the Small Business Innovative Research Act. It started in the National Science Foundation, was a success there and later when this Act came out, all government agencies that supported research were forced to spend 2% of their research budget in the small and medium-sized business. The thing was that the agencies could stipulate what kind of new specific thing they wanted. I think it is worth while for CERN to consider that scheme and maybe look into what happened in the US.

**DR. U. KLEIN:** I am from Accel Instruments and I would like to discuss this further, because nothing really works when there is no real interest from the partners. And I am a little bit contradicting that this interest on the partner’s side is not met. The interests do meet if one introduces a new concept, I think. The interest of a company is very clear: it is economic success which does not only mean short-term profit, it means long-term existence for which investment is needed. Now taking CERN as an example, political pressure is not a good primary reason for technology transfer. Why could technology transfer be an investment? Because the nature of investment is long-term existence again. Technology transfer can be looked at as investing in dedicated companies and if you think that looking at technology transfer is an investment which has a long-term nature, then many of these definition problems are solved.

Looking at technology transfer as an investment can solve 80% of the system. Then if it is an investment, then you have to look at what is good for your future, and I think CERN has to lay out something in the showcase.

**DR. R. PERIN:** I think one of the speakers said: Who takes the initiative, what are the motivations? The initiative is usually taken by the party who has the motivation and the motivation comes from a need. So at the beginning there must be a need. In the past, I think, the initiative came from CERN for these common developments with industry because CERN had a need to develop a new technology. The second motivation was to have help, in fact manpower and money. The first models of LHC magnets were developed mostly with money from industry and with a lot of personnel from industry. We had up to 16 people working at CERN, some of them for years, being paid by firms. Then the third purpose was to form a market of competitors from whom we could then buy the things when the project would come. There may now be needs coming from industry and it would be very nice that we do just the opposite, that industry identifies certain areas in which CERN can help them to develop certain technologies and to market them.
But when it comes to marketing it is the role of the firms of course. Perhaps we should start looking the other way round now.

DR. A. ORLANDI: I suppose that in many fields the problem is the need. It is quite unusual that looking at the needs of other markets, I am talking for the US Inter-Physical Research Center, they are spending a lot of money in this field and we have no symmetric expenditure and need in Europe. This seems quite strange. And in partnership, I foster also the concept to create a need or to have common pressure on the decision-making in Europe in order to build up the need. Because in many fields, it seems that strangely there is no need.

DR. J.-P. HUSSON: I would like to comment on these two last dimensions. Aren’t we saying that the cooperations or collaborations you mention are more linked to orders of the needs of the institution than to cooperation in transfer of technology?

DR. H. WENNINGER: I think as R. Perin said, we are half-way in tomorrow’s topic as also U. Klein said. Yes, of course, for industry in the end it is a question of how the joint venture R&D continues in contracts and real money. I think an Organization with this potential and this know-how available needs an active development programme which we created by the call for technology on joint venture with industry. We are now risk stopping all this when we focus just on a project implementation. No investment would be better used than creating with industry, organizations and national institutions a new initiative: call for technology for the years beyond LHC.

DR. J.-P. HUSSON: You mean partners?

DR. H. WENNINGER: Yes.

DR. I. BELHAU: I have an additional question. What is now the strategy of CERN? Is it compatible with space industry? But I understand it is really only your purpose to come to good results. In the space industry they need, for political reasons of course, not only to have the best market or the best satellite, but afterwards they have to argue that for that huge amount of public money there will be other applications in the commercial sector afterwards.

DR. H. WENNINGER: I understand the initiative from our Finance Committee and Council. They would like us not to have the technology potential sleeping but to take an active role to see beyond what are our presently defined needs, which we think we now more or less understand. That is why we want to see with you what is reasonable or not. Fraunhofer has a clear mandate and therefore you probably know exactly what is your role. We had until now the role to satisfy CERN’s needs as a service organization towards universities. Now if I interpret the idea, since the potential is here, maybe it is wise to use it beyond this narrow project view. This may be the message that we can give to our Finance Committee and others in elaborating together how we can meet this task. It has to be a policy supported by all Member States.

DR. G. FERRERO: I only want to add to what was said by Dr. Perin. People have talked about technology transfer from institutes or CERN to industry. But there is also a big transfer of technology from industry to CERN and institutes. Ansaldo has financed the first dipole for CERN 12 years ago. Why? Because we had confidence in this project. In fields like magnets or other big components, there is much more transfer of technology from industry to CERN than from CERN to industry.
DR. H. WENNINGER: We speak internally about technology exchange, and it is certainly true that the leading computer companies are not seeking know-how from CERN, they use us as a test bench, as a critical community of future potential user markets. They bring the know-how, but they are happy to have us because we are critical and we push them to develop the products for the future. And they give us as a credit very good conditions for whatever they sell us. If I want to use CERN’s potential, CERN now focuses on a project suppressing all R&D which we did for the last five years, and many of our staff would be happy to continue this very interesting work, but I now say: Do the service part. We do not give industry the know-how, industry gives the know-how to us and, via us, to others who need it.

DR. J.-P. HUSSON: Dr. Wenninger, you just mentioned ‘service’. And service is something which is becoming an industry. And services need a push-pull approach inside institutions, not only CERN. I strongly believe that this step-by-step procedure on marketing inside and externally ‘selling’ the services should be one of the goals of the marketing.

DR. U. KLEIN: Just taking again this concept of investment, that means as the first priority there has to be a vision, all these things that we discussed, have to be sort of following a main vision. The first step should be really to define a core interest of the Organization. And that means looking towards the future.

DR. F. VIVALDI: For a long time in CERN we talked not only about transfer, but also about outsourcing.

DR. H. WENNINGER: Yes. It is obvious that we outsource as much as possible. We outsource even core business of CERN. We place contracts which have a mandate to develop together with a firm a concept of how to improve or how to change or how to implement a better operation into a service contract. This certainly is the strategy supported by our Finance Committee. We have a vision of the future, but we have a project which has to be completed. And we have shrinking means, so we have to find a way out to do more.

DR. A. REED: I am from Rutherford Appleton Laboratory in the U.K. I am responsible for the commercial aspects. I would just like to pick up on the theme that we seem to be developing now, that there should be partnerships, and they need to be the goals of the organizations involved in this partnership. These goals don’t have to be the same but they need to be complementary and that seems to be a very fundamental aspect here. I think that involves organizations knowing what their vision is and knowing what their strengths are and playing to those strengths on both sides. And this can lead to a sustainable development if there is this complementarity. Alluded to it earlier in the day in the technology gap, how to know what the market needs are? Be they internal, long-term or external, and how they match up with technological capabilities? And I think an issue that we might want to address, is to how to stimulate partnerships that can address this marketing. I think the concepts of service and marketing are very relevant here. I would like to add perhaps one other point which relates to this internal marketing, on how one in an organization really energises and gets this communication right down in the organization. One of the things we are beginning to learn is that in order for this to become self-sustaining and to propagate, we have to be careful to give good recognition to individuals when a project takes off successfully.

DR. J.-P. HUSSON: I would like to stress another directly related subject. It is the real follow-up of the industry-institutions collaboration. Because if you ask people (in the computer industry the Jurassic times are six-month periods, in magnets it is probably a five-year cycle, in others it is more), you discover that very honestly, whoever the partners are, it is very difficult to determine a share of who has triggered what for the market of eventual products. What about the follow-up of this idea in the real paths of the
research in the fair share of the different partners. After five years, does Ansaldo know exactly what percentage of the CERN project contributes to its market?

**DR. O. BARBATA:** In fact the idea of a follow-up was raised at CERN I think ten years ago when I got my mandate. And the trouble is in practice that the people who are qualified to do the follow-up are so overloaded by the day-to-day. And therefore, the follow-up is forgotten. I tried to initiate some follow-up, I failed. Recently, there has been a proposal from Norway, from a management institute in Bergen, who made a proposal to follow-up the whole LHC project and see what technology is needed to make the project, what happens later on in industry or whatever on that technology which was initiated by the need of the project. Again there is a problem of the time needed by CERN to help that external structure to follow-up.

**DR. J.-P. HUSSON:** In my experience, it is shared between the firms and the institutions. Because people disappear, or have no time, or both.

**DR. K. HÜBNER:** The real dilemma of the management is how much of the resources do you allocate for the vision, as U. Klein said so correctly, and how much resources do you allocate for the follow-up? And which one is the best investment for the future?

**DR. J.-P. HUSSON:** I have no definite answer to that. But I would like to answer on the spot. Resources mean different things for the management and for the operational people. For some people it means money and political interference, for the others it means time or vocation.

**DR. H. WENNINGER:** We should have enough connections and possibilities to interest the universities in the Member States to do the follow-up for us. They could follow up better than we can do with our own engineers who are on the next job and forgot about what they did in the last five years. In 20 years we want to analyse how it was possible to create a billion Franc detector with 35 countries, funding agencies having control over the money and how we coordinated that work as a model for worldwide collaboration in the future. Somebody should pick it up and study it in parallel with us. I hope we can trigger universities and we have some indications that they are interested. So it is not necessary for CERN to do it. We are planning to propose this follow-up, but we have to set some kind of scheme of how to implement it.

**DR. J.-P. HUSSON:** The last subject is the transfer of technology policy to be shown to the Member States. Because all the Member States ministries are faced with the same problems, and some are becoming very tough to demand re-orientations of their policies.

**MR. R. MIEGE:** I would like to react on the presentations and the discussion. For me it is clear that there are two things that need to be done. I am reacting to Dr. Wenninger’s comment on outsourcing part of the follow-up. I think if you really want to make technology transfer one of your objectives, you will not escape building up some form of internal capability. Technology transfer needs to be managed, organized, documented, followed up. I agree that you have to find the right balance between the internal capability you can devote to that and between farming out. Several of these functions could be farmed out. But as soon as you farm something out, you will need an internal interface. I found the examples of this afternoon very interesting and enlightening. What was shown was that technology transfer occurs. But you need to clearly set yourself goals and objectives. The cases presented highlighted two groups of companies which have benefited from technology transfer: specialist equipment suppliers and large companies interested in co-development such as described in the Ansaldo or France Telecom case. These two groups of companies are very small in number. If you collaborate with intermediary organizations such as contract research
organizations, whose business is to adapt technologies to the needs of a large number of customers you may reach a wider group of beneficiaries for the CERN technologies.

**Dr. J.-P. Husson:** I could add you have to measure and to present it to the company boards, and to measure it is a very difficult thing.

**Dr. H. Wenninger:** We have countries who do it. We have programmes where fellows from Member States are coming to us and that is a good scheme. Politics was different in Europe, when LEP was decided and every resource was put on LEP. It was a special development programme in parallel which allowed us to set the framework for the future. And we developed and recruited the people who still today are the design engineers of electronics for the future. CERN is not just CERN, it is all the laboratories which are partners.

**Dr. H. Hoffmann:** I am working on one of the experiments that have been discussed today. I think that what Dr. Wenninger said is really very interesting because this experiment is realised with 15% contribution from CERN, 85% from outside institutes. And it is high-tech, I can assure you. We heard a very nice story this afternoon about the Crystal Clear collaboration. I find this absolutely important because here is a development for one of these experiments. It is based at CERN. It is based in the institutes. But the institutes themselves, they do technology transfers to local industries. So I think the technologies get developed for CERN, however, the technology transfer to industry is done in the local institutes. And don't forget another thing: an organization like the ATLAS experiment is such that basically you can realise the whole knowledge of ATLAS in each of the institutes. Because we talk to each other, we know each other. So if somebody is interested, any institute can show you how to do it. We almost have a success story, the EDMS (Engineering Data Management System). The way we organize the construction drawings throughout the collaboration accessible through the Web.

**Dr. C. Le Pair:** I think you should patent this EDMS.

**Dr. J.-P. Husson:** And make it known to the outside community.

**Dr. H. Wenninger:** If you can support us in our idea that CERN should maybe set the goals but that the collaborating institutes should be the ones who help in making then the transfer; that is a scheme that would help us to be successful with reduced resources.

**Dr. C. Le Pair:** There is one comment I want to make because of what some people said. The question was whether you should protect knowledge. I can assure you that in 95% of the use of knowledge, it will only be used if it is protected. Maybe the WWW was too big for that. If you protect knowledge, you are giving an incentive to industry to use it.

**Dr. J.-P. Husson:** I will add I eventually started and triggered pre-marketing studies. And found a market two years later by miracle. Why?

**Dr. K. Hübner:** Had we protected the WWW, would this have really spread out as it has done? Would it have not disappeared in a drawer somewhere?

**Dr. C. Le Pair:** It depends on the way you do it, of course. Yes, if you had charged everybody 2000 guilders to be able to use it.
Dr. E. Byckling: I mentioned earlier the story about how in the US the WWW sort of started being used only after it had left the university environment. I totally agree with you that commercial things should be protected. But I think the crucial thing is who is protecting it? I think it would be efficiently used if a commercial company protects it, because it can go to the right market. I propose something quite opposite. You know, typically of course, an employer owns the inventions inside the company made by the personnel. But the UNESCO suggestion is that in the universities, the faculty own their own inventions. Most countries in the world have actually implemented this. And I think that is very important, because in that way you really have the motivation for people to do the inventions. And I would actually propose that CERN should adopt the same policy and motivate its people to make inventions. It would be beneficial to CERN if the world knows that many inventions were made here and have become used widely.

Dr. J.-P. Husson: It is perhaps time not to die, but to survive in other social things. Thank you for your cooperation. And remember that to be too transparent can sometimes lead to bumping in a mirror.
4 Technology transfer through purchase

Saturday 29 November 1997 (Morning)

Chairman: H. Wenninger

4.1 Agenda

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Intermission

11.35–12.30: Round-Table Discussion
Chairman: M. Gigliarelli-Fiumi (INFN)
4.2 Review talks

‘Commercializing technology Through Partnerships’
Dr A. Reed / CLRC

CLRC’s approach to commercializing technology recognises the need for it to be a strategic, planned marketing activity and the importance of people in effecting the process. Partnerships are crucial to success. Organisations should play to their strengths and seek complementary skills, e.g. technical, manufacturing or market access. All are needed for success. Forming partnerships at early stages is helpful since the technology transfer process is long and people-intensive. It often requires a broad range of skills to be made available and a common commercial appreciation to be held by all parties. Each party must also be committed at all levels (corporately and individually) and recognise the process as adding to its overall vitality. Bridging the technology gap between market applications, technology and suppliers is perhaps the most difficult stage. Formal and informal networks are vital in finding appropriate partners. Industrial collaboration over long periods on contract development with CERN has been highly effective and mutually beneficial.

CLRC provides leading edge research facilities and expertise. Commercial activity represents 20% of £100M turnover and is growing substantially, reflecting our position as the natural UK interface between science and industry. CLRC is a major partner of CERN in design, commercialization, training and interfacing between CERN and UK industry; case studies and lessons learnt are discussed in the presentation. Such complementary activity suggests it and other organizations may be able to extend CERN’s outreach by acting as partners in its developing technology transfer and commercial programmes in member countries.

‘Technology transfer by purchasing; practical examples’
J. Rootes / JRA Technology,

The acquisition of technology by purchasing covers several possible scenarios. These range from the purchase of a licence on a patent for the exclusive (or non-exclusive) further development/exploitation of a technology, to the outright purchase of a novel complete technology element (usually on a non-exclusive basis) to add capability, increased performance or enhanced market penetration to a planned or existing product.

The success rate in effecting technology transfer for cash is relatively low. For every success there are usually many failures and the gestation period is often long even for successful transfers.

Several key risk factors may be identified in the transfer process. These will significantly affect the chances of success and should be individually assessed for each potential transfer opportunity. These factors are:

- Technical Maturity It is more difficult to assess the potential, hence worth, of immature technology. Cost of development/adaptation could be high and difficult to assess. Risk is high
and will frighten off investors. On the plus side, cost of acquisition should be lower for immature technologies.

- **Documentation/Data** Coupled with maturity comes proof of capability which is related to supporting documentation, test data etc. Lack of design and process documentation can be a major hurdle for successful software transfer in particular.

- **Cost of Adaptation** Again this is often coupled with maturity, high forecast costs to market and lack of obvious investment sources are a major cause of transfer failure.

- **Protection** Complicated existing IPR distribution makes for difficult and risky transfers.

- **Market** The knowledge of the existence of a definite and quantified market for the technology helps the negotiations over the other hurdles. The reverse is true, hence investment in thorough market research is vital for both parties — for the donor to determine what to charge and for the receiver to determine what to invest.

- **Human Factors** The least recognised factor, but a major element in many failures. Initial enthusiasm, on either donor or receiver side, may be vested in a small group, or only one person. This may not reflect the corporate view, which often rejects TT on strategic grounds, even when confronted by favourable economics. Similarly, intransigence or plain inefficiency of a key person in the transfer process may adversely affect chances of success.

Large research institutions, some way removed from the commercial market place, face additional difficulties in implementing technology transfer programmes.

Some of the difficulties encountered during several years’ experience of working with many large organizations, including the UK Defence Research Agency, universities, the UK Met Office and ESTEC will be outlined. The talk will finally briefly identify how the ESA TT programme is configured to address these difficulties and how CERN may benefit from ESA’s experience.

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**Technology transfer Policy in AREA Science Park**

M. Sancín / AREA

Science and Technology Parks contribute to the development or the economy of the surrounding territory by spreading innovation, by exploiting the results of research and through technology transfer. Moreover they foster communication and co-operation both transregionally and transnationally. This paper sets out to present:

- the main features of AREA Science Park, Trieste, the principal multisectorial Science and Technology Park in Italy, which hosts Centres, Companies and Institutes working in the fields of basic research, high-tech and advanced business service;

- how this environment can help create the right conditions for triggering the exploitation or research and innovation;
Technology transfer through purchase

- the initiatives that the AREA Science Park Consortium, which is responsible for the management, promotion and development of the park, has taken in order to promote technology transfer and spread innovation.

‘CERN AND INDUSTRY’
G. FERRERO / ANSALDO

Among the Research Institutes, CERN, in the realization of the projects, has always shown an attitude of approach to industry.

In fact, for the magnets used in particle accelerators, the phase of theoretic studies has always been strictly followed by a first ‘engineering’ phase and by the manufacturing of prototypes together with industry, aiming to the validation of the project.

This approach turned out to be winning, since it fostered a ‘technical dialogue’ with companies, whose main task is to operate on the market with products linked to magnets (e.g. electric A.C. and D.C. machines) but being fundamentally oriented towards industrial products.

The meeting of these two realities allowed a transfer of technologies and then the convergence of the two products: advanced and industrial.

The result has been the validation of the series manufacturing of a product not completely ‘developed’ in all the details.

Another keystone of success has been the continual assistance provided by CERN to Industry, even in the manufacturing phase, which allowed to overcome rapidly the unavoidable inconveniences occurring in the course of the activities.

According to this procedure Ansaldo, in the frame of the LHC project, manufactured 3 prototypes 1 m long, 3 dipole prototypes 10 m long, and now a 15 m dipole: this production allowed the validation of the whole project, obtaining Council approval.

FIRST SHORT MODEL FOR LHC PROJECT (1986 –1988)

The CERN–Ansaldo collaboration for LHC started in 1986 with a first model 1 m long, entirely financed by Ansaldo: two designers joined the engineering team in Geneva for the study and development of the model.

The need was to combine CERN studies and projects with the experience of a manufacturer, in order to prove the feasibility of the conceptual design.

The final result was that during the test the magnet reached a field of 9.3 T, a world record at that time.

10-METRE PROTOTYPES

A team was set up for this project, including CERN and Ansaldo technicians with full responsibility for the development and manufacturing.
Since the beginning the team had to face a 'cultural problem': the magnets manufacturing required mechanical precision an order of magnitude higher than the magnets for the physics manufactured in the past.

Both sides showed great flexibility in accepting the idea of 'prototype', separating the technical problems from the economic ones.

The technical development of the main activities was tested on full-sized prototypes, in particular on dummy coils, collaring, quench heaters and electric connections manufacturing.

The three dipoles were manufactured with good results: the first dipole was successfully tested on April 14th, 1994 and the string magnet, with the same good results on December 2nd, 1994. It is worth noting that the Council approved the project on April 15th, 1994 and the financing on December 15th, 1994.

15-METRE PROTOTYPE MANUFACTURE

Starting from the positive experience made on the three 10 m long prototypes, the design was modified. In addition to the test activities on collared dummy coils and 1 m welded models, and with a view to face the problems relevant to series production, rationalizing and simplifying processes were carried out.

The possibility was checked to wind the outer layer on the inner one already polymerized; the assembly, bending and welding techniques of a 15 m cold mass were also experimented.

Even in this situation the product was worked out by a continuous interaction between CERN and Ansaldo: exploiting the acquired know-how and the systematic approach established during the manufacturing of the previous prototypes, the manufacturing problems were considerably reduced as regards analysis and decision times.

The dipole was delivered on November 12th, 1997 for the introduction in the cryostat.
4.3 Completed examples

"Technology transfer through purchasing at CERN"

C. Wyss / CERN

(Handouts)

Introduction

Purchasing is paid from the yearly Material Budget (381 MCHF)

- Supply Contracts (155 MCHF): equipment for infrastructure, upgrade of existing facilities, new projects (components for vacuum, RF, magnets, cryogenics, instrumentation, computers, electronics, controls, power converters, etc.)
- Industrial Services (175.5 MCHF): industrial support, temporary labour, maintenance, work contracts, computer and office equipment, telecommunications, rental, leasing, insurance
- Electricity, utilities (50.5 MCHF) may be included in Industrial Services once the relevant markets are effectively open to competition

General purchasing policy

- Ensure that the bids fulfil all the necessary technical, financial and delivery requirements
- Keep overall cost as low as possible
- Achieve well-balanced industrial return coefficients for all the Member States (MS)

Industrial return

- Definition of return coefficients for Supplies and Industrial Services for each Member State
- Return coefficients: ratio between percentage share of purchases and percentage contribution to the Budget
- Return coefficients averaged over 4 years
- Member States can be 'well-balanced' or 'poorly-balanced'
- Return coefficients used in the process of selection of firms and contract adjudication

Call for Tenders for contracts over 200,000 CHF

- Forthcoming Calls for Tender Document
- Market Survey
- Selection of firms to be invited to tender
- Call for Tenders, Adjudication
- Contract execution
Early information of Industry

- Forthcoming Calls for Tender documents
  - Issued four times a year to: Member State delegations, Industrial Liaison Officers (ILO), Chambers of commerce
  - Keyword information on: type of equipment, technologies, processes, R&D requirements
  - Names of technical and commercial responsible persons are given

Search for qualified potential bidders

- Market Survey
  - Summary of technical specification
  - Qualification criteria (resources, competence)
  - Questionnaire

- Information from firms interested in bidding
- To allow to all parties involved to propose suitable bidders
- Early exchange of technical information
- Advice from firms for drawing up specifications

Selection of potential bidders

- Technical and financial qualifications of the firm
- Likelihood that the selected firm will submit a bid
- Previous CERN experience with particular firms

Number of firms selected from each Member State

- Member State’s contribution
- Industrial return coefficients and industrial structure
- Future commitments in the various Member States

Find the firm able to deliver at the lowest price

- Call for Tenders

- Functional technical specification with guaranteed performances and definition of interfaces, for equipment for which the know-how is available in Industry

- Design and detailed technical specification for equipment of novel technology. Manufacturing details specified only when imperative
  R&D, at CERN:
  in collaboration with Institutes and Laboratories,
  in collaboration with Industry

- Design and computations, at CERN, or purchased from Industry
Adjudication: lowest price & balanced return

- Directly to the lowest bidder complying with the stipulated requirements, if the firm (consortium) is from a poorly-balanced Member State.
- Where the lowest bid is from a firm A (consortium) from a well-balanced MS: negotiations with the two lowest bidders, firms (or consortia) B and C from poorly-balanced MS, providing that their bids fall within 20% of that of the lowest bidder.
  - If B agrees to align its price to that of A, the contract shall be awarded to B, provided that he still complies with all the stipulated requirements.
  - If B does not agree to realign but C does, the contract shall be awarded to C, provided that he still complies with all the stipulated requirements.
- Incentive to firms in well-balanced MS to create a joint venture with firms in poorly-balanced MS.

Contract execution

- Often custom-made equipment, with tight tolerances, surface processing/treatments, joining of different metals.
- Nomination of responsible persons.
- Approval of sub-contractors, of design calculations.
- Approval of manufacturing drawings, quality test protocols.
- Factory visits, main and sub-contractor(s).
- Progress follow-up meetings.
- Agreement of modifications proposals by the Contractor or by CERN.
- Presence at factory tests, provisional reception tests at CERN.
  - Close technical relationship.
  - Optimize for manufacture.
  - Find together solutions to difficulties.

Technology exchange

- Train contractor's staff (leak testing, magnetic measurements, etc).
- New technologies: surface treatments, sputtering of SC Nb films, specially designed e-beam welding guns, clean room working procedures, joining of different materials, etc.
Technology transfer through purchase

Completed examples

'Aluminium Ultra-High Vacuum Chambers for LEP'

E. Peter / Euromotive GmbH,

Aluminium Ranshofen (Austria Metall AG) submitted an offer in 1983 in reply to CERN’s invitation for tendering for the assembly and preliminary testing of the LEP aluminium ultra-high vacuum (UHV) chambers. The contractual work consisted of producing and UHV leak testing 2050 units with integrated Non-Evaporable Getter (NEG) pumps and up to 12 metres in length, within two years, i.e. during 1985–87.

The company was awarded the contract in 1984, and all efforts were made to meet the stringent requirements set out in the relevant CERN technical specification, which included the design as well as the required performance.

With the constant support by CERN, and following several improvements in the manufacturing procedures, such as machining, chemical cleaning, clean rooms, automatic welding techniques, dimensional checking and UHV leak testing, Aluminium Ranshofen (Austria Metall AG) improved their expertise in the field of welding, in particular, with respect to UHV standards and the related quality control, i.e. He mass spectrometer leak testing of large components on an industrial scale. Finally, the ordered chambers were delivered on schedule, whilst meeting CERN’s technical specification in all respects.

The contract with CERN had its share in the acquisition of the ISO 9000 certification by the company. The part of finished products of the former Aluminium Ranshofen (Austria Metall AG) has now become Euromotive GmbH, a subsidiary of the Salzburger Aluminium AG.

‘Getter pump for LEP’

B. Ferrario / SAES Getters

From 1984 to 1986 SAES Getters supplied a pumping means for the LEP collider based on non-evaporable getter strips. At that time, SAES was already supplying both evaporable and non-evaporable getters to the electronic tube and vacuum industry, in a leading position achieved thanks to the dedicated activities of its R&D laboratories.

SAES also owned many related patents. The collaboration of SAES with CERN could materialize, therefore, on a sound technical ground.

This collaboration was, and still is, perceived as a particularly positive experience for the Company since it resulted in a technically successful supply of an essential component for a prestigious machine like the LEP collider. The Company could, however, also take advantage of the need to meet very demanding specifications to improve the characteristics of various types of non evaporable getters and, in some aspects to innovate in the related manufacturing technology. Moreover, the evidence of the potential of a getter based pumping solution greatly helped establishing the getter technology in the vacuum field with an important impact on the image of the Company, beyond the specific economic value of this supply. The
positive results are believed to be certainly ascribed also to the clear specifications set forth for the product to be supplied and to the close technical and scientific interaction between the two parties which was pursued by CERN throughout the collaboration.

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'Superconducting Sputter Coated Cavities for CERN/LEP 200'
U. Klein / ACCEL INSTRUMENTS GmbH
(Handouts)

ACCEL

<table>
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<tr>
<th>PRODUCTS, SERVICES</th>
<th>EXAMPLES, APPLICATIONS</th>
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<td>RF accelerating units</td>
<td>Normal and superconducting RF cavities and modules</td>
</tr>
<tr>
<td>Superconducting magnets</td>
<td>Accelerators, fusion, particle detectors, custom design</td>
</tr>
<tr>
<td>Cryogenics</td>
<td>Current leads; conventional, low loss, and zero-boil-off cryosystems</td>
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<tr>
<td>Beamline equipment</td>
<td>Wiggles, undulators, monochromators, Be windows</td>
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<tr>
<td>UHV devices</td>
<td>Dipole and quad chambers, plasma process chambers, all metal and elastomer sealed valves</td>
</tr>
<tr>
<td>Turn-key systems</td>
<td>Accelerators, particle and optical beamlines, cryomagnetic systems</td>
</tr>
<tr>
<td>Programme management</td>
<td>International consortia, industrial architect, quality management systems</td>
</tr>
<tr>
<td>Engineering and manufacturing services</td>
<td>High-precision machining, vacuum brazing, EB welding, special materials (stainless steel, aluminium, Cu, Nb, Ti, Be, etc.) surface chemistry, clean room assembly, dimensional control, magnet, cryogenics and RF test areas</td>
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**Technology**

- Radio-frequency cavities transform RF power into beam power
- Normal-conducting cavities (Cu, LEP1)
  - limited cw accelerating gradient
  - very inefficient power conversion
- LEP200 needed for superconducting cavities (niobium, 4.5 K)
  - ca. 300 4-cell cavities at 350 MHz
CERN's Development Programme

- Niobium sputter coated copper cavities instead of bulk niobium
  (25% cost saving potential)

- Challenges
  Manufacture and process copper 'substrate' cavities
  Deposit 1–2 μm niobium on 6 m² of surface with very high quality
  Design, manufacture, and assemble cavities, units, and modules
  7 years * 22 my/year * 300 kDM/myear + Financing —> 50 MDM

- R&D Result: Design, recipe and prototype demonstration

Request for Proposal, Analysis and Contracting

Are design and recipe feasible for a fixed-price contract based on cavity performance specification, e.g. what is the success rate for the coating cycle?

- Crucial element: forecast and trust in success of technology transfer

- Contract was made with us in 1991 on 1/3 of the volume, i.e.

- 80 cavity units, assembled into 20 modules (1991–1996)

- Two more companies were involved with 1/3 each (Ansaldo, Cerca)

Technology Transfer Process

- Primary interest of CERN and ACCEL was to reach specification in time and in cost

- Successful technology transfer was a necessity for this contract, but not the primary goal

- Duplication of CERN's special installations
  Support in build-up and tuning of our installations
  Regular visits at engineer, sometimes at technician level
  Flexible cooperation and help

Outcome

- Successful project both for CERN and for ACCEL (taking some considerable risk in the beginning)

- Our benefits:
  Several important enabling technologies and competences improved (rather than prototype or blueprints for a product)
  Competence to apply and develop this coating technique further for new projects (LHC and others)

- Now we enter into a technology transfer Agreement with CERN on continued support
Technology transfer through purchase

Completed examples

Remarks

What are the interests of the TT Partners?

- Company
  Economic success (long-term existence, growth, investment, profit)

- CERN (?)
  Technology transfer in fields deducted from CERN's future plans and vision is investment
  Technology programme for identified technologies important for its future
  Implement marketing strategy for finding TT partners in order to stimulate industry

- Companies should define and lead specific TT programme

- Practical, short term measure for TT improvement

Purchase some more on the system/subsystem level, specified by performance

'Technology transfer in the environment of SMEs'
J. Gomez Fernandez / INGOVI

The INGOVI group has been present in the mechanics sector since 1967, developing a continuous analysis of the current managerial sector, identifying clients' needs through market tendencies.

Our products serve the high technology market, being able to support vacuum conditions in the range of $10^{-10}$ mbar.

All our procedures assure the maximum quality of the product, according to the ISO 9000 standard models.

The European Organization for Nuclear Research (CERN) in Geneva uses ultra-high vacuum chambers for their accelerators. For this reason INGOVI is interested in participating in such projects as the radio-frequency HOM (Higher Order Mode) couplers.

INGOVI therefore investigated the development of the first manufactured prototypes, entering in this way into contact with the French company SICN, specialized in joining technologies such as electron-beam welding, brazing welding in a vacuum furnace, and other processes with superconducting magnets.

It became apparent that the establishment of a consortium between INGOVI and SICN would facilitate the exchange of ideas among those participating in the project.

Such a consortium would profit from the experience of both companies, thus improving certain production processes and obtaining a final product of higher quality.
There have been no particular problems with this consortium, apart from small inconveniences that arise during the process of adaptation to the different work methods and organization used by both companies.

At present, since we move in a very complex and specialized activity sector, we do not wish nor can afford to be alone, and we need to create an environment of technological development that allows us to continue competing with the best at world level.

4.4 Round-table discussion

(SUMMARY PREPARED ON THE BASIS OF THE VERBATIM)

Dr. M. Gigliarelli-Fiumi: I have a legal background and since the beginning of my career I have always worked in the research sector, dealing in particular with scientific international relations. Until two months ago, I was the Director for International Affairs at the Italian National Institute for Nuclear Physics, INFN. I have been a member of the Italian delegation at the CERN Finance Committee and Council since many years, and at present I am the Chairman of the CERN Finance Committee. I have also chaired the CERN Working Group on Purchasing Policies and Procedures which formulated the new CERN purchasing rules in 1993.

Before opening the discussion, I would like to make one comment of a general nature concerning one point which was raised yesterday but which is relevant, I think, for the discussion of today. Yesterday, it was reported by O. Barbalat that in some ways the present purchasing rules represent an obstacle to the transfer of technology. I have to disagree with this statement, as the present purchasing rules for high technology contracts specifically foresee the possibility of deviating from the rules precisely in view of facilitating the technology transfer to firms in more than one Member State.

Listening to the various talks of this morning, I have noted some points which may be kept in mind and considered during our discussion. During the talk of Dr. Rootes, the needs and the importance of pre-competitive development were stressed. Another point is the importance of sound market surveys. And a full management understanding and commitment towards technology transfer is also needed. Another point which I consider extremely important is what has been emerging from the reports made by Dr. Ferrero, Dr. Klein and Dr. Ferrario. They have illustrated excellent results, obtained during their contracts and cooperation with CERN, through a strong technical interrelationship between CERN and industry since the beginning of a given project. So the question is: how can CERN contribute in some way to the further development by the firm of the technology which has just been developed during the contract? And if the answer is yes, how and through what means? Another important factor for facilitating technology transfer is represented by the existence of national institutes and centres (like RAL in the UK and INFN in Italy) which may act as an interface between CERN and industry, as has been pointed out by the talks of Dr. Reed and Dr. Ferrero.

On the basis of these first points we can open the discussion on these problems of purchasing, with the aim of giving some clear indications to the management.
**Technology transfer through purchase**

**Round-table discussion**

**Dr. H. Wenninger:** It is certainly important that you give us the advice we need. You may be assured of the management commitment to implement, with the Finance Committee and Council, the recommendations applicable to CERN's know-how.

**Dr. L. Behau:** I feel that more or less all participants already belong to a dense network of CERN and I think that the expectation of this Workshop is to include others. We agreed to some first steps, to include FhG in technology transfer from CERN. My recommendation is really to think, about participating or in integrating potential users during the development phase. To integrate them in the very first phase so that they can decide where they deviate into other ways. A positive approach of ESA is that they contacted the European Association of Contract Research Organisations, and that goes in line with what Mr. Miège yesterday told us, not to get in contact with industry only, but to approach more the Contract Research organizations.

**Dr. J. Berny:** Technoparc of Pays de Gex. I would just like to give you a feeling of people working and living close to CERN for 20 years since I was the manager of a very small company in the laser field.

Although we are in the Technoparc so close to CERN, sometimes it seems so far. What I want to say is 'The shoemaker's wife is always the worst shod'; well I think that we must come back to the main topics of the discussion of these two days. The first thing is that one does not discuss transfer of technology for transfer of technology. CERN in my opinion is a laboratory dealing with the building of large equipment for physics and making sure that CERN develops, imagines, improves some technology in different fields but is not specifically in charge of transferring it.

So the second thing is: how to transfer technology to SMEs? And SMEs, you must remember, are 75% of the total turnover and employment in Europe. So I think that one way for technology transfer may be: why not open the doors of CERN (and the other laboratories) to SMEs?

And one target for that could be, as in laser physics, to increase the cross section between partners in technological fields. I mean: to multiply the opportunities of contacts between physicists and SME managers through meetings, courses, seminars in order to multiply the number of meetings among two different populations of the economical field.

**Dr. E. Chiaveri:** I would like to stress one point that you have touched upon, and that is the follow-up after the transfer of technology. In my experience, after the transfer of technology on the superconducting cavities, there is now a company who asks CERN to have a collaboration, and to have a collaboration from the start of the project in design, in development, measurements, and also in following the company in future projects. But companies cannot move into this business if CERN is not helping them.

**Dr. H. Wenninger:** technology transfer in itself is not the issue. The issue is that there are some fields which need that technology, there are other markets to be found and industry, who wants to open this technology to other markets, is asking for help to continue to benefit from CERN.

**Mr. J. Rootes:** I did not want to be too pessimistic, but I thought you probably wanted some talk-provoking stuff rather than sales talk. A couple of things I did not mention: I very much hope that in fact CERN does go ahead with some initiative. In some of the projects you have got obviously there is a lot of enabling technology being developed. It is very difficult to establish relationships with small companies and other industries. One of the ways that ESA's programme has tried is cross-sector workshops, focused workshops on specialists' technologies in the oil sector and the automotive sector.
**Technology transfer through purchase**

**Round-table discussion**

**DR. H. WENNINGER:** Once more, I would like to recall one of the points which was mentioned by our chairman. CERN and its partners in the countries: the national labs, the universities. Crystal Clear was an example where we see how the follow-up of technology transfer is not left to CERN but taken up actively in this collaboration by local universities or institutions. In fact we have in Italy a structure that helps, it is also for our Member States to see which structure can help.

**DR. J.-P. HUSSON:** At this point, we have heard several special wordings. There is a basic definition to adopt for CERN by its structure to define what could be the best technology transfer mechanism for CERN. And not only by definition, it is mainly internally that things have to be put on the table.

**DR. R.F. HEYN:** I would like to put a rather provocative question to the last speaker, because when Carlo Wyss made an excellent presentation — and I say excellent because it is fantastic how he has reduced many hundred pieces of paper into his very few slides — when he presented our procedures, I saw J.-P. Husson really getting into 'trances'. I would like to know why. I have personally been working for eight years on the CERN management side with much less complex rules and I thought that was already a headache every second month. Jean-Pierre, would you be kind enough to explain why you were making these gestures.

**DR. J.-P. HUSSON:** My 'trances', I am sorry, were they so extraordinary to be seen? But actually, to be very serious, you have a lot of international mechanisms involving industry with a lot of variations and variants with contracts and so on. What I have seen this morning is probably, at least like it was contracted, a very difficult scheme. You see the criticisms which have been made and addressed to national contracts, to European Community contracts, to Parliament contracts. There, the ultimate scheme we have seen for companies is very different from other international institutions. And these differences may lead to a kind of fortress and club of users who know how to deal with this, and are out of the scope for other matters.

**MR. E. PETER:** The market at the moment requires all companies to have a very lean organization to cut down costs in all fields. And you also have to cut down sources for R&D. So more and more this part is cut down to a level which is needed for the running potential. This is why the supplier cannot work on separate projects which need too much manpower in R&D.

**DR. B. FERRARIO:** Some general considerations concerning technology transfer as seen by a company. A company has a mission, has a market to serve, and has a technology to help the company to serve this market. So normally this technology is developed inside the company for various reasons, but certainly for one important reason which is the protection of intellectual property. So companies tend to spend money when they are sure to obtain results which can be protected, patents, etc. And sometimes the complications in collaborations are such that the company decides not to go further. So, I think this issue concerning the way the technology is really transferred is very important. It is different if the transfer happens in different ways, e.g. by motivating a company to improve its technology.

**DR. H. WENNINGER:** I think this also refers to the fact that we need professional help to define these rules. This was mentioned by many colleagues here today.
Mr. R. Miège: I tried, while the discussion was going on, to list a number of practical suggestions which were made over the two days. I will, if you allow me, list them. First a preliminary remark: one has to differentiate between the different routes for technology transfer and the different targets. Transferring technology through people means different targets and different tools than transferring technology through purchasing. I think the latter is probably the easiest and the most successful way so far for CERN, because CERN is a very demanding customer.

What were the ideas that have been mentioned?

- A lot of former staff of CERN hold important positions. They can be regrouped in a club which can then be instrumental in publicising results and activities.

- The idea was expressed also of industrial clubs. Why not an industrial club in the technologies which CERN masters, like vacuum technologies and where CERN could be a natural focal point.

- Why not incentives for staff.

- Publications to sensitize staff on patenting, on IPR.

- Systematic training of staff and introducing an option for a course on entrepreneurship for the PhD students here at CERN, in collaboration with the local business schools.

If you want to reach out to the wider world, probably you have to resort to optimize the use of relay organizations such as contract research organizations or other national correspondents.

Two other suggestions which were made: the need to reinforce and to structure your internal technology transfer and related areas. So, in other words, setting up a dedicated unit. And finally a communication plan, a PR exercise based on the successes that CERN has had in transferring technology to end-products.

Prof. J. Rourri: A couple of things call for a general comment. One is the question of fair financial return to member countries which is raised often in European research funding. Industry also has to face questions like is there going to be a big order or is there going to be an order at all. It is a difficult thing to maintain competence in areas where there is not a constant flux of projects. Big companies could use their best people to design complex devices, but they do not want to do it because they may have only one or a few deliveries. Even for big companies but much more for the small companies, there is a high threshold of entering the world of CERN because people here talk about hadrons, leptons, quarks, and so on. There is a need to have an organization which translates CERN requirements into industrial needs, such as steel, cables and computers. It is difficult for CERN to reach SMEs in particular. There is thus an important role for an intermediary such as the Cerntech Company created with good results in Finland.

Similar questions also emerge when discussing other large projects, such as ITER costing several billion dollars. It is clear that the last thing you are able to do is to collect all funds and then start ordering components and technology. Everybody wants to make in-kind contributions. There are also cost-level differences, which can be balanced by reference design for in-kind contributions. This is one way to achieve a fair share. This approach is also used by CERN when detectors are built by existing labs in the member countries. We need also to balance the question of a fair return with the need to achieve the best technology available at the lowest cost.
DR. K. HÜBNER: I would like to give some additional information on the useful suggestions by Mr. Miège. Your second point was an industrial club in one of our leading technologies areas. In a certain sense we have tried to do this. Dr. Lefebvre yesterday talked to you about the series of European accelerator conferences which were really initiated here. We have two other areas which have not been mentioned here and where CERN has made quite some effort: there is another series of meetings between industry, universities and specialists, on the European level, that is in the field of power supplies and cryogenics. These meetings have a strong component of technology transfer through exchange of ideas and informations. They are organized together with professional organizations of the relevant industry.

MR. F. BOURGEOIS: I just would like to make one comment: I can see both from my previous activities in electronics, and today with my new activities, that CERN's structures can be very cryptic for industries and that partners from industry have often difficulties to understand the way we operate: where to find the good contacts, etc. In my view, this has to be improved.

DR. G. FERRERO: I would like to add another thing to what Prof. Routti said. Why does CERN start new technologies? Because it has a need for the product for a new experiment, not for other reasons. And why does CERN need industry? Because CERN cannot make this particular product. But why should industry pay to help CERN? There is another reflection: yesterday one of our colleagues presented a slide in which it was said that 300 companies had asked a finance company the funding for the study of new technologies, under the assumption that such funding should be recovered by selling the new products. It should be studied how much will be the economic return of a new technology for a company in order to make this onerous transfer of technology attractive.

DR. H. WENNINGER: I think I have to stress that we are very grateful that you came here to help us to shape our opinions. I am asked by our DG to give an overall report to our Council in December, which means I have to work on your recordings in order to get the essential messages out. But some of the summaries at the end of the discussion include lots of the points I can transmit to the Council and the Finance Committee. I think the best way is in fact as you said: we have now to go forward and look for a practical solution and help to give CERN what it needs, industry partners what they need, but also to help CERN not to forget its obligations to the rest of Europe. And this includes also this question of how one can exploit the technological potential of CERN.
Technology transfer through purchase

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