Joint German-OECD Conference

Benchmarking Industry-Science Relationships

Proceedings of the Joint German – OECD Conference held in Berlin, October 16-17, 2000
Table of Contents

| I | Introduction | 5 |
| II | Managing and commercialising know-how and core competencies of universities and public research institutions | 8 |
| III | Innovative instruments for joint value creation at the industry-science interface | 13 |
| IV | Fostering the creation of new industries and economic renewal: regional and sectoral approaches | 16 |
| V | Industry-science relationships in the context of globalisation | 20 |
| VI | Meeting the global demand for skills and mobility | 24 |
| VII | Evaluating industry-science relationships | 29 |
| VIII | List of speakers, chairs and rapporteurs at the Joint German-OECD Conference “Benchmarking Industry-Science Relationships” | 33 |
Relevant literature:
The following two studies provide you with an excellent overview of the actual analysis in the field of knowledge and technology transfer on an international and German level:


→ Knowledge and Technology Transfer in Germany. U. Schmoch, G. Licht, M. Reinhard (eds.), study commissioned by the German Ministry for Education and Research, Fraunhofer IRB Verlag, 2000, ISBN 3-8167-5600-x.

Contributions of workshop participants can be obtained from the German Federal Ministry of Education and Research, contact: e-mail: Claudia.Seltmann@bmbf.bund.de
Germany’s Federal Minister of Education and Research Edelgard Bulmahn and the Deputy Secretary-General of the Organisation for Economic Co-operation and Development Herwig Schlögl, hosted a two-day joint conference in Berlin on “Benchmarking Industry-Science Relationships” on 16-17 October. Across the world, governments are recognising the opportunities for innovation and growth from stronger interactions between industry, universities and public research institutions. At Berlin, the OECD and the German Federal Ministry of Education and Research brought together 400 stakeholders from industry, public research, universities as well as civil society to discuss what policies and incentives must be put in place to yield economic benefits from collaboration and what measures and rules are needed to safeguard public investments in research for the well-being of society.

The German Federal Government and the Organisation for Economic Co-operation and Development (OECD) wish to express their gratefulness to all speakers, chairs, rapporteurs and participants who made this conference an outstanding success and a benchmark for future events.

Discussion in the Conference centred around three main questions: How can the public research sector adapt to the emerging entrepreneurial model of research and innovation? How can the stakeholders – governments, public research institutions and industry — ensure that the knowledge that results from collaboration contributes to both economic and societal objectives? How can governments, universities and industry grow the human capital necessary for sustaining research and innovation in a context of increasing global competition for talent?

The Conference showed that OECD countries are at different stages in tackling these challenges. Countries in Europe and in the Asia/Pacific region are emulating successful practices and reforming regulations and creating incentives. The United States, which has gone furthest in bringing industry and science together over the past two decades, faces new challenges related to managing the risk of conflict between the missions of the different stakeholders and the exploitation of intellectual property rights from publicly-funded research. Among the participants there was broad agreement on the following:

→ Industry-science relationships are a pillar of the “new economy”. The exceptional economic performance of the United States in recent years underscores the role of efficient interactions between business and public research in transforming knowledge into innovation, which is a key driver of economic growth. Strong relations between business and universities are also critical for countries to be able to attract and retain research “talent”.

→ Research and commercialisation goals are not only compatible but can re-enforce one another. Countries such as Germany, the United Kingdom, Finland, Australia and France have made recent progress in achieving greater commercialisation from public research but many other countries continue to lag in reforming rules and creating incentives for commercialisation.
There is also no single model for commercialising research but common rules are needed. Publicly funded research organisations (universities and public laboratories) and industry are best placed to determine how in practice their collaboration can be enhanced. Governments have the responsibility for setting the basic rules that reflect the public interest but provide the right incentives to both firms and public researchers and organisations.

Despite international differences in the organisation and intensity of industry-science relationships, the Conference identified good practices and highlighted priorities for action for all countries. To balance opportunities and risks, conference participants agreed that policy action is especially important in six areas.

1. Ensuring appropriate intellectual property rights frameworks. Governments must establish clear rules and guidelines with regard to the intellectual property resulting from publicly funded research while granting sufficient autonomy to research institutions. A good practice is to grant intellectual property rights to the performing research organisation while ensuring that individual researchers or research teams can share in the rewards. Globalisation of research accentuates the need for additional efforts to harmonise IPRs regimes and practices at international level.

2. Safeguarding public knowledge. Setting clear rules about IPRs is key but not sufficient in order to achieve a balance between commercial aims and the research and teaching missions of public research institutions. Governments must ensure sufficient public access to knowledge from publicly funded research. It must also acknowledge the risks to the research and innovation system that may result if the IP protection granted is too strong. Finally, ethical guidelines for and by public research institutions are necessary to prevent or resolve conflicts of interest among the institutions and researchers involved in collaboration with industry.

3. Promoting the participation of smaller firms. Young technology-based firms play a key role in linking science to markets. Governments rightly attach priority to encouraging spin-offs from public research to stimulate innovation. Spin-offs fill the gap between research results and new innovative products and services. They are also a tool for universities to broadly license technology. But there is also a case for public support and incentives to existing SMEs and especially those in mature industries in order to help them link up with the science base and enhance innovation capacity.

4. Attracting and retaining human resources. Strong demand for highly skilled personnel increasingly extends across borders, raising concern of a “brain drain” in some countries as the loss of one or two key individuals can be undermine research capabilities. For companies and research institutions, keeping talent requires investments in in-house training, career growth potential as well as excellent research working conditions. To attract students at university, graduate pro-
grammes must better integrate interdisciplinarity and contacts with industry in training and research. For governments, removing barriers and disincentives to mobility and flexibility in research employment are also essential.

→ Improving the evaluation of research. Evaluation of publicly funded research must evolve in response to the considerable expansion of the commercialisation activities of universities and public research institutes, and evaluation criteria must take into account that excellence in research and training of graduates has become, at least in some disciplines, more tied to applications in industry. The evaluation of researchers of many public institutions should be reformed to give more recognition of their contribution to commercialisation efforts. Generally, governments lack information and tools to monitor industry-science relationships and evaluate their efficiency. In this area national initiatives should be complemented by further efforts at international level to develop benchmarking indicators and methodologies.

→ Responding to globalisation. The accelerating internationalisation of large firms’ R&D activities, as well as increased global competition to attract entrepreneurs, research talent and venture capital, challenge national policies to promote industry-science relationships. On the one hand, the participation of foreign firms to national programmes is often more than ever the key to their success. On the other, national research institutes and universities must be encouraged to internationalise their linkages with industry.
## Managing and commercialising know-how and core competencies of universities and public research institutions

| Chair: | Thomas von Rüden, Chief Scientific Officer, MorphoSys AG, Germany |
| Rapporteur: | Eyal Press, Journalist and Research Fellow at the Open Society Institute, New York, USA |

### Part 1:

**The changing roles of universities and public research institutions in the innovation process**

- Demonstrating the benefits of industry-science linkages:
  - Vicki Sara, Chair, Australian Research Council

- Balancing excellence in research and education with commercial objectives:
  - Achim Mehlhorn, Rector, Dresden University of Technology, Germany

- Safeguarding the freedom of research and the broad diffusion of knowledge:
  - Mildred Cho, Senior Research Fellow, Stanford Centre for Biomedical Ethics, USA

- Getting it right: frameworks for encouraging co-operation between science and industry:
  - Jacques Serris, Deputy Director for Technology, Ministry of Research, France

### Part 2:

**Successful national approaches to joint value creation at the industry-science interface**

- Improving framework conditions for industry-science co-operations - the European perspective:
  - Peter Löwe, Innovation Policy Unit, Directorate General Enterprise, European Commission;
  - David Brown, Arthur D. Little International Inc.

- National frameworks for encouraging co-operation between science and industry: the case of Israel:
  - Baruch Raz, Science Counsellor Embassy of Israel, U.K.

- National frameworks for encouraging co-operation between science and industry: the case of Japan:
  - Fumio Kodama, Professor of Science and Technology Policy, University of Tokyo, Japan

- Successful US models of organising the industry-science interface:
  - C. Kumar N. Patel, Professor of Physics, University of California, Los Angeles, USA
The workshop aimed to address three central questions:

→ How can we balance the commitment to excellence in public research with the delivery of economic benefits?
→ How should industry-science relations be organised at both the national and regional level?
→ What are the tensions that can arise between industry and science, and how can these tensions be managed?

There was consensus among the speakers and participants that in order for industry-science partnerships to work; these partnerships must be arranged in a win-win manner, so that both sides benefit. There was also consensus that the key to successful innovation in the new economy is the flow of knowledge, skills and people between different sectors (the private sector, universities, research institutes), and that facilitating these links requires concrete steps by government, universities and industry.

The role of government

Among the key steps that speakers proposed governments should take to promote knowledge transfer and build industry-science relations were:

→ Promoting Public-Private Partnerships: numerous countries have recently launched initiatives to foster partnerships in targeted areas that are designed to fuel innovation. While policy-makers must play an active role in fostering such partnerships, speakers emphasised that the key to success is allowing the partners, not government, to set the priorities.

→ Building Venture Capital Funds: government must do more than simply “get out of the way” to encourage investment: positive action is needed to create tax incentives in order to encourage private sector investments in research. As Baruch Raz, Science Counsellor at the Israeli Embassy in the U.K., pointed out, “good intentions without capital doesn’t work.”

→ Fostering Regional Concentrations: the most successful industry-science partnerships involve links between universities and a cluster of local industries. This ensures that there is a regular flow of information and contact between both sides, and that such partnerships fuel economic growth at the local level.

→ Changing Laws Governing Universities: recognising that innovation is often a function of the incentive structure created by national laws, various countries are changing their laws to allow universities greater flexibility in forging partnerships with industry. France, for example, recently passed an “Innovation & Research Act” which allows researchers to create businesses to promote their work, become shareholders, and serve as boards of directors in companies.

→ Raising Public Awareness: governments must take active steps to highlight the benefits of investing in research and forging industry-science relations.

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In addition to these steps at the national level, several speakers highlighted steps that need to be taken at the international level, including:

- **Harmonising the International Patent System**: far too much time is wasted attempting to work out the details and differences in the patenting and licensing policies in different countries. Creating uniform standards would greatly reduce red-tape.

- **Benchmarking Between Countries**: international goals are needed to measure the success of different tax and innovation policies, and to facilitate peer reviews that can help nations learn from one another. As Peter Löwe of the European Commission noted, national goals are not sufficient: international comparisons are needed.

### The role of universities and research institutes

The modern university’s central challenge is to balance the abstract search for truth with the creation of practical benefits for society. Speakers highlighted numerous steps that universities can take to fulfil this objective without sacrificing their traditional mission.

- **Changing The Culture of the University**: because relations with industry and applied research are often seen as outside the mission of the university, changing the culture of the university requires highlighting the benefits of forging relations with industry. These benefits include: (1) new sources of funding; (2) new opportunities for graduates; (3) new directions for research in some fields.

- **Balancing Excellence in Theory with Excellence in Practice**: the modern university draws its excellence and reputation from more than just abstract intellectual achievements. Universities should not forsake their traditional mission of pursuing “knowledge for knowledge’s sake,” but at the same time space must be created for innovative research in applied science.

- **Creating Comprehensively Educated Students**: in the new economy skills are often less important than innovative thinking: the most successful students will have a well-rounded education that enables them to cross-disciplinary boundaries. In addition, universities must develop programmes to help students learn about other parts of the world, which is increasingly essential in the global economy.

- **Working With Rather Than Against Faculty**: various panellists noted that while some professors want to pursue entrepreneurial activities, others do not. It is important to allow for flexibility, while creating positive incentives for those professors who see a value to forging ties with industry.

- **Working Within the Confines of National Law**: universities should not attempt to circumvent national laws in order to pursue links with industry. If the national law is too restrictive, researchers must work with policy-makers to change the framework of the laws.
The role of governments

Industry leaders would like to accelerate the translation of research findings into practical results, but the challenge for business is to respect the different rules and norms that apply at universities and research institutes. Key points raised by speakers included:

→ Thinking Beyond Short-Term Programmes & Goals: industry must appreciate that most research performed at the university takes years to develop into practical results, and that science is inherently unpredictable. The benefits for industry will usually not be immediate.

→ Fostering Openness and Co-operation on Matters of Intellectual Property: while industry has a right to stake proprietary claims to research results and intellectual property that is privately-funded, it is important to maintain public access to the results of publicly-funded databases.

→ Promoting Mutual Respect Between Cultures: both sides must respect each other’s differences, and appreciate what they stand to gain from working together. Industry can help scientists by bringing ideas to the marketplace and providing expertise in marketing, manufacturing, engineering and service. At the same time, industry can benefit from: (1) access to new ideas generated at universities and research institutes; (2) access to graduates; (3) access to research laboratories and databases.

Managing tensions and conflicts of interest

The growth of industry-science relations raises a host of tensions that must be addressed and managed in order to maintain public support and trust. The key issues include:

→ Managing Conflicts of Interest: more and more researchers have direct financial ties to the companies sponsoring their work, and studies show that industry-funding can bias the results of research. Mildred Cho of Stanford University’s Centre on Biomedical Ethics, for example, has found that 98% of papers based on industry-sponsored research reflected favourably on the drugs being examined, compared to 79% of non-industry funded studies. Financial ties between researchers and companies must be publicly disclosed, and governments should create guidelines to ensure the integrity of science. (In the United States, for example, the federal government is currently reviewing rules that govern clinical trials involving human subjects, where conflicts-of-interest have resulted in lawsuits and accusations of misconduct).

→ Balancing the Need for Openness with Proprietary Concerns: the need to file for patents requires that some research results be kept secret for a certain period of time. However, proprietary restrictions should not lead to unreasonably lengthy delays on publication. At the same time, public access should be maintained to databases that have been publicly funded.
→ Balancing Applied Research & Basic Research: nations must work to foster applied research with short-term, practical benefits. But nations will suffer in the long-term if space is not preserved for basic, non-directed research, whose benefits often surface years (or even generations) later.

There was general agreement among speakers, panellists and audience members that in the new economy, economic growth and development will rely increasingly on investment in science and successful knowledge transfer. Leaders in government, the research universities and the private sector can work together to improve linkages, foster innovation and help bring ideas to the marketplace. All sides must remember that innovation is not primarily about technology: it is about people, culture and communication.

But as various speakers emphasised, while there is widespread agreement on the need for greater linkages between industry and science, there is no single formula for success. Because of differences in national cultures and different laws that apply in various countries, a one-size-fits-all approach will not work. Open co-ordination between the various countries of the OECD is important not to create a single standard that should be adopted by all countries, but to highlight best practices and help countries learn from one another. The key challenge is for government to enable and facilitate innovation; while ensuring that there is a spirit of co-operation and mutual respect between the partners in industry-science relations.
### III Innovative instruments for joint value creation at the industry-science interface

**Chair:** Luke Georghiou, Executive Director PREST, University of Manchester, U.K.

**Rapporteur:** Phillipe Mustar, Centre for the Study of Innovation, Ecole nationale supérieure des mines de Paris, France

#### Part 1: Intellectual property management, marketing and information platforms

New tools for optimising the transfer, sharing and joint generation of knowledge: Luke Georghiou, Executive Director PREST, University of Manchester, U.K.

IPR management: licensing – privatising public knowledge: Bernhard Hertel, CEO, Garching Innovation GmbH, Germany

Marketing the know-how of universities: Janet Scholz, Member Executive Board, Association of University Technology Managers, USA

Launching a successful start-up: key success factors and the role of financing: Karl-Heinz Schmelig, Investment Manager, 3i Deutschland, Germany

Conceptual framework for cyclic interaction at the industry-science interface, theoretical foundations and implementation examples: A.J. Berkhout, Vice-President Research, Member of the Board, Delft University

#### Part 2: Making it happen - financing successful implementation

New instruments for financing spin-offs and industry-science co-operations: Michael Bornmann, Director, Kreditanstalt für Wiederaufbau, Germany

Creating a platform for enhanced industry-science relationships: Adrian Paterson, Vice President Technology and Chief Information Officer from the Council for Scientific and Industrial Research (CSTR), University of Pretoria, South Africa

New approaches for SMEs: finding the right research institution and co-operating efficiently: Markus Koskenlinna, Member group of Executive Directors, National Technology Agency (TEKES), Finland

Key elements and pitfalls in promoting spin-offs from a public research institution: Laurent Kott, Vice-President for Technology Transfer, National Institute for Computer Science and Control (INRIA), France

Launching a successful start-up: key success factors and the role of financing: Marc Clement, Merlin Biosciences
For a long time public policies have considered that universities and public research institutes were a kind of reservoir in which it was possible to fish for new ideas and new knowledge. The presentations and the debates in the workshop showed that this view of public research is changing. The key words of the workshop were interactions, partnerships, alliances, co-operation, and networks. The workshop addressed three main groups of issues.

Policies and mechanisms of industry-science relationships

These relationships can take many forms (research contracts, joint research programmes, university patenting and licensing, spin-offs) and the current policy focus on spin-offs and licensing should not overshadow other important mechanisms of interaction. The workshop reached three main conclusions:

→ Industry-science relationships do not develop spontaneously. Policy frameworks play a key role, particularly at the local level where policies have the strongest impact and can reach all actors, especially SMEs.

→ Policies can use a wide range of instruments (technology centres, technology transfer bureau, technology hub, public agencies, incubators, university-owned companies, seed capital funds, technology licensing offices). But these instruments are useful only if the actors (universities and the public research institutions) have a clear strategy.

→ There is not “one best way”. A mechanism of interaction can be very efficient in one country, and not in another. Even within the same country, it can one in some universities, but not in others which have a different culture. It can be well suited for some research areas, such as biotechnology, but not for others like software or engineering know-how.

Skills needed in the public sector to manage relationships with industry

Publicly funded research institutions need to invest in the management of their relationships with industry, provided that only a very small number of patents, licenses, or spin-offs will become significant sources of funding.

→ The most important investment is in people (liaison officers, patenting managers, incubators managers) that are capable of evaluating the technologies, identifying the markets, cultivating excellent industry/university relations and, last but not least, coping with possible conflicts of interest.

→ Whether public research institutions should internalise commercialisation activities or rely on outside competent individuals or organisations, depends on their size. But the creation of mixed management committees comprising universities staff members, academics, industrialists, and venture capitalists seems to be generally advisable. Forming open networks of competencies should be the rule.

* Centre for the Study of Innovation, Ecole nationale supérieure des mines de Paris, France
**Spin-off formation**

In most countries the generation of spin-offs is a rather new mission for public research institutions and universities. Workshop participants agreed on the following:

→ Spin-off firms are a particularly powerful mechanism to transfer research results and to create permanent links between publicly funded research organisation and the markets, particularly at the regional level.

→ Public policy must take into account the diversity of spin-offs. Some are created by students, and others by university professors. Some are set up on the basis of a university patent, while others are only based on the transfer of tacit knowledge. Some spin-offs are high growth projects and require large amount of seed financing, whereas others are and will remain small.

→ A large number of financial and non financial instruments can be used to foster spin-off formation, but the involvement of venture capital is key to success since it does not only provide money but also active management support based on marketing, business and financing know-how.
### IV  Fostering the creation of new industries and economic renewal: regional and sectoral approaches

| Chair: | Guiseppe Biorci, Advisor Ministry of Universities, Research, Science and Technology (MURST), Italy |
| Rapporteur: | Theo Roelandt, Head Research & Development; DG Industry & Services, Dutch Ministry of Economic Affairs, Netherlands |

#### Part 1: Fostering new industries

- Lessons learned from innovation policy approaches at regional levels:
  - Frieder Meyer-Krahmer, Director, Fraunhofer Institute for Systems and Innovation Research (ISI), Germany

- The strategic role of science in building a successful regional cluster:
  - Heather Munroe-Blum, Vice President Research, University of Toronto, Canada

- Industry-science relationships in high-tech sectors: lessons from Europe and North America:
  - Christoph Büchtemann, Director, Centre for Research on Innovation and Society, Germany

- Government policy for promoting new growth industries:
  - Moon Seob Youn/Yong Soo Kwon, Senior Research Fellows, Science and Technology Policy Institute, Korea

#### Part 2: Creating momentum to rejuvenate maturing sectors

- Revitalising the fish farming sector through science - the case of Norway:
  - Viggo Halseth, Director Marketing and Product Development, Nutreco Aquaculture Research Centre, Norway

- Bringing new momentum to the automotive industry - the case of Saxony:
  - Volkmann Vogel, Manager “Automotive Supplier Network Saxony 2005”, Ministry of Employment and Economic Affairs, Saxony, Germany

- Promotion schemes for co-operation between industry and public research in knowledge based industries for long-term strategic research:
  - Hiroshi Watanabe, Director for Research Co-ordination and Planning Office, National Institute for Advanced Interdisciplinary Research, Japan
Since the 1980s collaboration between science and industry is one of the core elements of innovation policies of any country. There must have been a conference like this during the 80’s as the most common policy solution for bridging the gap between industry and science was to initiate intermediary organisations like technology transfer agencies. These bridging institutions tried to bridge the gap between curiosity driven academic researchers interested in new concepts and ideas on the one hand and the goal-oriented product developers in industry on the other. We had a very lively discussion on the role of intermediary organisation.

Nowadays, innovation is seen as a social and interactive process with direct interactions between the various actors in the innovation system and value chains. Regional approximity might facilitate that process and what is really important in innovation processes is the establishment of stable and long term relationships based on trust and informal relations. For these type of innovation processes intermediary organisations are on the return. That does not mean that they cannot play any role. One of the conclusions of our workshop was that bridging institutions (including consultants) might be important when it comes to the role of SMEs in clusters and innovation.

One general observation in almost all contributions to our workshop was on the role SMEs play in economic renewal and innovation. The major complaint is that quite a substantial part of SMEs has a very weak R&D-capacity. A part of the SMEs does not seem to have a sufficient knowledge base to interact effectively with universities and research organisations. US-speakers called it a “challenge”, EU-speakers interpreted the issue as being a “problem” and the Asian contributions indicated this as a “change” in managerial capabilities of SMEs. Anyway, the conclusion was that intermediary organisations including consultants might play a role in assisting SMEs to use knowledge from universities and to give knowledge a central place in their business strategies.

Broadly speaking in our workshop there were two ways of how to improve industry-science relations:

- Setting up high tech clusters or networks (combining suppliers, manufacturers, researchers, main suppliers, in short the whole value and knowledge chain). A good example is the biotech regions in Germany.
- Promoting university spin-off companies. You all know that the “start-up fever” is going around the world.

How can we get new knowledge and new technologies integrated in the value chains of more traditional industries?

There are three answers to that question:

- Increasing competitive pressure. We had some good examples in our workshop. In the Norwegian Salmon Fishery case the risk of overfishing and the regulation of fishery put much pressure on suppliers as well as manufacturers to innovate. In the automotive cluster in Saxony only those SMEs will survive which can cope with the demands of main sup-

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pliers and original equipment manufacturers. The role of government in this case is quite simple: create a strong and though competition policy.

- Initiating collaborate networks or clusters in which suppliers, researchers, main suppliers and original equipment manufacturers exchange knowledge. This direct interaction between science and industry is very important to keep more traditional industries in touch with new technological developments.

- Education of the workforce at lower levels as well as at high levels. The flow of people having the most recent knowledge is a quite strong mechanism to keep traditional industries in touch with new developments.

Next to setting up high tech clusters / networks (like the biotech programme in Germany) another way to a more efficient industry science relation is the promotion of start up companies at universities.

One conclusion of our workshop was that governments as well as universities can assist students and researchers to start up their own firms (facility sharing, coaching, business education and so on). And university spin off companies might at the same time be the solution for the intellectual property right (IPR) induced collaboration blockage.

**What can governments do to improve the industry-science interface?**

Governments can play a role in launching new networks by providing a platform for knowledge exchange between industry and science in specific areas (ICT, biotech, pharmaceuticals, also in more mature industries). But the government role is always a temporary one. When a cluster or network grows; when things are getting serious, governments have to step aside and leave the initiatives to the free functioning of markets. The main role of government in this field is:

- to facilitate the knowledge exchange in the very beginning of industry/science co-operation

- to invest in a high quality research and education system.

More mature industries, existing networks and clusters, are at risk of being locked in traditional technological trajectories. Traditional industries most of the time focus on their core knowledge base and by doing so, tend to loose contact with new technologies that might be relevant for them. One future challenge for universities, as well as for policy makers, is to find mechanisms to get existing or mature industries locked out of their proven successful knowledge base.

At the end of the workshop one of participants came to me and said: “We now have a view of what might work in this field and it definitely has something to do with creating industry science networks and clusters. But as a matter of fact the discussion has just started and we now have to elaborate more on how these networks are actually functioning and what the role of the players can be.” And I feel he is right. Our workshop has much in common with the very beginning of an innovation process, starting with exchanging the various perspectives and
knowledge. We learned in our workshop that social interaction is the key to success. And also the creation of stable and long term relationships, trust and informal relations do matter. So, it now comes to continuing our dialogue and to find new solutions to the new challenges of the knowledge and network economy.
V Industry-science relationships in the context of globalisation

Chair: Risaburo Nezu, Director, Directorate for Science, Technology and Industry, OECD/Carlo Corsi, General Director, Roma Ricerche, Italy

Rapporteur: Alexander Gerybadze, Chair for International Management, University of Hohenheim, Germany

Part 1: Going global - trends in R&D management

Managing an international knowledge base:
Alain Bravo, Director of Research, Alcatel, France

The National Institutes of Health approach to managing industry-science relationships in a global economy:
Maria Freire, Director, Office Technology Transfer, National Institutes of Health, USA

Integration of Eastern European research into global innovation systems:
Yuri Gleba, CEO Icon Genetics, Director International Institute of Cell Biology, Ukraine Academy of Science

Managing global industry-science relationships: an approach via performance measurement:
Nick Fisher, Chief Research Scientist, CSIRO Australia

Part 2: Building and exploiting global networks

Building technology platforms and global partnerships:
Laurent Gouzenes, ST Microelectronics, France

Building and exploiting a global network around a large public research institution:
Jarl Forsten, Deputy Director General, Technical Research Centre, Finland

Linking national research centres to international expertise:
Thomas Brzustowski, President of the Natural Sciences and Engineering Research Council (NSERC), Canada

New education for a new Economy: Intel’s global initiative:
Chris Parr, Education Marketing Manager, Intel Corp, U.K.
Globalisation strongly affects the process of scientific discovery and industrial innovation in all OECD countries. Nevertheless, industry-science relationships are still embedded in national systems of innovation, and science policy and research institutions often have a national agenda. The workshop aimed to address the following core topics:

→ What is national and what is global in R&D and the innovation enterprise, and how does globalisation affect the relationship between science and industry?

→ What lessons can be learned from best practices and from different models of effective industry-science relationship in OECD countries?

→ How do multinational firms exploit dispersed knowledge pools at the global level and to which extent do they actively participate in industry-science-relationships in different countries or in selected high-tech regions?

→ To which extent are governments and public research institutes themselves becoming “globalised”? Is this seen as beneficial for the national innovation system and what are the side-effects and tensions created through these developments?

**The Perspective of the Global Firm**

Some industries have become truly globalised in terms of R&D and knowledge generation/dissemination: electronics, telecommunication, chemical and pharmaceutical firms. The perspective of the firm was presented by companies from Europe and the United States (i.e. Alcatel, Intel and ST Microelectronics). In addition, the impact of globalisation was also assessed by a technical service organisation (VTT from Finland).

→ Centres-of-Excellence Worldwide: Companies want to achieve world leadership, and industrial research must be carried out with a global perspective. Firms need to maintain centres-of-excellence at several leading locations around the globe. This leads to new managerial challenges, but it also has some profound implications for national as well as regional policies.

→ Intra-Corporate Learning from Best-Practices: Multinational firms are effective mechanisms for the discovery and transfer of best-practices across locations.

→ Externalisation of R&D and Outsourcing Innovation: Most industry participants emphasised the strong role of alliances, and new forms of partnering and outsourcing. Industry-science relationships and, particularly, new forms of arrangements between global firms, top-level universities and research centres are a critical element of global innovation management.

→ Integrated Knowledge Management across countries/business units: Most global firms have redefined their “R&D-Management” and “Innovation Management” practices. The topic of “Knowledge Management” across business units, across areas of expertise as well as across
geographical locations was emphasised. New forms of knowledge management may complement integrated knowledge management within firms across institutions, including at the industry-science interface.

The Perspective of Government Agencies

Five representatives of government agencies and national research institutes from Australia, Canada, Finland, Ukraine and the United States described national experience and new forms of managing the industry-science relationship. Globalisation has affected national programmes and research activities quite differently in each country. Four topics were identified as being important for the countries considered.

→ Basic Research Mandate for “Excellence in Science”: Science policy in the advanced countries still emphasises the strong role of research excellence, basic science and the intent of “pushing the frontier”. This “public good view” of science has partly been undermined by shortsightedness. Increasing global competition with emphasis on time-based management and cycle-time reduction has led to an overemphasis on short-term, application-specific research. Only very few countries were able to maintain a good balance between long-term oriented basic research and industry-oriented applied research.

→ Inward Globalisation: Industry-Science relationships have been affected by the strong R&D related inward FDI activities of large multinational corporations. A major recipient has been the US research system, where firms from Europe and Asia have set up R&D laboratories. According to Marie Freire, (US National Institutes of Health) up to 30% of users of NIH related research results are now foreign firms. The resulting key issue: under which conditions should foreign firms be allowed to participate in national programs, and what are the appropriate mechanisms?

→ Outward Globalisation: Government agencies, national research centres and universities are often supporting the international expansion of national high-tech firms, and they are increasingly involved in international projects themselves. As an example, the major research unit and technical service centre from Finland (VTT) has expanded its activities in foreign countries. Research centres and Universities from several other OECD countries are now globalising their activities (e.g. Fraunhofer Society of Germany, TNO in the Netherlands, MIT in the US).

→ New Mechanisms for Industry-Science relationships: Throughout the 1990s, there have been considerable qualitative changes in the way industry-science relationship were managed. Core issues revolved around intellectual property regimes, public-private partnerships, new ways of managing consortia, as well as stronger performance evaluations. Dr Freire (NIH) outlined how technology transfer mechanisms in the US were revolutionised through legislation during the 1980s, and how intellectual property regimes have affected science-industry relationships in the health and biotech fields. Thomas
Brzustowski (NSERC) described the Canadian model of linking national networks of research centres to international expertise. Finally, Mr. Nick Fisher (CSIRO) presented how performance measurement and the customer value approach have been adapted to the evaluation of research centres in Australia.

National Interests vs. Transnational Knowledge Flows: The “Janus” face of globalisation was addressed by many workshop participants. This is a critical issue in advanced countries like the US and Canada, where there is heavy debate whether taxpayers’ money should be used to support the research activities of foreign firms. NIH programmes are open to foreign-based firms with R&D and manufacturing operations in the US. The NCE programme in Canada is actively supporting foreign partners and is connected to a global network of firms and universities. In both cases, the national research base is very sophisticated and international relationships are reciprocal and of mutual benefit. This may not be the case in countries like Russia, Ukraine or India, where the issues of “brain-drain” and transnational knowledge flows are of increasing concern. Yuri Gleba gave an interesting account of the pros and cons of international technology transfer for a country like Ukraine. The workshop participants discussed appropriate forms of reciprocal exchanges between global corporations and research institutions in Eastern Europe (e.g. new forms of collaboration between research institutes and foreign multinationals, support of Ph.D.s by western companies etc.).

Learning from best practice?

The workshop provided an excellent overview of policies and business practices with regard to industry-science relationships in different countries. Some of these practices are country-specific and firm-specific; some other processes may be more easily transferable, and they may represent effective “role models” that can be adapted in other countries. Candidates for such “benchmarks” are:

→ The US National Institute of Health’s (NIH) policy of running a strong, health-related support program, involving universities, basic research centres, potential users, as well as global pharmaceutical firms.

→ The Canadian Networks of Centres of Excellence (NCE) program has effectively managed 18 consortia involving universities, research centres and business firms, with strong participation of foreign partners.

→ There are good examples of national research units that have become “internationalised” and “privatised” at the same time. An interesting case is VTT from Finland, an organisation that has built up an extensive global network.

→ Alcatel and ST Microelectronics presented interesting examples for intra-corporate best practices in the fields of global centres-of-excellence. Finally, the process of effective management of international human resource management and training was illustrated by the Intel Corporation.
## VI  Meeting the global demand for skills and mobility

| Chair:  | Michael Oborne, Deputy Director, Directorate for Science, Technology and Industry, OECD |
| Rapporteur: | Philip Shapira, Professor of Public Policy, Georgia Institute of Technology, USA |

### Part 1: Strategic human capital management for optimising industry-science interactions

- **Human capital as an engine for innovation and economic growth:** Suzanne Huttner, Director Biotechnology Research and Education Program, University of California, USA

- **Joint projects and partnerships for human capital development:** Brent Sauder, Executive Director, British Columbia Advanced Systems Institute, Canada

- **Encouraging mobility between science and industry:** Edward Robson, Director, Teaching Company Directorate, U.K.

- **Training partnerships between university and industry:** R. Natarajan, Director, Indian Institute of Technology Madras, India

### Part 2: International competition for highly skilled personnel

- **Meeting the demand for a highly skilled staff: experiences from fast growing industries:** Juhani Kuusi, Director, NOKIA Research Centre, Finland

- **International mobility - experiences and lessons learned from EU measures:** Georges Bingen, Head of Unit, Directorate General Research, European Commission

- **Career Patterns of Scientists: changing needs in coming decades:** David Soskice, Director Department Economic Change and Employment, Wissenschaftszentrum Berlin, Germany

- **Attracting and retaining research talent:** Heinz Roggenkemper, Executive VP Development, SAP Labs Inc.
The exchange of real experiences and case studies of how varied regions and industries around the world were addressing skills and mobility needs greatly enriched the discussions that occurred in this workshop. It was reconfirmed that not only was human capital one of the most essential ingredients in innovation, but also that the evolution, growth, and networking of human capital was a dynamic element influencing enterprise, regional, and national competitiveness.

**On the supply side**

- It is apparent that universities and research institutions have to develop to meet new demands from industry in the training of scientists and technologists, as science and technology evolves, new fields develop, and the pace of knowledge growth and innovation accelerates. These institutions are challenged to shift from ivory towers and knowledge factories to networked hubs that are more flexible in interacting with local and global companies, industries, and regions in education, research, and technology transfer. This is a significant task. Institutions, by their nature, often change more slowly than might be hoped for, with many in-built incentives to maintain traditional patterns. In public universities in several countries, research incentives continue to encourage the best doctoral students to focus on incremental topics in traditional fields. However, with committed leadership, universities and other institutions can find ways to change curriculum, research incentives, and orientation to better meet current and emerging skill needs.

**On the demand side**

- Companies and industries are changing too, becoming more networked and engaged in the co-production of new technologies and products. It is essential to understand the interplay within technology intensive industries and the effect this has on the demand for skills and mobility. As case studies from SAP and Nokia confirmed, scientists and technologists increasingly need team skills, business understanding, and flexibility, as well as excellent technical skills. And, they can increasingly expect to be mobile, particularly in the early stages of their careers, moving between companies and in and out of education.

**Intermediaries**

- Can usefully aid the promotion of denser networks between industry and universities. The workshop considered examples of how intermediary organisations in British Columbia and the United Kingdom strengthened research and technology transfer linkages and provide graduate training and career development. These cases illustrated how intermediaries can collate individual industry needs for skills and articulate these more broadly to universities and research organisations, while at the same time facilitating institutional interactions with industry.

* Georgia Institute of Technology, USA
Different countries, regions, universities, and industries evolve their own particular strategies

of research training, influences by the characteristics of innovation systems, institutional relationships, industry structure, history, and culture. For example, the research systems of Germany and Sweden have traditionally rewarded incremental, discipline-based innovation focused towards long-established sectors such as engineering and chemicals. Leading university researchers have close relationships with the major companies in these sectors, encouraging many of the best young advanced researchers to pursue research careers in established fields. In contrast, in the United States, there are more incentives to encourage leading and young researchers to enter emerging fields or new interdisciplinary areas. This has allowed the U.S. to successfully pioneer a series of innovative breakthroughs in life sciences and informatics through research and new venture creation, as demonstrated at the workshop through a case study of research links and high technology business development in California. Some large European companies now conduct their most innovative research in the United States, with their applied development functions focused in Europe. This is a rewarding and profitable strategy for these firms, although it poses challenges for European research systems. Nonetheless, Germany and Sweden have been successful in creating innovative research and venture complexes in biotechnology and information technology, through strategies that moderate the risks for researchers and new companies. In one example, a large Swedish company encourages researchers to spin-out new companies in emerging technologies, but offers a safety net whereby they can return to the parent if those new companies fail. Similarly, new German biotechnology companies have found success not by risky U.S. style leaps for breakthrough innovation, but by emulating the tight customer links and high levels of customisation found in traditional middle-sized machining companies.

Availability of skilled personnel

A reoccurring theme in the workshop was that of critical shortage in the availability of skilled personnel in certain scientific and technical areas, for example in computer science and information technologies. These shortages are experienced in many countries. This raised issues of whether these shortfalls in growing areas of science and technology are short-term and cyclical, or part of a long-term trend that requires expansion in the supply in certain skills areas. Moreover, although universities are under pressure to expand places in growing areas of science and technology, in many countries (including those in Europe and North America) it is not always apparent that there are enough domestic students willing and able to take up these extra places. Efforts to improve the quality, attractiveness, and accessibility of training in science, mathematics, and other preparatory subjects in primary and secondary education (K-12) are needed. Additionally, at the tertiary and post-tertiary
levels, new approaches to training are essential, including the development of online teaching, more flexible institutions, and improved opportunities for continuing education and skills retraining for growth areas.

**Personnel mobility**

The migration of skilled scientists and technologists into countries and regions with high levels of skills shortage and which offer fulfilling opportunities to in-migrants is certain to continue. The United States, in particular, has attracted many foreign-born science and technology students and experienced researchers. The high levels of support offered by U.S. research universities, the leading-edge quality of the research, the openness of most research institutes and companies, the chance to found a company, and availability of work visas are positive attractors for these skilled in-migrants. European countries, by and large, also face skills shortages, but several countries, including Germany, seem less attractive to foreign students and scientists. Moreover, European countries also face the loss of some of their best scientists and technologists to the United States. In specific innovation fields, the movement out of one or two key individuals can be a major blow. Several European countries, again with Germany as a notable example, are pursuing initiatives to become more attractive to scientific migrants. The European Union, as it develops the concept of the European Research Space, also aims to encourage greater mobility within Europe and between non-EU countries and the EU. Several obstacles will need to be overcome to facilitate this, including reducing national administrative barriers to those trained in other countries. Also on the policy agenda: the encouragement of return migration by European scientists living outside Europe and the investment of resources in excellent European research teams, with the aim of keeping them in Europe.

**Scientist migration**

Many migrating scientists and technologists come from developing economies. Typically, this is viewed as a “brain drain” for these countries. However, the workshop learned that in India and other Asian countries, there is a new view that scientists and engineers working overseas represent a “brain bank” that can be drawn upon to encourage innovative development at home. Indeed, over the long run, successful scientists and technologists from some developing economies do establish entrepreneurial ventures in their original home countries or move back to lead research teams. Global technology companies are also establishing research and development centres in some developing countries, such as India or China, to draw on available scientific and technological talent. Such efforts will strengthen innovation clusters in these countries, encouraging new venture developments, which will attract local personnel. At the same time, they also open up new avenues for mobility, as skilled personnel in developing country research centres seek opportunities in the most advanced research units, which remain located in developed countries. In short, it is likely that global mobility flows of scientists and technologists are likely to become more complex and iterative.
Company approaches

The workshop examined the cases of Nokia and SAP, two global technology companies that search worldwide for skills and which have established multiple centres for research and development in both developed and developing countries. It was recognised that the counterpart to global skills search is the intensive internal promotion of in-house training, job rotation, risk-taking, career mapping, continually challenging assignments, and upside growth potential, as well as excellent compensation and working conditions. Such internal features not only encourage highly skilled and mobile young scientists and technologists to stay with these companies, but also help to create the conditions that stimulate innovation and creativity. There are lessons here for other companies that wish to compete for the most talented scientists and technologists, as well as for universities and public research institutes that face competition from leading companies for personnel.
### VII Evaluating industry-science relationships

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<th>John Barber, Director of Technology, Economics, Statistics and Evaluation, Department of Trade and Industry, U.K.</th>
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<td>Giorgio Sirilli, Head of Section, National Research Council (CNR), Italy</td>
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Building innovation indicator frameworks for benchmarking industry-science relationships:  
*Jean Guinet*, Directorate for Science, Technology and Industry, OECD / *Remi Barré*, Director, Observatory for Science and Technology (OST), France

Concepts for measuring and evaluating knowledge and technology transfer:  
*Anthony van Raan*, Universiteit Leiden, Netherlands

Using innovation indicators for assessing the efficiency of industry-science relationships:  
*Diana Hicks*, Research Analyst, CHI Research Inc., USA

Measuring and reporting intangible assets in a European contract research organisation:  
*Günter R. Koch*, Managing Director, Science and Technology, Austrian Research Centre, Austria

#### Part 2: Approaches that work - successful examples

DaimlerChrysler’s collaboration with science – benefits and risks:  
*Horst Soboll*, Director, Technology Policy, DaimlerChrysler, Germany

The viewpoint of industry: what is the commercial partner looking for and how is success measured?:  
*Miclharu Nakamura*, Executive Vice President, R&D Group Hitachi, Ltd., Japan

Incentive systems in evaluation systems of large public research organisations:  
*Jürgen Blum*, Vice-Chairman, Executive Board, German Aerospace Centre, Germany

The viewpoint of science: using performance measures to optimise co-operation with industry in a large public research institution:  
*Abbas Ourmazd*, Director, Institut für Halbleiterphysik Frankfurt (Oder), Germany

The viewpoint of policy analysis: key elements of successful science-industry relationships:  
*Ullrich Schmoch*, Deputy Head Technology Analysis and Innovation Strategies, Fraunhofer Institute for Systems and Innovation Research (ISI), Germany
Issues from various sectors like academia, research agencies, business firms, and international organisations have been discussed in this workshop. Overall, the workshop has addressed many relevant aspects of the measurement of industry-science relationships, but of course not all the ground has been explored and not always convergent views have been expressed.

This summary deals with some of the issues that the rapporteur considers particularly relevant.

The main theme has been how to measure in quantitative terms industry-science relationships: the presentations and the ensuing discussion have provided some answers and insights, which are described below.

→ Data available show that some 10% of firms do have some form of relationship with the science base made up of universities and public research agencies. This is reasonable, as only a limited number of firms are equipped with a research or technological infrastructure able to sustain a dialogue on a common ground of understanding with public research institutions. The great majority of firms innovate through equipment embodying new technologies, consultants, information gathered through clients, fairs, exhibitions, technical activities performed in house. Therefore the issue dealt with in the conference is relevant basically to what can be considered the “tip of the iceberg” of the industrial structure made of the most innovating firms.

→ The relationship between industry and science is definitely important and yields benefits for both partners. The following benefits for industry have been mentioned: commissioning basic research to universities and public research institutions, and concentrate firm efforts on R&D closer to business; improving research speed; accessing diversified knowledge, specially in high-tech areas. The benefits for university are: the possibility to expand sources for research funding; the identification of new research topics relevant to society; the identification of new disciplines to meet social needs; the ability to contribute directly to society; better assessment of R&D results due to external evaluation.

→ Measurement is necessary, but metrics is useless. In other words it is essential that the key aspects of the industry-science interaction are measured and monitored, but these indicators need to be interpreted by expert judgement in a contextual analysis, and a mechanical evaluation may be more dangerous than no evaluation at all. One speaker from industry said that in his company R&D management is basically made on the basis of qualitative assessment of projects and people, and that very little quantitative evaluation is performed. On the other extreme of the spectrum, a speaker has described a system for the reporting intangible assets of a contract research organisation using a battery of some forty indicators with the aim of benchmarking the agency with other similar organisations. Overall, as another speaker has put it, we cannot “measure beauty”, but we have attained

* National Research Council (CNR), Italy
quite interesting and useful results in the measurement of the interaction between industry and science.

→ The human factor is key in the industry-science interaction but it is difficult to be measured. All speakers underscored that trust, motivation, career of qualified personnel plays a key role in such interaction. Institutional and career rigidities represent a major problem in the European public research institutions and hamper a smooth transition from one sector to another as well as the start of spin-off ventures from academia. Some speakers showed a certain optimism towards the future, while others were quite convinced that, even though some changes are being introduced in the careers of researchers in public research institutions, the present structural difficulties in making the overall innovation system (in particular in some European countries) a more satisfactory one will persist.

→ Some presentations have showed that bibliometrics and patents data can provide quite useful insight in measuring industry-science relationships. These data make it possible the measure to what extent patents are linked to publications produced by public research institutions, and therefore to what extent private technology is dependent on public science. For example data show that over the last two decades in the USA there has been a rapid growth in information and health technology patenting and a shift from the East to the West Coast, as well as an increased participation of universities in technology and companies in science and a growth in links between science and technology visible in patent referencing. Scientific papers are also used to build science maps and their evolution over time, and to identify the role played by the various actors – both private and public – in the advancement and application of science.

→ Indicators illustrate some relevant aspects of a complex phenomenon and should be used within the context of an explanatory model. In the area of the interaction between industry and science there are no shared and convincing models and the measurement of relevant dimensions is largely at a very early stage. The problem is even more complicated by the fact that the object of the analysis is changing increasingly fast and theory building needs to come to terms with the need to devise analytical tools to be used for policy purposes – the world may have been changed once more when a plausible theory has been developed and tested. Nevertheless, indicators may be used both as entry-points – when they are subjected to criticism, but at the same time allow to start a disciplined discussion on a particular issue or set of issues – and as end-points – when they provide the required information to address the questions raised by analysts and policy makers.

→ Looking at the availability of indicators, the situation looks contradictory: on the one hand too much information is available and users find it difficult to discriminate between useful and irrelevant information – especially when explanatory theories are weak; on the other hand it is clear that the ability to measure the science-industry rela-
tionships is severely limited by the lack of a satisfactory understanding of the working of the whole mechanism and of the availability of relevant data. In the future it will be necessary to gain more insight on the phenomenon and to gather new data, mostly provided by firms. This raises the issue of the definition of shared measurement concepts, which need to be valid across countries and over time, and which should be used by data providers in firms and public research labs. The problem of the quality of indicators and their appropriate use raises the problem of making any effort to make sure that users of indicators derive from them the correct message and not misinterpret them. This preoccupation refers back to the need of contextualising the data by means of an “educated” evaluation carried out by specialists.

In conclusion, even though we cannot measure “beauty”, a lot of progress has been achieved in measuring various aspects of the science and technology endeavour and its impact. In the case of measuring industry-science relationships we are not starting from scratch: we need to use existing indicators in order to shed more light on this phenomenon as well as to devise new ones in order to answer new questions. We will certainly succeed only partially, but it is always better to learn imperfect lessons rather than nothing.
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<th>Position and Organization</th>
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