Unclassified **DSTI/STP/TIP(97)14/FINAL**

Organisation de Coopération et de Développement Economiques
Organisation for Economic Co-operation and Development

OLIS : 05-May-1998
Dist. : 11-May-1998

English text only

DIRECTORATE FOR SCIENCE, TECHNOLOGY AND INDUSTRY
COMMITTEE FOR SCIENTIFIC AND TECHNOLOGICAL POLICY

DSTI/STP/TIP(97)14/FINAL
Unclassified

Working Group on Innovation and Technology Policy

FACILITATING INTERNATIONAL TECHNOLOGY CO-OPERATION: PROCEEDINGS OF THE SEOUL CONFERENCE (13-14 October 1997)

65115

Document complet disponible sur OLIS dans son format d'origine
Complete document available on OLIS in its original format

English text only

FOREWORD

This document presents the proceedings of the Seoul Conference on Facilitating International Technology Co-operation in a Globalised Knowledge-Based Economy held at the invitation of the Korean Government on 13-14 October 1997. The Conference examined possible barriers to the implementation of the *OECD Principles on Facilitating International Technology Co-operation Involving Enterprises* adopted by the OECD Council in September 1995. The rapid globalisation of industrial research and development, as more and more multinational enterprises invest in research facilities abroad, is causing concern among both home and host governments which may run counter to encouraging technology co-operation. Despite considerable harmonisation of intellectual property rights regimes, there remain differences in patent approaches and procedures which can lead to uncertainties and difficulties for research collaboration at the global level. Other concerns relate to rules regarding participation by foreign firms in government-funded technology programmes and barriers to greater involvement in international technology co-operation by small and medium-sized enterprises. These issues are examined in this document in the form of analytical papers by experts and policy papers by government representatives.

The Seoul Conference and its proceedings are part of the work programme of the Working Group on Innovation and Technology Policy (TIP) of the OECD Committee for Scientific and Technological Policy (CSTP). This document contains: *(1)* a summary of the presentations and discussions by the rapporteur, David Mowery of the United States; *(2)* a summary of the opening remarks made by Sook-Il Kwun, Korean Minister of Science and Technology, and Risaburo Nezu, OECD Director for Science, Technology and Industry; and *(3)* the main Conference presentations.

This document is declassified under the responsibility of the Secretary-General.

TABLE OF CONTENTS

THE ROLE OF GOVERNMENT

(It should be noted that the views expressed in these papers are those of the authors and do not necessarily reflect the views of their organisations, the OECD or its Member countries).

RAPPORTEUR'S SUMMARY

David MOWERY, University of California, United States

Introduction

Globalisation in the knowledge-based economy implies an ever-expanding international flow of technology, scientific knowledge and know-how. The OECD Conference on International Technology Co-operation devoted two days to a consideration of a wide range of issues related to this topic, focusing on the globalisation of research and development, the role of intellectual property rights (IPR) in facilitating or impeding international technology co-operation and the role of governments in facilitating or impeding such co-operation. Both the presentations and general discussion at the conference took the view that international flows of technology and knowledge were both inevitable and desirable, supporting economic growth in nations throughout the global economy and contributing to the development of industrialising economies in Asia and elsewhere. Expanding international flows of technology and knowledge are closely connected to larger trends in the globalisation of other economic activities, such as markets for goods and services and production networks. But the unusual nature of knowledge as an economic good, as well as its central importance in the future development of a global knowledge-based economy, raise special issues that require attention.

Although they covered a diverse set of issues, the presentations and comments of the experts gathered in Seoul addressed common themes. Even in a global economy "without borders", government policies continue to be influential, especially in affecting international knowledge flows and technology co-operation. But the aims and effects of government policies now can be either intensified or frustrated by the actions of private firms. In addition, the formulation and implementation of the innovation policies of national governments in economies that are linked more closely by cross-border flows of technology, knowledge, goods and capital confronts a fundamental tension between the need of democratically elected governments to be accountable to national citizens for the operation and economic benefits of such programmes, and the growing reliance by national firms on foreign partners, foreign markets and foreign suppliers. Indeed, even the most basic question – "what is a national firm?" – has become very difficult to answer in many cases. Moreover, just as the increased integration of capital markets has limited the ability of many OECD governments to pursue sharply divergent economic policies, the development of a truly global "innovation system" appears to be intensifying pressure for harmonization in government policies toward intellectual property, regulatory, tax, research and development, and many other policies. But international demands for such harmonization also contribute to tensions between national autonomy and the achievement of high levels of economic performance. Finally, although the conference's title and this summary report discussed "globalisation" as a general phenomenon, its important economic effects, as well as the effects of many government policies on international technology co-operation, exhibit significant differences among industries. One makes sweeping statements about "industry-wide" trends at one's peril.

Globalisation of R&D

The first session considered the causes and effects of globalisation of R&D. Mr. Dambrine of the OECD Business-Industry Advisory Committee (BIAC), argued that the pace of globalisation had accelerated in recent years, as a result of firms' efforts to exploit scale economies through more rapid penetration of foreign markets. Globalisation also was supported by the more rapid transmission of information among nations and firms made possible by advances in communications and transportation. The globalisation of R&D has been motivated by firms' search for lower costs, fewer regulatory barriers, and access to markets and technology.

Mr. Guile of the Washington Advisory Group presented a different perspective on the process of innovation in a global economy in his discussion of innovation in US small-package delivery firms. Although these firms invest very little in formal R&D programmes, they have been characterised by high levels of innovation during the past decade, relying on the adoption, adaptation, and integration of technologies developed in other sectors, such as advances in portable computers, software, and fleet maintenance, to develop entirely new service offerings. Importantly, the leading US firms have drawn on technologies from sources throughout the industrial world in their innovative efforts. The development of new business services of the sort discussed by Mr. Guile support higher levels of vertical specialisation – rather than developing delivery or logistics capabilities in-house, firms now are able to contract for such services. Such vertical specialisation, especially the extension of these "contract logistics" services to cover global markets, could significantly lower the impediments to SMEs' participation in export markets. Mr. Guile's presentation also underscored an important point concerning the economic benefits from new technologies, noted as well in the recent OECD report on *Technology and Industrial Performance* (1996) – the economic benefits associated with the adoption of new technologies are as large or larger (depending on the sector) as those flowing from the initial development of new technologies.

Mr. Minne of the Netherlands Central Planning Bureau discussed research on the determinants of investment in R&D and physical capital of leading multinational firms in electronics and pharmaceuticals. His empirical results suggested the existence of significant differences among these industries in the extent of interdependence among firms in R&D and physical capital investment decisions. He also pointed out that national government policy makers face a serious dilemma in considering the effects of economic policies on national welfare. Although his results indicate that R&D investment may be less sensitive to fluctuations in firm-level income, and therefore less sensitive to changes in demand-management policies, the results of R&D investment, especially those of multinational enterprises, may not flow to the citizens of these economies.

Two other presentations discussed the experience of individual economies in the globalisation of R&D. As Mr. Beyer of the German Ministry of Education, Science, Research, and Technology noted in his presentation, outward R&D investment by German enterprises has grown significantly during the past decade, raising concerns among German policy makers over the loss of technological competences. Growth in outward R&D investment appears to be linked to increased outward investments by German firms in manufacturing activities, some of which have involved German firms' acquisition of established firms in other OECD economies. Inward R&D investment in Germany from foreign sources also has grown during this period. Nonetheless, policy reforms now are being launched to use government investments in R&D infrastructure to increase the attractiveness of Germany as a destination for inward R&D investment from foreign sources. These reforms include reforms in the German higher education system, as well as steps to increase the share of competitively allocated grants in the R&D budgets of public research laboratories, and efforts to develop decentralised programmes in "competence network development" among the German Länder.

The final presentation by Mr. Lee of the Korean Science and Technology Policy Institute discussed the growth of outward R&D investments by Korean firms. Such investments are only one component of a broader strategy of many Korean firms, largely drawn from the nation's large chaebol, to increase their awareness of and access to scientific and technological developments in other nations, complementing their efforts to strengthen overall innovative capabilities. Korean firms thus far have relied on strategic alliances, acquisitions of foreign firms, and R&D investment to pursue these goals. In most cases, strategic alliances bring together the production expertise of Korean firms with the product technologies of firms in the United States, Japan, and Western Europe, primarily in the electronics and information-technology sectors. Merger and acquisition activities have been similarly focused on Triad economies, and have also been concentrated among the electronics and automotive industries. The foreign R&D laboratories of most Korean firms are small in size, suggesting that their primary function thus far is to serve as "listening posts" or monitors of technological developments in other economies. These R&D investments are also directed mainly toward the United States, Japan, and Western Europe.

Although the R&D systems of the major industrial economies surely are becoming more closely intertwined, and the international dimensions of each OECD Member country's R&D system are assuming greater importance, it is important to avoid generalisations about any single pattern of "globalisation" of R&D activity that fits all OECD Member countries, all industries, or all activities subsumed in the term, "industrial innovation". As Mr. Guile's presentation suggested, many activities that contribute to technological innovation are not captured by national surveys of R&D investment, nor are they apparent in studies of international flows of R&D investment. The publicly available data on international flows in R&D investment also rely on crude characterisations of the "national identity" of multinational enterprises whose ownership may be distributed among several OECD countries. These data therefore carry with them some of the simplistic definitions and anomalies that afflict the development and implementation of national technology policies that affect such multinational enterprises.

Nonetheless, even the imperfect data on international R&D investment flows suggest important differences among individual industries and OECD Member countries. US National Science Foundation data reveal very little growth in total outward R&D investment by US firms, when measured as a share of total industrially-funded R&D investment, since 1981. This share experienced a significant decline during 1981-85, a steady increase through 1992, and a decline during 1992-93. Across the entire time period, the share of industry-financed R&D devoted to foreign R&D increased by less than 5 per cent (National Science Board, 1996). During this period, however, R&D investment in the United States from foreign sources has grown significantly. Measured as a share of national industrially funded R&D, foreign R&D investment in the United States more than doubled during 1980-93, from slightly more than 3 per cent of industry-performed R&D in 1980 to 9.8 per cent in 1993. Outward R&D investment from the United States thus has grown little, if at all, but inward R&D investment has expanded significantly. A portion of this reported increase in inward R&D investment during the 1980s reflects acquisitions of new and established US firms by foreign enterprises – the contribution of mergers and acquisitions to inward R&D investment. Trends in the "internationalisation" of their R&D systems also appear to differ among the OECD Member countries. As Mr. Beyer noted in his presentation, trends in German R&D investment contrast with those in the United States – both inward and outward R&D investment in Germany have grown during the past 15 years. In other countries a significant and increasing share of R&D is funded by sources outside the country including parent companies (OECD, 1997*b*). In Canada, for instance, this share which was 7.4 per cent in 1981 more than doubled by 1995; over the same period, in the United Kingdom it rose from 8.7 per cent to 19 per cent, in France from 7 per cent to 11.2 per cent. In contrast, in Japan this share has remained almost unchanged at the low level of 0.1 per cent.

Trends in overall international flows of industrial R&D spending for individual Member countries also mask wide variation and significant contrasts among individual manufacturing and non-manufacturing industries. According to the National Science Foundation's foreign R&D investment data for the United States, the share of R&D spending allocated to foreign sites declined in the electrical equipment and (presumably non-electrical) machinery industries during 1981-96, while this share in the scientific instruments increased slightly (National Science Board, 1996). The chemicals industry (including pharmaceuticals, a major investor in foreign R&D) and non-manufacturing industry (for which the time series coverage is especially imperfect) both display significant increases in the share of their R&D spending devoted to foreign sites.

According to the above mentioned OECD study (OECD, 1997*b*), the available data on internationalisation of R&D thus points to the presence of contrasting trends and levels among individual industries and among individual OECD Member countries. Thus the share of industrial R&D under foreign majority control between 1991 and 1993 represented 10 per cent in the United States, 32 per cent in Canada, 68 per cent in Ireland, 16 per cent in France and in Germany, 20 per cent in Sweden and only 1.3 per cent in Japan. At the sectoral level, differences can also be observed. In the United States, for example, it is estimated that more than about 30 per cent of the R&D of the American chemical industry (including pharmaceuticals) was carried out by companies under foreign majority control in 1992 whereas the corresponding figure was around 9 per cent in the automobile industry.

Other indicators further suggest that some phases of the innovation process are more internationalised than others. Specifically, MNEs from relatively large economies appear to have broadened their activities in the development and commercialisation of new technologies, while maintaining a considerable "national focus" in their fundamental research and technology-creation activities. The patent data compiled by Patel (1995) suggest that the technology-creation activities of large firms, crudely measured by the site of invention for their US patent applications, are less internationalised than their manufacturing operations, sales, or (in many cases) their R&D (Patel's 1995 work extends previous work by Patel and Pavitt, 1991). The US patenting activity of large firms from the United States, Japan, France, Italy, and Germany during 1985-90 was dominated by domestic inventive activity, based on the reported site of the patented invention – more than 85 per cent of these firms' patents are based on "home-country" inventive activity. For US and Japanese firms, these shares exceeded 90 per cent. Large firms from Belgium, Canada, the Netherlands, Sweden, Switzerland, and the United Kingdom are somewhat less domestically focused in their inventive activity, but with the exception of Belgian and Dutch firms, all of these firms report that more than 50 per cent of their patents are based on inventions from their home countries. Equally interesting is the reported geographic distribution of inventions made outside of their home countries by these firms. Their foreign inventive activities are located primarily in Europe and the United States.

If this measure suggests that technology creation remains "localised", abundant other evidence on the development and exploitation of technology suggests that these activities are more international in scope. Foreign patenting in the US economy has risen significantly as a share of total patenting activity, from 38 per cent in 1978 to almost 45 per cent in 1993. And the growth in "strategic alliances" linking firms from Japan, Western Europe, and the United States is well-known. Most of the trends in R&D internationalisation, however, thus far have been concentrated on the "Triad" economies – Japan, Western Europe, and North America. Although Korean and Taiwanese firms are beginning to develop international R&D operations (focused primarily on technology monitoring, as Mr. Lee's presentation pointed out), their international R&D investments are concentrated in the Triad economies.

The most straightforward explanation for the trends in R&D globalisation extends work by Cantwell (1991, 1995), who emphasizes the use by multinational firms of international R&D strategies to create interfirm and intrafirm networks for the creation and strengthening of firm-specific knowledge and technological capabilities. This view contrasts with the previous view (notably, that of Vernon's celebrated 1966 product-cycle model) of multinational firms' R&D strategies as motivated primarily by their efforts to exploit products developed to serve the market of a high-income economy in foreign markets. Both motives influence international R&D strategies, but the first is likely to grow in importance.

Cantwell and others argue that the acquisition or maintenance of firm-specific technological capabilities relies on extensive contacts with external sources of expertise in both the home and foreign economies. These contacts require either a physical presence or some other sort of novel organisational form, because of the difficulties of transferring technologies through blueprints or conventional contracts. Although advances in communications and information technology may eventually reduce the importance of physical proximity, and thereby limit the growth of offshore R&D investments motivated by the search for access to expertise, technological advance thus far appears to be having the opposite effect. Moreover, the local infrastructure supporting the creation of the ingredients for these competencies may be very concentrated in a specific region, such as the Silicon Valley in California or the biotechnology complex around Boston. As a result, specific sites become centres for specific technological competences and attract considerable investments by multinational firms in R&D and production (because of the need for close links between R&D and other activities).

These influences on cross-national R&D investment and other forms of international interaction in the innovation process resemble the factors that have given rise to high levels of intra-industry trade – the growing returns to specialisation in specific technological activities or competences, some apparent decline in "scope economies" among specific competences (reflected as well in the efforts of US firms to restructure, divest unrelated lines of business and focus on "core competences"), and the increased international dispersion of these competences. As a result, we find firms in industries such as pharmaceuticals seeking to establish R&D centres in "centres of excellence" around the world, even as these R&D centres specialise in certain products of drug therapies. Strategic alliances among firms for the development or manufacture of new products often are based on the effort of participants to combine their complementary technological and other skills.

International flows of R&D investment and other forms of international interaction in the innovation process thus reward national or regional economies for their ability to nurture specific technology-based capabilities, just as other forms of international investment flows tend to reward localities for policies favouring economic stability, property rights, and human capital. This argument has several implications. Even as the nationality of investors in R&D activity within a given locality may become more and more blurred, the importance of "national innovation systems" in supporting the infrastructure and other local capabilities to attract these investments increases significantly, and it is by no means obvious that increased cross-national R&D investment will reduce international or even intranational differences in such localised capabilities and infrastructure (within the United States, for example, California's Silicon Valley remains a dominant centre for R&D in the electronics industry, although it now has very little manufacturing capacity). Secondly, these localised capabilities are developed through path-dependent processes in which both supply and demand factors, as well as history, matter a great deal.

In other words, an expanded version of Vernon's original "product cycle" model of international investment, in which one takes into account the existing supply of technological capabilities in a specific locality as well as the profile of demand, can help explain patterns of international R&D investment in industries such as computer software and multimedia. Nations or markets in which demands for specific types of new products appear first, and technologies for which close interactions between users and producers are critical to the development of new products, are likely to attract R&D investment from around the world, as firms recognise that a presence in such a market is essential to their ability to innovate and compete globally. But greater similarity of tastes and incomes means that new products are likely to be marketed throughout the industrial world shortly after their release, rather than being sold only in the "lead market" for some period of time.

Intellectual property rights

The role of intellectual property rights in facilitating or impeding international technology co-operation was the focus of the next panel. The industrial speakers on this panel and contributors to the general discussion emphasized the importance of strengthening IPR as a way to reduce firms' resort to secrecy as an alternative means to protect their intellectual property. Since they are published upon issue and do not protect intellectual property indefinitely, patents serve to disseminate important technical information and limit inventor monopolies in ways that trade secrecy does not.

Two speakers from the business community revealed a substantial transatlantic consensus among MNEs on the importance of IPRs for the management of global R&D and innovation. Mr. Villella of IBM and the OECD Business-Industry Advisory Committee and Mr. François Sueur of L'Air Liquide emphasized the need for consistency and predictability in the IPR environments of economies in which they seek to develop or to exploit their intellectual property, especially in the enforcement of their intellectual property rights. They recommended that the existing WTO TRIPS agreement be expanded to cover current non-signatory nations, that the agreement be updated to cover new technologies, that long accession periods for developing economies be minimised to the extent appropriate, and that enforcement mechanisms for the TRIPS agreement be strengthened for current signatories. Both speakers also supported the establishment of regional patent offices as a means of reducing costs, improving harmonization, and strengthening IPR regimes.

The failure of the United States to achieve harmonization between its IPR system and those of other industrial nations, notably in pre-issue publication of patent applications and in the continued use of the "first-to-invent" basis for establishing precedence in the United States, also was discussed. Considerable support for a transatlantic agreement, in which US adoption of these changes in its IPR system would result in the institution of a grace period in Western European and Japanese IPR systems, was apparent in the presentations and discussion. Despite this support, however, considerable domestic opposition to such harmonization seems likely to impede its realisation within the United States (see below).

The changing incentives and interests of Korean firms that now are important innovators in several industrial fields, as well as the effects of multilateral and bilateral negotiations on an important component of domestic economic policy, were revealed clearly in the discussion of the changing Korean IPR system by Mr. Kim of the Korean Industrial Property Office. Mr. Kim described a series of significant reforms in Korea's IPR system, including the creation of the Korean Industrial Property Office and the institution of a special court for hearing intellectual property cases. His discussion reveals the influence of globalisation on domestic technology policy convergence. Ms. Callan of the US Council on Foreign Relations discussed the evolution of US IPR policy, focusing on the efforts since the early 1980s by the United States to develop stronger international protection for the intellectual property of US firms. Ms. Callan noted that these US efforts included bilateral, plurilateral, and multilateral initiatives, and contributed to the eventual negotiation of the WTO TRIPS agreement. The US position in IPR was based primarily on policy makers' concern with the inability of US firms to capture the economic returns to their innovations.

The potential impediments created by stronger IPR regimes for some forms of technology collaboration were the focus of the presentation by Mr. Cameron of the University of Manchester, who discussed the complex IPR arrangements associated with recent EU collaborative technology programmes. As Mr. Cameron pointed out, the need to negotiate complex agreements to cover both the disclosure by firms of any intellectual property contributed by them to such collaborative programmes, as well as the requirements for agreements to cover the IPR produced by such programmes, add considerably to the complexity and cost of EU collaborative programmes.

Much remains to be done in the area of IPR harmonization and improvement. As the speakers from US and French MNEs noted, the lack of predictability in standards, enforcement, and the litigation environment for their companies' intellectual property has impeded their global operations. Moreover, the anomalous position of the United States, one of the leading proponents of international harmonization of IPRs, is striking. The United States is alone among the industrial nations in retaining a "first-to-invent" basis for determining inventorship, and US patent applications remain secret until the patent issues, in contrast to policies in Japan and Western Europe. Domestic political opposition to change in these US IPR policies may well prevent full harmonization of the US and other industrial economies' IPR systems. Indeed, the nature and strength of this opposition within the United States, most of which derives from independent inventors and SMEs, illustrates an important point about the economic role of IPR. A strong IPR system often benefits SMEs in emerging sectors, such as biotechnology or software (OECD, 1997*a*). Nevertheless, patents also may be used by established firms to block inventive activity or entry, and large firms have greater resources to pursue patent infringement suits against smaller would-be entrants or competitors (Cohen *et al.*, 1997). Stronger IPR thus is something of a double-edged sword for SMEs in the United States and other industrial economies.

Most of the limited empirical evidence on the importance of formal protection of intellectual property (e.g. through patenting) indicates that the value of patents varies considerably among manufacturing industries. Historically, patents have provided the strongest protection, and have been very valuable, in industries such as pharmaceuticals and in some areas of electronics (see Levin *et al.*, 1987). But surveys of industrial executives suggest that in other industries, patents are of limited significance for realising the returns from intellectual property. As is true of R&D globalisation, these differences in the economic importance of formal IPR mean that the effects of the TRIPS agreement on globalisation and on overall production or job creation are likely to differ among industries.

Partly because of these inter-industry differences, the effects of IPR harmonization on the globalisation of R&D and related activities are difficult to predict. There is surprisingly little empirical evidence to support the widespread faith of policy makers and others in the ability of stronger IPR to facilitate international technology transfer, for example. Moreover, as the earlier discussion of R&D globalisation suggested, the role of IPR will vary considerably among the different phases of the innovation process. Harmonization is likely to have its most powerful effects on the commercial development and exploitation of new technologies in industries for which formal intellectual property protection is economically important. But even in these industries, the international distribution of much R&D activity may not be affected by IPR harmonization.

Finally, the discussion by Mr. Cameron and other conference participants underscores the tension between stronger IPR and other dimensions of publicly funded R&D programmes. Mr. Cameron pointed out that intellectual property concerns have complicated the operation of EU co-operative R&D programmes, often producing lengthy negotiations and delays. Other discussants noted the growing interest of scientists and (especially in the United States) universities in extending intellectual property protection to the results of scientific research, much of which is supported by government funds. The welfare implications of tighter protection for the results of academic or scientific research are not well understood, partly because the policies seeking to extend such protection "upstream" are relatively new. But these policies and their effects merit close scrutiny during the next decade.

IPR is an excellent example of the ways in which the globalisation of economic activity has led governments in the industrialising and newly industrialising economies to undertake initiatives aimed at international harmonization of policies formerly treated as entirely domestic in scope. These pressures for harmonization illustrate the ever-closer links between international trade policies and the domestic technology and other policies of OECD Member countries that have been created by global economic expansion. IPR policy harmonization also impinges on another policy arena that will figure prominently in future trade talks – competition policy. The United States and most OECD Member countries have long incorporated IPR issues into their domestic competition policy statutes and enforcement guidelines. In future negotiations, these complex policy areas, domestic integration of which has often been a demanding task, will be the focus of demands for consistency and predictability in enforcement throughout the industrial economies.

The role of government

The final two sessions of the Seoul conference considered a central challenge of globalisation – the role of government. Mr. Rogers of the European Commission described the European Union's efforts to promote international technology collaboration with firms from non-EU countries. As Mr. Rogers noted in his remarks, international R&D collaboration was one of the defining missions of the post-war trans-European organisations (such as CERN or Euratom) that preceded the Treaty of Rome, and the Commission and member states remain committed to the principle of collaboration with non-member states on the basis of a perception of "mutual benefit". Collaborations with 193 nations have been launched under the auspices of the 4th Framework programme, and the bulk of expenditures on such collaborations now involve collaborations with firms or organisations from the former Soviet Union and the nations of Central Europe.

Mr. Guy of Technopolis discussed the policies, both formal and informal, concerning foreign-firm participation in European Union and member-state publicly supported R&D programmes, in addition to PERVs (non-EU pan-European research ventures, such as EUREKA). Typically, these programmes are closed to firms without any production or R&D operations in the European Union or the relevant member state. For subsidiaries of foreign-owned MNEs with European facilities, however, access to publicly funded R&D programmes in many cases is not restricted. Nevertheless, various informal impediments to participation by such entities are not uncommon. Of particular importance, in view of the emphasis placed by MNEs and other managers on predictability and stability in government policy, was Mr. Guy's emphasis on the lack of transparency and frequent inconsistency in case-by-case decisions on participation in such programmes.

Mr. Quevreux of the French Ministry of Education, Research and Technology described an interesting case of public encouragement for the participation by a foreign firm in publicly supported R&D activities. In 1996, Hoechst, the German chemicals firm, acquired Roussell, a leading French pharmaceuticals firm (and major investor in R&D), as part of an initiative to expand the firm's pharmaceuticals activities, especially in biotechnology-based drug development and production. French policy makers became concerned over the implications of this acquisition for the French technology base when HMR announced that it planned to establish a major corporate biotechnology R&D centre in the United States, rather than in France. These concerns led to a novel collaborative agreement, under the terms of which HMR funded a foundation for the support of French pharmaceuticals R&D, the results of which would be made available to HMR for potential commercial exploitation.

Describing a very different government role in response to the challenges of globalisation, Mr. D. O'Doherty of FORFAS discussed the Irish government programmes to improve the technological performance and competitiveness of SMEs, which account for a substantial fraction of Irish employment. Mr. O'Doherty argued that SMEs face enormous challenges in gaining access to information concerning foreign market opportunities, technologies, and the like. His discussion of Irish government programmes emphasized the range of SME needs and the importance of developing a diverse set of programmes to meet these needs.

The final speaker in the first session on the role of government, Mr. Choi of the Korean Ministry of Science and Technology, reviewed the changing role of the South Korean government in supporting inward technology transfer and the development of innovative capabilities in the nation's economy since the early 1960s. According to Mr. Choi, the governmental role has changed considerably during this period. Government policy originally focused on licensing foreign technologies and importing technologies through capital goods purchases and the construction of "turnkey" plants for operation by Korean firms. With the development of technological capabilities in many Korean firms (primarily among the large chaebol), however, government policy shifted toward a more open attitude toward inward foreign investment, an important channel for the transfer of advanced industrial technologies, and policy began to focus more intensively on creating a technological infrastructure that could support technological innovation by Korean firms, in addition to inward technology transfer and adaptation.

The final session of the conference was a panel discussion of the role of government in globalisation. Mr. Nakamura of Hitachi discussed the outlook for the global science and technology system, emphasizing the growing importance of "society-oriented R&D", focused more intensively on environmental and social issues and relying more heavily on the exploitation of multiple disciplines and collaboration among different institutional actors (e.g. government, industry, and universities). Mr. Leitterstorf of the German Ministry of Education, Science, and Technology discussed the challenges faced by government policy makers charged with responsibility for the development and implementation of national policies in a world in which innovation and R&D systems span national boundaries. As he noted, even the most basic determination of a large multinational enterprise's nationality has become more difficult, complicating the use of restrictions on foreign-firm participation in public R&D programmes. Mr. Chung of the Korean Science and Technology Policy Institute noted the importance of increased mobility of human resources, particularly scientists and researchers, to enhancing globalisation of research.

Ms. L. Richards of the US Department of Commerce discussed the expanded use by the US government of bilateral and regional programmes for international collaboration in S&T issues, noting that such collaborative programmes now are much more industry-led than in the past. Mr. J. Barber of the Department of Trade and Industry in the United Kingdom discussed the role of intellectual property rights in the international science and technology system. In his remarks, Mr. Barber pointed out the potential risks for both national and international R&D systems associated with the aggressive extension of IP rights beyond industrial technology development into the sphere of basic scientific research. If "open science" is restricted by more extensive restrictions on the circulation of its results, the productivity of national and international innovation systems could suffer. Finally, Mr. J. Bell of ANUTECH discussed the complexities for his enterprise's international technology licensing activities resulting from incomplete harmonization of intellectual property rights among OECD countries. Mr. Bell emphasized the importance of IPR for international technology transfer, and praised the recent moves by the Korean government (described by Mr. Kim in an earlier session) to strengthen domestic intellectual property rights.

The increased international interdependence of many OECD countries' economies and domestic R&D systems has coincided with a dramatic shift in the international political environment – the end of the Cold War. The confluence of these developments means that the "national defence" rationale that long underpinned a substantial fraction of the public R&D investments of many large OECD economies has lost much of its political saliency. Efforts to define a new economic rationale for such investments often acquire a nationalistic tone, and set up a clash between the design of programmes to benefit national taxpayers and the realities of international economic and technological interdependence. Virtually all of the commentators on the final panel noted that policy makers face strong and understandable pressures to ensure that foreign firms do not appear to "free ride" on public R&D programmes. But their response to these pressures may increase restrictions on international scientific and technological co-operation and thereby prove to be counterproductive.

Governmental concerns over access to one another's public R&D programmes is part of a broader set of frictions over "reciprocal access" to the innovation systems of one another. The "national innovation systems" of OECD Member countries are collections of institutions and policies that affect the creation, development, commercialisation, and adoption of new technologies within an economy. They include not just the institutions performing R&D and the level and sources of funding for such R&D, but policies – such as anti-trust policy, intellectual property rights, and regulatory policy – that affect investments in technology development, training, and technology adoption. Government policies by no means determine all elements of the structure of national innovation systems, which are the legacy of institutional and industrial development, government policy, and history. Moreover, the performance of these systems within most industrial economies depends on the actions and decisions of private enterprises, and these decisions can offset the effects of public policies.

For example, much of the current controversy over foreign firms' exploitation of US technological assets through their R&D investments in the United States rests on a set of assertions about the contrasting structures of the United States and other national innovation systems, such as those of Japan and Germany. Access by foreign enterprises to locally developed inventions or technologies within an economy is heavily influenced by the structure of that economy's national innovation system. The US system, in which relatively "open" institutions, such as research universities, are important research performers, and in which new start-up firms may be easily acquired, provides relatively easy access to non-US firms. But these conditions of access are only loosely related to national government policy, and any large-scale effort by the US government to limit access would be ineffective, counterproductive, or both.

The national innovation systems of other industrial economies are similar combinations of government policy, historical evolution, and private decision-making. As such, the possibilities for intergovernmental negotiations over access to industrial technologies to produce meaningful results are limited. How, for example, should one measure the extent of openness of one nation's "innovation system", relative to that of another? What does reciprocity imply? Since a far greater proportion of Japan's R&D is carried out in industry, does an agreement on reciprocal access imply that both US and Japanese firms must open their sensitive technology development activities to visitors from firms in each nation? Such an agreement would not be welcomed by US firms. In addition, as this example suggests, government policies may have little near-term effect on access – the contrasting systems of corporate governance in the United States and Japan are not likely to respond quickly to any imaginable Japanese government initiative. Concerns over the access by one nation's firms to another's industrial technology base may be well-founded, but their resolution is likely to be very slow. Although national innovation systems do change, they change slowly.

The influence of government policies on the “openness” of national innovation systems also is mediated by public policies and private firms’ reaction to these policies. Indeed, a portion of the recent growth in international strategic alliances reflects the actions of individual firms in reaction to state policies. For example, the “technonationalist” R&D policies of the European Union and the United States in semiconductors have provided an important motive for the formation of strategic alliances among firms from these economies; so have managed trade policies in industries like automobiles. Both the static characteristics and the dynamic evolution of these national innovation systems thus depend critically on the behaviour of private firms. As such, intergovernmental negotiations can contribute to a reduction in tensions, but it is very unrealistic to expect government actions to eliminate the causes of such tensions in the near term.

Conclusion

International technological co-operation is indispensable to economic growth and improvement in the lives of billions of citizens in the industrialised and developing economies. OECD Member countries, and the OECD itself, have a responsibility to develop policies that will support this trend. But the development and implementation of such policies by democratic governments also requires policies to support adjustment and prevent the “losers” from globalisation from obstructing liberalisation. In pursuing these goals, it also is important to recognise that “globalisation” of the innovation process is proceeding at a very different pace among individual OECD Member countries. The speed and current level of internationalisation of their R&D operations vary considerably among individual manufacturing industries. Although public policies will be applied to all industries, assessments of current and future trends must recognise the significant differences among individual industries and technological areas.

The discussions at the Seoul conference also put to rest any notion that “governments no longer matter” in the face of globalisation in economic and innovative activities. Government policies of investment in national R&D infrastructure and human capital are essential to the attraction of international flows of R&D and related high value-added activities. Among other advantages, the fruits of such investments are somewhat less internationally mobile than are the results of technology development programmes supported by public funds – indeed, regional agglomerations of technological expertise are surprisingly enduring. By focusing on the less mobile assets as targets for their investments, governments may be able to avoid some of the political tensions that arise from the clash between national political goals in an internationally interdependent economy and innovation system.

But investment in R&D infrastructure alone is an insufficient prescription – the structure of national R&D infrastructure also must be reformed, to place greater emphasis on institutional autonomy, competition for scientific talent, and peer review of research proposals and performance. As Mr. Leitterstorf and Mr. Beyer both remarked, a useful indicator of the quality of national university systems is their ability to attract foreign students seeking a top-flight graduate education. In this area, as in others, the pressure of international competition appears to be triggering efforts in a number of OECD economies to undertake such reforms. But government policies must maintain a balance between support for the creation of new technologies and support for their rapid and efficient adoption. The latter goal in particular is best served by a policy of openness to foreign investment in manufacturing, services, R&D, and a relatively non-restrictive policy toward foreign firms’ participation in public R&D programmes. It may also require a more nuanced approach to the development of domestic intellectual property rights policies, as well as co-ordination between policies in IPR and in other spheres, such as competition policy. The interests of SMEs in particular are likely to be best served by such a balanced and co-ordinated approach to policy formulation.

Governments thus still matter a great deal. But the effects of many government policies now are mediated to a greater extent by the actions of private firms, especially MNEs with operations throughout the industrial and industrialising world. In the area of technology policy, governments rely on such enterprises to make the investments that translate public R&D and related investments into employment opportunities and economic growth. Moreover, the contrasting structure of the innovation systems of many OECD Member countries reflects the legacy of private firms' investment and operating decisions in previous decades.

The remarkable post-war history and economic development of South Korea illustrate another aspect of the role of government in economic development and globalisation. Economic development in the post-war South Korean economy benefited from government policies that initially combined support for inward technology transfer, restrictions on imports and foreign direct investment, policies to ensure intense competition among domestic firms, and policies to encourage entry by domestic firms into international markets. Throughout this period, government policy focused on supporting the inward transfer and adoption of new technologies. One of the most remarkable features of government policy was its adaptation to changing economic circumstances – as South Korea has shifted from reverse engineering and imitation of foreign technological innovations to a position of operating at the technological frontier in many industries, South Korean government policy has shifted to address new challenges and opportunities. In the economic sphere, government policies have adapted to support stronger IPR, more support for fundamental research, and greater openness to imports and foreign investment. Many of these new policies have come about in response to direct pressure from other governments as a result of South Korea's growing economic power, while others reflect change in the domestic political environment.

The potential for a strong promotional role of government is effectively illustrated by the South Korean experience, as is the need for extraordinary flexibility and adaptation on the part of government. The future role of government in South Korea's economic development is unclear, but it is likely to involve less direct intervention, more deregulation, the development of a stronger domestic competition policy, and a continued responsibility for supporting the R&D infrastructure.

The Seoul conference produced several ideas regarding future research needs. The participants of the Conference emphasized the need to improve the collection of data on internationalisation of R&D and to analyse the impact of the globalisation of industrial research on innovation potential and technological policy in OECD countries. The extension of IPR protection is another important issue. Much remains to be done to improve consistency of policies, standards, and enforcement within the OECD, to say nothing of the challenges associated with extending this IPR regime to cover more of the global economy. At the same time, however, additional research is needed on the economic effects of stronger protection of IPR and on the effects of efforts to extend the areas covered by IPR into those formerly classified as fundamental research, in contrast to technology development (see David and Foray, 1997, for a critical discussion of these issues).

The Seoul conference vividly illustrated the close linkages between technology policy issues and trade policy issues in both the domestic and international political arenas. These closer links reflect the substantive connection between these areas that results from increased economic and technological integration among the OECD Member countries, as well as the fact that the dominant channel for multilateral negotiation and enforcement of meaningful agreements in many areas relevant to the issues debated in Seoul is trade policy. IPR issues obviously are directly implicated in trade policy, but they also will be linked more closely to future multilateral negotiations over competition policy. Issues of access to public R&D programmes involve issues of subsidies, trade-related investment measures, and IPR, to name only a few.

The Seoul conference devoted too little attention to another important concern – how are the fruits of closer economic and technological integration within the OECD to be conveyed to the numerous nations and far more numerous individuals who are not part of this network at present? The earlier discussion of R&D globalisation, and most studies of direct foreign investment, note that these flows are largely concentrated among the Triad economies and a few favoured destinations in East Asia. Private direct investment flows are critically important channels for the international transfer of technology, advanced manufacturing and management policies, and a host of other capabilities that are essential for the economic improvement of the world's citizens.

The issues covered in the Seoul conference have emerged as by-products of the remarkable success of post-1945 multilateral political and economic policy. The liberalisation of the global trading and investment system benefited both the industrial and many developing nations. OECD Member countries now face challenges in maintaining and extending such liberalisation in an international political environment that differs from the environment in which these policies took root. The issues discussed in Seoul are minor impediments at worst to continued liberalisation, and support for removing such obstacles to international technological co-operation appears to be strong. An even greater challenge, however, is the need to spread the benefits of such liberalisation more widely in the future. This will tax the ingenuity of policy makers in OECD and other governments well into the next century.

BIBLIOGRAPHY

CANTWELL, J. (1991), *Technological Innovation and Multinational Corporations,* Blackwell, Oxford.

CANTWELL, J. (1995), "The Globalisation of Technology: What Remains of the Product Cycle Model?", *Cambridge Journal of Economics*.

COHEN, W., R. NELSON, and J. WALSH (1997), "Appropriability Conditions and Why Firms Patent and Why They Do Not in the American Manufacturing Sector", presented at the OECD Conference on New Indicators for the Knowledge-Based Economy, Paris, 19-21 June.

DAVID, P.A. and D. FORAY (1997), "Accessing and Expanding the Science and Technology Knowledge Base", *STI Review No. 16*, pp. 13-68.

LEVIN, R.C., A. KLEVORICK, R. NELSON, and S. WINTER (1987), "Appropriating the Results of Industrial R&D", *Brookings Papers on Economic Activity*.

NATIONAL SCIENCE BOARD (1996), *Science and Engineering Indicators: 1996,* US Government Printing Office, Washington, DC.

OECD (1996), *Technology and Industrial Performance*, OECD, Paris.

OECD (1997*a*), *Intellectual Property Rights: Patents and Innovation in the International Context*, OCDE/GD(97)210.

OECD (1997*b*), "Internationationalisation of Industrial R&D: Patterns and Trends".

PATEL, P. (1995), "Localised Production of Technology for Global Markets", *Cambridge Journal of Economics* 19, pp. 141-153.

PATEL, P. and K. PAVITT (1991), "Large Firms in the Production of the World's Technology: An Important Case of 'Non-Globalisation'", *Journal of International Business Studies*.

VERNON, R. (1966), "International Investment and International Trade in the Product Cycle", *Quarterly Journal of Economics*.

INTRODUCTION

OPENING REMARKS

Sook-Il KWUN, Minister of Science and Technology, Korea

It is a great honour and pleasure for us to host this OECD Conference on “Facilitating International Technology Co-operation in a Globalised Knowledge-Based Economy” here in Seoul. First of all, I would like to extend a warm welcome to all of you, especially to the foreign participants who have travelled far to join us here at this conference. Let me also thank the Conference Steering Group, the Science and Technology Policy Institute, and the Conference Secretariat for their hard work in preparing for this meaningful gathering.

Challenges of the globalised knowledge-based economy

The world economy today is undergoing unprecedented change, which is characterised by the emergence of a knowledge-based economy and the rapid globalisation of economic, scientific and technological activities. In some OECD Member countries, knowledge-based industries account for more than 50 per cent of the gross domestic product. Indeed, knowledge-generating activities have now become the key source of economic growth and job creation. The emergence of the knowledge-based economy and the globalisation of industrial activities are closely interlinked: globalisation has fuelled the growth of knowledge-based industries by accelerating scientific and technological interactions and advances. Globalisation has enabled industries to better exploit their technological advantages and reduce R&D costs and risks.

However, globalisation challenges many areas of policy, too. As globalisation proceeds, national economics are becoming more closely integrated. Hence, a nation can no longer have its own policy, independent of others. National strategies should be built on co-operation and agreed upon paradigms. Globalisation has also led to more intense competition in the market, both domestic and international, creating an urgent need for adjustment in domestic policies as well as international norms and practices. This presents a new challenge to our national governments. In other words, our national governments have to play the role of facilitator in the process of the global generation and diffusion of technologies by reducing institutional barriers to globalisation.

Korea’s response

In response to the challenge, the Korean Government has placed ‘globalisation’ at the top of its policy agenda since 1993. Under this policy direction, our government has been trying to reduce the disparities that exist between the domestic policies and the international norms and practices. In particular, major action has been taken to liberalise trade and investment and also to strengthen the protection of intellectual property rights. In addition, the government has recently taken several important measures in order to facilitate the globalisation of scientific and technological activities of Korea.

First, we believe that the success of globalisation depends critically upon our scientific and technological capability. Thus, we have readjusted the focus of our science and technology policy from facilitating "learning" to fostering "innovation". To this end, earlier this year, the government enacted "the Special Law for Scientific and Technological Innovation", which provides the legal base for the government's reinforced efforts for innovation. Under the mandate of the law, the government has recently prepared a "Five-Year Plan for Scientific and Technological Innovation". On the basis of the plan, the Korean Government will increase its R&D budget from the current 3 per cent to 5 per cent of the total budget by the year 2002. In addition, we launched a new national R&D programme called "the Creative Research Initiative Programme". The programme has been designed to stimulate and support scientific research for new and creative objectives.

Second, to facilitate S&T globalisation, our Ministry launched the "Programme for S&T Globalisation" in 1996. The programme is geared to supporting international activities of universities, R&D institutions as well as individual scientists. The programme encourages domestic R&D institutions, both private and public, to expand external R&D as a means for efficient generation and utilisation of new technologies. It also supports and encourages the creation of branch laboratories in Korea by foreign R&D organisations and industries. The "K-Star Project", a Korean fusion research programme, presents a good example of our recent efforts for international co-operation. To achieve the goal of constructing an advanced super-conducting tokamak by the year 2002, we have organised an international network of collaboration with such institutions as the Princeton Plasma Physics Laboratory, the Culham Institute of the United Kingdom, the National Institute of Fusion Science of Japan, and the Kurchatov Institute of Russia.

Lastly, Korea is attempting to change its historical role as a latecomer in science and technology and to take up the role as a catalyst for international co-operation. Korea pursues active participation in the international joint research programmes that address the major issues of global concern, such as climate change, acid rain, deforestation, natural disasters, and so on. Our strong commitment to OECD activities to promote international co-operation also stems from this basic policy.

Conclusion

I appreciate the pioneering work and contribution to the promotion of international technology co-operation undertaken by the OECD Committee for Scientific and Technological Policy (CSTP). I would like to take this opportunity to express our strong support for the initiatives of the OECD/CSTP pertaining to international science and technology co-operation. In conclusion, I hope that this conference will make yet another meaningful addition to the accomplishments of the CSTP and set a new milestone in international science and technology co-operation in the era of the globalised knowledge-based economy.

OECD PRINCIPLES FOR FACILITATING TECHNOLOGY CO-OPERATION INVOLVING ENTERPRISES

Risaburo NEZU, Director for Science, Technology and Industry, OECD

Background

The Directorate for Science, Technology and Industry (DSTI) began the current phase of its work on international technology co-operation with a symposium in Paris in May 1994. Subsequently, "Principles for Facilitating International Technology Co-operation Involving Enterprises" were drafted and discussed by the Ministerial meeting of the Committee for Scientific and Technological Policy (CSTP) in September 1995. They were adopted by that Ministerial and by the OECD Council.

Work since that time has focused on understanding barriers to implementing these principles. There are a variety of institutional factors which constrain the ability of firms to develop and share knowledge and technology across national boundaries. It is our task to find out what governments can and should do to remove these barriers and to facilitate co-operative R&D. This work has been done in co-operation with the OECD Business and Industry Advisory Committee (BIAC), several members of which are here at this conference. The discussions and findings of this conference will further our understanding and should feed into the discussions at the next CSTP Ministerial meeting, scheduled for March 1999.

OECD principles

In 1995, Ministers felt that it was impossible for any country to achieve its national science and technology objectives in isolation from other countries. In addition, governments had to adjust to the problem of reduced S&T budgets and the challenge of globalisation of industry. Increasingly, the development of many high-payoff technologies is a high-risk, and costly venture, which exceeds the capacity and capabilities of individual firms, and even of countries.

Ministers recognised that it is in the interest of governments to play an active role to facilitate joint international R&D – both government-led endeavours and firm-to-firm co-operation. The benefits include: reducing the cost of developing new technologies and products; providing experience for firms in co-operative endeavours; additional opportunities for market access; and the involvement of less-developed regions and countries and small firms.

At the same time, Ministers recognised that there are barriers to such co-operation. They thus agreed on a set of principles which, in brief, stated that governments should encourage technology joint ventures by:

- maintaining effective intellectual property rights protection;
- applying international standards, where practicable;
- establishing consortium structures which allow flexibility;
- facilitating participation by small and medium-sized enterprises; and
- agreeing on access to, and use of, the results of research co-operation.

Issues in S&T co-operation

The Seoul Conference will address outstanding issues pertaining to the implementation of these OECD principles. It should also highlight areas where governments may take co-ordinated action:

R&D globalisation

Increasingly, countries are competing for international R&D investments which goes “against the grain” of encouraging technology co-operation by these same firms. Studies show that it is largely the quality of national innovation systems which attracts industry R&D spending. Governments can work together to understand and improve the operation and quality of their innovation systems. This is a major part of our work programme at the OECD.

Intellectual property rights

Many differences exist in intellectual property rights policies and regimes such as underlying frameworks and philosophies, costs, filing procedures and enforcement. Such differences could constitute major roadblocks to firms from different countries which attempt to engage in joint R&D. Forging agreement on the main elements of their patent systems is one important way in which governments can facilitate S&T co-operation.

Foreign access

The national rules determining which foreign firms can participate in government-funded technology programmes are confusing and unclear, perhaps purposely so. There are also requirements regarding reciprocal treatment and exploitation of research results which can limit participation by foreign firms. This is an area where governments can develop some broad guidelines or guiding principles to allow fair access to firms on an international basis.

Small firm participation

Unfortunately, joint international R&D is still primarily the realm of large multinationals. Small firms may lack information, technical expertise and financial resources. But they still may be able to make significant contributions to some co-operative programmes. Governments need to devise approaches to increasing participation by SMEs in global technology development in order to diversify both inputs and outputs.

This conference has an excellent Chair and Rapporteur and a long list of distinguished speakers. It will close tomorrow with a high-level panel which will attempt to develop some recommendations for government action. I encourage all of you to be bold in your suggestions so that we can advance this work at the OECD and speed the implementation of the OECD Principles for Facilitating International Technology Co-operation.

GLOBALISATION OF RESEARCH AND DEVELOPMENT

GLOBALISATION OF RESEARCH AND DEVELOPMENT: A BUSINESS VIEWPOINT

Christian DAMBRINE, Business and Industry Advisory Committee to OECD

Globalisation of research started centuries or even millenaries ago, in a certain way, with the movement that led artists and craftsmen in quest of training all over the world, within its known borders, in an effort to acquire and master new knowledge and skills to put into practice upon their return to their home-based activities. Centred essentially on art and craftsmanship, the domains of science emerged early in man's history, specifically concerning astronomy and its links to human activities – like navigation – it grew stronger, in particular from the time of the industrial revolution, and its needs expanded for a science base.

The need for external sources of knowledge in support of industrial activities was slowly recognised in the latter part of the 19th century. It grew after World War II and has been steadily increasing over the last 10 to 20 years, to the point where companies – clearly a limited number of them, but a significant portion of the total industrial research budgets – now conduct research and development activities far from their own bases in order to support their global operations and access intellectual resources at the best level of excellence.

The main reasons quoted in most relevant surveys for this trend towards globalisation include factors like technological infrastructure, business location, public attitudes, labour costs, regulations, tax relief, etc. They are usually quoted in order of importance in management decisions concerning the location of R&D activities and research centres. Not only do markets influence and attract new international industrial investments, and the corresponding necessity to set up an intellectual support for them, but also factors like the availability of high-quality educational and research institutes, and well-educated and trained manpower, play a part, often an important part, in a decision regarding the localisation of an investment.

Industrial economies, and innovation as a driver for growth, increasingly rely on immaterial investments and resources. The costs for the creation of new knowledge are soaring and therefore the need to protect its value through intellectual property rights appears more important. Globalisation of R&D goes along with the globalisation of businesses, as two faces of the same coin. Globalisation of economies is now a fact of industrial and business life, considered in both cases by some as a threat, by more as a chance, for wealth creation.

There is a difference, however, in pace, as the globalisation of business is exploding, and globalisation of R&D is only accelerating. This difference in the tempo is easily explainable, and leaves some time, though limited, to set up a few rules which should be observed if industry and services as well as academia are really to profit from globalisation. It also leaves some time for the learning process to develop, as we still have a lot to learn concerning the best ways to conduct the process.

- **We certainly have to know more of the reality and importance of the globalisation of R&D;** we need better definitions, more means of measurement, more reliable data, in a domain where information is not that readily available. Large companies publish data, less important ones may not communicate to the same extent; or analysts may not consider them with enough importance in their surveys. OECD is certainly a right forum to monitor the phenomenon.

- **The rate of creation of new knowledge is generally considered as growing much faster** as compared to what it was in the past, its dissemination grows even more. More and more, knowledge is considered as a public good, to be made available to everyone across the planet, without relevance to the country or group of countries where it has been produced. Most of the basic knowledge created by research is funded though public budgetary funds, while the cost of research keeps increasing. If the basic knowledge resulting from research is to remain common to all researchers, and available as a sort of public good, then, each country has to contribute to its creation in proportion of its wealth. All industrialised economies and progressively the industrialising economies should contribute.

- **Training of foreign students is an old established tradition** as explained in the preamble, it is likely that most of the participants in the Conference have experienced, enjoyed and profited from the status of foreign student in their life. It is clear that training of foreign students is both a cost and a resource, a cost to the training centre, a resource for its research work and potentially for industry, in their home country or in the country where training takes place. While a balance should be kept in order to avoid both brain drain and knowledge drain, the training of foreign students is even more desirable in the context of an increased globalisation in general, but in particular of R&D.

- **Globalisation of R&D, like globalisation of economies, cannot be effective without a strong, affordable, enforceable intellectual property rights system** to protect its result. It is trivial to state that R&D is an investment, and any investor, let it be governments, when it concerns public research most often funded by public money, or business, should be recognised as having a right for a certain return on their investment as a counterpart for the dissemination of the knowledge they have created. The IPR system should tend to be global, in its structure and its coverage, as the sole way to ensure the creation and extension of markets for technology, or more generally immaterial investments. It is worrying to see the evolution at a very slow pace of the world Intellectual Property Rights systems while globalisation of economies is exploding, and globalisation of R&D is growing; law should not drag behind the evolution of real life, a lesson that OECD might repeat obstinately to its Members.

- **Governments are developing supportive actions** to encourage the creation and development of centres of excellence in their territories as means for attracting foreign investments and eventually foreign research centres. Similarly, they foster through various means the collaboration of their research bodies, industry with industry, and/or industry with public research; such programmes are very popular and tend to be fruitful to all participants. It is clear that in the context of globalisation of R&D, business expects that equal access to publicly funded research programmes should be ensured for national and foreign-owned firms established in the same country, with proper monitoring.

- **Globalisation of research creates a new challenge for the staff in charge of research** in entities where research is becoming global, or where globalisation keeps growing, whether these entities are in the business community, or encompass also public research institutions which, in turn, will also be impacted by the same tendency to globalise. Managing programmes across countries and continents requires skills that are not taught, on the scientific as well as the personality level, they require above all a capability to accept and integrate different cultures, recognise differences as well as synergies. The same qualities are also an absolute must to the actors of globalised research, not only the managers thereof; this aspect of globalisation represents most probably the greatest challenge and also the main factor that may slow the globalisation of R&D. After all, most failures so far in the process of globalisation of R&D can be traced to individuals, it may take some time for business, industry, and academia to adapt.

CASE STUDY OF GLOBAL LOGISTICS AND PACKAGE TRANSPORTATION

Bruce R. GUILE, Washington Advisory Group[1]

> Last year American companies spent $670 billion – a gaping 10.5 per cent of GDP – to wrap, bundle, load, unload, sort, reload, and transport goods. So clogged is the gross national pipeline with unnecessary steps that the grocery industry alone believes it can wash $30 billion, or nearly 10 per cent of its annual operating costs, out of the system. A typical box of breakfast cereal spends a stunning 104 days getting from factory to supermarket, haltingly progressing through a concatenation of wholesalers, distributors, brokers, diverters, and consolidators, each of which has a warehouse.
>
> (Henkoff, 1994)

Logistics and express package transportation

Price and service competition among US manufacturing and service companies are driving firms to adopt business practices (logistics) that minimise inventory costs and reduce cycle times throughout the value-adding chain of events in the production, distribution, and delivery of goods and services. These economic pressures and opportunities are driving rapid changes in the physical flow of goods – transportation, trans-shipment and warehousing of materials, components and finished goods – in the US economy, and to a certain extent globally.

As a result, there is a rapidly growing demand for relatively rapid (2-3 days domestic; 10-14 days international), time-definite package transport that is supported by enough information technology (package tracking and access to the information) so that the transportation system can be treated by manufacturers, distributors, and retailers like a nearby warehouse and by customers like a local retail store, i.e. you know exactly where something is and when you can get it.

Changes in the physical flow of materials, components and finished goods are enabled by two technologically dynamic, though not R&D-intensive, industries: electronic commerce and express package transportation. The marriage of these two industries in application is variously described as supply chain management, logistics, or value chain management. This function is not easily characterised as it often links a whole business enterprise, from Web-based retail "store" through production and materials and resource planning. Management scholars and practitioners know it as a combination of the hardest aspects of Materials Resource Planning II, Just-In-Time, and Total Quality Management. US manufacturers, service companies, and consumers appear to be driving demand for logistics[2] services but it is a global phenomenon, if for no other reason than many production processes involve international transport of materials, components, and finished goods.

The "market" for logistics services – like the market for accounting services or legal counsel – is demand that is satisfied both by in-house providers (the logistics division of a company) and vendors. The logistics function is a systems integration and management activity that can improve customer service and company image while reducing cycle time (increasing asset utilisation) and reducing inventory and transportation costs. And there is plenty of opportunity to take costs out of most supply chains. Distribution – the function that logistics providers most commonly handle – is generally defined to address inventory processing, storage and warehousing, transportation network analysis, transportation and delivery, and sometimes order processing and customer service.[3] The expense associated with these functions in a company varies greatly. One long-running survey-based US data set yields an average distribution cost equal to 7.94 per cent of company sales revenue with costs higher in some industries (e.g. processed foods) and in smaller companies (under $200 000 000 in sales), and lower for products with high value to weight and volume ratios. In other economies the average costs of distribution are usually higher, 8.8 per cent in Japan and 14 per cent in South Korea by one recent estimate.

The competitive pressure that is driving value chain management and time definite delivery – both for manufacturing and service companies and for the carriers that serve them – is illustrated by rates of growth in time-definite originated shipments. Comparing four quarters beginning in October 1993 to four quarters beginning in October 1994 the annual rate of growth in time-definite shipments handled by integrated carriers was 13.5 per cent[4] – or between two and three times the rate of GDP growth in that period.

To understand what is happening it is important to understand that effective value-chain management is an organisational innovation that is a complex soup management expertise, information technology, and transportation assets. Therefore, the industry that provides this service isn't one industry, but several.

- Integrated express carriers (management, information technology and transportation assets) provide these services to companies, as well as traditional business-oriented package shipping and package express services and individual consumer services. Globally, these companies are joined by "hybrid" express carriers that offer express service within a country but use freight forwarding to reach overseas locations, and by multinational freight forwarders. These companies compete – sometimes directly sometimes not at all – with national postal services.

- Trucking and air cargo companies – traditional transportation assets for industry – move huge volumes of goods. Increasingly these companies are forced to provide, both independently and with dedicated fleets closely managed by the customer, rapid and time-definite delivery.

- Third party logistics providers – sometimes using their own transportation assets and sometimes using other's assets – provide supply-chain management solutions by providing the necessary scheduling, control, and information technology. Typically, third party logistics suppliers have a history either as a freight forwarder (no assets) or as a transportation carrier with some transportation assets – tractors, trailers, trucks, planes and/or warehouse or trans-shipment facilities.

- Information technology companies, especially network and software companies, play a large and growing role in the industry. The limiting factors in a company's ability to extract value from time definite transportation are the MRP, DRP, and other information systems that companies run and the daunting (mostly organisational, not technical) task of making them work together well enough to be of value.[5] A further issue is the relationship of opportunities in logistics to the growing use of the Internet for commerce. Dedicated communication networks for controlling a supply-chain are developing in tandem with growing uses of the Internet for the same functions. Some very credible participants (Microsoft, for example) in the information business view the Internet as an information/communications tool that can allow smaller companies to handle the information aspects of value chain management and logistics. In some companies, the use of sophisticated approaches to value chain management involve working through the use of the Internet for retail selling, customer service, and dealer and vendor information exchange.

A very broad set of technological advances are relevant to these diverse companies in the package transportation and logistics industries: *(i)* computers, communications networks, database software, electronic/optical sensors; *(ii)* electromechanical devices for materials handling in facilities and vehicles; *(iii)* vehicle/fleet related specialised equipment; and *(iv)* decision support or system design and analysis tools (see Figure 3). In the context of a broad base of relevant technologies, three generic business problems motivate technical work in the industry:

- improve customer-perceived value of service offered, e.g. communications and computer technology that allows reliable tracking and time-definite delivery;

- improve efficiency in production of logistics and transportation services, e.g. materials handling and tracking technology to drive transportation and handling cost down or increase volume of packages handled at same quality;

- enable creation of new markets, e.g. technology which allows a company to offer new services (supply chain management, integrated logistics) or operate in new geographic regions (integrating a cross-docking facility in Louisiana or a hub in Asia into a transportation system).

The technological underpinnings of electronic commerce and express package transportation – and of their marriage in application to business problems – are diverse. In general, however, the core technologies are primarily information technologies (sensors, databases, and networks) that can provide value-chain visibility and enable control of the value chain. Critical supporting technologies include operations research, materials handling, and a broad range of transportation technologies.

The industries that provide these services, as mentioned above, are not traditional R&D-intensive industries. The technical work (research, development, and demonstration) performed by companies in these industries is constrained by several factors:

- Only a few transportation service companies command enough of the market to justify traditional product or process R&D activities across a broad range of technologies. This is not unrelated to assets. Companies such as UPS, FedEx and DHL can justify R&D investment in sensors, vehicle design, and materials handling equipment, for example, because they can apply such technologies in a large number of assets. Software companies, as suppliers to both transportation services companies and to users of logistics services have a broad base that justifies R&D investment.

- The importance of systems integration – for integrated carriers like FedEx and UPS, for third party logistics suppliers such as Ryder Integrated Logistics, and for manufacturers such as Hewlett-Packard – means that companies often focus on assembling and deploying compatible technologies rather than performing traditional R&D. Industry leaders shop globally for technologies such as computers, software, communications networks, and materials handling equipment and rely on vendors to do R&D.

- In the delivery of package transportation and logistics services there are few "controlling" technologies. In contrast, for example, to pharmaceutical research where a patentable product confers long-lasting advantage there are few unique technical solutions to those problems confronting companies. Consequently, even the most technically advanced companies in the industry do little research. The dominant technical work is engineering research or system development that is directly motivated by specific business problems. Companies are engaged primarily in the development of specialised new function/performance equipment or software and all that implies in terms of system design, testing and deployment.

The global technical base for this industry is, therefore, best understood in two parts. The first part is made up of a wide variety of "hard" technologies in which there are classic product R&D challenges. What advances in sensor or bar-coding technology would reduce cost and increase efficiency in moving packages? What is the necessary bandwidth for global communications systems handling millions of packages a day and what compression algorithms work best for the type of data being handled? What technological constraint limits the viability and value of alternative fuel vehicles in package delivery truck fleets?

The second part is an expensive and technically risky investment in systems integration – such as electronic links between flower growers and flower buyers nation-wide. This is a type of technical innovation that is perhaps best characterised as demonstration rather than R&D. A company "demonstrates" the viability of a technology-enabled organisational innovation to the market. In this type of technical activity there is rarely a separate R&D organisation and companies rarely have R&D budgets. Generally, the focus is on tailored applications – specialised systems developed jointly by providers and users. It is as risky and technically demanding as traditional product R&D (remember Federal Express ZAPMail?).

In summary, companies that deliver value-chain management or logistics do, in general, very little research or development; the primary technical value-added is in integrated system design and deployment, including system software development. Further, in the design and deployment of systems, US companies buy software in the United States but shop globally for electronic and materials handling components, some of which are technically or economically superior to those available from US companies.

Package transportation and logistics: a global industry but a US story

There is a pervasive trend in the United States that integrates a specialised transportation service with management systems, transportation facilities, materials handling, and information technology (communications, databases, tracking, etc.) to dramatically improve the productivity and flexibility of both manufacturing and service companies. The applications are, at their heart, organisational innovations driven or executed by companies – manufacturers, service companies, or transportation companies – acting as system integrators. They would, however, not be possible without substantial advances in the application of information and electromechanical technologies to business logistics problems.

In many ways, these are traditional goods transportation industries, albeit with some special characteristics – the goods travel relatively fast (from overnight to a few days) and in units with relatively small weights and volumes (no bulk shipments, train car loads, or truck loads). What is lost, however, in thinking of this as a traditional transportation industry is the way in which these transportation services, when supported by sophisticated tracking and materials handling technologies, are revolutionising both service and manufacturing industries.

To some carriers, it doesn't matter whether products move in units of truckloads, train car loads, on pallets, or one or two at a time boxed in cardboard. Traditionally the economics of transportation has dominated decision making about how products are aggregated for shipment. The physical characteristics of the goods being moved affect the economics of transportation but not the physics: only a small portion of non-bulk shipments (less than 5 per cent) cannot be broken into packages[6] of 150 pounds or less. What is particularly interesting about package transportation and logistics is how the changing economics of production – the total value chain managed by a manufacturing or service firm – is changing the calculus of distribution, appears to be driving the disaggregation of shipments, and making winners and losers out of manufacturing and service operations.

The 1996 US market for "expedited cargo" is estimated to be 4.7 billion shipments that generate $65.3 billion per year in revenue for transportation carriers.[7] A few companies dominate this diverse market – UPS, Federal Express, RPS Inc., and the US Postal Service. A very large number of trucking companies compete for small shares of this market by providing less-than-truckload (LTL) transportation services. There is an analogous – but much smaller group – of cargo air carriers and passenger airlines that handle cargo in this category. While a few companies are dominant in this $65 billion expedited cargo market there are also both private and dedicated fleet operations that handle – for a single parent company – what would be called expedited cargo were it handled on a contractual basis with a transportation carrier.

The international express package market is somewhat different in that it is best characterised as a segment of the air cargo business. The striking things about the international air cargo market are: *(i)* the small size of the international markets relative to the US domestic market; and *(ii)* the degree to which the United States plays a dominant role in world air cargo as an origin or destination. In 1995, for example, US domestic air cargo was 6 090 000 tonnes, United States-Europe was 1 182 000 tonnes, and United States-Pacific Rim was 1 762 000 tonnes. In contrast, Intra Asia/Pacific Rim was 2 868 000 tonnes, Intra Europe was 983 000 tonnes and Europe-Pacific Rim was 1 139 000 tonnes.[8] In the international express package market, DHL and TNT join (and in many cases lead) UPS and FedEx as dominant carriers. For example, one recent estimate of the Intra-Asia market for express package services estimated that DHL holds about 36 per cent of the market; TNT has 27 per cent of the market; FedEx has 13 per cent; UPS has 5 per cent; and all other carriers split the remaining 19 per cent.[9]

It is much harder to estimate markets for logistics services, both vendor provided and in-house services. In the United States, according to one estimate of the 1995 market, the largest US third party logistics supplier was Ryder with $867 million in logistics revenues and the largest 20 logistics firms had combined revenues of over $5.1 billion. The global market for logistics services is provided by a wide range of companies, including divisions or groups within very large industrial firms such as Hitachi (Hitachi Transport Systems, Ltd.) that provide both in-house and third party services.

On a national basis there appear to be two key features of the United States that make it a leading location for logistics activity (provider companies and user companies) that are linked to value chain management. First, the United States is a large market with few internal political barriers to the flow of goods. Trucking deregulation, in particular, has made national logistics systems possible.

Second, the United States leads in the development and application of a broad set of technologies that can be described as network technologies – private networks, the Internet, and the software to use them for electronic messaging and commerce – is a another key feature. Although value chain management and logistics – in theory – do not depend on electronic networks the implementation of these business practices in the modern US economy are heavily infused with electronic commerce. The application of value chain management and logistics by US companies rides on the back of heavy private and public investments in network technology and information technology for transportation systems; the core *national* R&D base for electronic commerce and express package transportation is in networks and it is a very robust R&D base.

R&D, services and competitiveness: the case for targeted public investment logistics and package transportation

National competitiveness is a function of the ability of a nation's assets (location, people, capital) to add value to products and services sold both domestically and in other countries. There is a well-documented conclusion that scientific and engineering research, development, and demonstration activities – and the personnel, facilities, and supporting educational programmes that drive such work – play a key role in competitiveness. First, research and development jobs are often relatively high-wage activities, making a contribution to national welfare directly through the incomes generated for individuals. Second, research and development can create effective dominance for a company (first mover or fast follower) with long-term benefits to the company and its host country. Third, R&D can help create a locational advantage that is not specific to a particular company by creating R&D assets in the form of a density of skilled people and culture of technical entrepreneurs. Finally, R&D competence in industrial equipment or systems can create a competitive advantage and economic gains for user companies that are downstream from the companies performing R&D.

Most studies of national competitiveness, and industry studies in support of competitiveness arguments, have focused on manufacturing industries; it is widely accepted – implicitly – that a nation's economic performance is directly connected to its natural resource endowments and manufacturing prowess. However, in 1994, manufacturing, mining and agriculture – three production activities often associated with national competitiveness – combined accounted for less than 24 per cent of US gross domestic product (GDP). The services which collectively account for the remaining 75 per cent of US GDP also account for 79 per cent of US employment. As services have come to dominate the US economy – and the economies of other industrialised nations – it is critical that our thinking (and policies) change to reflect the changed nature of our economy.

The service sector includes such fundamental societal functions as:

- finance, insurance and real estate (18.4 per cent of 1994 GDP);
- wholesale and retail trade (15.5 per cent of 1994 GDP);
- transportation, communications and utilities (8.7 per cent of 1994 GDP);
- traditional private services such as health care, private education, entertainment and repair services (19.4 per cent of 1994 GDP).

The dominant role of services in the US economy is not a new phenomena – the number of people employed in service businesses has exceeded the number of people employed in manufacturing and agriculture combined since about 1950 and service sector employment doubled between 1970 and 1995. However, misperceptions abound. Services are regarded as secondary industries that are technologically backward, employ people only at low wages, and are not capital intensive. In reality, the technological intensity of service industries is often high (transportation, telecommunications, and health care services, for example); many service industry incomes are often well above average (doctors, lawyers, investment bankers and airline pilots, for example); and there is substantial capital investment by service companies (transportation firms, communications firms, and national retail chains are excellent examples).

Logistics and package transportation is a particularly interesting (if not necessarily representative) technically dynamic service industry with an intimate connection to a nation's competitiveness. There are two characteristics of the industry that cloud the water with regard to the relationships between technology and national competitiveness: *(i)* both in the United States and abroad, package transportation is historically a regulated and/or subsidised industry; and *(ii)* the nature of the industry means that users reap substantial economic benefits from logistics regardless of who owns or controls the assets, i.e. US producers and consumers can reap considerable economic benefits from effective logistics whether the services are provided by the US Post Office, US companies, or foreign-owned companies.

With regard to regulations and subsidies, there is a long history of transportation regulation, at both the national and international level, that continues to play a role in the structure of the market and of competition. State and national government (United States and other nations) regulation and state-financed competition for carriers have dramatically shaped the industry to date. Regulations in air cargo transport and inter- and intrastate trucking have shaped the development of the US express package industry. Essentially, the regulations (covering entry control, service areas, tariff filings, prices and commodity limitations) served to limit competition by: *(i)* impeding new carriers from directly competing for routes or commodities, and *(ii)* regulating price competition.

Deregulation of US domestic air cargo transport in 1977 and interstate trucking in 1980 effectively transformed the competitive environment for the domestic express package industry. Deregulation led to increased competition among package carriers – the number of carriers authorised for nation-wide general commodity services rose from zero in 1980 to 5 400 in 1987. As a result of this new competition, prices dropped for express package operations – by almost 25 per cent six years after deregulation. The more recent (1995 and 1996) deregulation of intrastate transportation is expected to increase competition in US express package transportation.

Government regulation of, and involvement in, international competition in expedited cargo (both transnational and in-country) also has a long history and many forms – regulation of trade, government financed competitors (postal services), and laws restricting foreign ownership of vital infrastructure industries. There is a long history of nations demonstrating the belief that there is an inherent national interest in having a healthy (if not efficient), domestically controlled package transportation system. World-wide government investments in postal services, and regulations making it difficult or impossible for companies based (and usually owned) in one country to carry goods into or compete for domestic business in another country, are clear evidence of this. These expressions of national interest in infrastructure die hard, even in an increasingly global economy.[10]

With regard to economic importance of who owns logistics providers, there is no simple argument. National interests in controlling package transportation – whether motivated by national security or economic concerns – do not map well onto a global economy in which materials, components, and finished goods move across national boundaries with the same frequency and purpose that goods move to and from a warehouse across the street from a factory. The implementation of sophisticated global logistics and package transportation systems enables globally dispersed and transnational patterns of production and consumption. They allow Asian manufacturers to serve US customers and south-of-the-equator produce growers to serve north-of-the-equator restaurants. The growth and increasing capability of these systems allow rapid changes in the assets (location, people, capital) in use and – to a certain extent – unhinge traditional notions of national comparative advantage and competitiveness.

Further, it is not clear how a country captures high value-adding activities from a technically sophisticated and effective logistics and package transportation industry. In product industries a good is produced and consumed one, two or several discrete places and it is possible to understand "national" returns from production and consumption because economic activities have locations. Logistics and package transportation industries – like inter-city passenger transportation, finance, and telecommunications – are infrastructure-based where both production and consumption are network based.[11]

Two figures (2 and 3) illustrate how logistics and package transportation differs from some traditional manufacturing industries. Figure 2 was developed to illustrate the critical importance of, and controlling role played by, semiconductor manufacturing equipment. In the case of semiconductor manufacturing equipment, upstream "control" of technology has considerable downstream consequences. This picture of the industry is strategic in nature and relates to the ability of firms in the downstream electronics industries to compete. The national economic benefits that this Figure highlights, are jobs in electronics industries. This producer-focused approach to competitiveness analysis is quite common. Figure 3 illustrates the relationship of package transportation and logistics to the industries technology base. There are no controlling technologies and the primary economic benefits are assumed to accrue to the users of the service. This user-focused approach may lead to very different policies.

In an increasingly global economy, where the most efficient production process for goods and services demands that goods cross national boundaries quickly and without significant impediment, the value of domestic ownership or government control of the industry would be outweighed by the value of efficient participation in the global economy. A country that is effectively served internally and linked to global markets by a group of express carriers benefits enormously regardless of the national origin or ownership of the express carriers.

Figure 1. The technology base for express package transportation and logistics

Facilities, equipment and rolling or flying stock:

- hub or cross-docking facility design, maintenance and operation;
- materials handling – hub, warehouse (cache areas), in-fleet;
- equipment;
- coding, tracking, sensors;
- software, databases, communications (LAN, WAN, GPS).

Fleet design, maintenance and operation – aircraft and vehicles:

- specialised design;
- fuel efficiency;
- operating procedures/decision support for maintenance and operating control;
- packaging/containers;
- distributed communications, database co-ordination/interactivity.

Supporting and providing logistics and value chain management:

- distributed package collection systems ("retail" package collection);
- customer site shipping systems ("wholesale" sites);
- provision of outsourced distribution and vcm for customers:
- global (multinational; multi-site; package transport; sorting and tracking) system design, maintenance and operation.

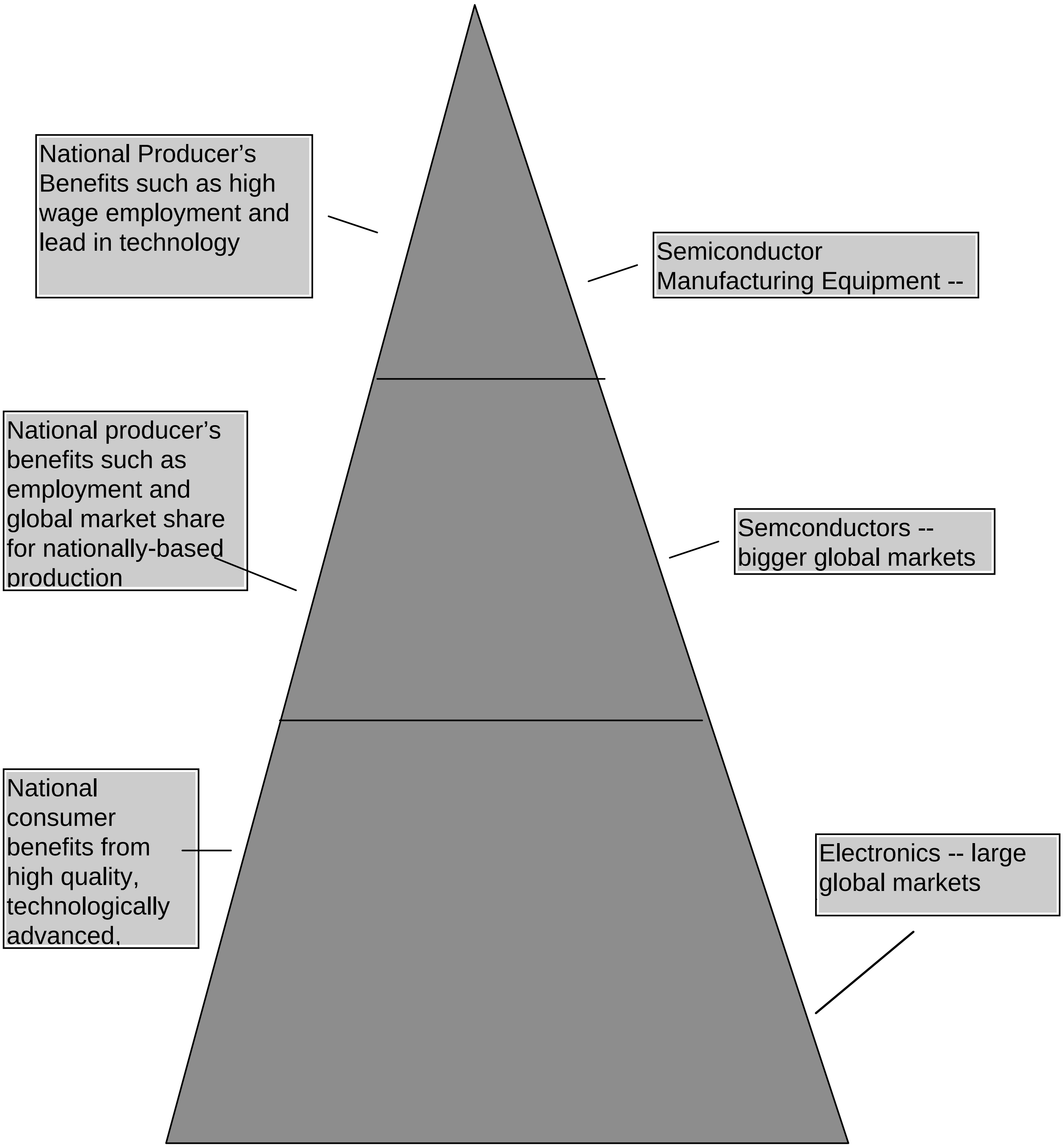
Strategic business analysis and decision-making

Data mining

Operations research; modelling and simulation in support of network design or operation

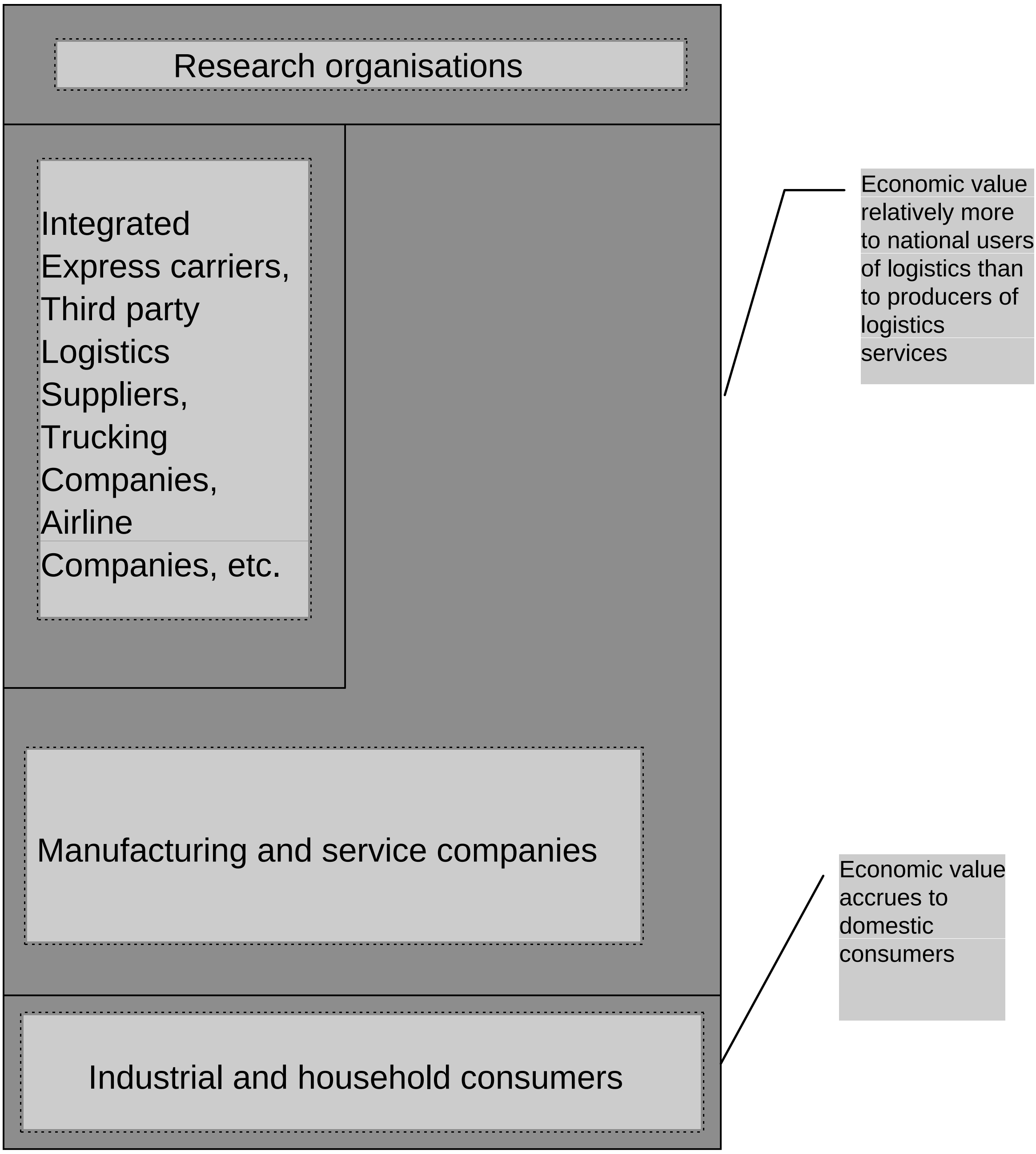
Source: Author.

Figure 2. Producer-focused analysis of the economic benefits of technology



Source: Author.

Figure 3. Technology in logistics and package transportation



Source: Author.

NOTES

1. The author is the Managing Director, Washington Advisory Group, LLC. This paper is being prepared under contract with the private, non-profit Council on Competitiveness. The opinions and conclusions are the author's and should not be attributed either to the Washington Advisory Group or to the Council on Competitiveness. Comments should be addressed to the author at the Washington Advisory Group; 1200 New York Ave, NW, Suite 410; Washington, DC 20005. Telephone 202-682-0164; Fax 202-682-9298.

2. It is important to note that logistics typically applies to more than just business applications and does not apply exclusively to packages. Military logistics (humans, equipment, weaponry, and food to and from where it is needed when it is needed) is a related and important field. Also, many of the technical tools and techniques of logistics are as valid for managing supertankers full of oil as they are for moving boxes of baby powder through a retailer's distribution chain. The Council of Logistics Management – the dominant association for logistic professionals – defines logistics without regard to speed or weight: "the process of planning, implementing and controlling the efficient, cost-effective flow and storage of raw materials, in-process inventory, finished goods and related information from point-of-origin to point-of-consumption for the purpose of conforming to customer requirements".

3. Author after *MGI Cargo Analyst*, "R is for Logistics," January/February 1995, p. 11.

4. *MGI Cargo Analyst*, "Where (800-Pound) Gorillas Come From," Third Quarter 1995, p. 23.

5. The organisational difficulty of marrying new information technologies to transportation services to reduce distribution costs and improve flexibility and productivity may mean that *new* implementations are easiest. Companies that grow up in an environment where these tools exist for experimentation, development and use may be more likely to adopt these approaches. This may partially explain why some of the most successful implementations of these approaches occur in relatively new and rapidly growing organisations (Dell, Wal-Mart). Personal communications with Daniel DiMaggio, Senior Vice President and COO, UPS Worldwide Logistics and Ray Greer, Senior Vice President, Logistics and Technology, Ryder Systems, Inc.

6. Package shipping can include a number of overlapping markets such as customers/individuals shipping packages, letters or flats, catalogue or Internet sales shipping, company-to-company or site to site within a company by an independent carrier, and company to company or site to site within a company by private fleet or dedicated contract fleet.

7. Colography Group, from "UPS Walkout Delivers Few Crises – So Far," *Wall Street Journal*, Tuesday, August 5, 1997, page B1. Expedited cargo is defined to include domestic air, domestic ground parcel, domestic less-than-truckload, and US air exports.

8. *MGI Cargo Analyst*, "World Air Freight Forecast," Fourth Quarter 1995, p. 23.

9. MergeGlobal Inc., *The Wall Street Journal*, "Federal Express, UPS Battle for a Foothold in Asia," p. B1.

10. See, for example, "The Continent is Still a Tough Neighborhood for UPS," in *Business Week*, September 29, 1997.

11. Health care and education (network-based production with long-term consumption) occupy some middle ground.

BIBLIOGRAPHY

ARMSTRONG, R.D. (1996), “Who’s Who in Logistics: Primary Characteristics of the Major Players”, *Annual Conference Proceedings*, Council of Logistics Management.

AYOTTE, M.J. (1994), “Congress Acts to Preempt Regulation of Intrastate Transportation of Property”, Briggs and Morgan, www.briggs.com/preempt.htm.

BOWERSOX, D.J. (1990), “The Strategic Benefits of Logistics Alliances”, *Harvard Business Review*, July-August 1990.

DAVIS, T. (1993) “Effective Supply Chain Management”, *Sloan Management Review*, Summer 1993.

DAVIS, H.W. and W.H. DRUMM (1995), “Physical Distribution Cost and Service, 1995,” *Annual Conference Proceedings*, Council of Logistics Management, San Diego, California, 8-11 October, pp. 219-228.

DEPARTMENT OF COMMERCE (1996), *Survey of Current Business,* August 1996, p. 151, Table 11.

HENKOFF, R. (1994), “Delivering the Goods”, *Fortune*, 28 November.

INDUSTRY LOGISTICS ASSOCIATION (of South Korea) (1997), quoted in “Korea Needs to Streamline the Supply Chain,” *Korea Herald*, October 5.

MOORE, T.G. (1983), “Rail and Truck Reform – The record so far.”, *Regulation* (November/December): 38.

MULLER, E.J. (1990), “Pipeline to Profits”, *Distribution*, September 1990.

SACCOMANO, A. (1995), “Demand-chain management turns traditional supply chain inside out,” *Traffic World*, March 13.

SMITH, F. (1988), “Air Cargo Transportation in the Next Economy.”, in Bruce R. Guile and James Brian Quinn, eds., *Technology in Services* 163.

EXPENDITURES OF LARGE R&D PERFORMING FIRMS: CASE STUDY OF THE NETHERLANDS

Bert MINNE, CPB Netherlands Bureau for Economic Policy Analysis

Introduction

Research and Development (R&D) and fixed assets directly affect technology. In its turn, new technology promotes economic growth. We make a distinction between R&D and fixed assets, because both types of investment play a different role in technology. R&D investment creates new technology, which is applied after the sale of the new products. Fixed assets are a major carrier of new technology, which improve the efficiency of the production process. Technology is an international phenomenon. New insights are diffused across many countries by means of e.g. foreign establishments of multinational enterprises, international conferences, and professional journals. Equipment is distributed across the world by means of international trade.

Policy makers, operating from the perspective of competing nations, attempt to stimulate these types of investments in order to enhance national growth. The effectiveness of this national approach is questionable, because the large R&D performers operate and compete globally on a company level rather than a national level. Therefore, national policy makers face the problem of how to act optimally in order to promote growth (but should they aim at national or international growth?) and how to attract investments to their country in order to enhance employment and GDP (but how will other countries respond to their policy?).

This paper addresses two issues of international technology from the point of view of the boards of directors of large R&D performing enterprises. For these companies investment in both R&D and fixed assets are important. The first issue is the decision on the budgets of R&D and fixed assets at company level. Do giants respond to their past financial performance? And are the investments interrelated between companies?

The second issue is the international distribution of investment. The boards of R&D intensive firms eagerly supply foreign customers, because then they can better exploit their fixed amount of intangible assets in the shape of research know-how. Therefore, after the decision of the boards on the investment budgets, they decide on their international distribution. The question is when will they invest in their home country and export to foreign clients, and when will they prefer production near these customers after "foreign direct investment" (FDI)?

R&D and fixed assets expenditures at company level

Mechanism for the determination of investment budgets

This section analyses the determinants of R&D and fixed asset investments for a sample of large R&D performing global companies. Firms invest because these expenditures improve their future competitive position. R&D investment affects a firm's position in the long run because new products shape new market segments and replace existing ones. Investment in fixed assets creates capacity and improves the production process technology in the medium term, because new equipment embodies the best technology.

More precisely, this section investigates the following questions with micro-data. Do the giants respond to their past financial performance? Do they respond to each other's investments? Do they respond more frequently to R&D expenditures than to investments in fixed assets? Do they respond sequentially or mutually? If they respond sequentially, who are the investment leaders and who are the followers? Are the heaviest R&D spenders the leaders? What are the implications for policy makers? Usually, analyses of the determinants of investment assume that firms invest in fixed assets only in a passive environment. Moreover, the records of micro-data are establishments within a single country [see e.g. Chirinko (1993), Fazzari, Hubbard and Petersen (1988), and Caballero, Engel and Haltiwanger (1995)].

This paper deviates from this usual approach in three ways. First, it stresses the oligopolistic market structure of R&D performing firms. These companies do not regard their environment as passive. By contrast, their investments are strategic, as the investment decisions may depend also on the decisions of rivals. Scherer (1992, chapter 5) takes a similar approach. However, he limits investments to R&D only. Moreover, he takes a purely national approach, because he studies the impact of US imports on the R&D expenditures of US firms. Second, this paper uses company data. These better meet the concept of international competition than do the data of establishments within a country. Third, although an overwhelming empirical literature exists on the determinants of investment in fixed assets, papers studying the determinants of spending on both R&D and fixed assets are almost absent. Hall (1992) is an exception, but the period of investigation (1973-1986) is not recent, while the data refer only to US firms. This paper analyses a more recent period (generally 1985-1994) for global giants including those outside the United States.

Table 1 shows the sample of firms, which consists of large R&D performing companies in electronics, computers, pharmaceuticals and chemicals. The sample is largely drawn from the Fortune 500 list with an emphasis on companies with large establishments in the Netherlands. This small number of firms carried out about 17 per cent of total business enterprise R&D in the United States, the European Union and Japan in 1993. This percentage can be derived as follows: First, R&D is concentrated in these industries – companies in electronics/computers, pharmaceuticals and chemicals took respectively 22 per cent, 8 per cent and 10 per cent of total business enterprise R&D in this region in 1993. Second, the selected firms featured R&D shares (i.e. the share of the analysed firms in the R&D of the entire industry) of 56 per cent in electronics/computers, 34 per cent in pharmaceuticals and 20 per cent in chemicals in this geographical area in 1993. The data were copied from the annual reports of the companies.

Table 1. Companies per industry

Electronics	
Consumer goods	Matsushita (78-94), Sony (77-95), Philips (77-95), Sanyo (86-95)
Professional goods	Hitachi (78-95), Siemens (78-94), Toshiba (78-95), NEC (78-95), Ericsson (78-94), Honeywell (87-94), Bosch (78-94)
Electronic components	Motorola (83-94), Intel (78-94), Texas Instruments (78-94)
Computers	IBM (83-94), Canon (84-94), Digital (85-94), Compaq (85-94), AT&T (85-94), Apple (85-94), Ricoh (91-95)
Pharmaceuticals	Astra (83-94), MSD (84-94), Roche (84-94), Glaxo (78-94), Abbott (85-94)
Chemicals	Hoechst (78-94), BASF (78-94), Bayer (79-94), Dow Chemical (78-94), Akzo (78-94), Solvay (84-94), Avery (78-94), Hercules (83-94), Nalco (78-94), 3M (82-94), DSM (77-95)

Source: Author.

Response to financial variables

The impact of financial variables is investigated, because they potentially determine both investments in R&D and fixed assets. Determinants emphasized by the neo-classical theory (such as capacity shortages and the price of capital linked to the substitutability of equipment for labour) are not analysed, because they apply mainly to fixed assets. At this stage, it is assumed that the companies regard their environment as passive.

The following hypotheses are tested. First, more after tax profits stimulate investments later. The reason is that profits are a major source of internal funding, and the boards of directors often prefer internal over external funds. This "financing hierarchy" originates in cost advantages of internal funds. These advantages are due to information advantage of the management board over external funders to assess the returns on investment or research projects, while transferring the additional information to external funders is costly. Also, the acquisition of external funds involves costs associated with share or bond issues, which are absent for internal funds. Second, a higher debt/asset ratio discourages investment. A reason is that more debt makes it more difficult to meet interest obligations, which leads to investor risk aversion, and hence lowers investments (see e.g. Fazzari, 1988). Finally, the interest rate is added as an exploratory variable because high interest costs discourage investments.

Assume that the corporations pursue the simple strategy of keeping investments proportional to their sales. The determinants are added, according to:

$$I/S = \text{constant} + \alpha_1\, P/S_{-j} + \alpha_2\, D/TA_{-j} + \alpha_3\, r_{-j}$$

where I/S denotes the fixed investment (respectively R&D) to sales ratio (per cent). The explanatory variables on the financial performance are the company's net profits to sales ratio P/S (per cent), its debt/asset ratio D/TA (per cent) and r (per cent) the interest rate. Time lags of 1 and 2 years are attempted. The hypotheses are: $\alpha_1>0$, $\alpha_2<0$, $\alpha_3<0$. This equation has been regressed for the companies in Table 1, who are pooled by industry (between brackets regression period). Company-specific dummies adjust for structural differences in investment propensities between firms. Tables 2 and 3 present the estimated equations with the best fit and coefficients that meet the hypotheses (t-ratios between brackets).

Table 2. Determinants of fixed assets (financial determinants one year lagged)

	Profit	Debt/assets	Interest	R[1]
Electronics				
Consumer goods	0.27 (2.6)	-0.16 (2.7)	-0.02 (0.2)	56
Professional goods	0.16 (2.2)	-0.12 (2.2)		50
Components	0.12 (1.6)	-0.19 (2.2)	-0.48 (1.7)	71
Computers	0.15 (2.8)	-0.07 (1.7)		77
Pharmaceuticals	0.77 (4.9)	-0.37 (2.6)		63
Chemicals	0.32 (3.5)	-0.07 (1.9)	-0.25 (1.8)	51

Source: Author.

Table 3. Determinants R&D (financial variables lagged two years)

	Profit	Debt/assets	Interest	R[1]
Electronics				
Consumer goods		-0.08 (2.4)[a]		55
Professional goods	0.03 (0.7)	-0.33 (11.5)		87
Computers	0.06 (3.0)		-0.60 (2.8)	92
Chemicals	0.09 (4.6)	-0.04 (4.9)	-0.02 (0.6)	89

1. Lag one year.

Source: Author.

The firms respond to their past financial performance. The impacts of net profits and the debt/asset ratio are more important and significant for investments in fixed assets than in R&D. A shift in a determinant leads to a change in fixed investments after one year and to a change in R&D after two years. With respect to the electronic component and the drug industries, the R&D strategy can be best described as proportionality to sales, because no other determinant could be found with the expected sign. Therefore these industries are absent in Table 2. Four interest rates are tested: nominal and real interest rate in the OECD, in both cases also including a time trend in order to adjust for trends in the interest rate. The expected sign, most often insignificant, is found only sometimes for the real interest rate in the OECD, adjusted for a trend. These results are presented in Tables 2 and 3.

Response to investments by rivals

We now drop the assumption of a passive environment. Three arguments contribute toward a positive response to the R&D investments of rivals. First, in a technological race, companies cannot stay behind competitors in R&D, as R&D expenditures are strategic complements (Tirole, 1988). In this type of oligopolistic market, a firm’s long-run profitability is endangered by an increase of the R&D efforts of a rival. In order to maintain its profitability, the first mentioned firm must thus respond with a rise in its R&D efforts. Second, a company may need to absorb the new inventions of its competitors and suppliers when they have intensified their research efforts. These efforts aimed at absorbing and building further upon the competitors' new know-how, require more in-house R&D spending. Third, companies probably find it difficult to set out profitability targets on R&D projects. In fact, we do not know of any such targets. Accordingly, R&D that matches the R&D efforts of rivals is an option.

These arguments favour a response also to investments in fixed assets, but to a lesser extent. First, compared to R&D, capacity creation and use of best practice technology are less strategic in nature. Moreover, firms hardly need to absorb know-how of rivals on the application of new machinery, because they get directions for proper use when they acquire equipment. Finally, in contrast to R&D, firms are able to target rates of return on fixed assets to some extent. Consequently, more interaction of R&D spending between companies is expected than of fixed asset investment.

Method

For pooled data, it turned out that profits and the debt/asset ratio affect investment in fixed assets and R&D with time lags of respectively one and two years. In exploring strategic effects, we start with a slightly different specification. For each company, fixed assets and R&D equations are regressed on its own net profit/sales and its own debt/asset ratio (with time lags of, respectively, one and two years). This provides firm-specific estimates for α_1 and α_2. Per company, the basic equation is defined as the one with the highest R^2 that satisfies $\alpha_1>0$ or $\alpha_2<0$. Subsequently, investments by competitors with a lag of one year are added to this basic equation. If the sign of this variable is positive with a t-ratio exceeding 1.6, the response is considered as significant.

For each pair of companies in the sample, the response is statistically estimated. The response is mutual if last year's investment of both companies exerts a positive significant impact on present investments of the other. In this case, both rivals gear up (or down) each others' investments. A mutual response is marked with "+"s in a matrix containing all possible pairs.

A company is leader of two companies, if its last year's investments exerts a positive significant impact on present investments of its rival whereas this is not the case for the reverse relationship (marked with an "X" in the matrix of pairs). A sequence of leaders is derived by reshuffling the rows and columns of the original matrix to one that best approximates a recursive matrix (i.e. the matrix with the least number of X's above the diagonal). This latter matrix provides the sequence of leadership. "No response" is the case if the response is neither mutual nor sequential, indicated as an empty cell in the matrix.

Electronics and computers

Tables 4 and 5 present the response-matrices for investments in fixed assets and R&D of 20 giants in electronics and computers. Table 6 summarises the response-rates defined as the frequency of response as a share of 190, which is the maximal number of possible responses between 20 companies. It appears that the firms respond quite frequently to the investments of rivals, and that they do it mainly sequentially. Moreover, the corporations respond more to R&D than they do to fixed assets. This confirms our expectation that the R&D responses outweigh those of fixed assets.

Table 4. Response to investment in fixed assets in electronics and computers

Follower	Co	In	Mo	Hi	AT	IBM	Di	Ca	Ap	To	Ne	Bo	Sa	Ma	Si	Ph	So	TI	Ho	Er
										Leader										
Compaq																				
Intel	X								X											
Motorola	X								X											
Hitachi			X																	+
AT&T																		X		
IBM		X	X																	
Digital																X				
Canon														X			X			
Apple	X			X						X				X						
Toshiba	X	X	X	X				X						+						
NEC			X												+					
Bosch							X				X					+				
Sanyo			X																	
Matsushita				X						+		X	X							
Siemens				X				X		X	+			X						
Philips				X		X				X	X	+			X				+	
Sony												X	X	X	X	X				
Texas I			X				X													
Honeywell					X		X									+				
Ericsson	X		X	+										X					X	

Source: Author.

Table 5. R&D response in electronics and computers

Follower	Hi	In	TI	To	Si	Co	Ca	AT	Ap	IBM	Ne	Sa	Mo	So	Ma	Ph	Bo	Ho	Di
	Leader																		
Ericsson													+				+	+	
Hitachi												+	+		+		+		
Intel			+																
Texas I		+										X		+					
Toshiba	X	X					+				+			+	+			+	
Siemens			X									X				+			
Compaq			X													X			
Canon	X			+							+				+			X	
AT&T				X	X		X				+				+	X			
Apple						X		X											+
IBM				X											X				
NEC	X			+	X	X	+	+	X						+	+			
Sanyo	+			X					X		X		X		+		+		
Motorola	+			X	X	X		X	X	X	X				+		+		+
Sony	X	X	+	+							X								
Matsushita	+	X	X	+	X		+	+	X		+	+	+	X			+		
Philips	X	X		X	+		X				+			X	X				
Bosch	+			X	X			X	X		X	+	+		+				+
Honeywell	X			+					X		X	X	X				X		
Digital						X		X	+				+		X		+		

Source: Author.

The sequence of leadership in investments in fixed assets follows from the first column in Table 4. For companies in electronics, the ranking in leadership is unambiguous. All “X”-cells of these companies (hence, without the computer specialists listed in Table 1) are below the diagonal. This implies that the companies on top of the list are leaders, because they directly and indirectly determine the expenditures of the companies down the list. Intel and Motorola are the leaders. Their fixed investments are not determined by other electronic companies, but their purchases of machinery and plants are imitated by their rivals. Both companies are specialists of the basic material of information technology: semiconductors and other electronic components. On top of that, Motorola is the world’s largest provider of wireless communication equipment. Hitachi, the world’s biggest company in electronics, is third. The specialists in consumer electronics, such as Sanyo, Matsushita, Philips, and Sony, are followers.

The computer companies neither lead nor follow each other’s fixed assets, because the common cells are empty. Compaq, the world’s largest supplier of personal computers, is an important leader for the electronics industry. This firm directly leads fixed assets investments of the electronics firms Intel, Motorola, Toshiba and Ericsson.

Table 6. Summary response rate in electronics and computers

	Fixed assets	R&D
	%	
Sequential	25	34
Mutual	3	15
No response	62	51

Source: Author.

Table 5 presents the sequence of leadership in R&D. For electronics companies, also excepted Sanyo, also the ranking is unambiguous, because again the “X” cells are below the diagonal. Ericsson and Intel emerge as R&D leaders because they do not follow other companies. Ericsson stands out, as it is the only company that leads Hitachi’s R&D. The component maker Texas Instruments is high on the list as well. Once again, the consumer electronics specialists are followers. Also Sanyo is a net follower, because it follows five companies and leads only three.

The computer companies respond moderately to each others’ research efforts: five times leadership occurs out of 30 possible cases. It is noteworthy that IBM the biggest spender on R&D does not act as a leader with respect to rival computer producers. The impact of computer companies on Motorola is strong.

The sequences of leadership of investments in fixed assets and R&D correspond with a stylised value chain with as leaders the producers of electronic components, next the makers of professional equipment (including computers), and as followers the specialists in consumer equipment. The value chain is important in electronics, because the produced devices must be mutually compatible in order to be able to assemble them in a next production stage. This requires standardization. The value chain of electronic devices has consequences for R&D. Component makers generate the fundamental knowledge and basic components; the final equipment producers must absorb this know-how in order to be able to use the components as inputs in their products.

The firms hardly respond mutually to their expenses on fixed assets. The mutual R&D response is concentrated at Matsushita, Bosch and Toshiba. Consequently, these companies have been important players, who gear up (or down) R&D waves. It is striking that computer makers are underrepresented in the gearing up process; even IBM is not involved. There is little evidence of a relationship between the size of R&D expenditures and leadership. The heaviest investors in R&D, IBM (US$ 4.4 billion in 1993), Siemens (US$ 3.6 billion) and AT&T (US$ 3.1 billion) are not leaders, whereas the leader Intel invested only US$ 1 billion in R&D.

Table 7. Response to investment in fixed assets in pharmaceuticals and chemicals

	Leader															
Follower	Av	3M	He	Gl	Bay	As	Do	MS	Ro	Ab	Ak	DS	So	Bas	Na	Ho
Avery											X					
3M	X															
Hercules	X															
Glaxo		X	X													
Bayer							+							X		+
Astra			X													
Dow		X			+								+			
MSD				X			X									
Roche			X	X	X		X					X	+	+		+
Abbott								X	X					X	X	
Akzo					X				X							X
DSM						X					X					
Solvay				X	X		+		+		X	X		+		+
BASF				X				X	+			X	+		+	+
Nalco		X		X									X	+		
Hoechst				X	+	X	X	X	+			X	+	+	X	

Source: Author.

Table 8. R&D response in pharmaceuticals and chemicals

	Av	Ab	So	Ro	As	Ms	Gl	He	Ho	Bay	Ak	Do	Ds	Bas	3M	Na
Avery					+											
Abbott									+	+	+		X	+	+	
Solvay		X					+		+	+	+		+	+	+	
Roche	X		X			X	+							+		
Astra	+			X												
MSD	X				X			X								
Glaxo		X	+	+					+	+	+	+	+	+	+	
Hercules																
Hoechst		+	+	X			+			+		+	+		+	
Bayer		+	+	X	X		+	X	+			+	+		+	
Akzo		+	+	X			+		X	X		+	+	+	+	
Dow	X						+	X	+	+	+		+	+		
DSM	X		+	X			+	X	+	+	+	+			+	
BASF		+	+	+			+		X	X	+	+	X		+	
3M		+	+	X			+		+	+	+	X	+	+		
Nalco																

Source: Author.

Pharmaceuticals and chemicals

Tables 7 and 8 present the response-matrices for investments in fixed assets and R&D of 16 giants in pharmaceuticals and chemicals. These firms respond frequently to the investments of rivals, while R&D is imitated more frequently than investment in fixed assets, and this difference is almost significant. This can be derived from Table 9.

The response rate of 41 per cent in fixed assets is higher than the corresponding response rate of 28 per cent in electronics and computers. Just as in the information technology industries, the response is mainly sequential. However, no robust leaders can be discerned, because Table 7 is not recursive. Moreover, the presented sequence has no clear economic interpretation. The mutual gearing up process is concentrated in the German giants BASF and Hoechst and the Belgian corporation Solvay.

The R&D response in pharmaceuticals and chemicals tends to be mutual in contrast to that in electronics and computers. Table 8 shows that the mutual gearing-up process is concentrated in the group of companies consisting of European-based Glaxo, Solvay, Hoechst, Bayer, Akzo, DSM and BASF and US-based Abbott, Dow Chemical, and 3M.

An explanation for the more frequent mutual response compared with electronics and computers is that many corporations in pharmaceuticals and chemicals are not very specialised. In fact, they have many overlapping divisions, while the corporations can hardly be ranked according to a stylised product chain. Instead, chemicals and pharmaceuticals are produced in a few production stages, preferably integrated on one location. Such integration saves energy costs of cooling and re-heating and enhances safety. This argument is supported by the fact that most highly specialised corporations in the sample are hardly involved in the mutual process, such as Hercules (special paints, paper technology, special food), Astra and MSD (both pharmaceuticals), Avery Denison (high tech adhesives and films) and Nalco (environmental control).

Although less leadership emerges in R&D than in electronics and computers, it appears that the more a company is specialised in pharmaceuticals, the higher the probability that it is a R&D leader. For instance, the pharmaceutical specialists Abbott, Roche, Astra, MSD and Glaxo are among the first in the sequence in Table 8, whereas the basic chemical specialists Dow, DSM and BASF are farther down on the list.

Table 9. Response rate in pharmaceuticals and chemicals

	Fixed assets	R&D
	%	
Sequential	33	23
Mutual	8	30
No response	59	47

Source: Author.

Policy implications

This section investigates empirically the investment response of large global R&D performing companies to their own financial situation and to their competitors' investments. Investment in fixed assets responds more strongly than R&D spending does to a firm's own past profits and debt/asset ratio. The firms respond frequently and significantly to changes in the R&D investments of rivals. The response is less intensive for investments in fixed assets. This result is consistent with the fact that companies have more reasons to respond to R&D investments of rivals than to their fixed investments. Furthermore, for firms in the electronics and computer industry, R&D spending of rivals follows a pattern related to the product chain. By contrast, large chemical firms respond mutually to each other's R&D expenditures. The size of the R&D efforts has no robust impact on the rank number of leadership.

Governments face dilemmas when they promote investments, especially in R&D. A stimulus to a national giant improves a company's competitive advantage over "foreign" rivals. However, the response of the competitors partly compensates for the original advantage. For the world economy as a whole, however, these international spillovers are favourable, because they produce an international multiplier on the original stimulus and consequently they stimulate economic growth. Such cases may call for international policy co-ordination.

Instruments that increase net profits or lower the debt/asset ratio stimulate the investments in fixed assets and, to a lesser extent, the R&D expenditures of large R&D performing companies. A dilemma for national policy makers is that if they succeed to increase net profits of a company, the company may invest the additional cash flow in another country. If policy makers succeed in increasing the R&D expenditures of a giant, this will lead to additional investments by other companies. In this way, European countries gain from triggered R&D in information technology in the United States or Japan. Most giants have the United States and Japan as their home base. There are only a few European giants and these firms are not leaders. However, European governments may succeed in starting a R&D wave in chemicals, because many giants have their major laboratories in Europe. Due to the strong mutual response, the R&D expenditures are geared up in Europe with spillovers to the United States.

A dilemma for national policy makers is that an investment stimulus to a national giant improves that company's competitive advantage over "foreign" rivals. However, the response of the competitors partly compensates for the original advantage. For the world economy as a whole, however, these international spillovers are favourable, because they produce an international multiplier on the original stimulus and consequently they stimulate economic growth. Such cases may call for international policy co-ordination.

The case of the Netherlands

After the investment decisions at company level, the firms decide on the international distribution of investments. What determines the international distribution of investments in fixed assets and R&D? The management board faces the question of what is more profitable: investment in the home country and export to foreign clients, or investment in foreign establishments (FDI)? This section shortly discusses the main determinants of the location decision, and highlights those which are relevant for the Netherlands. We apply the framework of Markusen (1995) and Markusen and Venables (1995) from which we derive two sets of determinants.

The first set is product related, and consists of two variables. The first variable is the ratio of the fixed costs of a new plant in a foreign country and the size of the foreign market. The other variable is the transport costs (including trade barriers) to export a product from the home country to the foreign client. This set dominates FDI, if countries are similar.

The second set is country-related, and consists of the set of national endowments and institutions. As far as the second set dominates the first one, the international distribution of investments is linked to the comparative advantages of countries. There are no general rules to explain the international distribution of investment which apply for all situations. It depends upon the specific product and the countries involved, which set dominates the explanation of the international distribution of investment in plants. Therefore, we illustrate the model with some concrete examples for the Netherlands.

For example: two countries are similar, as is approximately the case for America and north-western Europe. The Netherlands belongs to the latter region. When is export to Europe more profitable for a US enterprise than production in Europe after FDI? Export is preferred if the transatlantic transport costs are lower than the ratio of the fixed costs of a new plant and the north-western European market. This is generally the case for special machines (such as advanced medical scanners). The transport costs are rather low and the fixed costs/market ratio is high. The reason is that the European market is small, because it consists of the demand of academic hospitals, while the fixed costs of a factory which produces these scanners are high.

In contrast, investment in a European establishment is preferred if the transport costs to Europe are high, and the European market is large compared to the costs of a new European plant. These conditions are often met for oil products. Large American firms have refineries along the north-western European coast, for example at Rotterdam and Antwerp. The costs of a new refinery are billions of dollars. However, the European market is very large as well. Often their ratio is smaller than the transatlantic transport costs of semi finished oil products with special ships from the United States to Europe. Consequently FDI in Europe of companies such as Exxon and Mobil Oil is more profitable than export from the United States.

More spectacular is the choice of location of an American hotel chain. The transport costs of the hotel are infinite. A tourist or businessman who visits Amsterdam – the capital of the Netherlands – can only enjoy the concept of this chain after the US company has invested in a building and features, which copy those in the United States.

The costs of production of a specific good differ between countries, even if they can get access to the same technology. The reason is that countries differ in national endowments. The most important national endowments are the supply of natural resources, the physical infrastructure, the labour skills, the wage level, and specific agglomerated know-how.

For example, the Netherlands is often cheaper than other countries in north-western Europe in international distribution of goods (often after product refinement) and the production of basic commodities. This is due to comparative advantages of national endowments. The Netherlands has a comparative advantage in the natural endowment location at deep sea and the deltas of the Rhine and Meuse. By nature, this location is a favourable central knot of commodity flows between Germany, Switzerland and France and deep sea harbours all over the world. Also, the Netherlands has invested in additional physical infrastructure into north-western Europe which reinforces this natural advantage. It concerns networks of roads, canals, telecom-equipment, and pipelines into north-western Europe, and an international airport. On top of that, the labour skills strengthen these comparative advantages. Education in the Netherlands is specialised in languages. All pupils between 12-15 must learn English, German and French, besides Dutch. This facilitates communication with clients in north-western Europe and with all sea harbours across the world with the English language. In the course of time, the Netherlands has agglomerated a large stock of tacit know-how in the fields of logistics and international marketing.

Moreover, the Netherlands benefits from a specific soil and moderate climate, which makes it a favourable place for the agricultural industry and consequently the food industry. As a result, this country has built up a large amount of locked-in know-how in the agricultural-industrial field.

Also differences in institutions between countries have an impact on the international distribution of investments of large R&D performing companies. Important determinants are the flexibility of the labour market, political stability, corporate tax rates, national regulations on health and safety, and environmental measures.

Regulations on health and safety lead to investment of multinationals in small-scale plants and regional sale centres in every country in order to meet its national prescriptions. This applies to the pharmaceutical industry. National environmental measures can deter foreign investments of the basic metal and basic chemical industries. A low corporate tax rate attracts foreign investors, in particular in electronics. This industry is more footloose than other industries, due to the possibility of slicing the value chain; low transport costs because the components are light; and international standards.

The impact of the national endowments and institutions can be observed from the pattern of establishments of the large R&D performing enterprises. The Netherlands has developed as a European distribution centre of computer and electronic enterprises. For example, there are Canon, Digital, Apple, Texas Instruments, Compaq, Sun Microsystems, Toshiba and Sony distribution centres and a large IBM establishment. The reason is that the Netherlands possesses much locked-in tacit know-how on logistics and international marketing, and that the corporate tax rate is relatively low in north-western Europe.

The impact of national regulations on health has indeed led to small scale establishments in the Netherlands (or Benelux) of the major pharmaceutical companies. In addition, MSD has a large European distribution centre in the Netherlands. Many foreign giants in chemicals and oil-refining have large Dutch manufacturing facilities, such as Du Pont, Hoechst, Dow Chemical, ICI, General Electric, Fuji Photo and refineries of Exxon, Texaco/BP and Kuwait Petroleum Company for example. The main reasons are first the high transport costs of semi-finished oil products compared to the fixed costs/European market ratio; and second the location at deep sea. Moreover, national environmental measures may have an impact on the attractiveness of the Netherlands as a location for basic chemicals.

Determinants of R&D centres

What do these sets of determinants imply for the international distribution of R&D centres? The output of laboratories consists of new ideas. The first set of determinants of the international distribution of investment in plants is not relevant for intangible commodities like ideas.

But the second set remains relevant. Comparative advantages refer to the factors of production. The main factors of production in the knowledge production function are researchers and the public and tacit stocks of know-how, to which they can get access. A major stock of tacit knowledge is the regional locked-in know-how in a special field. Therefore, the comparative advantage of a region which determines its attractiveness as a R&D centre is related to the special field of know-how and experience in which the region is specialised. There is a distinction between research laboratories and development centres as regards the relevant concept of special regional knowledge.

The boards have no choice with respect to the international distribution of the research budgets. These are entirely spent on the company’s main laboratories. The reason is that for a main business research laboratory, the input of the stock of regional knowledge contains fundamental, supply-oriented elements. The knowledge of nearby universities also belongs to the stock, making suppliers and inquisitive customers. As this cluster of regional locked-in knowledge is a condition for successful research results, and at the same time immobile, the managers maintain the present situation with the main laboratories established in the home country.

This reasoning has three consequences for the Netherlands. First, existing main laboratories of the most important "Dutch" multinationals (Philips, Shell, Akzo Nobel, Unilever, and DSM) will probably remain in the Netherlands.

Second, the Netherlands is not attractive for "foreign" multinationals as a location for a research laboratory. In fact, at present there are none.

Third, regional knowledge explains the persistence of research activities of foreign companies in the Netherlands. The laboratories were originally erected by Dutch companies, which were later taken over by foreign enterprises. The owners kept exploiting Dutch experience by leaving the laboratory in this country. This holds for Solvay/Duphar (drugs), Lucent (telecommunication), Paccar/DAF (trucks), Buderus/Nefit Fasto (heaters), Petrofina/Sigma (paint), Cap Gemini/Volmac (software), Sandoz/S&G Seeds, Stork Wärtsilä (energy equipment), Sara Lee/Douwe Egberts (food), Medtronic/Vitatron (medical devices), Zeneca/van der Have (seeds), Thomson/HSA (military equipment) and ITT/Koni (shock absorbers).

The boards do have a choice for the location of Development Centers. These are located near to clients, whether they are foreigners or not. There are two reasons to invest in development centres in foreign nations. First, development is often necessary in order to adapt products to regional demands. Sometimes these are due to national legislation on health and safety. This requires knowledge transfer between the client and the producer, which preferably can take place near the client's home. Due to these takeovers, some Dutch know-how is probably transferred to the foreign headquarters.

Moreover, Development Centers can be watchtowers, if located near the main laboratories of competitors and their linked regional cluster of activities. These watchtowers draw from regional new know-how and transfer it to the main laboratories and company's headquarters, which can exploit this knowledge. Examples of European Development Centers in the Netherlands are the laboratories of Dow Chemical, Ericsson, IBM (software for internal IBM use), Yamanouchi, Yokogawa and Hercules/Tastemaker. Moreover, most drug companies of the Fortune Global 500-list have a Dutch technical centre, which carries out development, often in co-operation with local hospitals. These companies carry out a few percentage points of their company R&D in the Netherlands.

Conclusions

What are the implications for policy makers? In general, governments face less dilemmas than in the case of the enhancement of investment at company level, because the sign of the impact of a policy instrument is usually clear. However there are tensions due to the risk of competition between governments.

As regards fixed assets, governments have many instruments to make their nation attractive for foreign investors. Initially, this can be observed from the instruments which influence the first set of variables. Economic integration makes a region more attractive for foreign investors, because it leads to a drop in the fixed costs/market share ratio (the fixed costs of a foreign establishment can be better utilised). In turn, a lift of trade barriers (including national regulations) makes transport cheaper, and stimulates exports at the cost of foreign investment.

The most prominent instruments which influence the national endowments are education, wage policy, investment in the physical infrastructure, and the building of regional clusters of know-how. Important instruments which attract foreign investors in the sphere of institutions are low corporate tax rates (in particular for companies in electronics and computers) and political stability (including monetary and fiscal policy). The risk is that all governments aim at the same goals and compete mutually with policy instruments.

Governments have few instruments to attract main laboratories of foreign multinationals, because their locations are determined by regional locked in know-how in foreign countries. However, governments have some possibilities to attract development centres of foreign multinationals. This brings dilemmas however. A development centre supports the innovative spirit in the region and it gives employment. The risk is that such a centre is a watchtower too, which transfers know-how from the host to the home country. Consequently, it may diminish the competitive advantage of the host-region.

BIBLIOGRAPHY

CABALLERO, R.J., E. ENGEL, and J. HALTIWANGER (1995), "Plant-level adjustment and aggregate investment dynamics", *Brooking Papers on Economic Activity*, 2, pp. 1-54.

CHIRINKO, R.S. (1993), "Business fixed investment spending: A critical survey of modelling strategies, empirical results, and policy implications", *Journal of Economic Literature* 31, December, pp. 1875-1911.

DEVEREUX, M.P. and R. GRIFFITH (1996), "Taxes and the location of production: evidence from a panel of US multinationals", Institute for Fiscal Studies, London.

FAZZARI, S., R.G. HUBBARD, and B.C. PETERSEN (1988), "Financing constraints and corporate investment", *Brooking Papers on Economic Activity* 1.

HALL, B.H. (1992), "Investment and research and development at the firm level: Does the source of financing matter?", *NBER Working Paper 4096*, June.

MARKUSEN, J.R. (1995), "The boundaries of multinational enterprises and the theory of international trade", *Journal of Economic Perspectives*, Volume 9, Number 2, Spring, pp. 169-189.

MARKUSEN, J.R. and A.J. VENABLES (1995), "Multinational firms and the new trade theory", NBER Working Paper, No. 5036.

SCHERER, F.M. (1992), *International high-technology competition*, Harvard University Press.

TIROLE, J. (1988), *The theory of industrial organization*, MIT Press, 3rd Printing.

GLOBALISATION OF RESEARCH AND DEVELOPMENT: CASE STUDY OF GERMANY

Engelbert BEYER, Federal Ministry of Education, Science, Research and Technology, Germany

Introduction

Globalisation is the catchword of the debate on economic policy – at least in Germany. The extreme pressure for change felt by national economies and societies is attributed to changes in the world economy. But this explanation has been much contested. Many argue that – at least from a eurocentric point of view – globalisation is not a genuinely new phenomenon. The first chapters in history books mentioning the terms "world exhibition" and "world revolution" are those on the 19th century, when more than 50 million people left Europe for the New World. At that time the capital exports of the big European countries amounted to up to 9 per cent of the GDP – today this percentage is much smaller. In 1913 foreign trade as a percentage of GDP reached a peak which was not reached again until 1970. Globalisation in the 19th century was also supported by a broad range of new technologies including communications technology, electricity and the rapid development of traffic infrastructure.

However, the intensity of exchange in numerous aspects of life and business, the speed with which almost all parts of the world can be interlinked at the end of the 20th century have led to a redefinition of the term globalisation. Today's movement toward a knowledge-based society is giving globalisation its real drive. Knowledge is becoming a decisive factor in the economic process. High-tech products account for a rapidly growing share of world trade. The demand for goods and services is increasingly being met with new products and newly developed know-how. Invested know-how now accounts for the largest share of the value of many products. No longer do the raw materials used or the manufacturing costs invested make up most of this value. A recent editorial in the New York Times explained the United States' current economic success as follows: "We are leading in everything that is light: microelectronics, software, pharmaceuticals, computers, aircraft". Every day, over 20 000 publications appear world-wide. Currently, as many scientists are at work world-wide as have lived in the 2000 years before us. Much of the knowledge which is produced can be codified, that is it can be made available to all parts of the world in a fraction of a second – provided that people are equipped with the relevant information and communication technology. As a result, the global transparency of economic processes is increasing. An increasing number of countries in the world are – fortunately – in a position to offer high-tech products. A lead in innovation can therefore be quickly lost to others. Global competition is increasingly becoming an innovation competition, in which the criteria will be speed and flexibility.

This development essentially results in greater international division of labour. Features are the integration of product markets across national borders, the growing international interlinkage of production and trade through direct investment, strategic alliances and global sourcing. In the world economy – just as in personal life – division of labour offers good prospects for more prosperity for all. But greater division of labour requires the readiness to give up part of one's previous activities, to co-operate and to develop new high-tech fields of activity. In this process there will be winners and losers in different groups of society.

A consequence of globalisation is increased pressure for structural change. Politics must therefore provide a basis for structural change while paying due regard to other objectives of government policy such as social balance. Traditional descriptions of tasks as well as traditional instruments and priorities of national policy are no longer adequate in view of such megatrends as globalisation and development into a knowledge-based society. Apparently, innovation policy has become a major topic and instrument of modern economic policy. This paper describes globalisation of research and development from the German point of view and explains how innovation policy in Germany responds to this process.

Germany's integration into international production and research networks

By tradition, the German economy is involved to a great extent in international division of labour. Exports as a percentage of GDP amount to over 33 per cent in the West German Länder – an extremely high percentage for a large economy. Foreign investment in particular by big US companies – such as Ford, General Motors (Opel) and later also IBM and Hewlett Packard – contributed substantially to the development of efficient industrial structures in Germany after the Second World War. On the other hand, German companies, though major exporters, were rather reluctant to establish or purchase facilities abroad.[1]

Since the early 1990s at the latest, the situation has been changing. Major efforts are now being made to develop global company networks. German companies' activities abroad are in line with the global increase in the volume of direct investment. Direct investment abroad as a percentage of GDP amounted to approximately 1 per cent in Germany in recent years. The same percentage was achieved in the United States, in Japan and in France while it was somehow higher, namely 2.5 per cent, in Great Britain. It is in particular the R&D intensive industries which are leading in foreign investment. Companies' increasing activities abroad were at first commented rather critically by the public and the political community. There was talk about the world champion in the export of jobs, which did not take into account the positive effects of foreign investment. Involvement abroad is necessary to ensure industrial companies' competitiveness in world markets. According to empirical surveys, companies with strong capital links with other countries also show an extraordinarily positive domestic employment trend.

What is alarming, however, is that foreign investment in Germany seems to be decreasing. While in the production sector the percentage of persons employed by German companies abroad climbed from 13.8 per cent to 23.7 per cent between 1977 and 1994, the share of staff employed by foreign companies in Germany has been stagnating for years at about 16 per cent (1977: 17.1 per cent; 1994: 15.9 per cent). The volume of foreign direct investment in Germany (the indicator being the number of staff as a percentage of total activity) has thus attained about the same level as that in the United States but it is considerably less than similar investment in smaller European countries, in Canada and in Great Britain. This development is considered disappointing in particular because, in the new German Länder, there is a great demand for investment needed to establish new economic structures. It is also emphasized that, with a lack of dynamism in investment by foreign companies, technology import opportunities cannot be seized. But direct investment is not always a suitable indicator of a location's attractiveness. In 1996, for example, the German car manufacturer BMW acquired a controlling interest in the British Rover company. Had this participation transaction been the other way round, this year's direct investment balance would have been quite different. But from the point of view of Germany's economic competitiveness, this would not have been more favourable by all means.

The internationalisation of production has resulted in the growing importance of research abroad by multinational companies. The volume of research done by German enterprises abroad amounts to about 17 per cent of the German R&D budget. The product areas on which R&D activities focus show a clear pattern: German companies do research and development abroad above all in particularly internationalised industries (pharmaceuticals), in their main products areas and in areas in which they hold a strong position in the world market (road vehicle construction, automobiles). R&D activities of German companies abroad are concentrated mainly in Europe and the United States. In particular, electrical engineering companies are also active in the dynamic countries in South-East Asia.

The development of German companies' research capacities abroad is to a great extent linked to the acquisition of research-oriented companies. Only in very few cases do German companies systematically hive off R&D capacities. In addition to the development of closely production-related research capacities, non-production-related research institutes are established abroad, which, in the interest of the corporation as a whole, are to participate in the development of research and technology trends in the host country (global technology sourcing). Thus, German companies currently operate 95 independent research centres in the United States (Japanese companies 136), most of which are located in the immediate vicinity of leading universities.

Not only have German companies been engaged in research abroad – foreign companies have been involved in research activities in Germany to a considerable extent. According to estimates by the *Deutsches Institut für Wirtschaftsforschung* (German institute for economic research) and *the Zentrum für Europäische Wirtschaftsforschung* (European economic research centre), at least 42 500 people are employed in research and development in German affiliates of foreign companies (R&D expenditure: DM 9.6 billion). The share of the R&D budget of foreign affiliates increased from 15.9 per cent to 16.7 per cent between 1993 and 1995 according to the science statistics of the Donors' Association for German Science. Between 1982 and 1993 Germany was the most important non-domestic research location for the United States. About a quarter of all R&D money spent by American enterprises outside the United States went to Germany. During the same period, Great Britain's share in US foreign investments for R&D dropped from 22 per cent to 15 per cent. However, R&D expenditure by US corporations in Germany is concentrated on the well-known and successful transportation equipment affiliates. Companies with production facilities in Germany also conduct R&D there to an above average extent. The ratio between research expenditure and value added is above average. This indicates that Germany is considered an attractive location for R&D by internationally active companies. As a research location, Germany remains highly internationalised, also compared with other countries. The further dynamic development of foreign research capacities is, however, retarded by stagnation in the volume of foreign direct investment in Germany.

It has to be assumed that international financial locking will continue to intensify. The following figures succinctly show the dynamic of this development: in the mid-1980s direct investment world-wide amounted to US$ 77 billion. In 1995 it was already four times that amount. Two hundred and eighty thousand foreign affiliates of 45 000 parent companies are producing and selling world-wide. Almost 75 per cent of the 100 biggest companies intend to increase their direct investment in the coming five years. UNCTAD's 1997 world investment report recently predicted that multinational companies' production abroad would double until 2001. This development can contribute to further weight-shifting in the world economy.

In the early 1990s numerous OECD conferences still focused on the issue of technoglobalism versus technonationalism. Today, the figures show that, in view of the intensity of world-wide transactions, no country has a real possibility to remain unaffected by international developments. Capital links described are only part of the international division of labour. More than 50 per cent of the output of the manufacturing sector in Germany has to compete on import and export markets. More than 30 per cent of all science papers involve co-operation by international co-authors. In recent years, the cross-border exchange of ideas and results has multiplied in numerous ways.

The fact that companies are now optimising all their activities in an international perspective – including research, planning, production and marketing – changes the situation for national economic policy, which must face increasingly fierce locational competition for internationally “mobile” investments. The ties between countries and companies are loosening. The question is therefore not what economic policy can do for German companies but what it can do to improve Germany’s attractiveness to domestic and foreign companies. Improving the investment and framework conditions for the development of production and research capacities in Germany is therefore a major goal of Federal Government policy.

What makes locations attractive for direct investment?

A wealth of literature has recently dealt with the major factors determining locational decisions for international R&D investment. The major factors are market access, costs, regulation, investment incentives as well as access to qualified staff. Weighting of these factors depends on the type of investment, which as a rule is **not** based on a mere R&D-related locational decision.[2]

- Like the internationalisation of production its serves above all to **open up** differentiated **markets** involving high quality requirements (innovative applications). The lead market function is of decisive importance for innovations, which can develop only in close contact with critical innovative customers.

- This applies in particular to development activities closely related to the respective **production sites** and the specific demand of regional markets.

- As regards exploratory research activities in fields of technology closely related to science – which account for only a small percentage of R&D activities abroad, however – not only the market potential but also, and to an even greater extent, the **research environment** existing in a country is of prime importance.

The global interlinkage of research and development is obviously not accompanied by an equal global distribution of innovation activities. Studies on global company R&D management have revealed that many multinational companies tend to concentrate on a few high-performance centres, which are gaining a reputation world-wide. The evaluation and selection of these top-quality locations is made at the level of strategic business units or a certain technology. These centres have access to the international R&D potential of the company. Frequently they are the first to turn new technology into products.

The criterion governing the choice of locations by leading international enterprises which conduct R&D activities is to be where optimum conditions prevail for innovation and knowledge generation in the respective product and/or technology field. In particular in sectors with a rapid succession of new generations of products and fierce technological competition, business enterprises are attracted by locations which offer participation in relevant technological and market competence. Of course, locational decisions are not taken every day. Flight trends can hardly be observed in economic history. A major factor is orientation to the headquarters of the company or plant concerned. However, a comparison of locations in different countries and regions is a natural component of investment decisions in global business networks, which are becoming an economic reality. Long-term economic trends can be influenced by these decisions.

The clustering of high technologies can play an important role. It can be observed in many individual cases. Examples include scientific instruments in Cambridge (United Kingdom), musical instruments in Hamamatsu (Japan) or biotechnology in the Boston area (United States). In an overview, the OECD expects that globalisation of the world economy will lead to greater regional specialisation and further clustering of economic activities. The development of these clusters shows that co-operation, local advantages and regional innovation cultures play an important role in the innovation process. In a closely interrelated world economy those locations which will be successful, owing to their competence and openness, are becoming centres of information, communication and knowledge application.

On the whole it can be said that market, production and research competence must be combined. Where they are combined – for example in the automobile industry – Germany is becoming more attractive; a return of R&D capacities can even be observed there. It seems important for policy-makers to have a realistic idea of domestic specialisation patterns. One of Germany’s major locational advantages is usually considered to be the scope of German research. Greater participation in internationally mobile R&D capacities, however, requires above all that Germany also offers attractive market potentials and conditions for the production of high-quality goods and services.

Strengths in technological performance can mainly be found in capital goods markets (vehicle technology, automobile construction, mechanical engineering) as well as in the chemical industry. Many of the export strengths of German industry thus depend on a rather traditional range of goods. This aspect has for many years been discussed in analyses on the future of the technological performance of German industry. But, as has been shown, companies have repeatedly succeeded in upgrading a traditional range of goods by integrating high technologies and have thereby been able to open up new markets. By pursuing this strategy it proved possible to engage permanently in high-price and thus high-performance markets. The most recent case in point is the consolidated world market position of a number of motor-vehicle companies. In exports of research-intensive products Germany has a share of 16 per cent, while the comparable figures are 19 per cent in the United States and 21 per cent in Japan. In terms of its population, Germany is thus the leader in exports of research-intensive goods.

In this connection, outstanding and strategic areas of competence have been developed in recent years (for example, laser technology and robotics); Germany maintained its position in important traditional areas of competence (manufacturing technology, vehicle construction) and even regained ground in areas some had given up for lost (manufacturing of memory chips). Microelectronics focuses on fields in which close contact could be established with the traditional strengths of German industry, i.e. in telecommunications and motor car electronics, for example. What can be noted in addition is the emergence of new clusters of economic activity around core industries and related services. In contrast to what has often been supposed, the structural change towards the industry-based service society is taking place at relatively high speed in Germany compared to other countries.

According to a report by Arthur D. Little, Germany has a good potential compared with other countries on its way to the information society. A particular advantage is its extremely efficient telecommunications infrastructure. Over 100 000 km of optical fibre cable have been laid in Germany. Two point three million Germans now have access to the Internet – the growth rate in 1996 was 72 per cent. From 1995 to 1996, the number of direct online accesses in Germany grew by 42 per cent. Some 30 per cent of all private households use a computer; German households have a total of 7 million PCs. One in three ISDN accesses in place world-wide is located in Germany; Germany is currently a world leader in this category. The German research community has a high-performance research network. The Federal Government’s Telecommunications Act, which will enter into force on 1 January 1998, and its Information and Communication Services Act pave the way for liberalisation of existing networks and for the admission of providers of new media. Considerable market momentum is to be expected as a result.

The assets of our national innovation system must, however, not prevent us from considering continuing weaknesses. Such weaknesses include in particular a lack of reform in the higher education system and management – although some progress has been made recently. Another liability is insufficient innovation orientation in science and insufficient co-operation between science and industry. German industry did not fully engage in the establishment of innovative new firms in the 1960s, 1970s and 1980s, which slowed down its innovation dynamics. But what is most important is that German industry has on the whole not opened up those growth markets which would have been necessary for reducing the alarmingly high unemployment rate. The central task for the coming years is to change this situation. The positive indicators of technological performance show that there is a sound basis to build on.

Consequences of globalisation for national innovation policy

Innovation policy has to take into account the fact that locational factors differ between industries and fields of technology. A central task for innovation policy is to combine the research, market and production capabilities, to strengthen the regional ties of high-performance centres and to establish critical links. For practical innovation policy, those instruments gain in importance which have great locational pull, which are suited to preserve a location’s attractiveness when compared to other countries and which allow the best possible utilisation of the knowledge available world-wide. Globalisation is a major challenge for all areas of national innovation policy as well as for the organisation of international R&D co-operation. In the following, some policy fields will be described by way of example – fields which are trying to meet these challenges.

Support for innovative networks (centres of competence)

It would not be the right approach for the Federal Government to consider how regional technology centres could be planned or designed. Innovation policy can, however, provide incentives for competence networks to organise themselves. The Federal Government will increasingly do so in Germany in the future. One instrument to develop useful regional networks which was recently tested is the BioRegio competition. In the 1980s, research policy established a large scientific potential in the field of biotechnology. Among the 50 relevant research institutions most often mentioned currently are eight German institutions. But efforts were not sufficiently successful in linking this potential to the strong chemical and pharmaceutical industries in Germany. The BioRegio competition involves participation by 16 regions which compete for the best environment for turning biotechnological knowledge into products, processes and services. Numerous initiatives for the best possible networking of knowledge have emerged all over Germany. Biotechnology in Germany has started moving. German companies which some years ago shifted research and production to other countries are now investing again in Germany. Dynamic regions such as Munich or the Rhein-Neckar area, are gaining a new locational profile and demonstrate relevant technological competence to the world.

Another instrument developed is the so-called lead projects. Innovations increasingly need a broad network of participating companies and research institutions including producers and users of technology. Innovations emerge at the boundaries between scientific disciplines and the traditional activities of companies and research institutions. The lead project concept has been designed along these lines. The projects are to combine ambitious research tasks and a perspective for practical application. In addition they are to combine various disciplines and applications. Ideas competitions have been started inviting industry and the scientific community to submit joint project proposals in defined fields (innovative products based on new technologies, software for training and continuing education, applications in molecular medicine, improvement of mobility in conurbations). From a total of more than 500 different outlines submitted in these fields, independent juries have selected in a first round certain proposals which, in the second round of the competition, will be specified by their initiators and developed into concrete project proposals. The political community is not involved in the project definition phase. The competition has created partnerships between industrial enterprises, research institutions and government authorities which would not have joined forces outside lead projects. It can be expected that partnerships will continue even if the projects proposed are not approved for funding. The ideas concerning new mobility concepts have shown that consideration is no longer given to individual means of transport or infrastructures but to intelligent integrated mobility services. Germany and Europe can develop major potentials with innovative applications of telematics systems (traffic control technology) in conurbations, with the organisation of an environmentally compatible closed substance economy and with creative solutions for various public services. Lead projects at the national and European levels are to help create new, internationally leading markets.

More competition in higher education institutions and research institutions

Quite a few comments and studies focus on issues of access to, and definition of, national R&D programmes. It is claimed that they are levelling the playing ground, which seems to clearly overestimate the role of governmental R&D programmes. Public funding for R&D projects in companies has for some years amounted to approximately DM 1.5 billion. The major part of that money is used to support small and medium-sized enterprises as well as contract research carried out in the government’s interest. The remaining sums are allocated as seed money. Hardly any enterprise will link its long-term strategic decision to establish R&D capacities to participation in time-limited project funding. A major factor in enterprises’ investment decisions will rather be the long-term integration in dynamic R&D and innovation networks.

A central challenge is increasing the attractiveness of the public research infrastructure. Research institutions are to become not only centres of excellence but also catalysts for the utilisation and application of knowledge. Their attractiveness for co-operation with industrial enterprises is to be enhanced further. It is obvious that research institutions can meet new requirements only with the aid of new instruments and incentives. Ongoing reform activities imply that, with limited budgets, areas which are internationally leading in terms of performance can grow quicker than others and quicker than in the past. Peak performance must be worthwhile also in public structures. Stronger competition in the financing of research institutions will therefore be necessary. In the future, institutions should earn major parts of their budgets through projects. The decision on which projects are to receive support will be made not by the state but by the *Deutsche Forschungsgemeinschaft* (DFG, German Research Association) or the Senate of the national research centres. Thus the quality of the project proposals will determine whether the institutions are to grow in future or lose importance.

New thinking is required also in international co-operation. Research institutions should make their international attractiveness an explicit part of their business policy. The Federal Government supports them in their international commitment. A central element of the German research community is the Fraunhofer Society. It is unique in building bridges between science and industry. The Fraunhofer Society has always earned part of its revenue from projects with foreign contractors. It has developed further its international orientation via service and contact points. Now it is increasingly establishing its own institutes abroad. That step was carefully considered. The Fraunhofer Society’s activities abroad can account for 5 per cent of its basic funding. Anyone wishing to offer cutting-edge research at the international level must have an opportunity to learn at the world’s leading research centres. The host and the home country will benefit from such international activities of a research institution.

Higher education reform

The main pillar of education and science is the system of higher education. As a result of the globalisation of research and development, the systems of higher education are now competing for the first time. Students' contacts often become lifelong contacts; often they open opportunities for co-operation and tap the markets of tomorrow. For decades, the number of foreign students in Germany has been growing only slowly, however. The number of foreign students in the United States, especially Asian students, has skyrocketed over the past ten to 15 years. For this reason, one of the Federal Government's central aims is to enhance the attractiveness of studies in Germany. In autumn 1997 the structural reform of the higher education system in Germany gained momentum. After close co-ordination with the Länder and the institutions of higher education, the Federal Government adopted the draft of the fourth law amending the Framework Act for Higher Education as a federal legal frame for higher education reform. Priority issues include the introduction of performance-oriented financing of higher education institutions, the introduction of higher education and research evaluation, redefinition of the standard period of study as well as a greater share for the institutions in the selection of students for part of the study places (about 20 per cent).

Apart from the possibility of awarding the internationally recognised bachelor's and master's degrees, the development of a credit point system is of central importance for the national and international mobility of students and graduates and for the competitiveness of German institutions of higher education at the international level. The international exchange of students and researchers is of vital importance in view of European unification and global networking. Markets for services in the education sector are emerging world-wide. With a view to increasing Germany's international competitiveness in the education sector, the Federal Government has improved the administrative and legal framework for international students in Germany and launched a set of supporting initiatives. The reform measures meet with wide approval and support in higher education, science, industry and politics. They will contribute to removing existing deficits in studies and academic training, to increasing the efficiency and international competitiveness of German higher education and to open up better opportunities for higher education graduates on the increasingly international labour market. On the whole, there are excellent prospects – also owing to improved information – for enhancing the international attractiveness of German higher education institutions in accordance with their scientific and technical potential.

Technology transfer and start-up companies

Dynamic economic centres throughout the world are characterised by a considerable start-up dynamic. Improving the conditions for venture capital was therefore a priority goal of policy-makers in recent years. Small and new enterprises are very important for the economy's innovative capacity. The Federal Government stated at the beginning of the current legislative period that any committed individual with good ideas who is willing to assume entrepreneurial responsibility and risk must not be allowed to fail in Germany because he or she does not have the necessary capital. Some progress has been achieved. The market providing direct investment capital for new innovative companies has developed rapidly in Germany in recent years. Indicators show that take-off has been successful. For example, under the BMBF programme entitled "Direct investment capital for small technology-based enterprises" there has been a recent exponential growth in new companies with new forms of venture capital funding. In 1997 alone, about DM 4600 million in direct investment capital were provided under that programme – a new record. Within three years an increase by 400 per cent in the provision of venture capital for technology-oriented start-up companies was achieved – and the trend is still upward.

The provision of direct investment capital for biotechnology is booming. An amount of DM 565 million in private direct investment capital is now available for BioRegio activities alone. Never before has there been such a development on the German innovation capital market. The number of innovative hive-offs from research institutions is markedly increasing. With its third financial market promotion act, the Federal Government again considerably improved the environment for innovation funding. New stock market tiers are emerging. It is now important in Germany to introduce potential entrepreneurs to venture capital markets. The education system in Germany still has considerable deficits with regard to entrepreneurship training. Political measures and industrial initiatives should therefore aim to improve the provision of training for potential entrepreneurs. In this connection, a set of measures is currently being prepared ranging from entrepreneurship chairs at universities to academic competitions. The aim is to help German institutions acquire a reputation in entrepreneurship training.

Conclusions

No single policy will be able to enhance considerably the attractiveness of an innovation location. The relevant literature points to the relationship between various locational factors. Lead markets develop where an efficient technological environment, an attractive production environment and innovative demand on markets combine. An example of good practice is the introduction of cellular phones in Europe. Early on, the technological basis was established including a uniform GSM standard (a major contribution having been made by the Federal Government via its technology support). By liberalising the market, the Federal Government created a favourable environment in Germany. The cellular phone proved that the development and large-scale application of innovations creates jobs not only in production but also in upstream and downstream services. Between 1990 and 1996 the number of jobs increased from 1 600 to 30 000.

The introduction of cellular phones involved approaches which could also be adopted in other fields: supporting anticipatory research with a perspective for application, developing technology on the basis of relevant scientific and technical knowledge, establishing appropriate standards, deregulation, early provision of a proper framework for new fields of growth and development of a flexible institutional framework – these are the most important. The specific measures to be taken will have to be redefined regularly for the different sectors, technologies and branches concerned.

NOTES

1. However, there have been special developments in certain sectors. By the 1970s, the automobile industry had very much expanded internationally. For example, Volkswagen had established new factories in the United States. In the 1980s there was a marked decrease in such activities.

2. NIW, DIW, FhG-ISI, “SV Wissenschaftsstatistik”, *op. cit.* p. 47.

BIBLIOGRAPHY

BEYER, E., Division 113, *Economic Aspects in Education and Research*, Federal Ministry of Education, Science, Research and Technology, Heinemannstr. 2, 53175 Bonn, tel.: 49 228 573065, fax: 49 228 572096, e-mail: Engelbert.Beyer@BMBF.Bund400.DE.

BUNDESMINISTERIUM FÜR WIRTSCHAFT, REFORMEN FÜR BESCHÄFTIGUNG (1997), “Jahreswirtschaftsbericht 1997” (1997 annual economic report of the Federal Ministry of Economics).

DEUTSCHES INSTITUT FÜR WIRTSCHAFTSFORSCHUNG (DIW), (1996) (1994: preliminary data).

DEUTSCHES INSTITUT FÜR WIRTSCHAFTSFORSCHUNG (DIW), ZENTRUM FÜR EUROPÄISCHE WIRTSCHAFTSFORSCHUNG (ZEW) (1997), “Berichterstattung zur technologischen Leistungsfähigkeit Deutschlands 1996”, *Materialienband: Internationalisierung von Forschung und Entwicklung*, Berlin, Mannheim.

GERYBADZE, A., F. MEYER-KRAHMER, and G. REGER (1997), *Globales Management von Forschung und Innovation*, Stuttgart.

KLODT, H. and R. MAURER (1996), *Internationale Direktinvestitionen: Determinanten und Konsequenzen für den Standort Deutschland*, Kieler Diskussionsbeiträge.

KLODT, H., R. MAURER, and A. SCHIMMELPFENNIG (1997), *Tertiarisierung der deutschen Wirtschaft*, Kieler Studien 283, Tübingen.

SOETE, L. (1997), “Auswirkungen der Globalisierung auf die wirtschaftliche Integration in Europa”, in “IPTS Report”, special edition “Made in Europe”.

NIEDERSÄCHSISCHES INSTITUT FÜR WIRTSCHAFTSFORSCHUNG (NIW), DEUTSCHES INSTITUT FÜR WIRTSCHAFTSFORSCHUNG (DIW), FRAUNHOFER-INSTITUT FÜR SYSTEMTECHNIK UND INNOVATIONSFORSCHUNG (ISI), “WISSENSCHAFTSSTATISTIK IM STIFTERVERBAND FÜR DIE DEUTSCHE WISSENSCHAFT”, ZENTRUM FÜR EUROPÄISCHE WIRTSCHAFTSFORSCHUNG (ZEW) (1997), *Bericht zur technologischen Leistungsfähigkeit 1997* (Germany’s Technological Performance), Hannover, Berlin, Karlsruhe, Mannheim.

OECD (1997), *Science and Technology Indicators, Scoreboard of Indicators*, OECD, Paris.

OECD (1997), Globalization of Industry, Overview and Sector Reports, OECD, Paris.

GLOBALISATION OF INDUSTRIAL RESEARCH AND DEVELOPMENT: THE KOREAN EXPERIENCE

Myung Jin LEE and Sung Chul CHUNG, Science and Technology Policy Institute, Korea

Introduction

The industrialisation of Korea has been a process of learning how to absorb and improve upon imported foreign technologies for industrial development. Throughout the development period, especially in the early stages of development, the policy emphasis has been directed toward technology transfer as a means of technology acquisition, as opposed to indigenous technology development. As such, international co-operation has been an important part of science and technology policy in Korea.

With the fundamental changes in the international market as well as in the process of technological change, Korean industries have been seeking a new strategy for technology acquisition. In addition to their conventional efforts for acquiring technology from foreign sources, they began to locate their R&D operations overseas. Globalisation of industrial activities and research and development has now become a major business strategy not only for large scale conglomerates but also small and medium enterprises in Korea.

During the 1940s and 1950s, Korea depended upon foreign aid for the reconstruction of the nation which had been devastated and flattened by the colonial rule and the subsequent war. Korea, in the late 1950s, was one of the poorest economies of the world, with a per capita income of less than 80 dollars. It was only in 1962 that Korea launched the First Five-Year Economic Development Plan. On the basis of the plan, the government initiated industrial development projects focusing on light consumer-goods industries for import substitution and expanding exports of industrial goods to obtain foreign exchanges required for industrialisation. This plan also aimed to build such basic industries as electricity, transportation, fertilizers, cement, petroleum refineries, and chemical fibres.

Lacking in technological capability, however, Korea had to rely almost completely on imported foreign technologies for industrial development. Yet, in the face of a deteriorating foreign exchange situation coupled with the general public's sentiments against foreign capital, the government had no option but restricting technology imports and direct foreign investment, which are the major channels for technology transfer. The government, instead, brought in large-scale loans to finance the importation of capital goods and turn-key plants, which became the source of learning for the industries.[1] Shipbuilding and machinery industries were the only exceptions as they relied mostly on foreign licensing and technical consultancy as a means of acquiring technology.

Beginning in the 1970s, the policy focus shifted toward developing heavy chemical and machinery industries which are more capital- and technology-intensive. Both economic and political factors contributed to the policy shift. The oil-shock in the early 1970s aggravated the prospect of securing stable supplies of petroleum and petroleum products, and therefore the chemical industry was picked up as one of the strategic areas for development. On the geopolitical side, the Nixon Doctrine led to a partial withdrawal of US forces from Korea, which in turn increased Korea's defence burden. Korea had to respond to this by developing defence or defence-related industries which were in those days mostly heavy machinery-oriented. This strategic-industry-targeting policy was further reinforced by increased import protection for the strategic industries. This drive generated huge demands for advanced technologies, but due to the restrictive policy on foreign licensing and direct foreign investment, the major channels for technology transfer were largely blocked.

In the later part of the 1970s, as the foreign exchange situation improved, the government took a series of measures to gradually liberalise its restrictive policies in order to meet the demand for new technologies created by the massive investments in the heavy machinery and chemical industries.[2] Around the end of the 1970s, Korea suffered from a serious imbalance in the economy and severe problems of over-capacities in the strategic industries, all of which were caused by the excessive investments.

To improve the situation, the government gradually withdrew from actively engaging in industrial development from the beginning of the 1980s. The government, rather, promoted the role of market for the efficient allocation of resources while liberalising economic policies. In order to meet the technological requirements of Korean industries that had become increasingly complex and sophisticated with industrial development, the government also softened its restrictive policy on direct foreign investment and foreign licensing.[3]

During the 1980s, Korea completely liberalised, in a technical sense, technology imports through a series of measures. Since 1993, when the current government came into power, the focus of industrial policy has been placed on redressing the structural imbalance through minimising government intervention in industrial activity and facilitating technological innovation in the private sector. During this period, Korean firms began facing requirements to break into the international market and started quite different schemes for technology acquisition. Coupled with the deregulation and liberalisation policy and an indigenously grown technology base, companies started to establish overseas R&D bases, become involved in strategic technological alliances, and merged with and acquired foreign firms having advanced technology. In other words, Korean firms started to actively engage in technology outsourcing when they began externalising all of the available resources, both at home and abroad.

Korean experiences in R&D globalisation

Over the past 30 years, Korea's economic growth has taken on a "catch-up" form of growth. Firms imported advanced but mature technology, and by utilising domestic natural resources, they absorbed, improved and successfully applied them to the production process. Recently, Korean private firms have become involved in different and more active stratagems of research and development. In fact, one of the most conspicuous characteristics of the R&D activities of Korean firms has been the recent surge in R&D globalisation activities.

The most common motivations for globalising R&D activities are the following: *(i)* to monitor foreign technological developments; *(ii)* to acquire or generate new technology; *(iii)* to maximise use of specialised skills in a host country; and *(iv)* to support the needs of foreign production operations and the parent company. By spreading production, product development, and research components around the globe, multinational corporations can reduce the cost and risk of technological innovation. Korean firms in particular relieved the serious problem of limited R&D capacity and personnel. Leading Korean firms have invested in R&D subsidiaries abroad, established local R&D branches, merged and acquired foreign firms that hold advanced technology, and initiated strategic technological alliances with overseas firms.

Overseas research centres

Acquisition or maintenance of firm-specific technological capabilities relies on extensive contacts with external sources of expertise. These contacts require a physical presence because of the difficulties of transferring technologies through blueprints or conventional contracts. The globalisation activity of the Korean private firms in research and development by physically being present at the place of advanced R&D has been centred around two forms of overseas R&D centres. First, they invested and established local subsidiary R&D firms abroad. Second, they advanced in setting up branches of domestic research facilities abroad. The overseas R&D centres of Korean firms including both subsidiaries and branches are still in the developing stage with much room for improvement, but in several cases they are quite active in accessing local knowledge and personnel resources.

Since the late 1980s, Korean firms, mainly large conglomerates, have started investing abroad and setting up local R&D subsidiaries for the purpose of accessing to the advanced technology. They, 45 in total as of 1995, are located mainly in the technologically advanced and major trading partner countries, with 28 cases in the United States, eight in Japan, three in Russia, and two in Germany, China and others respectively (Table 1). Technology areas for these investments are mostly in hi-tech areas of electronics and communications (20), medical and biotechnology related (8), etc. The average investment is US$2.5 million with three large (more than US$10 million) and 18 small (less than US$1 million) cases. About half of them are invested by firms of the top 30 largest conglomerates (*chaebols*). Concerning personnel, they mostly employ a small number (less than ten) of researchers and some exceptional R&D centres employ more than 20 people with almost half of them being local residents. (Table 2).

Table 1. Overseas Korean research centres (as of December 1996)

Country	Overseas R&D subsidiary									Overseas research branch										Total
	1988	1989	1990	1991	1992	1993	1994	1995	st	1988	1989	1990	1991	1992	1993	1994	1995	1996	st	
United States	4	2	4	4	4	4	5	1	28			1	3			1			5	33
Japan			1	1	2	2	1	1	8	1			2			1	1		5	13
Germany				1			1		2					1		1		1	3	5
Russia			1		1		1		3						1				1	4
United Kingdom															1	1			2	2
China							2		2											2
Others	1						1		2									1	1	3
Total	5	2	6	6	7	6	11	2	45	1		1	5	1	2	4	1	2	17	62

Source: KITA (1997), Bank of Korea (1996).

Table 2. Research personnel of overseas Korean R&D subsidiaries

Area	Location	Ph.D	M.A.	B.A.	Dispatched from home	Korean resident	Foreigner
Electronics	France	1	3	3	3		4
Electronics	France			4	4		4
Electronics	England		1	7	4		7
Electronics	CA, US	2	2	3			45[1]
Electronics	CA, US	6	20	22[1]	2	1	4
Computer	NJ, US	1	2	4	2	1	
Medicine	CA, US						6
Metal	MA, US	6		1		1	

1. 22 and 45 includes five local part-timers.
Source: Suh and Lee (1995)[.1].

The Korea Industrial Technology Association (KITA) reported that the number of overseas branches of Korean firms R&D institutes is 17 as of the end of 1996 (see Table 1). Like overseas R&D subsidiaries, they were established starting in late 80's and, mostly in the 1990s. Firms from the electronics (10) industry set up the lion's share of overseas R&D branches, implying an active advancement of the large hi-tech firms for technology acquisition from wherever sources are available. Their establishment by country is: United States (6), Japan (4), Germany (2), United Kingdom (2), Russia (1), India (1), and most of them (14) are by large conglomerates. Again, firms locate R&D branches in the countries that are major trading targets as well as being technologically advanced; thereby, having abundant knowledge and personnel resources.

The majority of the responses to the survey by Suh and Lee (1995) as to the selection of the location are reported to be proximity to relevant research institutes for easy access to joint R&D activities. Other responses include favourable information gathering, supporting exports and local sales, and favourable investment environment as the reason for selecting the location. Responses to the question of function of the R&D branches are reported to be evenly divided between "R&D and information gathering" and "marketing support." Researchers working at the branches mostly number less than 20. Several branches employ a relatively higher portion of local personnel (Table 3).

When compared to overseas R&D branches of Fortune 500 firms (Fortune branches hereafter) and Japanese firms (Japan branches hereafter), the characteristics of the Korean R&D branches abroad become clearer.[4] Seventy five per cent of the Fortune branches were established before 1980, while all Korean branches were quite recently established, starting in the 1980s and mostly after 1990. More than half of Fortune (50 per cent) and Japan branches (58 per cent) are located in the United States, 35 per cent of them in Europe and only a few of them are in Japan, while Korean branches are spread almost evenly among the United States, Europe and Japan. The number of research personnel in the Korea branches is far smaller than those of the Fortune branches. About half of the Fortune branches and 7 per cent of the Japan branches employ more than 50 research personnel as opposed to less than 20 personnel for most of the Korean R&D centres abroad. Comparison of Korean overseas R&D centres to those of advanced countries indicates that they are in a developing stage with much room to improve.

Table 3. Overseas Korean R&D branches (as of December 1996)

Company	Place	Date	Research personnel			
			Ph.D.	M[1]	B[1]	T[1]
Samsung Electronics	Tokyo, Japan	87.9	-	-	6	6
Yukong	NJ, United States	90.3	5	-	-	5
Samsung Electronics	Osaka, Japan	91.1	-	-	5	5
Young Chang	MA, United States	91.1	-	5	11	16
Kumho Tire	OH, United States	91.11	1	3	4	8
Samsung Electronics	Hamamas, Japan	91.11	-	1	5	6
Kia Motors	MI, United States	91.10	-	1	5	6
Samsung Electronics	Steinbach, Germany	92.4	-	-	7	7
Samsung Electronics	Moscow, Russia	93.5	2	4	2	8
Dong-A Construction	London, United Kingdom	93.12	-	-	29	29
Samsung Corning	Berlin, Germany	94.7	3	5	-	8
Cosmo Laser	NY, United States	94.8	2	1	2	5
Samsung Electronics	Surrey, United Kingdom	94.9	-	-	6	6
POSCO	Tokyo, Japan	94.11	2	3	5	10
Standard Telecom	United States	95.3	1	5	6	12
Samsung Electronics	Bengalo, India	96.5	-	1	4	5
POSCO	Dusserdorf, Germany	96.5	3	-	3	6

1. M: Master's, B: Bachelor's, T: Total.
Source: KITA (1997) and Suh and Lee (1995).

Table 4 shows the general picture of the overseas R&D centres including both subsidiaries and R&D branches. Out of a total of 51 centres abroad, 24 centres are located in the United States, while there are 12 in Japan, 13 in Europe and two in Russia. They are mostly in the fields of electric and electronics (31) and automobile related (9) and three quarters of them (38) belong to large conglomerates.

Table 4. Overseas Korean R&D centres

	Electric & Electronics	Automobile	Others	Total
United States	15	4	5	24
Japan	8	3	1	12
Europe	7	2	4	13
Russia	1	-	1	2
Total	31	9	11	51

1. Numbers in the cells denote number of centres.
Source: Suh and Lee (1995).

Korean R&D facilities in the United States, whose characteristics are a good indication of focus of the Korean overseas R&D, are also mainly in the fields of electronics (computers, software, semiconductors, HDTV) and automobile related (see Tables 5 and 6). Korean R&D in the United States in terms of the number of facilities is ranked seventh in 1995 right next to Switzerland and the Netherlands and followed by Sweden. Considering Korea's low overseas R&D expenditure ratio, this indicates Korean firms' strong intention of accessing advanced technology.[5]

Table 5. US R&D facilities of foreign companies

Industry	Japan	United Kingdom	Germany	France	Switzer-land	Nether-lands	Korea	Sweden	Total[1]
Computers	22	-	4	-	-	3	7	-	39
Computer software	27	6	4	3	-	1	1	-	43
Semiconductors	19	-	3	-	-	2	10	-	37
Telecommunications	15	2	4	2	1	-	1	2	30
Optoelectronics	11	2	3	-	-	-	-	1	20
HDTV, other electronics	33	10	9	4	5	4	4	-	72
Drugs, biotechnology	25	23	18	11	17	5	1	6	115
Chemicals, rubber	24	19	28	17	10	4	-	-	110
Metals	5	3	1	4	1	-	-	1	18
Automotive	34	1	11	2	-	-	3	2	53
Machinery	7	4	2	3	-	-	-	6	25
Instrumentation, controls	1	23	3	6	6	3	-	1	43
Foods, consumer goods	7	19	6	2	6	7	-	1	55
Total	230	112	100	54	46	29	27	20	660

1. Total: includes others.
Source: Dalton and Serapio Jr. (1995).

Table 6. Korean R&D facilities in the United States

Company	Location of Facility	R&D Activities
Daewoo	Santa Clara, CA	Computer research (1988)
LG Electronics	Goldstar Electronics, San Jose, CA	Semiconductors and DRAMs (1983)
LG Electronics	United Micro Tech, NJ	Semiconductors, PCs (1984)
LG Electronics	Phoenix, AZ	Advanced wireless telecom equip. (1990)
LG Electronics	North American Lab, Chicago, IL	HDTV (1991)
LG Electronics	Zenith Electronics, Glenview, IL	Color TV, HDTV, picture tubes
LG Electronics	GSEA, San Diego, CA	Semiconductor technology survey
Hyundai	Detroit, MI	Automotive (1986)
Hyundai	Los Angeles, CA	Auto design centre (1989)
Hyundai Electronics	NCR-Microelectronics Products, Fort Collins, CO	ASIC devices, communications Ics, VLSI fabrication (1994)
Hyundai Electronics	NCR-Microelectronics, CO	SCSI controllers, software drivers (1994)
Hyundai Electronics	SEMR Research Institute, CA	Hard disk drives (1995)
Hyundai Electronics	Maxtor, San Jose, CA	Hard disk drives (1995)
Hyundai Electronics	Maxtor, Longmont, CO	Hard disk and tape drives (1995)
Kia Motors	Detroit, MI	Automotive (1989)
Lucky	Lucky Biotech, Emeryville, CA	Genetic engineering, biotechnology
Samho Computer	CA	Computer research (1989)
Samsung	Advanced Media Lab, NJ	HDTV (1988)
Samsung	Samsung Semiconductor, CA	256K DRAM design (1983)
Samsung	US PC R&D Center, San Jose, CA	Next generation PCs (1990)
Samsung	Boston, MA	Computer research centre (1988)
Samsung	Samsung Software, Andover, MA	Customised software development
Samsung	AST Research, Irvine, CA	Personal computers, peripherals (1995)
Samsung	Harris Semiconductor, NJ	Semiconductors (1994)
Samsung	Harris Semiconductor Products, Melbourne, FL	Integrated Circuits, CMOS, PROMs (1994)
TAE IL Media	National Micronetics, NY	Solid state ferrite tech., recording heads
Young-Chang Akki	Young-Chang Boston Research Institute Boston, MA	Synthetic sound, multimedia chips (1990)

Source: Dalton and Serapio, Jr. (1995).

The above findings in combination show that Korean overseas R&D centres are still in the neophyte stage in terms of the establishment period, the number of personnel, and the roles they are performing. Their location is centred around countries that have advanced technology and are Korea's major trading partners, implying that there is the dual purpose of gaining access to knowledge and personnel resources for the advanced technology and supporting parent firm's export products into the local market. Some centres are located in less developed countries, such as Russia, and help the parent company to better understand these rapidly changing markets and to take advantage of the skills of highly educated researchers and designers. The centres are, in many cases, established by large firms involved in developing and producing hi-tech products.

Inducement of foreign R&D institutes is another valid mode of technology acquisition and a good index of evaluating national ability to nurture specific technology-based capabilities. The Korean Industrial Technology Association lists R&D centres of foreign firms' subsidiaries stationed in Korea based upon their registration. Their activities are minimal in terms of number of researchers and the budget scale, except for few cases. Foreign contribution ratio in local industrial R&D in Korea is also quite low. This rate is measured by R&D expenditure of foreign firms stationed in Korea over total domestic industrial R&D expenditure. Compared to Belgium, Germany and England (15 per cent); Australia and Canada (45 per cent); Ireland (70 per cent), and United States (15 per cent); foreign firms' contribution to Korean industrial R&D is lowest at 0.02 per cent indicating lack of a proper R&D infrastructure.

Mergers and acquisitions

Merger and acquisition by Korean firms of foreign firms with advanced technology is another mode of R&D globalisation activity that has recently started to take place. Usually, it involves large-scale investment, yet at the same time holds the expectation of the instant benefit of acquiring advanced technology and research personnel.

Recent technology-related M&As by Korean firms rank the highest among major foreign direct investment cases (see Table 7), suggesting that Korean firms have the ambitious intention of acquiring needed technology fast. They are centred around US firms with hi-tech technology which are facing financial difficulties. In some cases, large Korean conglomerates have spent more than US$300 million to acquire firms possessing advanced technology and research personnel. AST by Samsung, Maxtor by Hyundai, Zenith by LG, and AT&T GIS by Hyundai are highly publicised examples.[6] Daewoo, the other one of the four largest conglomerates), shows a different strategy and invests mainly for marketing and sales purposes as opposed to acquisition of technology and personnel. Considering the huge investment required, it is not surprising to find out that small- and medium-sized Korean firms are rarely involved in these M&A investments.[7]

Korean firms investing heavily and acquiring US technology-intensive firms expected instant injection of US technology and brand loyalty, plus American management and marketing expertise. However, the result so far is not so promising. One of the main difficulties that the acquiring Korean firms have faced was managing foreign (local national) workers. Many local staff and even local bosses, who were main targets of the acquisition, departed after Korean firms' acquisition.[8] Moreover, due to business difficulties afterwards, several ambitious investments were stopped and even withdrawn.[9] There are criticisms that many overseas M&As are not based upon precise cost and benefit analysis but rather a result of pursuing external expansion. Under the current financial crisis of the Korean economy, the strategy of acquiring foreign firms with huge investment would not continue at least for a while.

Table 7. Major Korean overseas investments

Investor	Year started	Target Company	Equity (%)	Investment ($m)	Type
Samsung[1]	1995	AST Research, United States	46	438	personal computers
Hyundai[2]	1993	Maxtor, United States	60	380	disk drives
LG[3]	1991	Zenith, United States	57	366	consumer electronics
Hyundai	1994	AT&T GIS, United States	100	340	non-memory chips
Cheil Jedang	1996	Dream Works SKG, United States	n.a.	300	movie
Daewoo[4]	1995	FSO, Poland	40	280	passenger cars
Samsung	1994	FGT, Germany	100	260	glass bulbs
POSCO	1984	UPI, United States	100	246	steel
Sammi	1989	Atlas Steel, Canada	100	210	special steel
Daewoo	1994	DCM, India	50	190	passenger cars
Yukong	1987	Indonesia	50	188	oil
Hundai	1986	Hyundai Auto Canada, Canada	99.7	184	cars and parts
LG	1977	LG Electronics America, United States	100	184	electronics trade
Daewoo	1992	DAEHA, Vietnam	70	163	hotel
Daewoo	1995	Rodae Automobile, Romania	51	156	passenger cars and engine
Samsung	1995	Inversiones Hispano, Netherlands	100	147	electric telecom service
Samsung	n.a.	Entel, Chile	15	147	telecoms
Hyundai	1985	Hyundai Motor America, United States	100	141	car trade
Samtan	1982	Kideco Jaya Agung, Indonesia	100	131	coal
Daewoo	n.a.	FAW, China	50	137	car engines
Samsung	1978	Samsung Electronics America, United States	100	129	electronics trade
Orion	1993	Orion-Hanel, Vietnam	70	122	monitor
POSCO	1994	Japan,	100	111	real estate
Daewoo	1993	UZ-Daewoo Auto, Uzbekistan	50	100	passenger and commercial cars
Korean Air	1989	Hanjin Int'l, United States	100	99	real estate
Samsung	1994	Samsung Electronics Holding, Germany	100	93	electronics trade
Korea Air	1991	Japan	100	88	real estate
Poongsan	1990	PMX Ind. United States	88	74	copper
Daewoo	1988	Societe Algerienne D'hotellerie, Algeria	49	71	hotel
Hyundai &	1985	North Yemen	25	67	oil
Samsung	1990	Samsung Electron Devices, Malaysia	100	65	TV monitor
LG	1995	LG EDD Indonesia, Indonesia	100	63	TV monitor
Sunkyong	1990	Sunkyong Keris Indonesia, Indonesia	85	63	polyester
Daewoo	1974	Daewoo Int'l, United States	73	56	trade
Samsung	1995	Union Optical, Japan	50	57	optical
SsangYong	1988	SsangYong Pacific, United States	100	54	cement
Daewoo	1994	Nile Int'l, Sudan	100	51	cotton yarn
Samsung	1995	Integrated Telecom		9	ATM chip
Dongwoo	1992	Int'l Metrology Systems, Scotland	100	2.8	3-D measuring instrument

1. Samsung acquired 8 per cent of AST Research in 1995 for $ 75 million, invested $ 360 million more in 1996 raising its stake to about 46 per cent.
2. Hyundai acquired 40 per cent of Maxtor in 1993 for $ 150 million, pumped $ 230 million into the loss-making company in 1996 holding 60 per cent.
3. LG purchased 5 per cent of Zenith in 1991 for $ 15 million, raised its stake to 58 per cent for $ 351 million in 1995.
4. Daewoo's investment in FSO in Poland is reported to increase to $ 1 100 million. (Maeil Business News, Jan. 3, 1997).

Sources: Adapted from *The Economist* (October 5, 1996), Bank of Korea (1996), *Fortune* (October 28, 1996).

Strategic technological alliances

Strategic technology partnership denotes inter-firm agreements for which joint R&D and/or other innovative activities are a major objective, and that can reasonably be assumed to affect the long-term product market positioning of at least one partner.[10] In other words, strategic alliances among firms for the development or manufacture of new products often are based on the effort of participants to combine their complementary technological and other skills. Technology-motivated strategic alliances can take the forms of licensing, cross licensing, technology exchange, technology sharing, joint development, and second sourcing.

Recently, Korean firms, mainly the *chaebols*, started allying with foreign firms on equal terms, or based on mutual benefit (see Table 8). One major motive for cross-border alliances by Korean firms is to gain access to core technologies possessed by their alliance partners. However, to maintain a mutually beneficial business relationship with alliance partners, Korean firms must offer as a *quid pro quo* some form of complementary asset, such as manufacturing capabilities, market access and the like as opposed to unilaterally importing technology.

Table 8 lists the available technology alliance cases and, therefore, is not exhaustive. Observation of the listed cases indicates that this mode shares similar characteristics with the other two modes of R&D globalisation discussed above. Since the last half of the 1980s, they are initiated exclusively by the largest Korean firms with firms from the United States and Japan, and are mostly centred in the fields of electronics and others including aeroplane, chemical and automobile. After 30 years of unilaterally importing technology, Koreans firms are finally in a position to have something to offer. As shown in the table, Korean semiconductor firms, in several cases, offer large production capacity in return for core technology, patents, or duty exemption.

A new strategy for technology acquisition

Korean firms have started several different types of overseas R&D activities encouraged partly by the deregulation and liberalisation of public policies. What is the management motivation behind this advancement? Although the productivity of an economy can be elevated through such measures as pursuing efficacy of capital distribution, bringing about economies of scale, policies on adjusting government structure and ensuring effective management of industry; in the long term, it largely depends on the intellectual ability of an economy, or in other words, technological advancement or capability. The current stage of Korea’s economy is now at a turning point in terms of educating to raise intellectual capability.

As technological innovativeness in an economy appears to operate as consolidation of the human dimension, industrial technology and economic structure, it is difficult to make measured comparisons of any one. Globalisation of advanced industry is largely based on the relative superiority of the technology it occupies, which is not applicable to the globalisation of Korean industry. Describing the character of the growth of Korea’s economy as quantitative growth is important in understanding the growth of Korean industry. The industrialisation of Korea fundamentally began in the 1960s. Therefore, modern growth of Korean industry is the same as the process of industrialisation of the economy.

Table 8. Recent Korean technology alliances

Activities	Subject	Remarks
Samsung Air – Pratt, United States, 1985	PW4000 engine joint development	
Samsung Air – Northrop, 1986	Aeroplane parts production	
Samsung Air – De Havilland, 1989	DASH-8 production	
Samsung Air – Boeing, 1989	Aeroplane parts production	
Samsung Electronics and Hewlett Packard, US, 1990	RISC Workstation development and sales	HP supplied needed technology
LG–Hitachi March 1990	1M DRAM chips production	*Hitachi: for additional production facilities for 1M DRAMs, *LG: to acquire chip technology and strengthen its technology capability so as to catch up with Samsung in the DRAM race
Samsung – Toshiba December 1992	Development of flash memory chip	*Toshiba: needed Samsung's production strength *Samsung: for Toshiba's technologies and patents
Samsung-General Instrument, US, January 1993	Broad-band agreement of HDTV chips	
Samsung – OKI, February 1993	16M synchronous DRAM	Samsung: technology transfer to OKI
Samsung-Array, US, April 1993	Digital signal programming chips	Joint development
Samsung-Mitsubishi, July 1993	Dashed DRAM	Standard setting
Samsung-Micron Technology, US, November 1993	Second sourcing	Samsung: 16M synchronous DRAM MT: triple-port Asynchronous DRAM
Samsung-General Electric	HDTV chip	Joint development
Samsung-Toshiba, November 199J	LCD-motivation integrated circuit	Joint development
Samsung-AT&T, 1993	Notebook PC joint development	Samsung: development, production AT&T: sales
Samsung-Tokin, Japan, 1993	Ferrite production and sales	
Samsung Air-Lockheed, 1993	F-16 fighting plane parts manufacturing, assembling	
Samsung-IBM, 1993	Desktop PC joint development and sales	Samsung: production IBM: sales and marketing
Samsung-Texas Instrument, January 1994	Joint production (Portugal assembly factory)	Samsung: DRAM (4M, 16M) TI: Logic
Samsung-NEC March, 1994	DRAM (256K)	Joint research
Samsung-ARM, US, May 1994	Microprocessing unit	
Samsung-ISD, US, September 1994	Voice signal process chips	
Samsung-General Instruments, US, 1994	HDTV	Samsung: development, manufacturing GI: technology support

Table 8. Recent Korean technology alliances (continued)

Activities	Subject	Remarks
Samsung Automobile-Nissan, 1994	Passenger and commercial vehicle production	
Samsung Chemical-Plastmassy Research Centre, Russia, 1994	Seven-linear-ester plastic additive manufacturing	
Samsung-Toshiba, January 1995,	Technical exchange for memory and non-memory chips	Samsung: memory technology Toshiba: Bipolar processing, HDTV IC
LG Semicon-Synchrowork (Japan) Alliance, 1995	Establishing joint ASIC design centre in Japan	*Plan to design ASICs in Japan, produce them in Korea, and export them back to Japan
Samsung-NEC February 1995	Production collaboration of semiconductor chips for the European market	*Samsung: to avoid duties of 14 per cent on memory chips imported into the European Union *NEC: be assured of Samsung's supply of certain memory chips in times of strong demand for DRAM chips
Samsung-Fujitsu, April 1995	Technical exchange for TFT-LCD	
Samsung-Toshiba, April, 1995	Development of 64M flash memory	
Samsung-General Instrument, June 1995	Semiconductor for multimedia instrument	Joint development
Samsung-Siemens, November 1995	Smart card IC	Sharing technology, joint development
Samsung-NEC, November 1995	Micro-controller (16bit)	Joint development, sales
Samsung Electronics and Dancall, Denmark, 1995	DCS 1800/GSM mobile telecom joint development	
Samsung-NEC January 1996	16M Synchronous DRAM	Standardization, brand use
Samsung-SGS Thomson, January 1996	Multimedia instrument non-memory, 16bit DSP, 32 bit MICOM	Joint technology development
Samsung-Sun Microsystems, May 1996	Java One (Network semiconductor)	

Sources: *Adapted from KIM, Wan-Soon (1996), *Financial Times* (Feb. 7, 1995), Bank of Korea (1996), *Korea Economic Weekly* (May 1, 1995), and http://www.samsung.co.kr/present/global/alliances.html.

Growth of Korea's economy over the past 30 years took on the form of "catch-up growth" involving the introduction of advanced but mature technology. Korean industry, then, utilised existing natural resources, and absorbed it into the production process and improved it rather successfully. The advanced technology introduced in Korea from abroad, later combined with domestic resources, was a significant contribution in creating comparative advantage in the world market. Korea's industry came to establish economic compatibility in the world market through such domestically available resources as low wages and maximal utilisation of equipment, more than that of the advanced countries while it generally still depends on core technology from abroad. From this perspective, Korea has sustained her economic compatibility without a compatible technology (or knowledge) base.

However, as time goes by, the existing factors of comparative advantage are beginning to disappear partly as a result of domestic labour disputes and the pursuit of the neighbouring underdeveloped nations. This is reflected in the change of Korean industry's strategy for acquiring technology in sustaining economic compatibility and furthermore achieving economic superiority in the world market. The importance of making efforts to develop technology on its own, which has been relatively neglected until recently, is now largely acknowledged.

The fact that private industry is attempting vigorous research and development abroad is very encouraging although it is merely beginning. The research and development activities of private enterprises abroad is not only industrial activity abroad that penetrates the crack in the market in accordance with economic structural advancement, but is an attempt to sense the necessity in the industrial dimension that without technical superiority a firm cannot be competitive. This is in accordance with the fact that Korean firms are beginning to compete with industries of the advanced nations in the world market.

Conclusions

The significance of private industry's research and development activity abroad, viewed from the management strategy perspective of industry, is that it gives a competitive advantage (competitive superiority) in the world market and especially in the markets of the advanced nations. Private industry's research and development activity abroad is based on the recognition that without technological superiority, industry is not able to compete, as industry abroad must compete with the industry of advanced nations in accordance with the structure of the economy developing into that of an advanced nation.

Private industries are establishing research and development activity abroad as a means to overcome this technological barrier: *(i)* when they want to export as their own brand rather than the OEM method; *(ii)* when hi-tech industries of advanced nations become reluctant to transfer technology; and *(iii)* when their product competitiveness is lost due to technology superiority of advanced industry. When seen from the perspective of technology acquisition strategy for Korea's economy, which is at a turning point, it can be seen as a new attempt to depart from the conventional technology acquisition process used up until now. From this perspective, private industry's spontaneous drive to do research and development activity abroad is very desirable.

Until now research and development has been centred on development more than research, that is more strictly speaking, on improving the obsolete technology from abroad. Further, discussion about technology acquisition now focuses on technology transfer mainly from the point of the user. One reason is that the objective of Korea's economic development has been to catch up with the advanced nations, which is attributed to "catch-up growth". However, viewed from the point that the Korean economy is transforming into that of an advanced nation, time is ripe to address the issue of technology acquisition as an innovator as opposed to a follower. In industry where the speed of innovation is faster, and technology standard is undecided especially, the advanced nations' industries become more selective in transferring their own technology. They transfer technology as a means of setting up partnerships for the future and, accordingly, even avoid transferring technology to industries that do not have the proper knowledge base high enough to absorb it.

Therefore, the following points are necessary to differentiate the differences in strategies to acquire technology as a follower and strategies to acquire technology as an innovator: *(i)* research and development at the place where technology exists; *(ii)* long-term perception about research and development; and *(iii)* a technology mechanism. According to the latest research findings on technology import, the reasons most private industry opted to import technology instead of developing it themselves are: 52 per cent, lack of ability to develop; 38 per cent, not enough time; and 18 per cent, both too risky and uncertain.

What also resulted from interviews with those persons responsible for the research organisations and subsidiaries abroad is that accumulating technology by acquiring technology adds to the causes indicated above and reveals the motivation to learn source technology from abroad rather than overcoming these limits. Until now, especially from the domestic research and development viewpoint, leaning towards development rather than research results in not being able to accumulate either source technology or core technology. Compared to this, private industry's research and development abroad is doing comparatively more compared to domestically. Therefore, in order to accelerate the research and development activity abroad which takes longer for the results to be accomplished for evaluation, both the government and private industry will have to promote this activity over the long term.

We need to stress the ability to create markets as a result of new technology. That is, the capability for technology marketing is an area where past experience in Korea's industry just does not exist. In the case of a minority of Korea's industries that have a technological superiority base in the world market, the ability for technology marketing has rarely been developed at all. The prominent industries of advanced countries now guiding the world market not only possess advanced levels of technology but also the technology marketing capability to produce products as they like and make them standards in the market. It needs to be stressed that these foreign industries consider the task of setting standards in the market from the start of research and development.

NOTES

1. The Foreign Capital Inducement Act of 1966 regulated technology inflows for which the contracting period is longer than one year and payment is by foreign exchange. The Act encouraged FDI by assigning no limits to the amount of investment and assuring the remittance of returns on investment.

2. Enactment of Technology Development Promotion Act of 1972 and the revision of the Foreign Capital Inducement Act in 1973.

3. In 1984, under the Foreign Capital Inducement Act, examination for individual technology import was abolished, and a reporting system replaced the approval system. Under this system, technology imports were almost automatically allowed. Liberalisation of technology imports proceeded by 11 revisions of the Act during 1978 to 1997. In 1995, all technologies except nuclear and defence related can be transferred even without reporting to the government.

4. Comparison is based upon Suh and Lee (1995) and Pearce and Singh (1992).

5. Overseas R&D expenditure ratio is measured by the overseas R&D expenditure over total R&D expenditure of the private firms. For Korea the ratio is 6 per cent, while for the Netherlands and Belgium, 50 per cent+; England, Switzerland, Sweden, Finland, Norway, 30-40 per cent; Germany and France 15 per cent (OECD 1997, STEPI 1997).

6. See for example “Guess Who’s Betting on America’s high-tech Losers”, *Fortune*, October 28, 1996.

7. Dongwoo, a typical SME, is one of the few exceptions and acquired International Metrology Systems of Scotland for $2.8 million in 1992.

8. Local bosses of AST Research and Zenith left companies under new management.

9. The liquidated investment cases are 73 with US$646.2 million, which is 15.5 per cent of the total investment in 1996.

10. GUGLER and DUNNING (1993).

BIBLIOGRAPHY

CHUNG, S.C. and L.M. BRANSCOMB (1996), "Technology Transfer and International Cooperation," in Branscomb and Choi (eds.), *Korea at the Turning Point*, Prager.

DALTON, D.H., and M.G. SERAPIO, Jr. (1995), *Globalizing Industrial Research and Development*, US Department of Commerce, Office of Technology Policy.

GUGLER, P. and J.H. DUNNING (1993), "Technology Based Cross-Border Alliances," in R. Culpan (ed.), *Multinational Strategic Alliances*, Haworth Press, Binghamton, New York.

KIM, W.-S. (1996), "Globalization and Strategical Alliance Among Semiconductor Firms in the Asia-Pacific: A Korean Perspective," KIEP Working Paper No. 96-01, Korea Institute of International Economic Policy (KIEP).

KOREA INDUSTRIAL TECHNOLOGY ASSOCIATION (1997), *Management Handbook for Private Research Center* (in Korean).

OECD (1996), *Reviews of National Science and Technology Policy: Republic of Korea,* OECD, Paris.

PATEL, P. (1995), "Localised Production of Technology for Global Markets," *Cambridge Journal of Economics* 19.

PEARCE, R.D. and S. SINGH (1992), *Globalizing Research and Development*, Macmillan Press.

SUH, J., and M. LEE (1995), *Overseas R&D Activities of Private Firms: Status and Tasks*, Science and Technology Policy Institute (in Korean).

INTELLECTUAL PROPERTY RIGHTS

INTELLECTUAL PROPERTY PROTECTION: A BUSINESS VIEWPOINT

Joseph F. VILLELLA, Jr., IBM World Trade Asia Corporation

A prerequisite for international technology co-operation is strong intellectual property protection. This includes a system of broad protection for patents, copyrights, trademarks, trade secrets, and designs as well as more narrow protection for plant varieties and semiconductor mask works. It is essential that all of the above forms of protection be available and work together in a compatible way.

A good example of how various types of protection work together is the protection of software. The development of an information economy and society depend heavily on software innovation, which is protected concurrently by copyright as well as by patents, trade secrets, and trademarks. All forms of protection are important and all must work well together. Indeed, innovation in information technology is a major force in assisting innovation in all industrial sectors. My primary focus today however will remain on the impact of patent protection on innovation and technology development.

Strong intellectual property protection balances the benefits that products and technologies provide society with the need to provide incentives for continued innovation and an environment in which that innovation is rewarded. This protection induces innovators to develop and bring their technologies to the market place. The historical record in the industrialised countries of the OECD demonstrates that intellectual property protection has been one of the most powerful instruments for economic development, export growth and the diffusion of new technologies. Today’s challenge is to ensure that:

- all countries set high standards of intellectual property protection and enforcement in their national laws and effectively support and enforce the standards once the improved laws are in place;
- all countries recognise the special intellectual property needs of industrial sectors whose inventions, because of regulatory requirements, reach the market place with considerable delay after patent grant; and
- that intellectual property protection is maintained and updated appropriately in today’s rapidly changing technological world.

Companies like IBM require a high level of effective intellectual property protection world-wide, including substantial reductions in the escalating costs of acquiring, maintaining and enforcing intellectual property rights. It is also essential that we have non-discriminatory regimes that are conducive to full market access for intellectual property-protected products throughout the world. It is recognised that the means and political will for such cost reductions will be facilitated by a move towards uniform systems such as a patent system with the same specifications and claims for all countries. This uniformity would then be able to benefit from a common data base and a standardised novelty search with universal recognition of the search results. Taken together, all of these improvements would lead to greater legal certainty and hence to greater investment in technology. Legal uncertainty on the other hand often has a chilling effect on investment. IBM supports the harmonization of the criteria for obtaining patents. The following 12 specific items should be considered in the development of an efficient system among the OECD countries:

Adoption of first-to-file

Currently the United States is the only major country to follow a first-to-invent rather than a first-to-file patent system. This has resulted in cumbersome "interference" proceedings to determine who actually invented first. These proceedings are expensive, require years to complete and require inventors to maintain detailed records that will show the date that an invention was conceived and subsequently reduced to practice. IBM urges the United States to move to a first-to-file system as part of an overall harmonization effort. We recognise that some parties, especially small inventors, feel they will be hurt by such a system, but the evidence, as shown that first-to-file has worked well in other countries and should work well in the United States.

Early disclosure of patent applications

Publication of a patent application 18 months after its effective filing date presently occurs in most countries except for the United States where patent applications are kept secret until the patent is issued. Pending legislation in the United States would partially correct this and we feel strongly that it should be passed and subsequently that the publication rules be harmonized on a world-wide basis.

Adoption of grace periods

Grace periods permit an inventor to file for his invention for a limited time, even though he or she may have made the invention public. It is unfair to strip an inventor of the right to file simply because he or she, perhaps inadvertently, discloses the invention through publication, public use or public sale. A system of grace periods has worked well in the United States and should be harmonized and implemented world-wide.

Continued prior use is another right under a number of major patents systems but has not been implemented in the United States. Pending legislation in the United States would establish such a right and IBM feels strongly that it should be implemented. While some groups, such as small inventors oppose this, we feel that the pending legislation strikes a balance between protecting inventors and protecting industry by only granting prior use rights to entities that were using the invention at least one year before the filing of the patent application. There is no uniform industry position on grace periods. Some members of industry believe that too long a grace period leads to uncertainty.

Improvements in the process for challenging granted patents

Processes like re-examination in the United States or post grant opposition in Japan are essential to provide an administrative system to challenge patents that is cheaper and faster than litigation. It is essential that the challenger be able to participate fully in the proceedings and that the results can be appealed by either party to the courts. Safeguards should be added to prevent abuse of this type of proceeding by preventing multiple use of the proceeding for the same issues. Pending legislation in the United States would make such changes to the re-examination proceeding in the United States.

Modernisation of foreign filing license systems for patent filings abroad

Some systems are currently cumbersome and inhibit filings outside of the country of origin of the invention. We recognise, however, that this must be balanced by the legitimate security concerns of the country where the invention was made. However, the rapid globalisation and movement of technology should help dissipate such concerns as time goes on.

Improvements concerning validity and effective technical scope of the patent right

Rules for novelty and obviousness should be harmonized around the world. This also applies to rules, such as the doctrine of equivalents, that define the scope of the claims. The validity and scope of a patent should not vary from country to country, but rather should be uniform on a world-wide basis.

In addition, improvements in the laws and civil and administrative procedures governing the enforcement of patent rights including adequate damages and other remedies such as injunctions for infringement are needed. It is important that patent owners have a full range of adequate remedies and that infringers do not find it easy and financially beneficial to continue these unlawful actions.

Practice of "discovery"

In patent infringement suits, it is often only the infringer who possesses all of the facts necessary to prove infringement. This is especially true for method patents where it is often impossible to determine how a product was made from looking at the product itself. There is no uniform industry position on discovery. IBM believes that the practice of discovery should be adopted. Others think that the cost of discovery deters innovation.

Patent costs

Reduction in government fees for obtaining patents and in the number and extent of required translations, possibly with a stipulation that translations of the entire patent only be required when a infringement suit has been filed, is also needed. It is currently estimated that it costs more than US$ 140 000 to have a patent application mature into a patent and then be maintained for its entire duration in the five EPC countries, Japan and the United States. This cost seems highly excessive and discourages the wide dissemination of technology. IBM urges that patent fees be set in all countries at a level just sufficient to cover the costs of operating an effective and efficient patent system and that patent fees no longer be used to raise general tax revenues the way they are today.

OECD and non-OECD countries

Countries seeking accession to the OECD should be required to provide the highest levels of intellectual property protection and enforcement at the time of their accession. Membership in the Patent Co-operation Treaty should be promoted in order to realise an international standard of patent examination.

Developing nations and least developed nations should abide by the provisions of the WTO TRIPS treaty and provide, at the very latest, by the end of the transition period granted, (by the year 2000 and 2006, respectively) the legal and administrative structure, procedures and remedies required to achieve the minimum standards for effective intellectual property rights enforcement. Those governments of developing countries or of economies which have recently accomplished their transition to a market-based environment, although recognising the importance of adopting strong intellectual property legislation, may face many operational problems – such as effective patent examination and enforcement – as they seek to build up their industries and intellectual property infrastructure. For example, low quality of patent examination adversely affects industry as patent holders have a less certain right and patents that should never have been issued provide barriers to other innovations. It is incumbent upon the OECD Member governments and their industries to support the provision of technical assistance, both on bilateral and multilateral bases, for the purpose of, for example, improving the quality of patent examination, establishing domestic or, preferably, regional patent and trademark offices and the proper training of police, judicial and customs officials in the enforcement of intellectual property rights.

Positive action by government officials towards eliminating counterfeit or imitation goods is necessary. Action against imitation goods, especially in developing nations, should not however be limited to government organisations. Education of and recognition by the public is indispensable. The need for public education is universal and not limited to just a few countries.

International organisations

IBM believes that the WTO, WIPO and the OECD have critical roles to play in ensuring that intellectual property protection is a positive force for innovation and the development of technology. WTO is the international mechanism for ensuring that all countries meet their obligations to provide high levels of intellectual property protection and enforcement. WIPO, through its administration of the PCT, facilitates the acquisition of patents; through its technical assistance, helps developing countries and economies in transition to overcome the institutional hurdles to effective intellectual property protection; and, through its role in treaty negotiations, can serve as the venue for the elaboration of appropriate international norms of intellectual property protection. The OECD, through its intellectual property-related projects and analytical support, can help make the economic and technological case for strong intellectual property protection and, through its ability to develop guidelines, can help in the development of principles of intellectual property protection that will form the standards that countries should be seeking.

Different industrial sectors have different priorities with respect to intellectual property protection and enforcement. For many industrial sectors in the OECD countries – particularly in the agricultural, chemical, and pharmaceutical industries – innovation and technology development are related to the state of intellectual property protection and enforcement outside of the OECD countries. For these industries, improved intellectual property protection and enforcement outside of the OECD will be particularly critical. For other industries based in OECD countries, whose inventions enjoy strong protection, enforcement of the standards – including the cost of enforcement and litigation – within and outside of the OECD countries is paramount. For yet other industries, the need for harmonized, low cost and efficient patent systems is the principal intellectual property issue faced.

Patent examination

One area that IBM feels should be focused on initially is patent examination. A system which provides for the issuing of uniform rights through such methods as promoting the use of a common database, establishment of patent examination standards, exchange of patent examiners, and universal recognition of search results, is necessary. This requires the existence of a common system with uniform criteria for novelty. The ability of innovators to reap the benefits of their innovations may be severely circumscribed by narrow systems of claim interpretation. Narrow interpretation of claims enables companies to make minor insubstantial changes to other companies' patented products or processes without being found to infringe upon them.

As economies are becoming increasingly borderless, the establishment of a regional patent office and other co-operative mechanisms for patent grant based on economic regions (North America, South America, European Union, ASEAN, etc.) such as that being considered in the ASEAN region, should be seriously explored. These must go beyond present "regional patents" such as those obtained from the EPO.

Emerging issues

In discussing international intellectual property standards, reliance on standards found in the WTO TRIPS Agreement may not be sufficient. It is critical that there be a recognition that the TRIPS Agreement was negotiated with the technological issues of the 1980s and early 1990s in mind and included only minimum standards. In some areas of technology, new internationally-recognised norms are needed. For example, international patent norms should recognise the essentiality of pipeline protection for the pharmaceutical industry. This would help deal with the impact on innovation in that industry resulting from the current environment where periods of marketing exclusivity are effectively being shortened by both heightened competition within therapeutic classes and the simultaneous lengthening of the development time for such products. In addition, the continued development of the biotechnology industry requires internationally-recognised standards of patent protection for its inventions. One of the key first steps in that direction is to close the gaps among the OECD Member countries concerning the patentability of genetic material, including plants and animals. It will be necessary in any international negotiations to guard against attempts to roll back intellectual property standards ostensibly out of concern for such legitimate objectives as the environment and biodiversity.

In other areas of technology, international norms have already been developed since the negotiation of the TRIPS Agreement. Some of these norms are contained in such international treaties as the NAFTA chapter on intellectual property and the recently-negotiated WIPO Copyright Treaty and WIPO Performances and Phonograms Treaty.

To deal with emerging issues associated with the protection of intellectual property in an age of growing technological standardization, especially in network apparatus and systems, international rules should be established to develop procedures that will balance the interests of intellectual property owners and users. There is an emerging issue being encountered in technological standardization, especially in a network society, that relates to intellectual property rights. Standardization of network apparatus and systems is necessary to achieve compatibility of network technology. A feature of advanced network technology is that many kinds of patentable technology created by a number of different people may be included in the relevant network products as standardization and technological development occur in parallel. The dilemma is that in order to compensate for investments made in R&D, patent owners need to secure significant returns. However, if the royalty fees of the patents are too high, or licensing limited to certain companies, the technology will not be deployed as a standard, thereby limiting distribution, and resulting in inaccessibility of mutual communication.

Voluntary systems work well and are preferable due to their technology-neutrality. Voluntary licensing whereby technology leaders promote standardization by offering licenses on reasonable terms is the optimal solution from the industry point of view.

Finally, there has been much focus on the issue of exhaustion especially in view of the recent BBS case in Japan. In order to ensure that the appropriate high levels of protection of intellectual property rights are achieved and maintained, national or regional exhaustion applicable only to regional areas that have achieved full economic integration should be recognised as the norm. Consumers will not necessarily benefit from international exhaustion, because the traders in parallel goods would “shadow price” (that is, price just below the free market price), thereby reaping most of the benefit from any price differentials. International exhaustion also prejudices supplies and the transfer of technology to low price markets, since the patent owner fears prejudice to his main markets.

INTERNATIONAL COLLABORATIVE R&D AND INTELLECTUAL PROPERTY RIGHTS

Hugh CAMERON, PREST, University of Manchester

Introduction

Fundamental economic and technological forces have created pressure on commercial organisations throughout the world to collaborate in order to achieve economies of scale and critical mass in production and marketing activities. Research and development has also moved towards international collaboration at regional and global levels. The structure of, and participation in, collaborative R&D projects is driven by the economic advantages to be derived from the activity, and the main results of such projects are in the form of knowledge, patents, designs, and other forms of intellectual property. Successful collaboration depends upon the establishment of frameworks of rights to intellectual property, in all its types and uses.

The European Union provides an example of an evolved framework of intellectual property rights in its programmes of collaborative research and technology development, with accepted rules concerning background and foreground rights, rights of participants to use results (especially patents and information) in further research, in commercial products, and in licensing third parties. Similar features form the basis of privately funded collaborative projects.

Many national patent systems exist, of which three (United States, European Union, and Japan) are most significant. All systems are compromises between the rights of inventors and innovators to derive benefit from their activities, and the rights of society to benefit from the rapid development and diffusion of new inventions and technologies. However the systems differ in the weights given to each of these: the United States system tending to benefit the inventor, while the Japanese system focuses on diffusion of technology, with the EU system somewhere between. There are resulting incompatibilities between national systems which lead to uncertainties and difficulties for international patenting and collaborative activities.

The past century has witnessed a gradual trend towards harmonisation of national patent systems, and much has been achieved, in particular with the recent TRIPS Agreement. But new technologies repeatedly challenge this harmonisation, as these economically significant sectors (especially biotechnology, pharmaceuticals, and software) find it difficult to achieve acceptable protection, and governments negotiate with the welfare of their domestic industry in mind. In addition to these, anti-competition and anti-trust laws add very significant complications to the field of collaborative R&D. Though most governments encourage the R&D collaborations in themselves, the implications of some agreements (licensing restrictions, marketing agreements, etc.) are in contravention of anti-trust laws. There are many grey areas concerning what is permitted in collaborative R&D ventures, and what goes against the public interest.

Collaborative research and development in the European Union

This section gives an overview of the framework which has been developed within the European Union (EU) in order to facilitate the collaborative research programmes which are at the heart of EU science and technology policies. It is significant because:

- European Union collaborative research and technology development (RTD) programmes are the largest, longest running of their type;
- the intellectual property rights framework has evolved over 15 years and has proved a successful basis on which to operate such programmes and projects, from public and private perspectives;
- though some of the details reflect particular EU concerns, in general the Commission's intellectual property rights requirements represent the public interests in a wider context, particularly the desire to allow intellectual property rights only to the extent that the results promote economic welfare by the dissemination of patents, etc.

In pursuance of the objectives of the Treaty on European Union, the European Commission has developed RTD policies which are aimed at strengthening the science and technology bases of European industry enabling it to become more competitive at the international level, and to promote all other European policies relating to the welfare of European citizens and co-operation. In pursuit of these the Commission has promoted a series of collaborative programmes which became consolidated in 1984 in the first "Framework" programme. This is the collective name for a large number of programmes in specific areas ranging from basic research in industrial technologies and in information technologies, to more fundamental long-term research programmes in scientific fields. The Fourth Framework Programme ends in 1998 and planning for the successor is at an advanced stage. The planned budget for the Fourth Programme was ECU 13 billion[1], and as such is the largest continuous collaborative RTD programme in existence.

The programmes encourage collaboration between:

- the EU states (in general all projects must involve participants from two or more EU states);
- other associated states, for example the countries of Eastern Europe and of the former Soviet Union;
- industrial enterprises within the European Union (in particular small- and medium-sized enterprises);
- academic and other non-profit research organisations;
- government and Community research laboratories.

The main activities described here are the "pre-competitive" projects in which the companies and other researchers carry out their work together before bringing out their own resulting products and competing on the open market. The Commission dispenses these significant public funds to collaborative projects in order to achieve EU objectives, and as such insists on certain conditions being fulfilled. In particular, there is an increasing insistence upon the effective exploitation of the results of projects, to the extent that exploitation plans must be submitted and agreed before approval is given for funding. These conditions contain detailed requirements concerning the treatment of intellectual property rights, which are included in a Standard Contract[2] imposed on most projects. Though these are clearly not requirements in many non-publicly sponsored collaborative projects, they are important for the following reasons:

- They identify the issues facing participants in any collaborative project.

- They are the result of an evolutionary process of improvement over many years, have been revised to cope with the concerns of participants and sponsors, have been applied to a wide variety of circumstances, and have proven to be a sound basis for collaboration.
- Non-EU companies are permitted to take part in projects (without the funding support) if they maintain substantial R&D facilities within the European Union.

The relationships between the various participants in EU collaborative research projects are shown in Figure 1. The participants, or contractors, in a project may be either:

- full partner[3] or contractor;
- complementary contractor (or associate partner, or sub-contractor);
- co-ordinator (or project manager); one of the full partners, taking a full part in the research activities, will be responsible for overall management of the project, for example transmitting evidence of financial claims to the Commission, arranging meetings, etc.

Other project activities are divided between the participants as appropriate. When a project is approved by the Commission, the Contract is signed by the full partners and Commission representatives. A separate contract (complementary contract) is agreed between an associated (complementary) partner and one of the full partners, which is not subject to Commission scrutiny, but must contain certain elements, for example relating to intellectual property rights. The Contract[4] includes Annex II, Part B of which specifies in detail the intellectual property rights requirements to which participants must agree. The next section reviews the contents of this document.

Competition law in the European Union

Intellectual property rights involve a legal compromise between individual ownership rights and the community's wish to exploit technological advances fully by disseminating knowledge. The exclusive ownership rights allowed entail another compromise, allowing a degree of monopoly rights, but with a series of restrictions to limit the exploitative power of owners.

An additional source of restriction comes from outside the intellectual property rights field: that of restrictions on anti-competitive practices. The Treaty of Rome contains specific measures to control anti-competitive agreements [Article 85 (1)] which have as their object or effect the distortion of competition within the Union. Collaboration agreements which involve cross-licensing or intellectual property pooling arrangements may come within the terms of Article 85, contravention of which can result in very heavy penalties to offenders. Examples could include a patent sharing agreement together with a market sharing agreement in either geographical or product divisions allocated to participants. "Commission regulations allow block exemptions in respect of patent licensing under certain circumstances, but this does not apply to pooled patents, joint venture patent agreements and cross-licensing, that is reciprocal patent licenses."[5] Other exemptions may be granted even outside the exempted areas.

Bainbridge reports on a case of an R&D project: *Re Alcatel Espace and ANT Lachrichtentechnik (1991).* Two telecommunications companies requested individual exemption for an agreement for joint R&D, production and marketing of equipment. The agreement included a patent sharing agreement under which both would be able to work on each others' patents on a royalty free, non-exclusive license basis. The Commission at first refused the exemption, on the grounds that: it would allocate R&D so that only one party would carry it out, that the agreement provided for equipment procurement from one party by the other, and that decision-making was to be taken by one committee. Each of these would, considered the

Commission, restrict competition. The block exemption for R&D was inapplicable as the agreement went far beyond R&D in its scope. However, the Commission eventually gave permission for a ten year exemption, on the grounds that:

- the co-operation would lead to more rapid technical solutions and thus benefit consumers;
- the agreement only imposed restrictions necessary to the objective stated above, and did not prevent either party from engaging in other activities outside the scope of the agreement;
- the nature of the market implied that separate marketing was not practicable;
- the parties' market share was not high.

This type of "horizontal" agreement, together with "vertical" agreements involving licenser and licensee, are both liable to challenge on competition grounds. Bainbridge identifies terms in agreements which could lead to challenge:

- those attempting to extend the agreement beyond the term of the patent;
- those tying the licensee to the licenser (e.g. with unconnected goods purchases);
- those which restrict the licenser's working in the patent in countries other than those included in the license terms;
- terms which prevent the licensee from challenging the validity of the patent, or forbid competing with the licenser.

However, some terms have been permitted:

- minimum royalty clauses;
- terms requiring minimum quantities of purchases of the product to be made by the licensee.

Article 85 (3) of the Treaty of Rome permits agreements if they:

- contribute to the improvement of the production or distribution of goods or;
- to promoting technical or economic progress;
- if consumers are allowed a fair share of the resulting benefit;

and providing that:

- only restrictions essential to the attainment of the objectives are included; and
- they do not restrict competition in respect of a substantial part of the products in question.

Certain patent licensing agreements are exempt from the application of Article 85 (1), including R&D agreements. One set of these applies to patent licenses between two parties that are territorial in nature, and another to agreements that are not restrictive of competition.[6]

Though there are block exemptions for some aspects of EU R&D programmes, they still have application to the exploitation phases of projects. For example, the CAs should not contain any clauses which divide markets between participants, or which agree a fixed price for products which derive from project foreground. This can produce some difficulties during the exploitation phase of projects. For example, use of the same foreground by several collaborators, either in commercial sales or in licensing other companies, may amount to selling very similar products, thus the pressures towards some form of pricing agreement may be considerable.

From remarks made earlier, however, it should be clear that successful collaborative projects are assembled with the aim of minimising any potential intellectual property rights conflicts, and the same applies to the competition laws. Direct competitor companies, say in the same market in the same country, do not normally take part in collaborative R&D projects together.[7] Companies addressing different market sectors, sometimes with very distinct market niches, make far happier collaborators, and do not conflict with competition laws. It may be noted that some apparently "horizontal" projects, perhaps involving several "software" companies, are in reality encompassing a broad range of "software" activities, including services, training, customisation, systems, etc., as well as code writing. These companies overlap rather than conflict in their activities.

Comparison of patent systems

European states have their own national patenting systems, but a pan-European system for patenting was introduced in 1977, with the founding of the ***European Patent Office (EPO)*** which can issue European patents having a validity in the national systems of member countries, under national terms.[8] Enforcement is through national legal systems. The European system has gained increasing significance due to its convenience and relative simplicity (against multiple national applications). It is estimated that about half of United States applicants in Europe apply through the EPO system.[9]

The United States system differs significantly from the others. European and Japanese patents are based on the ***"first to file"*** while United States patents are based on the ***"first to invent"*** application. Thus in the United States, when two or more claimants for the same invention apply for patent rights, the applicant who establishes the earliest invention date will receive the patent. Claimant conflicts result in "interference" proceedings, under which the ***US Patent and Trademark Office (PTO)*** determines the priority claimant. There are relatively few such proceedings, involving less than 1 per cent of all applications filed, and less than one-tenth of 1 per cent of all patents are awarded to other than the first to file.[10] However, the system has more widespread impacts.

Table 1 gives a summary of the main differences between the three main patent systems in use today. These include:

- Language: the European office accepts applications in any language of a convention country, and this is the legally binding version, though subsequently an English, French or German translation must be submitted. In the United States any language may be used but an English version is required within two months. In Japan, the Japanese language is the only one permitted.
- Examination: Japan and Europe only examine patents on request, in Europe within six months of publication, and in Japan within seven years of filing. Failure to request this results in disqualification. The United States PTO examines all applications automatically.
- Opposition: JPO and EPO have opportunities for third parties to oppose the grant of a patent; in Japan before a patent is granted and in Europe during a nine month period after grant. There is a more limited opposition system in the United States where parties may request a re-examination after the grant to determine validity.
- Term of patent: in the United States a patent is valid for 17 years from the date of grant. Japanese patents run for 15 years from the publication of the application (after the JPO has completed its examination), but not more than 20 years from the date of application. European patents are valid for 20 years.
- "Grace period": Japan and Europe permit some disclosures about the invention for a period of six months before the application is made, while the United States system permits disclosures of any kind to be made for 12 months before the application.

Table 1. Comparison of patenting systems

Features of system	European PO	US PTO	Japan PO
Basis	first to file	first to invent	first to file
Patents for discoveries?	no	yes	no
Breadth of claims	narrow	broad	narrow
Grace period	none	12 months	6 months*
Speed of processing claim	slow	fast	slow
Filing permitted in any language?	any European language	yes	no
Are patent examinations published?	18 months after filing	no, secret until patent is granted	18 months after filing
Can patent examination be deferred?	yes, for 6 months	no	yes, for 7 years after 18 month publication
Is there an opposition system?	yes, after patent is granted	no, but other parties may request examination	yes, before patent is granted
Patent term	20 years from first filing	17 years from first filing	15 years from date of publication for opposition purposes

Source: Author.

This list includes many of the detailed differences between the systems, however they may disguise the most important feature of note, that there is a major distinction between the perspectives by which the systems are viewed. The United States system, focusing on the rights of the inventor who has devoted time and resources to the inventive activity, allows the inventor to maintain confidentiality throughout the process of application, and, if it fails, beyond. There is no pressure to disclose the invention, and the clear intention is to identify the first inventor. The Japanese system appears to have been designed with the dissemination of technology as its main objective. Provision for the 18-month publication, seven year deferred examination, and pre-grant opposition evidence this view. Industry is able to learn from the invention before the grant of exclusive rights. Also, Japan requires compulsory licensing of patented inventions if a second patent improves upon the original patented invention.

The GAO study conducted a survey of United States company experiences in Japanese patenting, and identified a list of complaints:[11]

- Lengthy approval time, eating into effective exploitation period.
- Narrower scope of protection.
- Difficulty in patenting pioneering inventions.
- Patent flooding (attempting to limit patentees use of own invention by surrounding with minor improvement patents).
- Pre-grant opposition.
- Cost of the procedure (highest in the world) (for a 25 page application; in Japan: $4 772, in the United States: $1 390), due mainly to.
- High fees charged by *benrishi* [12]; differential charges for Japanese and foreign applicants.
- Translation fees (average per word cost for English to Japanese: 43 cents, translation into German/French 32 cents/word). The costs are significant as a typical application ranges from 15 to 40 pages, with computer and biotechnology sectors tending to be up to 100-125 pages.

The European Commission compared the costs of national patenting applications, and arrived at the following estimates[13]:

Table 2. Comparative costs of patent applications

	European patent	US patent	Japanese patent
Patent Office Fees	8 250 DM	3 304 DM	2 000 DM
Representational expenses	25 771 DM	9 000 DM	12 856 DM
TOTAL	34 221 DM	12 304 DM	14 859 DM

Source: Author.

However these do not include the costs of enforcement, which are highest in the United States due to the litigation costs and onerous procedures involved. Despite these, many patent experts do not believe that the Japanese patent system inherently discriminates against foreign applicants, but that cultural and structural aspects do conspire to make it difficult for non-Japanese firms to achieve effective protection in Japan, in comparison with Europe. Recently the JPO has implemented measures to improve the situation (from a United States perspective), such as increasing the numbers of examiners and accelerating procedures, under the United States-Japan Structural Impediments Initiative, and as a result of the TRIPS agreement.

Compared to United States practice, Japanese patent practices are aimed at restricting the patent claim's scope as much as possible, including limiting the scope of protection to the specific examples provided in the application. These examples must demonstrate the claims and results, while United States applications include broader claims without examples. In Japan, these examples are particularly important in the fields of chemical, biotechnological, and pharmaceutical fields, where actual physical data is required for all compounds covered by a claim. The examiners will not accept theoretical examples, unlike their United States counterparts. The United States view is that this makes it virtually impossible for pioneering inventions in these fields to be adequately protected. Inventions in the mechanical and electrical fields do not require such detailed examples, where drawings are sufficient.[14]

These observations fit well with the general feeling that Japanese patenting practice promotes large numbers of incremental inventions, while United States firms tend to apply for fewer, but more radical invention protection. Though the case above has been from a United States view, it seems that the frictions are caused by fundamentally different approaches to patenting in the two business and administrative cultures. An alternative view could be given from the other side: Japanese patent experts consider that United States applications do to conform to Japanese styles and procedures. More than 90 per cent of United States applications in Japan are virtually identical to their United States applications. It seems to be easier, and less costly to do this, and to revise them at the request of the JPO, thus lengthening the period of waiting.

In addition to these, the views of intellectual property rights litigation are very different in the two countries. In Japan, litigation is considered as an extreme and unwelcome action, entailing a loss in business reputation. Infringement suits are rarely considered; negotiated settlements are almost always concluded. In the United States, a far more litigious country in all areas of the law, actions are far more common. In 1990 there were 1 236 patent infringement suites in the United States, compared with 141 in Japan. Little business risk is involved in bringing an action in the United States, and to outsiders it may even seem that infringement, and litigation, are seen as legitimate and acceptable business strategies.

The damages awarded in the two countries also differ considerably. In the United States, triple damages are sometimes awarded, while in Japan the awards are little more than the license fees which would have been payable. Companies are often better advised to settle for negotiated license fees rather than pursue litigation.

From the Japanese perspective, the disparities have been equally problematic. This was brought into focus by cases of United States courts awarding punitive damages against Japanese companies for patent infringement. A list of problems from the Japanese side includes:[15]

- the breadth of scope of patents;
- the large size of damages awarded;
- balance between rights of inventors and rights of innovators;
- transfer of technology to developed countries and royalty payments;
- hindrances to technical standardization;
- language and retrieval of information;
- "submarine patents", which emerge from the confidentiality allowed by the United States system, to disrupt the use of subsequent, independently generated patents already in use.

Sectoral problems

National patenting systems are themselves subject to evolution in response to changing technologies. Frameworks which were developed over centuries to address contemporary problems may have to be revised or added to in order to cope with new advances. The differences in national "philosophies" underlying intellectual property systems are revealed again when each country addresses these challenges. Three major sectors which are affected by this are the biotechnology, pharmaceuticals and software industries.

In the biotechnology field, the different approaches to intellectual property and protection for the newly emerging industry have led to conflicts between the United States and Europe over the *"patenting of life"*. In the European Union itself there have been prolonged discussions and disagreements over the approach to take. The European Parliament rejected the European Commission's draft directive for the patenting of genetically altered organisms and other biotechnological inventions, affecting the development of new pharmaceuticals. The issues at stake were the alteration of inheritable genetic characteristics, the patenting of elements of the human genome, and genetic manipulation of animals.

In the software field, in general the copyright laws are used to protect intellectual property, but there has been increasing debate over the extension of patents to cover software. The United States has already permitted patenting of certain algorithms, which were previously thought to be outside the scope of patent law. The different capabilities of countries in these sectors, and forecasts of their future economic significance, are leading to conflicting negotiating positions in international discussions. Though the tendency to international harmonization is powerful, it must be remembered that there are significant pressures that produce new conflicts in national systems.

Conclusions

In summary, the following issues in international patent conflicts may be identified:

1. Conflicts between national systems, including some fundamental conflicts, e.g. first-to-file vs. first-to-invent. Though the United States is the main exponent of the latter procedure, changes due to the TRIPS agreement have allowed foreign dates of invention to be considered. However, the differences in balances between the rights of inventors and the objective of diffusion are still in evidence.

2. The costs of obtaining patents have been referred to above. While the increasing harmonization of patents can be expected to reduce these disparities in some areas, others (such as the propensity to undertake litigation) may remain.

3. Conflicts regarding territorial jurisdiction. There are inconsistencies between the systems regarding location of the inventive activity and location of the applicant for a patent. Some require their nationally registered firms to file domestically, while others require first applications when the invention is made under their jurisdiction. In an age where R&D facilities are distributed globally by multinational firms, and where electronic information exchange makes international collaboration a necessary and routine activity, these restrictions must be seen to be increasingly inappropriate, and unworkable.

The recent TRIPS Agreement has made a major step towards addressing the issues of international patent harmonisation. Some of the principal conclusions were:

1. For patents, TRIPS imposes obligations on the minimum term of protection (20 years), protection for products and process, allowable exclusions from protection, prohibitions on some forms of discrimination, protection of plant varieties, guidelines for compulsory licensing, and on evidence for infringement proceedings.
2. Members of the WTO which are not signatories of the Paris Convention are required to comply with Paris Convention provisions.
3. Developing countries have been allowed several years (until the year 2000) to enforce the provisions of the TRIPS Agreement. Developed countries had to apply the provisions by the beginning of 1996.
4. Signatories to TRIPS must accord “most-favoured-nation” treatment to all WTO members, with no possibility of delayed enactment.
5. TRIPS extends the Paris Convention’s prohibitions on the use of confidential data in a manner contrary to honest business practices. For example test data submitted to governments during the course of gaining approval for pharmaceuticals, may not be revealed or used for other purposes.
6. The TRIPS Agreement provides for obligations to ensure that effective enforcement of intellectual property rights is available to owners, and that enforcement procedures do not create barriers to trade. Certain remedies must be available, including injunctions, damages, forfeiture, performance measures of enforcement authorities, and criminal penalties for wilful trademark and copyright piracy.

This paper has identified many issues concerning the impact of intellectual property rights on the existence, structure and organisation of international collaborative R&D projects and programmes. It has stressed that the structures of intellectual property within particular projects is the main driver of collaborative R&D, and that acceptable legal frameworks are a necessary condition for their existence and their success. In the European Union, for example, there is a *de facto* framework, which has evolved over more than a decade, which addresses the main issues of concern to participants and public authorities, including the treatment of foreground and background patents and other intellectual property and its use in alternative ways (further research, commercial exploitation, etc.), and licensing requirements.

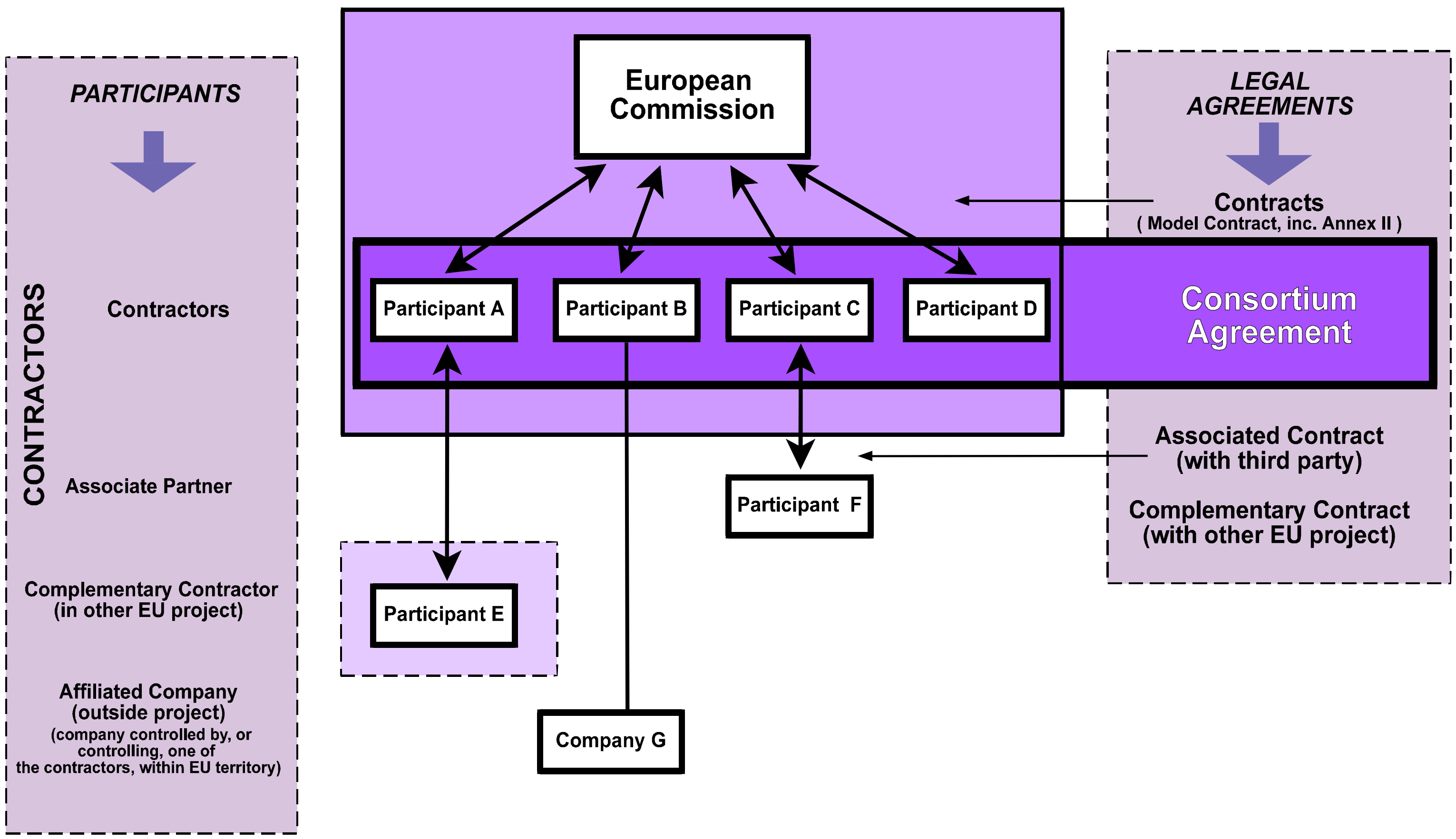
The basic objectives of national systems are similar, such as the need to encourage innovation and reward inventors, the encouragement of rapid diffusion of new technologies, and the need to limit monopoly powers deriving from intellectual property. However the details of compromises between these often conflicting objectives underlies the differences in approach described. Related issues of anti-competition regulation also affects the progress of collaboration. Though authorities encourage R&D collaboration *in itself,* such laws restrict the uses made of results, for example in licensing terms.

Despite gradual harmonisation of national intellectual property rights frameworks, by means of successive treaties and conventions, it is clear that substantial differences will continue to exist for some time. New technologies are producing new divergences in national patent systems, in particular in the biotechnology, pharmaceuticals, and software sectors. The issues identified clearly show that international collaboration is a complex undertaking, and potential participants have their own decisions to make in balancing the advantages to be gained with the difficulties and the uncertainties which are often faced. The commercial uncertainties are substantial (potential leakage if intellectual property, default of other participants, risk of technical failure, etc.). Yet the advantages to the global economy may be substantial, in the form of more rapid technological development. The uncertainties created by possible conflicts in patent and other intellectual property rules are additional, and in many cases unnecessary and costly both to firms and to economies.

NOTES

1. From "The European Report on Science and Technology Indicators, 1994", European Commission, Brussels, 1994, ISBN 92-826-9004-0, page 212.
2. Used in most Framework programmes.
3. Though the term "partner" is frequently used in discussions of collaboration and in their agreements, it does not imply the existence of a continuing legal partnership.
4. Often called the "Model Contract", or "shared cost contract".
5. BAINBRIDGE, D. (1994) "Intellectual Property", 2nd ed., p 323, Pitman Publishing, London.
6. See Bainbridge, pages 326-327 for a list of these exemptions.
7. With the notable exception of "standards" projects.
8. Member states are Austria, Belgium, Switzerland, Germany, Denmark, Spain, France, the United Kingdom, Greece, Ireland, Italy, Liechtenstein, Luxembourg, Monaco, the Netherlands, Portugal, and Sweden.
9. GAO, 1993.
10. GAO, 1993.
11. This gives only the US view, but exemplifies the frictions surrounding the subject.
12. Japanese patent lawyers.
13. *"IRDAC Opinion on Intellectual Property Rights"***,** Industrial R&D Advisory Committee of the European Commission, 1996.
14. GAO, 1993.
15. KAMAKAWA, Yoshihisa: "*A Study On The Way to Protect Intellectual Property Rights***"**, Institute of Intellectual Property Bulletin, 1994, Vol. 3, pp. 107-113, Tokyo.

Figure 1. Contractual structure of European collaborative research projects



Source: Author.

INTELLECTUAL PROPERTY RIGHTS: POLICIES AND ISSUES IN THE UNITED STATES

Bénédicte CALLAN, US Council on Foreign Relations

Introduction

Since the early 1980s the United States has been an aggressive proponent of strong, global intellectual property right standards.[1] American negotiators have pushed intellectual property (IP) into the international trade arena by concluding dozens of bilateral agreements on intellectual property rights; making IP an integral part of the GATT/WTO and NAFTA agendas; and occasionally threatening the use of trade sanctions. While IP regimes world wide are much improved at the end of the 1990s, the United States Government and private sector is not fully satisfied with the level of protection found in many countries. The American trade community continues to search for strategies which will encourage its partners to improve IP protection.

High on the US trade agenda are the intellectual property practices of the big emerging markets (BEMs), especially of countries like India, China, Brazil, and Indonesia. While these markets for entertainment products and high technology goods are expected to boom, the BEMs have a mixed record of intellectual property right enforcement. The United States wants to ensure its most innovative industries can compete in the BEMs and will closely monitor their intellectual property regimes. Other facets of the American intellectual property agenda should put at least two additional groups of countries in the limelight. First Europe and Japan, with whom we do most of our IP based trade and who serve as examples to the global trading system, are under pressure to immediately provide as broad and enforceable protection as possible under TRIPs. Second, new signatories to the World Trade Organization (WTO) – no matter what level of development they have achieved – are being asked to fulfil their Trade Related Intellectual Property Rights (TRIPs) obligations prior to accession.

To American trade partners, the rhetoric may sound familiar but in fact the US external IP policy is at a crossroads. The challenges to creating a strong global system of protection are simply not the same at the dawn of the 21st century, and the United States is having to adjust its demands and its methods. Increasingly, it is not the IP statutes of foreign countries but behind-the-border factors – weak judicial systems, untrained administrators or customs officials – which US negotiators would like to see improved. Pushing for *de jure* adoption of IP laws overseas was comparatively easy, more difficult is to ensure quick *de facto* implementation of those laws. There is also uncertainty about what policy tools are still useable or effective. The official US position is to continue pursuing all unilateral and bilateral avenues of influence in addition to multilateral ones. The establishment of the WTO's dispute settlement mechanism, however, has both expanded and constricted the type of actions the United States can take. The good news is the United States has come to rely on the World Trade Organization to a greater extent than originally anticipated. But in order to go beyond TRIPs, the United States is searching for new ways to influence trade partners – it needs credible threats or attractive benefits to dole out in exchange for co–operation in building a strong IP system globally.

US intellectual property policy

The present US intellectual property rights policy is built on the foundations of NAFTA, TRIPs, and the many bilateral agreements we have forged since the mid-1980s. In the most general terms, the objective of the United States is to strengthen and harmonize intellectual property regimes so as to curb piracy rates, reinforce domestic and foreign incentives to innovate, and expand markets for export in a world of increasingly porous international boundaries. Ideally, the United States would like global intellectual property protection of a breadth[2] and strength[3] equivalent to that available in the United States, and judicial systems capable of enforcing the letter of the law. While US objectives have not much evolved, the global economy has, altering both the challenges the United States faces and the tools it has at its disposal.

The dramatic rise in the level of intellectual property protection found world-wide is in no small part due to the GATT agreement on Trade Related Intellectual Property Rights which was concluded in April 1994 and established a base level of protection for most forms of intellectual property, be they patents, copyrights, trademarks, geographical indications, industrial designs, trade secrets, or semiconductor topographies.[4] The minimum standards of protection which the original 120 WTO signatories agreed to provide broke an old tradition in which a diversity of IP systems was accepted as long as each country granted national treatment to foreigners. WTO members gave up a degree of freedom in setting domestic IP laws in exchange for greater international uniformity. They also had to extend (in most cases) most favoured nation treatment for IPRs, meaning that any advantage granted to one country has to be extended to all other WTO signatories. From the US perspective TRIPs was a great success, achieving far more than anyone originally hoped it could.

Yet two years into the life of the TRIPs Agreement, the United is dissatisfied with its loopholes and weaknesses. The transition period granted to developing countries, five or ten years depending on the self-declared level of development, is deemed too long. The full benefits of a strong global IP system will not be fully realised until after the new millennium. There are exceptions and derogations from the TRIPs standard of protection – the exclusion of recombinant technologies and Internet publications – which the United States would like to expunge from the agreement. TRIPs permits some compulsory licensing, and is unclear about what constitutes international exhaustion of intellectual property rights. American negotiators also fear that existing rights could be rolled back. India and Korea, for example, want to reduce protection for inventions that have environmental or bio-diversity impact, a possibility which the United States is adamantly against.[5]

The TRIPs agreement was epochal when concluded in the mid-1980s, but it addressed the problems of that decade. As we enter into the next century, TRIPs must be amended or added to in order to correct omissions and address new problems. The business community in the United States has already made explicit what aspects of TRIPs are objectionable in statements by the ACTPN, the Transatlantic Business Dialogue, and the IIPA among others.[6] In the government, the Trade Representative’s office hopes to model any new bilateral IPR agreements on a “TRIPs plus” format. The additional requirements include stronger provisions against discrimination on the basis of foreign nationality, explicit protection of encrypted satellite signals and of pharmaceutical pipelines, and protection against parallel imports. Such bilateral agreements will remain of critical importance to the United States since key countries, like the People’s Republic of China and Russia, are not signatories to the World Trade Organization. Progress on other regional agreements – APEC, FTAA, or the expansion of NAFTA – are also seen as promising means of ratcheting up protection globally by the United States. Few multilateral initiatives, however, have strong momentum in IPRs at the moment.

The main challenge, therefore, is to make sure that existing agreements are fully implemented. The emphasis of US policy is shifting from surveillance of IP statutes, to a results oriented scrutiny of behaviour behind the borders. The dispute settlement mechanism of the WTO may be a boon for the United States in this regard. So far, only 30 countries – the advanced nations and Hungary, the Czech Republic, Romania, Slovakia, Slovenia, Poland – claim to have fully implemented their TRIPs obligations. Review of their notifications by the TRIPs Council was exhaustive and took two years to complete. Countries learned a great deal about one another's IP regimes and what TRIPs compliance entails. Experts suspect there will be a flood of WTO dispute settlement cases when reviews of developing country notifications takes place in the year 2000. Evaluating these notifications will be a Herculean task, but the US government is sure to go over developing country TRIPs implementation in assiduous detail.

Because the United States feels that TRIPs is incomplete, because technology continues to change, and important developing countries remain unconvinced of the value of strong IP systems, one should expect repeated rounds of IP negotiations in the future. The conclusion of the TRIPs agreement in no way marks the end of trade disputes over intellectual property rights. In order to get a sense of the problems the United States considers most pressing, we now turn to the official US track record of Section 301 investigations and WTO dispute settlement cases.

Examples of intellectual property problems

Culling from the bilateral agreements the United States has recently forged, its Section 301 investigations, and the cases it has filed with the WTO, the issues presently at the top of its intellectual property agenda are:

1. the full and timely implementation of TRIPs by all countries party to the WTO;

2. the extension of TRIPs-level protection to countries not yet signatory to the WTO;

3. the adoption standards and enforcement mechanisms that go beyond those contained in TRIPs;

4. the expansion of protection to new issues through WIPO or other multilateral agreements.

These are not trivial goals. Eradicating piracy increasingly involves behind-the-border intervention in national policies, which is diplomatically delicate, and a long term commitment to fighting piracy in factories, at national borders, and in the courts. Governments – US and foreign – need to have both the will and the resources to do so.

In 1984 an amendment to Section 301 of the 1974 Trade Act made intellectual property rights actionable trade issues. A second amendment in 1988, dubbed Super 301, required the USTR to conduct annual reviews of trade partner IP practices and to instigate bilateral discussions with countries whose observance of IP rights are considered sub par. Annual lists of countries who do not provide adequate and effective protection of US intellectual property interests are published, and the worst class of offenders – called *Priority Foreign Countries* – can be subject to retaliatory trade sanctions if bilateral discussions do not lead to a resolution. (See Appendix 1 for a list of all the initiated Section 301 investigations). Much to the chagrin of other nations, Section 301 has been a powerful stick for shaping foreign IP practices, especially for those countries which rely heavily on exports to the United States. Of those countries named *Priority Foreign Country* only Brazil did not act to change IP practices to the US Government's satisfaction, resulting in the imposition of trade sanctions.[7] Occasionally, the United States also revokes duty free treatment of specific products from developing countries through the Generalized System of Preference, in order to force improvements in IP regimes (e.g. Argentina in 1997). The threat of trade sanctions or of benefit reductions have been a factor in changing the IP regimes in countries like Korea, Brazil, Argentina, Indonesia, Thailand, and most recently China.

Section 301 investigations

Over the past 12 years, the United States has named about a dozen *Priority Foreign Countries*. The ensuing investigations reveal a good deal about US concerns (see Annex 1 for data on Section 301 Priority Foreign Countries).

Emerging markets as main targets

First, the target of most investigations are the big emerging markets. While advanced countries are often placed on the *Watch* or even the *Priority Watch* lists for IPRs, they have never yet been threatened with retaliatory sanctions. Similarly, the least developed countries are often put on the second order watch lists, but rarely are their transgressions considered important enough – because of the small size of their markets – to warrant trade sanctions. The main target of the United State's policies, therefore, has been fast growing economies which rely on US markets and where US commercial interests are not overshadowed by other diplomatic concerns.

Enactment of new laws

Second, until recently the USTR measured progress mostly in terms of the enactment of new legislation. The end-goal of negotiations was a change in statutes – either an increase in the level of protection afforded (for example, protection of longer duration) or an extension of protection to a new product area like pharmaceuticals.

The intellectual property right disputes with the People's Republic of China in the early 1990s, however, drove home the importance of changing incentive structures in order to ensure enforcement of new laws. In the post-Mao era, China came to recognise the rights of individuals and companies to hold intellectual property and implemented an impressive array of reforms – promulgating IP laws and joining the major international conventions. But the pace of change was unsatisfactory to the United States, and a series of agreements were negotiated, starting with the 1992 Memorandum of Understanding which committed China to improved protection for US inventions and copyrighted works. While on paper the MOU created exemplary IPRs, the laws did not guarantee enforcement. Through 1993 and 1994, the United States presented China with evidence of violations, sometimes including the names and addresses of companies blatantly ignoring China's new IP laws. US complaints culminated in 1995, and again in 1996, with threats of sanctions if China did not take measures to shut down and prosecute domestic infringers, halt the export of infringing goods, and open the Chinese market to US movies, sound recordings, and computer software. Tensions ran high, but in both instances China eventually capitulated.

American negotiators and business people are increasingly aware that IP diplomacy must focus on changing the behaviour of bureaucracies and pirates alike, if new IP statutes are to have any effect.

Subject areas

Third, a relatively limited set of industries have pushed the United States government to take action on IP infringement abroad. Many Section 301 investigations focus on (and sometimes are instigated by) the pharmaceutical, software, and film industries. In the United States, these intellectual property dependent industries have political clout because they are the stars of the American economy. These are big dynamic sectors, who are important to growth and job creation. Five per cent of the US workforce is employed directly or indirectly in copyright dependent sectors like music, film, software, and print. And the growth rates of copyright industries have been twice that of the US GDP (5.6 per cent vs. 2.7 per cent between 1991-1993). In addition, intellectual property dependent industries are important because they export and are internationally competitive. Copyright industries exported $45.8 billion in 1993, and the chemical industries, which include pharmaceuticals and are patent dependent, exported $45.1 billion. Only the automotive industry posted higher export sales. High-technology goods account for over half of all merchandise trade, and its exports are growing rapidly. For obvious reasons, complaints about piracy in sectors of American strengths fall on receptive ears in the US government, especially in eras when there is pressure to be tough on trade.

Companies in the intellectual property dependent sectors are expertly organised to lobby Washington. Groups like the MPA, RIAA, BSA, SPA, IIPA, IACC, PhRMA, and CMA to name the more active ones, detail the cost of global infringement to their companies and articulate to the US government how their losses hurt the US economy.[8] Industry lobbying was instrumental in making piracy an actionable unfair trade practice and putting IPRs on the Uruguay Round agenda, and industry concerns continue to drive many policy initiatives even though now the government frequently self-initiates investigations. Developing countries, therefore, should be tuned to the concerns articulated by the industry organisations as they upgrade their intellectual property regimes. Developing nation governments should also think of the private sector as a resource, increasingly willing to engage in technical aid and training, and even technology transfer, in exchange for a rapid upgrade in the level of IP protection.

In the future, the types of companies vulnerable to IP infringement may not be identical to those today. As an example, the popularity of CDs and the ease with which they can be produced and shipped has created a vibrant new market for music CD-ROM piracy which barely existed five years ago. If future industries are as well organised and as competitive as their predecessors, we can expect the US government to remain an energetic advocate of strong global IP rights in new sectors. (Biotechnology should be watched with interest because it is highly patent dependent, but has not yet been the focal point of US trade initiatives).[9] As long as American comparative advantage lies in knowledge-intensive products, processes, and designs, and as long as these are easily appropriated and disseminated abroad, the United States will have a significant stake in shaping the global management of intellectual property.

WTO dispute settlement cases

The TRIPs agreement accomplished in one fell swoop what the many bilateral agreements forged by the United States were attempting to do under the Section 301 umbrella. The WTO embraces most of the big emerging markets; it requires the enactment of new laws, when existing ones are not sufficient; it includes a broad range of IP instruments, and addresses some new technologies explicitly; and it requires civil and criminal redress when infringement is found.

The *pièce de résistance* of the World Trade Organization is its Dispute Settlement Understanding (DSU) which adjudicates complaints among member nations. Previously, IP agreements lacked enforcement provisions, so the United States frequently took matters into its own hands. Now member states are required to appeal to a Dispute Settlement Board to resolve their intellectual property disputes, rather than resort to unilateral threats or sanctions. If the case merits, and if no agreement can be reached through bilateral discussions, an impartial panel is set up to judge whether the TRIPs Agreement has been reasonably interpreted and carried out. Countries found not in compliance with the TRIPs Agreement will be required to comply with dispute settlement panel rulings, or the aggrieved party will be allowed to retaliate. Of the six cases initiated by the United States pertaining to IP disputes during 1996[10], four have been resolved bilaterally, and only two have resulted in requests for a Dispute Settlement Board. Four more cases were proposed in 1997. So far, the DSU has worked well for the United States in intellectual property disputes (see Table 1).

Table 1. IPR dispute settlement cases initiated by the United States at the WTO

Japan	1996	pre-existing sound recordings, issue resolved
Portugal	1996	patent term, issue resolved
Pakistan	1996	"mailbox system", issue resolved
India	1996	"mailbox system", dispute to appear before WTO panel
Denmark	1997	enforcement issue, US planned to initiate WTO case
Sweden	1997	enforcement issue, US planned to initiate WTO case
Ireland	1997	copyright laws, US planned to initiate WTO case
Ecuador	1997	general TRIPs obligations, US planned to initiate WTO case

Source: Author.

Just as the Section 301 investigations shed light on the topics and countries most in the limelight of US intellectual property policies, the WTO dispute settlement cases give us a sense of how those policies are shifting with time.

Full implementation

The full and timely implementation of TRIPs has become one of the dominant battle cries in US trade circles. Indeed, every dispute settlement case filed by the United States is about clarifying the differing interpretations of TRIPs compliance. In the hot seat are the advanced countries: they are required to be in full compliance with the Agreement at this time, and they serve as an example for countries still formulating TRIPs-consistent legislation.

In February 1996 the USTR initiated the first intellectual-property based WTO dispute settlement proceedings against Japan with respect to its protection of sound-recordings. Despite TRIPs obligations, Japan failed to extend copyright protection to sound recordings made prior to 1971. While TRIPs requires 50 years of protection for sound recordings, in Japan protection for recordings made prior to 1971 had already lapsed. After intense consultations with the United States, and the filing of a second complaint by the European Community, Japan agreed to provide retroactive protection. The case was an important victory for the United States not only because of the $500 million lost annually by American rights holders, but also because the case served as a warning to other signatories of the need to provide retroactive protection.[11] A second proceeding in 1996 filed against Portugal was over a similar technicality. In compliance with TRIPs requirements, Portugal extended patent protection to 20 years. But it only did so for patents filed after January 1, 1997, rather than for all patents in force on that date. Again, the issue was resolved in bilateral discussions and Portugal agreed to extend patent terms for all active patents.

The United States will be equally adamant about developing country obligations as demonstrated by the India and Pakistan mailbox cases. Developing countries which do not already provide product patent protection for pharmaceuticals and agrochemicals were required to establish a “mailbox” system of registration (to determine priority) and to grant exclusive marketing rights. Both Pakistan and India failed to do so. While Pakistan has since met its obligation, the dispute with India went to a WTO dispute settlement panel which decided in favour of the United States. The Indian government, which objects on moral and public good grounds to pharmaceutical patent protection, has appealed the decision. Such implementation disputes are likely to explode after the year 2000, when the developing countries are to file their notifications with the WTO TRIPs Council and complaints can be lodged against them.

Transition periods

Shortening the transition periods developing countries enjoy was an early US policy objective, but one that it has not pursued officially in the WTO. The TRIPs agreement allows developing countries until January 2000 to implement most of their obligations. The protection of pharmaceuticals and agrochemicals can be delayed in some cases another five years, although patent “mailboxes” and exclusive marketing rights need to be provided. In the mean time, developing countries may not decrease the level of protection offered, or withhold national treatment and MFN status for IPRs.

US negotiators and the private sector have strongly encouraged countries who have high per capita GDP, are at an advanced stage of development, and often have relatively robust IP regimes to file notifications of TRIPs compliance in advance of the full transition period. Particularly galling to the United States is the refusal of rich countries like Korea (an OECD Member), Israel, and Singapore to submit to an early TRIPs review. The US Government firmly believes that using the long transition period is in no one’s best interest as it delays the benefits of a strong IP regime. However, the United States cannot force acceleration in the WTO. So, the government and the private sector stress the need for quick implementation in other fora. In extreme cases, the United States will use sticks. The United States reduced Argentina’s Generalized Systems of Preferences benefits by half in 1997, in response to inadequate and ineffective protection for US rights holders in pharmaceuticals. Countries from Egypt to Indonesia can attest that they are under pressure to quickly and effectively implement TRIPs obligations.

Although acceleration cannot be forced on the original WTO signatories, the United States and Europe agree that aspiring members must fully implement TRIPs obligations prior to accession. The People’s Republic of China declared in March 1997 that it was prepared to comply. Of the recent developing countries signatories (which includes six Eastern European nations), Ecuador had pledged to fully implement TRIPs by July 1996. Since, it has declared that it will avail itself of the full transition period. The United States has filed for dispute settlement proceedings with the WTO against Ecuador, because of its failure to fully implement TRIPs and because it denies national treatment to US rights holders. As the Ecuadorian example demonstrates, new entrants to the WTO – no matter what level of development – should be prepared to proactively bring their IP regimes to TRIPs standards.

Enforcement

As the United States discovered in Korea in the late 1980s and in China in the 1990s, full implementation must include active enforcement of intellectual property rights by administrative, judicial, and customs authorities. TRIPs goes a long way to ensuring enforcement: its signatories have agreed to provide “expeditious remedies to prevent infringements and remedies which constitute a deterrent to further infringements”. Countries must, therefore, establish judicial procedures which allow intellectual property rights holders to initiate legal action against infringers. Countries must be able to grant injunctions to stop infringing activities, to seize and destroy pirate goods and the methods of their manufacture, and to impose fines for damages and expenses. For wilful trademark counterfeiting and copyright piracy on a commercial scale, countries must also establish criminal penalties. Finally enforcement also entails stopping infringing goods at the border of an economy, so that rights holders can inspect the goods to verify whether a violation exists, and the customs or police can seize and destroy infringing goods before they enter the economy.

Two very recent WTO cases highlight the important part enforcement is going to play in future IP disputes. In April 1997, the United States declared it was filing dispute settlement requests against Denmark and Sweden because they have not provided provisional relief in civil enforcement proceedings. In other words, their courts cannot order unannounced raids to determine whether infringement is occurring, seize allegedly infringing products as evidence, or order the allegedly infringing activities be stopped pending the outcome of a case. Pirates are forewarned and allowed to continue their activities until a court decisions falls against them. The outcome of the northern European cases may have important repercussions for how far behind the border TRIPs can dictate enforcement mechanisms.

For countries interested in increasing technology transfer, enforcement should be a top priority. American companies want to know whether there is adequate legal infrastructure to protect IPRs, and whether the relevant government agencies can enforce the laws and provide "prompt and equitable treatment to foreign firms." Confidence in the ability to enforce the laws on the books will take a long period to develop among foreign MNCs. Foreign firms are looking for evidence – from the courts, arbitration cases, government agencies – that rights will be enforced. During the several years Thailand was on the *Priority Foreign Country* list, the private sector complained of unduly burdensome bureaucratic impediments to obtaining redress from infringement. Firms are still hesitant because while new application procedures and IPR courts are being set up, enforcement seems to recently be slackening. Similarly, confidence in China will be slow to develop even though piracy is being combated by new courts, and at the local level through IPR committees and strike forces, significantly reduced piracy in some regions. Impressions are hard to change, and the belief among MNCs that IP rights cannot be easily defended will take time to dispel.

Bilaterals and multilaterals

The Special 301 investigations and the dispute settlement filings give a very good sense of the global IP issues which concern the United States. However, the full implementation of TRIPs is not the be-all and end-all of US IP policy: it has too many lacunas, and new technologies are already emerging. The US government is committed to several bilateral and multilateral initiatives designed to help extend intellectual property protection in countries who are not WTO signatories – like Russia and Vietnam, to address issues not adequately covered in the WTO, and to reduce the cost of intellectual property protection world-wide.

IPRs in the non-WTO countries

In order to reach countries who are not WTO signatories, the United States will continue to ratchet up IP protection through bilateral discussions. A recently concluded agreement with Vietnam on copyrights, for example is designed to bring down the country's 99 per cent piracy rates. Regional agreements like APEC are another channel by which to reach countries who are not party to the WTO. When necessary, the United States will also resort to trade pressure to accelerate change in IP regimes. *Priority Foreign*

Countries are heretofore likely to be mostly non-WTO members, just as the People's Republic of China was in 1996.

World Intellectual Property Organization initiatives

New technologies continuously challenge existing IP regimes. Only a few years ago nobody thought of genes as property, electrical signals were not the equivalent of paper copies, and software was considered text, not invention. The United States is eager to incorporate new technologies into existing international IP agreements. The WIPO Copyright Treaty and the WIPO Performances and Phonograms Treaty in December 1996 updated commitments for protection of the software and recordings. In the near future WIPO will also consider protection for multimedia productions, databases, and electronic information. The intersection of domain names and trademarks also looms as a new technical issue which needs to be considered internationally. Eventually, the United States would like to see the WIPO agreements (and any new IP texts) folded into the WTO because of its dispute settlement mechanism.

The United States is also very interested in automating and networking the industrial property offices world wide. The idea is to simplify and make more efficient global patent applications and searches. One proposition is to link the offices in order to exchange information, documents, and search patent and trademark databases internationally. Another project is to integrate electronic filings for the Patent Cooperation Treaty administered by WIPO. Developing countries, for whom the cost of setting up and maintaining such a database is very expensive, stand to gain from greater international linkage. International searchable databases might even help technology transfer.

Industrialised countries

The United States is also engaged in discussions with the industrialised countries. In the short run, the harmonization of US, European, and Japanese intellectual property right regimes will probably have a larger effect on international technology transfer than will the strengthening of developing country regimes, since most technology transfer is performed by multinational corporations in the first world. High on the American trade partners' priority list is that the United States convert to a first-to-file system for patent priority assignation. Other concerns include the high litigation costs in the United States; the promise made to Japan in a 1994 bilateral to publish patent applications 18 months after the filing date and to allow greater third party input in patent reexaminations. The United States, on the other hand, is concerned about the lack of discovery in other countries and the high costs of patent filings. The United States and Japan have engaged in extensive bilateral dialogue on IPRs harmonization. Similarly, the Transatlantic Business Dialogue also has bilateral IPRs harmonization as one of its main objectives. A major disagreement between the United States and its advanced country trade partners, however, is over the importance of pushing developing countries to upgrade their IP regimes. For the United States, third country issues are primary, while for Europe the harmonization with the United States is more important.

Technology transfer and IPRs

American policy makers are aware that their demands have profound effects on trade partner economies, but they maintain that strong intellectual property rights will expand the innovation pie for all countries. Enhancing the appropriability of knowledge in developing countries should not only stimulate local innovation, but also facilitate technology transfers, trade in technology goods, and foreign direct investment. Increasing access to technology, in turn, should spur growth in developing countries.

US negotiators tend to believe that strengthening intellectual property regimes is simply a matter of will, and they increasingly take a results-oriented, market share approach to evaluate the success of intellectual property reforms in foreign countries. Outside pressure – a sort of intellectual property *gai-atsu* – seems occasionally necessary to overcome political obstacles to stronger intellectual property regimes. In the end, however, the US government does realise that only the emergence of domestic interest groups for innovation will firmly ground the new regime in local culture and society.[12]

To build strong, enforceable intellectual property regimes will require time, money, and expertise. Most countries need to set up modern administrative, judicial and customs infrastructures. For the least developed countries, the costs of such a system may be prohibitive although dollar amounts are hard to estimate. Countries like Laos or Cambodia would have to create IP regimes from scratch, while Argentina and Brazil need only tinker with systems that already have relatively high standards.[13] A lack of expertise and funding may make it difficult for governments to establish, in a timely fashion, the administrative and legal structures – not to mention the legal culture – that must underpin any IP system.

The advanced countries are eager to help. In fact, they are obligated to help as stipulated in Article 67 of the TRIPs agreement and the 1995 Osaka Action Agenda in APEC. The United States has technical aid programmes scattered throughout the federal government – including the Department of Justice, the FBI, the Department of Commerce/PTO, and the Customs Service. The network of financial and technical aid projects, while extensive, is not very well orchestrated. It is important to keep in mind that American intellectual property rights policies are driven primarily by domestic US concerns. The aggressive IP tactics of the United States have as a first objective to strengthen exports in the technology and entertainment industries which lose from $20 to $60 billion annually from infringement of their intellectual property.[14] (See Table 2 for total copyright losses and Annex 2 for industry breakdown of copyright losses by world region). While technical aid is an integral part of the US policy, it is not the top priority at this time. *Technological* transfer to developing countries, the theme of this OECD conference, receives even less attention from most US policy-makers and bureaucrats.

Table 2. Estimated losses to the United States due to global copyright piracy, 1994

	Piracy losses (US$ in millions)	World percentage
West Europe	3809.2	25.50
United States and Canada	3517.0	23.55
Developing Asia Pacific	2296.2	15.37
Japan, Hong Kong, Singapore	1531.5	10.25
Russia and CIS, East Europe	1462.0	9.79
South and Latin America	1442.2	9.66
Middle East, Mediterranean	773.5	5.18
Africa	103.7	0.70
Total	**14 935.3**	**100.00**

Source: Adapted from International Intellectual Property Alliance. <http://www.iipa.com/>

For developing countries, the *quid pro quo* inherent in the TRIPs agreement was that increased levels of intellectual property protection would lead to higher levels of direct foreign investment and technology transfer from foreign MNCs. In theory, multinational companies should be more inclined to share technological know-how with local companies when the MNCs believe that their intellectual property cannot be legally appropriated by local competitors. Economic analyses and empirical data on the relationship of IPRs to foreign direct investment and technology transfer do not unambiguously support this view.

Edwin Mansfield's surveys for the World Bank conclude that businesses do take into consideration intellectual property regimes when making decisions about whether to invest in a joint venture, to transfer new technologies to a wholly owned affiliate abroad, or to license new technologies to unrelated firms abroad. More than 30 per cent of the companies surveyed would not joint venture, license, or transfer technologies to an affiliate in India, Thailand, or Nigeria. Technologies transferred to countries with weak IP regimes tend to be older, less cutting edge than what countries with more robust IP regimes receive. The effects of weak IP regimes are long lasting: while Mexico, Korea, Taiwan, and China have made important legal changes to the system of intellectual property protection, US firms in 1994 felt that only Mexico's reforms now make the transfer of advanced technologies feasible.

But even though businesses express concern about the IP regimes in their export markets, the economic data on the whole ascribes only weak effects of IP regimes on trade flows, FDI, and technology transfer. Many economic studies have found that there is no apparent correlation between the strength of a country's IP regime and the type of direct investments made by MNCs.

Furthermore, industrialising countries may find that they are outside the nexus of technological trade.[15] So far, the globalisation of research and development (R&D) has been driven primarily by a convergence in technical capabilities among the advanced countries. Of the $33 billion trade in intellectual property (royalties and licensing fees) by US firms, 95 per cent of the transactions are with the European Union (62.7 per cent), Japan (25.3 per cent), and North America (6.8 per cent). Even then, intra-corporate trade – between affiliated firms – accounts for 80 per cent of the total in 1995. Companies apparently like to keep a degree of control over their intellectual property.

This does not mean that industrialising countries cannot make the leap into higher value-added industries by developing or importing technologies. Korea's jump into the semiconductor industry and India's explosion of software service providers suggests that other developing countries could follow suit. In Korea, 45 per cent of merchandise trade was in high technology goods in 1993, while in China high technology accounts for 35 per cent of merchandise trade. In both countries technology product trade has grown by 200 per cent since 1985. An offshoot of this vigorous technological development, patent applications in Asia are also rapidly growing. From 1986 to 1995, applications for patents have increased by 2.5 times in China, and by more than 5 times in Korea, Taiwan, and the ASEAN countries. But to take advantage of the globalisation of research and development – and similarly to take advantage of stronger intellectual property regimes – developing countries need to actively foster a business environment which can identify and exploit new technologies. There must be an active search for new technologies which can be developed, absorbed, or adapted domestically.[16]

There are plenty of opportunities for industrialising countries to tap into the technology of the advanced world. The classic example, of course, is Japan which actively sought to adapt foreign technologies to its needs in the post-war period. Japanese delegations frequently visited US factories cameras and notepads in hand. Nowadays, American industry is not likely to be so unwittingly welcoming of foreign visitors. But there are plenty of other avenues for accessing information. In fact, as the United States has tried to reduce government spending in research and development, there has been a great push in the universities and national labs to license technologies, create spin-off corporations, or otherwise try to make a profit from the ideas that American scientist and engineers generate. "Technology transfer" is a buzz word in the public and university sectors.

Furthermore, American companies entering into developing country markets often choose to produce, market, and distribute goods there. In order to increase technology transfer, local governments should strongly make the case to multinational corporations that partnering with local businesses, and giving them a stake in the company's intellectual property, will help raise domestic interest in the protection of innovations.[17] Creating domestic support for intellectual property is the key to creating enforceable IPR regimes.

The question of how stronger IP standards relates to technology transfer is not of direct concern to the US government. It is not going to be the one investing or transferring technologies, because it has neither the resources nor the incentives to do so. Technology transfer is the domain of private firms. And the American private sector is increasingly actively involved in IP training and technical aid abroad in the hopes of changing attitudes. These are very important avenues for building confidence among American firms about the IP regimes of foreign trade partners. Industrialising countries should consider partnering with the American industry lobby groups to jointly move toward higher IP protection and greater technology transfer, otherwise the two issues may not go hand in hand as hoped.

NOTES

1. For a more detailed account of US intellectual property rights policy see B. CALLAN, *Pirates on the High Seas: Why we care about global intellectual property rights and what we can do about them*, Study Group Paper, Council on Foreign Relations, New York, October, 1997.

2. Breadth refers to the number of product and process categories covered in the IP system. Even in countries with relatively strong IP systems, products like pharmaceuticals and recombinant plants or animals have often not received IP protection because governments believe that public interest dictates that drugs and food be available at reasonable prices or because such IP protection would violate public order or morality.

3. The strength of patent protection includes the length of time the protection is offered (e.g. 20-year patent terms, 50-year copyright terms plus life of the author), and the ease with which one can defend the protection from infringers. The United States, for example, has long claimed that Japan's protection is weak because it does not have a doctrine of equivalents and tends to narrowly interpret patent claims. In Japan if the claims in two separate applications do not literally infringe then competitors are allowed to make similar products, whereas in the United States the courts would hold that if the products perform substantially the same function in substantially the same way, the products would infringe.

4. The GATT Uruguay Round was concluded in April 1994, and it established the World Trade Organization under which is subsumed all the previous GATT agreements.

5. Shorter patent terms, wider exclusions from patentability, and the ability to grant compulsory licenses more freely have been mentioned as revisions. See Gorlin, op. cit.

6. The ACTPN is a private sector advisory body to the United States Trade Representative; the Transatlantic Business Dialogue brings together US and European companies to suggest ways of improving trade relations; and the International Intellectual Property Alliance is a private organisation of groups in the copyright industries.

7. In 1987 Brazil was named priority foreign country for its lack of pharmaceutical patents. Retaliatory tariffs affected $39 million Brazilian exports per year and remained in place for two years. For a general discussion of the success of the use of Section 301 see Alan O. SYKES, "Constructive Unilateral Threats in International Commercial Relations: The Limited Case for Section 301," in *Law and Policy in International Business* Vol. 23, No. 2 (1992), pp. 263-331.

8. Motion Picture Association, Recording Industry Association of America, Business Software Alliance, Software Publisher's Association, and International Intellectual Property Anti-Counterfeiting Coalition, Association, Pharmaceutical Research and Manufacturers Association, Chemical Manufacturer's Association.

9. TRIPs requires patent protection for novel recombinant micro-organisms but not higher order plants and animals. The biotechnology based industries may find this to be an impediment to trade in the near future, and one which will require a strong advocate in the US Government since there is a good deal of antagonism against extending IPRs to biologic inventions.

10. In April 1997 the USTR announced its intention to file six more cases with the DSB.

11. See *1996 Annual Report of the President of the United States on the Trade Agreements Program,* <www.ustr.gov/reports/tpa/1997/part7.html>.

12. Michael Ryan discusses the need for cultivating local interest groups in his paper “Global Intellectual Property Diplomacy,” unpublished paper, The Brookings Institution, August 1996.

13. The United States actually fears that countries will use their IP systems to raise funds by charging high administrative fees.

14. Office of the US Trade Representative, *The Uruguay Round: Growth for the World, Jobs for the US - A Primer*, Dec. 1, 1993, p. 6. As quoted in Richard Steinberg, “The Uruguay Round: A Preliminary Analysis of the Final Act,” *Laws of International Trade*, February 1994. The US International Trade Commission estimated the aggregate world-wide losses to infringement at $23.8 billion for key US sectors in 1986. See US ITC, *Foreign Protection of Intellectual Property Rights and Its Effect on US Industry and Trade – Report to the US Trade Representative,* Investigation No. 332-245, Publication No. 2065, Washington, DC, 1988.

15. For an account of how US research and development activities are globalizing see B. Callan *et al.* (1997), *Exporting High Technology: Facts and Fiction About the Globalization of Industrial R&D*, Study Group Report, Council on Foreign Relations, New York, October.

16. The concept of technological absorption was put forward by David Teece two decades ago. A Country’s absorptive ability is thought to vary with market size, education, technical skill, managerial know-how.

17. Ryan, *op.cit.*

ANNEX 1

Section 301 and 302 IP investigations and WTO dispute settlement cases

		Resolution
Argentina	1988	agreed to better pharmaceutical patent protection, case withdrawn
Brazil	1985	on informatics policy and related IP protection, case withdrawn
	1987	legislation for software copyright protection proposed, case withdrawn
	1987	sanctions imposed for lack of pharmaceutical IP protection, lifted with agreement to legislate product and process patent protection, 1990
	1993	generally weak IPRs, case withdrawn
Chile	1988	pharmaceutical patent complaint withdrawn by initiating party
China	1991	agreed to improve general IP protection, case withdrawn
	1994	memorandum of understanding signed, case withdrawn
	1996	negotiated enforcement, case withdrawn
	1997	implementation under Section 302 observation
India	1991	for general intellectual property protection, case remains open
	1993	no new investigation, continued monitoring
	1996	WTO dispute settlement on pharma and agri mailboxes, open
Korea	1985	agreement reached on stronger IP protection
	1987	pharmaceutical patent complaint withdrawn by initiating party
	1988	two pharmaceutical patent complaints withdrawn by initiating parties
Pakistan	1996	WTO dispute settlement on pharma and agri mailboxes, WTO
Portugal	1996	WTO dispute settlement for patent term non-compliance, closed
Taiwan	1992	agreement reached on stronger IP protection, monitoring compliance
Thailand	1989	inadequate IPRs, GSP benefits partially lost
	1990	agreed to amend and enforce copyright laws , monitoring compliance
	1991-1993	inadequate patent protection, US delayed action
Turkey	1996	WTO dispute settlement, discriminatory box office tax, open

Source: Data from the USTR Website <http://www.ustr.gov>.

ANNEX 2

International Intellectual Property Association estimates of 1995 US losses due to piracy abroad

	Motion pictures	Level	Sound recordings	Level	Business software	Level	Entertainment software	Level	Books	Level	Total losses
Asia	513.8	30%	349.1	36%	2 775.5	64%	2 001.9	n.a.	376.7	n.a.	6 017.0
Mid. East and Med.	247.8	75%	53.9	40%	180.3	83%	100.1	n.a.	103.9	n.a.	686.0
Latin America	299.0	55%	225.7	46%	835.5	n.a.	358.5	n.a.	128.5	n.a.	1 847.2
Canada	22.0	n.a.	17.5	3%	270.0	44%	n.a.	n.a.	n.a.	n.a.	309.5
Africa	11.0	99%	25.4	60%	170.6	73%	0.0	n.a.	60.0	n.a.	267.0
E. E. and CIS	463.9	85%	362.6	70%	533.9	83%	396.3	n.a.	72.9	n.a.	1 829.6
West Europe	709.6	20%	245.3	5%	2 451.1	49%	235.8	n.a.	41.0	n.a.	3 682.8
Total	2 267.10		1 279.5		7 216.9		3 092.6		783.0		14 639.1

BIBLIOGRAPHY

COLEMAN, P. (1997), "US Trade in Intangible Intellectual Property: Royalties and Licensing Fees," *Industry Trade and Technology Review*, US International Trade Commission, Washington, DC.

INTERNATIONAL INTELLECTUAL PROPERTY ALLIANCE (1995), "Copyright Industries in the US Economy: 1977-1993," Washington, DC.

MANSFIELD, E. (1994), "Intellectual Property Protection, Foreign Direct Investment, and Technology Transfer", International Financial Corporation Discussion Paper 19, Washington, DC: The World Bank, pp. 9-10.

MANSFIELD, E. (1995), "Intellectual Property Protection, Foreign Direct Investment, and Technology Transfer: Germany, Japan, and the United States", International Financial Corporation, The World Bank, Washington, DC.

MASKUS, K. and D. KONAN (1994), "Trade Related Intellectual Property Rights: Issues and Exploratory Results" *Analytical and Negotiating Issues in the Global Trading System,* Alan Deardorff and Robert Stern, *eds.*, The University of Michigan Press, Ann Arbor, pp. 401-454.

MASKUS, K. (1996), "Regionalism and the Protection of IPRs," unpublished paper presented to the Council on Foreign Relations' study group, *American IPR Policy after the TRIPs Agreement,* 19 April.

OKSENBERG, M., P. POTTER, and W. ABNETT (1996), "Advancing Intellectual Property Rights: Information Technologies and the Course of Economic Development in China," *NBR Analysis*, The National Bureau of Asian Research, Vol. 7, No. 4.

UNITED STATES INFORMATION AGENCY, "Protecting Intellectual Property: Bilateral Agreements," <www.usia.gov/topics/ip/ipfac7.htm>.

YOSHIDA, T. (1997), "The TRIPs Agreement and Patents in Asia," paper delivered at the 5th Annual Conference on International Intellectual Property Law and Policy, Fordham University, New York.

INTELLECTUAL PROPERTY RIGHTS: IMPORTANT BUSINESS ISSUES

Thierry SUEUR, Air Liquide, France

Intellectual property has become a major factor for increasing international business in a global world. I would like to examine some questions or problems which should be studied or addressed in order to further improve international co-operation in technology involving enterprises. I will give you the point of view of a French corporation but this means in fact the point of view of European and Multinational enterprise which is today present in more than 65 countries. This will focus on four topics:

- the high level of protection of intellectual property rights;
- questions relating to international exhaustion of rights;
- licensing transfer pricing;
- transnational R&D co-operation rules of intellectual property rights.

Protection of intellectual property rights

Since the signature of the Marrakech Agreement creating the WTO, the signature of TRIPS, one of the three basic agreements of GATT has been creating a minimum standard for intellectual property. This represents a major improvement as we know that intellectual property and particularly patents play a very important role in the development of knowledge and of progress. It should be remembered that the patent system is the best weapon against secrets, as the basic principle of patent is that a temporary monopoly will be granted to the applicants, provided certain conditions are fulfilled (novelty, inventive step....), and as a counterpart, the patent (or patent application) is published. This publication increases general knowledge and consequently, it represents a factor for progress and the development of R&D.

It is generally accepted that 70 per cent of knowledge is included in patent publications and that 40 per cent of the knowledge is in patents only. It is consequently very important to further strengthen intellectual property rights and to resist any attempts which are continuously made to weaken them. In order to reinforce intellectual property rights, it is important to increase legal certainty and to address the questions of enforcement of rights which is not fully addressed in TRIPS.

It is essential that patent owners have access to fair trials with reasonable costs, obtain fair decisions in a short time and that ultimately the damages actually become dissuasive for potential infringers. It is also important, with respect to costs, that in the future, patent fees become lower and that ultimately through further harmonization, patent offices mutually recognise their prior art searches as well as their examination. It is also a positive move when, instead of creating their own national patent offices, different countries aim at creating regional offices (European Patent Office, Eurasian Patent Office, ASEAN Patent Office).

International exhaustion of rights

International exhaustion of intellectual property rights is not acceptable. The use of a technology depends on economical factors only and that a patent only enables the patentee to recover R&D expenses but does not, per se, act as a blocking tool for using a certain technology. The exhaustion of rights may be accepted in limited, economical coherent regions such as for example the European Union region. Whether we like it or not, this global world is not an economically coherent world and accepting that, because a product has been sold or manufactured in one country by the patentee or with his authorisation, should prevent this forbidding the sale of the product in other countries, does not make sense.

A recent decision of the Japanese Supreme Court of July 1st, 1997 (BBS Kraftverzeug Technik A.G. v. Racimex Japan KK & Jap Auto Products KK) seems to have accepted international exhaustion of rights. It should be said that this decision, nevertheless, still enables the patentee through a grant of exclusive license or through contractual agreements to restrict export of the patented product from one country to another. It should be important that countries study the economic impact of international exhaustion of intellectual property rights before making final decisions, as this might lead to unexpected dramatic economic consequences.

Transfer pricing

With respect to transfer pricing, the OECD model tax convention on income and on capital has been adopting the Arm's Length Principles as the international standard which should be used for tax purposes by MNE (Multinational Enterprises) groups and tax administrations.

According to the convention: "When independent enterprises deal with each other, the conditions of their commercial and financial relations (e.g. the price of goods transferred of services provided and the conditions of the transfer and provision) ordinarily are determined by market forces. When associated enterprises deal with each other, their commercial and financial relations may not be directly affected by external market forces in the same way, although associated enterprises often seek to replicate the dynamics of market forces in their dealings with each other", this Arm's Length Principle also applies for intangible property, that is to say the know how, the patents, trade secrets, trade marks, and copyrights.

Today it is important to firstly remark that, in order to save costs and also to improve the efficiency of R&D, it is better for a multinational group, as well as for smaller enterprises, to put their R&D efforts together in order to be able to become more ambitious and to achieve higher goals. For a MNE, this will also imply that the Mother company will have to grant a license to the Affiliated company in order to enable it to use the new technology, that is to say the result of the R&D. The tax authorities of each country have to make sure that this transfer of technology respects the Arm's Length Principle.

In certain countries, tax authorities, as well as some affiliated companies, have difficulties in understanding that if a company has been granting, throughout the world, licenses under patents and know how for a certain royalty rate, these financial conditions should also, *mutates mutandis*, apply in the other countries otherwise each of the preceding countries and their tax authorities might question and challenge the value of the technology. One additional factor should be taken into consideration: it is the fact that due to the higher strength of intellectual property rights, the value of technology also has a tendency to increase. Consequently, some royalty rates, which were in former times considered as reflecting the value of a technology, now have a tendency to increase.

R&D co-operation

In certain government funded programmes, it is from time to time required that the partners comply with certain strict rules concerning the sharing of information between partners and also concerning the access of technology to Third Parties. We have been exposed to these kind of problems in the European Union programmes and, from time to time, these rules prevent some companies from joining the programme.

One good example is the Intelligence Manufacturing System programme rules which give a lot of freedom for the inventors and partners to disclose or not, and/or to license their foreground intellectual property rights to third parties. More particularly, there is no automatic access to background information and, with respect to background intellectual property rights, it may be subordinated to the payment of a fair royalty as well as to the respect of confidence. This more flexible approach is better for the partners in international R&D.

CASE STUDY OF KOREA: IMPLEMENTATION OF THE TRIPS REQUIREMENTS FOR PATENTS IN KOREA

Won-Joon KIM, Korea Industrial Property Office

Introduction

The World Trade Organization (WTO) Agreement, including the Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPs), went into effect on 1 January, 1995. It has been two years since the WTO was launched. Each country has steadily carried out its duties such as the alleviation of import regulations and customs reductions in accordance with the WTO agreement.

Likewise, the Korean government revised intellectual property laws in accordance with the relevant provisions of the TRIPs agreement. Now, enhancing international competition has increasingly become an important concern for Korean companies. Intellectual property rights (IPR) including patents, play an important role when contracts for technical transfers are made. The circumstances of technical import and export by Korea are important aspects in the promotion of technology transfer. The Korean government increased its concerted efforts to remove the grounds for trading conflicts with its major trading partners by abiding by principles and rules recognised world-wide such as the TRIPs Agreement and the Paris Convention for the protection of IPR.

The Korean patent system

The system of administrating industrial property rights in Korea has been persistently changing and improving during the short period of time since 1946, and has reached the level of the industrialised countries. In the beginning, laws and regulations were adopted from the Japanese system. However, significant parts of the American and EPO systems have been adopted thereafter. Nonetheless, in order to improve the IPR protection system, Korea has striven to reform the institutional framework for IPR through revisions over the past several years.

Moreover, Korea has been actively participating in the UR/TRIPs negotiations and the international meetings for the harmonization of the various national patent and trademark laws.

History of the Korean patent system

- 1946: enacted the Patent Law encompassing Invention, Utility Model and Industrial Design and established the Patent Bureau;
- 1949: enacted the Trademark Law;

- 1961: the previous Patent Law was divided into the following categories of the Patent Law, Utility Model Law, Industrial Design Law, and Trademark Law; and
- 1977: Patent Office established and upgraded to the Korean Industrial Property Office (KIPO).

Date of entry to conventions

- 1979: World Intellectual Property Organization(WIPO);
- 1980: Paris Convention;
- 1984: Patent Co-operation Treaty (PCT) Chapter I;
- 1987: Budapest Treaty;
- 1990: PCT Chapter II;
- 1993: TRIPs Agreement; and
- 1997: PCT International Searching Authority (in September 1997).

Introduction of other Industrial Property Systems

- Copyright enacted in 1957 and revised in 1995;
- The Computer Program Protection Law in 1987;
- The Unfair Competition Prevention Law in 1991;
- The Protection of Trade Secrets Law in 1992; and
- Semiconductor Chip Layout Design Protection Law in 1993.

Current trends in patent filing

According to WIPO, the entire number of industrial property applications filed world-wide in 1992 was 3.7 million. In Korea, there were 274 069 industrial property applications filed in 1996, ranking Korea the fourth in the world following Japan, the United States and China. In cases of patent applications, the number of applications filed by Koreans and foreigners was 68 413 (75.7 per cent) and 21 913 (24.3 per cent), respectively. This means that Korean applicants have invested in developing new technologies and have increased the international competitiveness of industrial property rights.

However, at the end of 1992, a total of 3.8 million patents were in force. The Contracting States of the European Patent Convention, the JPO and the USPTO covered 84 per cent of the total patents world-wide.

In Korea, the number of registrations made by foreigners in 1996 was 16 881, accounting for 23.2 per cent of the total 72 363 registrations. Registrations by Koreans increased by 18.3 per cent and those by foreigners increased by 5.2 per cent over the previous year. The number of patent applications in Korea has increased since 1970s and shown a drastic growth of 20-30 per cent or more each year since. Prior to the 1980s, the applicants were mainly the inventors themselves. By the beginning of the 1980s, company applications began to surge and since the 1990s the number of company applications has increased remarkably. At this rate, it is expected that by the year 2000, the patent applications filed by Koreans will exceed 100 000 and represent 80 per cent of the total patents filed (assuming the applications by non-residents remain at approximately 25 000.

Technology transfer

Technology transfer in Korea is mainly related to technology of import-purchasing. The actual number of transfers is not accessible; only the number of cases reported and recorded with the government could be ascertained. The reported cases of technology transfer have increased steadily from 454 cases in 1985 to 707 cases in 1993. The number of reported cases in 1994 dropped to 430. This decrease was due to the new deregulated law enacted and the recording of technology transfer with the governmental agency is no longer required except for a few exceptional cases.

In terms of the major technology transferors, Japan ranked first with 2 746 cases, the United States ranked second with 1 852 cases, EC (including Germany, United Kingdom, France, Italy and Switzerland) ranked third with 1 053 and the rest accounted for 501 cases. The royalty paid was recorded as US$ 295 550 000 in 1985; a tremendous increase of US$ 1 276 600 000 was recorded in 1994 due to an annual increase in royalty payment.

Technology transfer is mainly related to patents. In 1985, there were 238 hybrid cases in a total of 454 cases; 333 hybrid cases in a total of 738 cases in 1990; 250 hybrid cases in a total of 430 cases in 1994; about half of the transfers show a form of technology transfer associated with a patent.

In technology purchasing with trademarks, there were 104 cases out of 454 cases in 1985, 157 cases out of 738 cases in 1990, 69 cases in 1994. About 15 to 20 per cent of the transfers accompany trademarks. In particular, purchasing of the technology with trademarks appears to be prevalent in the food and textile industries.

Until the early 1990s, technology transfer to Korea was generally available from the United States. Since the mid-1990s, however, this trend has changed. In particular, from 1994 to 1995, the number of the technology transfers from Korea to overseas countries has been increasing. The major receiving countries are in Southeast Asian (including China, Vietnam) and the Central American countries. In 1995, the rate of the technology transferred from overseas to Korea and from Korea to overseas was about 50:1. It is anticipated that by the year 2000, the rate of the technology transferred to Korea and from Korea will be in the ratio of 10:1. Based on the current growth rate in technology transfer, it is anticipated that the outgoing patent applications will also increase considerably.

Amendment of patent law

Korea has amended its relevant domestic laws and regulations in order to comply with its obligations under the TRIPs agreement, as ratified by the Korean Government in 1994. Amendments to four acts, including the Patent Act, became effective as of July 1, 1996. The especially important topics relate to the extension of the patent period, the expansion of patent subjects, the expansion of the scope of patent rights and the adjustment of the allowable range for compulsory license by arbitration procedure.

Article 88 of the Patent Act stipulates that the period during which patent rights are protected shall be 20 years from the date of the application. This provision is in conformity with the provision of article 33 of the TRIPs agreement, which states that “the term of protection shall not end before the expiration of a period of 20 years from the filing date." The revision mandated by the TRIPs agreement would extend the average term of protection by an additional two years.

With respect to patent protection, Article 32 of the Act, as amended, stipulates that "a Patent shall not be granted for an invention that would or is likely to endanger the social order, or corrupt public morals, or that might injure public health, notwithstanding the provisions of Paragraphs 1 and 2 of Article 29." It is stipulated in Article 27 of the TRIPs agreement, Paragraph 1, that "Patents shall be available for any inventions whatsoever, provided that they are new, involve an inventive step and are capable of industrial application." In addition, Paragraph 2 of the same Article stipulates that it is not acceptable to maintain as grounds for not granting a patent, the purpose of protecting domestic industry, unless this is necessary for the purpose of protecting the social order or public morals, or avoiding serious injury to the environment, etc. However, under Korean law, inventions on medical treatment methods for humans are considered to be without industrial applicability, and thus to be unpatentable.

Article 2, Paragraph 3, which specifies the scope of patent rights, stipulates that "[I]n the case of the invention of a product, the patent right includes the production, use, sale, or importation, or offering for sale including exhibition of the product for the purpose of assignment or lease. In the case of the invention of a process, the act of offering for sale of a product produced by the process is included as well."

Article 28 of the TRIPs agreement specifies the exclusive rights granted following patent registration. In the case of an invention, the making, using, offering for sale, selling or importing of it; it specifies in the case of the invention of a process, the act of offering for sale of a product produced by the process is added as one of the exclusive rights. Offering for sale as specified in the above Article is construed to include, for example, invitation by catalogue, distribution of pamphlets, as well as exhibiting the products for sale.

Where no agreement is reached or no consultation is possible on the non-exclusive license between patent owner or exclusive licensee and the person desiring to work the patented invention, arbitration for the non-exclusive licensee is possible according to the Article 107, Paragraph 1, Section 1, (non-working for 3 years or more continuously) or Section 2 (non-working for 3 years or more on a substantial scale). Such provision is identical to the previous law. Paragraph 1, Section 3 of the same Article limits the use to non-commercial purposes when it is used for the interest of the public. Section 4, which was newly established, stipulates that it is possible to file an application for arbitration in the case where the use of the patent invention is necessary in order to correct an act which has been judged to be an unfair trade activity according to judicial or "administrative procedures".

With regard to semi-conductor technology, Article 31, Paragraph c of the TRIPs agreement, stipulates that the non-exclusive license is permitted only "in the case where the semi-conductor technology is used for a public, non-commercial use or used in order to correct a customary act which has been judged to be an act of unfair competition according to judicial or administrative procedures." In accordance with this provision, Article 107, Paragraph 6 has been newly established. It is now possible to file an application for arbitration only "in the case where the use of a patent invention regarding the semi-conductor technology is for non-commercial purposes which are necessary for the interest of the public or for the correction of an act which has been judged to be an unfair competitive act according to judicial or administrative procedures.

Under the revised law, a 50 million won (about US$ 60 000) maximum penalty is imposed on a legal entity for its infringement. In order to effectively deter the legal entity's organised production and the sale of imitations, it is under consideration to impose a heavier penalty on such legal entity.

Article 64 of the existing Patent Act stipulates that a patent application be publicly advertised after 18 months has elapsed from the filing of the application. The amendment, however, stipulates that if desired by the applicant, it may be published before the 18 months have elapsed. This system grants protection upon application to the party who desires provisional protection.

In order to promote the grant of a right, the pre-grant opposition system was abolished, and the post-grant opposition system was introduced on 1 July, 1997. Any person can file an opposition against the grant of a patent within 6 months from the issue date of the publication of the grant.

Other changes in policies and practices

Korea has placed high priority on its policy for eradicating trade in counterfeit goods, because it recognises the negative effects this activity has on international trade. Parts of this policy also include maintaining strict control against trade in counterfeit goods by concentrating on the crackdown on the manufacturers and wholesalers of counterfeit items in major areas. The Korea Customs Administration (KCA) has carried out indirect anti-counterfeiting activities by examining the trademark of import-export goods so as to ensure that they agree with the one specified in the import or export permit. The recently revised Customs Law will make it possible to conduct direct anti-counterfeiting activities such as delaying the shipment of import-export goods upon the demand of the trademark owner and the exclusive licensee.

In compliance with the TRIPs agreement, the new Korean Trademark Law will become effective as of 1 March 1998. However, in order to implement the Trademark Law Treaty and Madrid Protocol, regulations of the Trademark Law are now under consideration. Under the current law, goods or services of only one class can be designated in one application. In order to offer a cost-effective means of protection, the multi-class application system will be introduced, so that goods or services in plural classes may be designated in one application.

Under the current law, it is difficult to exclude applications for trademarks that are well known only abroad, which have been filed by applicants other than the true owners of the well-known trademarks. This causes a free ride problem and dilution of the very well-known trademarks. In order to reinforce the protection of very well-known trademarks in foreign countries, it is necessary to revise the present provisions concerning the protection of trademarks identical to or similar to trademarks that are well-known abroad or on a nation wide scale, or the rejection/invalidation of an application filed against the rule of faith towards domestic trademarks.

The introduction of a registration system for three-dimensional trademarks is urgently needed since, under the current law, three-dimensional trademarks cannot be registered. In order to comply with international trends, a registration system for three-dimensional trademarks will be introduced. However, the shapes of designated goods or goods supplied for use in the provision of services will not be registerable, unless they become distinguishable by their use as trademarks or service marks.

Changes to institutions

KIPO is comprised of two trial boards, seven bureaux and seven director-level positions, as well as IIPTI. As of August 1997, KIPO has 16 trial examiners on the trial board and 11 appellate trial examiners on the appeal board.

In 1994, there was an attempt to amend the relevant laws, reform the judicial system, and establish an appellate court for industrial property cases, so as to facilitate a prompt resolution of disputes involving industrial property rights, and to render fair judgements in cases that involve technologically complex issues. As a part of the reform of the judicial system by the Supreme Court, the Supreme Court and KIPO began to seek ways to improve the system of dispute resolution involving industrial property rights. The basic agreement for improving the system of dispute resolution involving industrial property rights was reached on 8 July, 1994, between the Supreme Court and KIPO.

According to the agreement, KIPO will conduct the first trial of the industrial property right disputes by unifying its current Trial Board and Appellate Trial Board ("Patent Trial Institute"), and the Supreme Court will conduct the appellate trial involving industrial property right disputes by establishing a Patent High Court under its jurisdiction. Both institutes will be launched before 1 March 1998. In 1998, Korea's patent system will be changed to be more specialised. Specifically, Technical Judge System like the German federal patent court is now impossible but the opinion of the technical science circle in support of such a system has been very strong so this system will be introduced in the future.

There will be 16 trial divisions for each field, as well as a Trial Planning office and a Trial Administration office. The 16 trial divisions will consist of ten divisions organised according to the technology fields such as patents and utility models, two design divisions, and four trademark divisions. In 1998, the new trial system will be established to reach the level of developed countries. Also KIPO will strengthen its human resources to specialise in trial examination.

Conclusions

With the launching of the WTO, a new environment for increasing trade in areas such as technology, services, and agriculture is being created. Furthermore, the TRIPs agreement, which purports to enhance the level of international protection of intellectual property rights, is now playing an important role in forming a harmonized system for protecting those rights. Thus, patents should be considered as a mechanism for providing technology transfer involving trademark, in a globalised knowledge-based economy. With economic globalisation, there has been an increase in international trade in technology as well as in goods. The number of patent applications has increased at a much higher level.

In order to fully protect the results of technological development as well as to comply with relevant provisions of the TRIPs agreement, the Korean government has made concerted efforts to amend its industrial property laws. Moreover, Korea has increasingly recognised the importance of intellectual property rights protection by keeping up with the international trends and participating in international meetings. Finally, KIPO has pushed its ambitious modernisation plan as follows. It has endeavoured:

- to promote co-operative relations among countries;
- to take part in the international harmonization of laws;
- to develop paperless projects (computerised systems);
- to establish a new patent trial system; and
- to increase the number of full-time examiners so as to shorten the examination periods required for patents.

THE ROLE OF GOVERNMENT

INTERNATIONAL TECHNOLOGY CO-OPERATION IN THE EUROPEAN UNION

Mike W. ROGERS,[1] European Commission

Introduction

International Technology Co-operation in the EU Programmes and initiatives was a *de facto* element from the very earliest days. The constituent countries of the initial European Community already realised in the early 1950s that given the cost and complexity of R&D and infrastructure, national governments should join to collaborate. This would enable lost growth (to the two superpowers of the day) to be regained. By 1949, the Council of Europe had been established, at the instigation of "the Hague Congress", with the aim of encouraging co-operation between countries on legal, social, administrative and scientific affairs. The credit for the inclusion of science is generally awarded to the Frenchmen, Dautry and Auger, and the Italian Annaldi, who were very influential scientific administrators in their respective countries at that time. This laid the foundation for CERN[2] in July 1953 (B, F, BRD[3], GB, IT, NL, SW, YU; then CH, DK, NOR), and which now has 19 countries as partners. CERN was focused on purely nuclear R&D.[4]

The halting momentum of closer European co-operation of the early 1950s led to a retrenchment into structural integration. This led to the European Coal and Steel Community (ECSC) being established in 1952, with an R&D element; Article 43 in the Treaty of Rome referring to R&D, and EURATOM in 1956 as an instrument of energy policy, establishing a scientific and technical research organisation in the nuclear sector.

Supported by Eisenhower's "Atoms for Peace" declaration and Germany's interest in further integration, a major co-ordination and own R&D effort started but which, however, lacked focus and critical mass. Seventy per cent of EURATOM's funds were spent on Association Contracts, allowing it to participate in R&D programmes of non-member states and external R&D centres, while an initial impetus was supplied by technology transfer from the United States. However, the return of General de Gaulle to power in France in 1958 reduced the potential for common progress, as the French embarked on a strategic nuclear arms manufacturing programme. EURATOM has never recovered its potential.

The identification of the technology deficit highlighted the need of Europe to open its RTD programme, to acquire technology and reduce the brain drain. However, only isolated initiatives succeeded (e.g. the eventual foundation of the European Science Foundation), or NATO was motivated where the Community failed (such as in the creation of a parallel European Technology Community, an idea promoted by the UK premier Harold Wilson in 1966).

The rekindled French enthusiasm for deeper international R&D co-operation (e.g. the Marshal Plan-PREST of 1966) was totally negated by its political stance of vetoing the Community's expansion. The deadlock was broken in 1969 when Pierre Aigrain's proposals for "*Co-operation scientifique et technologie*" – COST were approved, with more non-Community states (total nine) participating than EU members states (just six at that time). Four years of work by 19 countries and the Commission finally resulted in 7 actions lasting 2 to 5 years but a total budget of just 6 MECU.[5] "The mountain gave birth to a mouse", quipped the then S&T Commissioner Spinelli.[6]

In 1974 the core of Community policy as we know it now was formed – on 14 January 1974 a decision was taken which created the Committee for Co-ordination of Scientific and Technological Research (CREST), and encouraged the definition of projects of Community interest (which allowed non-MS[7] to participate). The Commission recognised *that "... the nature of ... research... collaboration often extends beyond the ... Community*" and established a long range forecasting activity that was to extend its influence well into today ("Europe+30", then the "FAST"[8] programme).

By the 1980s, a series of unsuccessful co-operation attempts (three French "*plan calculs*" UNIDATA, Eurodata) prepared the ground for a further Commission initiative; this time clearly driven by industrial needs rather than European policy requirements, under the patronage of Commissioner Viscount Davignon.

Europe had only 10 per cent of the world IT market, and only 40 per cent of the Community market. The Versailles Economic summit stimulated ESPRIT into a full programme, and gave a concrete core to the Commission's First Framework Programme for RTD (1FP) (1984-7). Alongside this, the Single (European) Act came into force by mid-87 and for the first time, RTD was accorded a title: Title VI. This created the possibility of co-operation with third countries and international undertakings, complementing the essentially economic rationale of the Treaty. The EUREKA[9] initiative was established in 1986 after a French-based launch alongside its EU-based, more flexible and open structure.

International Co-operation was further strengthened in its new legal base within the 1992 Treaty on European Union[10] and its Article 130g which reads: *"In pursuing these (... science and research policy ...) objectives, the Community shall carry out the following activities, complementing the objectives complementing the activities carried out in the Member States: ... (b) promotion of co-operation in the field of Community research, technological development and demonstration with third countries and international organisations."*

By the time Commissioner Ruberti formulated the Fourth Framework Programme (for the years 1994-98), Co-operation with third countries and international organisations became one of four principle axes of the entire 13 BECU budget, which represented 3 per cent of all Community expenditure at that time. It was then, and still is, an important arm of the European Union's external relations policy.

Fourth framework programme – co-operation with third countries

In view of certain characteristics of current scientific and technological problems, such as scale, complexity and cost it is in the interest of the European Union and its member states to co-operate with industrialised countries, developing countries and international organisations.[11]

An innovation of the Fourth Framework Programme (covering 1994-98) was that this form of co-operation is grouped together in a single programme,[12] in addition to the co-operation actions which will be supported by the other specific RTD programmes, in order to improve the relations in the field of RTD between the Union and other (third) countries. Three areas have been identified:

1. "**Scientific and technological co-operation in Europe**" the aim of which is to strengthen links with COST, EUREKA and certain international organisations. In connection with PHARE and TEMPUS there will also be activities concerning the Central and Eastern European countries and the New

Independent States of the former Soviet Union in order to safeguard their scientific and technical potential.

2. "**Co-operation with non-European industrialised third countries**" in order to optimise the European Union's RTD efforts while ensuring, in the long term, that there is a better match between its RTD policy and potential international markets. This co-operation requires flexibility (consultations, exchanges of experts, joint studies or even mutual participation in research programmes on both sides).
3. "**Scientific and technological co-operation with the developing countries**" to enable them to find solutions to problems which affect them directly (natural resources, health, agricultural production, etc.) and to enable them to be involved in the quest for knowledge in relation to issues of global importance (environmental protection, communicable diseases, desertification, etc.). Another objective is to preserve the excellence of European researchers in disciplines of relevance to developing countries (development of agriculture and fisheries, etc.).

In order to meet these three objectives, individual countries are classed into groups of participations, each with clearly defined rules for participation. Usually, governments in each of the third countries are responsible for broadcasting the range – and limitations – of the arrangements. Bearing in mind that the Community has the responsibility to protect the use of public funds, these conditions represent one of the most liberal regimes for such participations.

The Commission has had somewhere in the order of 30 000 projects in the area of RTD which have a public dimension over the past 10 years. In total, there are some 193 countries outside the European Union which have, at some stage or other, participated in RTD activities through Community initiatives. Table 1 itemises those with participations in double figures.

The major participations are dominated, as to be expected, by third countries with close proximity to the European Union itself. All top ten places are occupied by either EEA or Central and Eastern European Countries (CEEC). Norway had engaged itself fully in research and development co-operation prior to a referendum which then rejected full EU membership, but the scientific community remains committed to close co-operation (based on a long history of close co-operation with its Scandinavian neighbours via the Nordic Council).

Participations by the United States, Japan, Brazil and Mexico are roughly equal in numbers (excluding Fusion), though there may be significant differences in the scale of projects. Participation with the United States is expected to increase now as the five year US-EU S&T agreement has been initialled recently in the past few days.[13] This is a major extension of access "width" relative to the 4th FP, and will be operational in time for the 5th FP. However, additional criteria will still apply for the participation of affiliates of EU companies in the US Advanced Technology Program and R&D Partnerships with the Department of Energy. These conditions involve an assessment of whether a foreign affiliate's participation would "be the economic interest of the United States" and how the relevant country treats the local affiliates of US-owned companies. This is not as equitable as one would wish.[14]

A more detailed analysis of 1 800 current direct RTD contracts[15] up to 1 September 97 showed that about every third contract had an element (i.e. at least one contractual partner[16]) of third country participation (some 627 contracts out of a total of 1 794). Over the last two full years (1994 and 1995), participations by Switzerland, Israel, Canada, South Africa and Australia – for example – increased dramatically from 85 cases in 75 contracts to 277 in 237 contracts, with average contract size increasing at twice the rate of participation increase (up by nearly seven times). Much of this is due to the implementation of explicit S&T agreements. Notably the EU-US Science and Technology Agreement has just been concluded.

The list of other countries who have had, or have on-going participation is long as Table 2 shows, (with due allowances for political definition errors in these times).

Central and Eastern Europe and Russia

Over the same period, participation by Central and Eastern Europe and Russia has increased five-fold, on average across 18 countries, with most notable increases in former Russian republics where recent increases are an order of magnitude – albeit from a small basis. The special situation of the European Union in relation to the changes in the Central and Eastern European Countries is worth developing a little. Large countries and those who are further along the road to market economies tend to be more active in RTD projects in the European Union. This group of states have 12 in the top 18 co-operation partners in terms of numbers of participations. This is due to the specific instruments available for enabling participations.

The rationale for the Community's special interest includes:

- prevention of further decline in the RTD potential there;
- supporting private sector access to previously closed RTD systems;
- improve the rate of conversion from defence oriented technologies to wealth creation technologies;
- to develop long-term scientific co-operation between the two groups of countries at a strategic and tactical level;
- to assist in the diffusion of management skills for RTD that embodies more demand-led traditions than these areas are used to.

The Commission has last year officially requested authorisation from the Council of Ministers to negotiate an agreement for scientific and technological co-operation with the Russian Federation. Acknowledging the important place occupied by Russia both among the new independent states (NIS) and on the scientific and technical international scene, the Commission believes that strengthening co-operation in the RTD sector will not only stimulate Russian economic development and human resources but also strengthen the European Union's own scientific and technological research activities.

In recent years, the relations between the European Union and Russia in the field of human resources and RTD have developed under various forms. Thus, for the period 1993-97, these activities involved a Community financing of almost 100 million ECU and concerned approximately 25 000 Russian researchers. This is over and above participation in EU projects.

Over the years, organisations from the Russian Federation have participated in nearly 1 100 European projects, mostly through INTAS[17] (889 projects) and INCO[18] (79 projects), but also through other specific programmes such as ACTS[19] and Environment & Climate (e.g. TESS[20]). There are over 400 projects running at the moment. In response to their request and to the substantial efforts of the Russian authorities to provide new structures more suitable to research needs, the European Union has reacted positively via its assistance and co-operation programmes, such as the TACIS programme, so as to develop the exchange of knowledge and expertise as well as the setting-up of partnerships and networks.

Thanks to TACIS' support, in 1992 the International Science and Technology Centre (ISTC) of Moscow was created jointly by the European Union, the United States, Japan, and the Russian Federation. The ISTC was established in order to prevent the development, production and delivery of mass destruction weapons, in particular through providing scientists and engineers from the NIS previously employed in the military sector with professional alternatives in civil research. TACIS contributes 17 MECU year to the ISTC, of which Russia obtains approximately 90 per cent.

In addition, active co-operation with Russian scientists is financed through INCO-COPERNICUS[21] and INTAS, and within the framework of the Joint Research Centre's (JRC) activities, and teams of Russian researchers can also take part in the other specific programmes of the 4FP. Of the 10 230 participants in 1996; some 1 917 were from the NIS and 3 756 from the PECO[22] states.

INTAS is an independent structure which aims to implement a concerted co-operation activity in the field of non-military research with scientists from the NIS. Actions primarily concern the support of joint research projects, bringing laboratories from INTAS Member States and the NIS together with European partners. Approximately 95 per cent of the INTAS budget is provided by the European Union and the INTAS contribution to Russia amounts to almost 54 MECU for the period 1993 until mid-1997.

Sixteen EU-CIS collaborative projects were carried out over periods of up to five years, between 1991 and 1996, on the consequences of the Chernobyl accident in 1986. The projects were made possible through a special budget created by the European Parliament and the research collaboration was formalised in an Agreement made between the Commission and the relevant ministries in Belarus, the Russian Federation and the Ukraine. The different research projects covered the transfer of radioactive material through the environment and into the food chain, a study of decontamination strategies and restoration measures, the investigation of health effects arising from the accident and the development of emergency management procedures for improvement of overall emergency preparedness.

Each of the research projects was executed in a co-operative venture between a group of institutes in the European Union and a group of institutes in the three republics. In addition to these major projects, there have been several recent specific initiatives, in particular in the fields of space research, information technology, telecommunications, environment, and transport. Moreover, the European Union and Russia already co-operate at a multilateral level in the framework of EUREKA, as well as at the level of some individual COST Actions.

All these elements taken together argue in favour of a more formal co-ordination and systematic follow-up of the strategy and the means available for R&D co-operation with Russia. A science and technology co-operation agreement would be the most appropriate Community instrument to benefit both the European Union and Russia. This agreement would allow Russian organisations to take part in EU research programmes (except in the nuclear sector) and, vice versa, would provide EU organisations with access to the equivalent Russian programmes. This agreement would also define rules concerning the intellectual property rights related to results obtained either by Russian projects involving EU organisations or by EU projects involving Russian organisations. Such an agreement would facilitate the exemption from taxes and other duties (import duties, VAT, etc.) currently applicable to grants received by Russian organisations participating in EU programmes. The Commission will be responsible for negotiating with Russia. At the end of this phase, an agreement should be ratified by the two parties. The Commission believes that this agreement could enter into force by the beginning of the Fifth Framework Programme.

Developing countries

Developing countries constitute an increasingly significant set of partners for the European Union in terms of scientific and technical co-operation. Science and technology co-operation with these countries is intended to reinforce their research capacity, through linkages induced with other, more advanced countries. Science and technology co-operation complements other development aid, acting at an institutional level to directly improve local capacity – infrastructures, education, technology transfer.

However, developing countries present a highly diverse, and often divergent, set of science and technology systems. Countries such as India and China have a large and highly developed scientific, technical and engineering base, whilst most ASEAN countries have science bases that can no longer be thought of in terms of the developing world. Nevertheless on the whole, a very high proportion of their populations (up to 80 per cent in India) are still in a "traditional" situation (in Asia, 80 per cent work on the land, compared to 6 per cent in Europe).

In particular, improvements for some Third World countries simply underline the marginalisation of other developing countries in the international economic and political system. The severe economic difficulties, malnutrition and drought problems of many of these marginalised Third World countries is compounded by the development of new or re-emerging pandemics. Although it is difficult to target science and technology support and co-operation in these situations, this is more necessary than ever as these countries, despite all their difficulties, have shown themselves increasingly capable of using science and technology effectively.

Certainly, many countries in Asia and parts of Latin America are now characterised by remarkable industrial and commercial dynamism, although these are combined with extensive social, environmental and health problems. Despite these difficulties, many developing countries manage, whatever their economic level, to sustain centres of excellence in some scientific field or another, as for example Kenya or the Ivory Coast in molecular biology.

Access to modern science and technology is important if these developing countries are to solve, or at least to ameliorate, these problems. But access must be gained through mutual co-operation and support between Europe and developing countries, based on mutual interest.

Since the inauguration of the Framework Programmes, Community science and technology policy has always included a component of co-operation with developing countries. As early as 1982, scientific co-operation with developing countries was implemented mainly as a thematic approach of the Framework Programme (STD,[23] followed by INCO-DC), addressing only those development issues common to all countries – sustainable management of natural resources, agriculture and health. Until 1994, this programme was supplemented for non-ACP countries by the International Scientific Co-operation Initiative (ISC), which offered a more individualised approach and covered themes other than those related to development. These two separate instruments were regrouped in 1994 into the present INCO-DC programme under the 4FP.

The INCO-DC programme was conceived with the aim of providing mutual economic, environmental and social benefits for developing countries and for Europe. The European Union nevertheless has four basic objectives in establishing links with developing countries. These are:

- to **promote the high quality** research required for development and economic co-operation;
- to **sustain and improve research** and technological development capacity, including human resources;
- to **support the retention of scientific know-how** and competence in Europe in fields of mutual interest and relevance to the problems facing developing countries; and

- to **honour the European Union's political obligations** in relation to sustainable development, especially as regards the recommendations of international fora such as the Rio Conference on research in developing countries.

The primary purpose of the INCO-DC programme and its predecessors has been to provide support to other EU policies related to the development of, and economic co-operation with, developing countries. As such, the programme serves as the European Community's political and operational instrument, contributing to global issues through various international fora, such as the Rio Conference (Agenda 21), Desertification Convention, World Food Summit, and World Health Organisation (WHO) ad hoc Review Committee. Europe must accept its share of responsibility for global problems, especially in the fields of health, malnutrition, migration and pollution, if for no other reason than to minimise their potential negative impact on political, economic and environmental stability.

The first initiative, the Science and Technology for Development (STD) Programme, included all developing countries and aimed to stimulate co-operation between scientists in developing countries and those in Europe, in order to find solutions to problems occurring in all participating developing countries, and specifically in the domains of agriculture (and natural resources) and health (including related environmental problems). Under the STD-3 programme, which ran from 1991 to 1994, some 297 contracts were agreed, involving some 1 372 research teams and comprising a total of 112 MECU spending by the European Union.

Overall, agriculture had the larger budget, ECU 73 million compared with ECU 37 million devoted to health-related projects – although in terms of participants there was less difference, as Table 3 shows. It is worth noticing that the cost to the European Union of promoting co-operation with developing countries is greater than that of fostering partnerships within its own territory – while shared-cost projects are a sufficient incentive for companies and public organisations to form domestic research partnerships (and sometimes even concerted COST type actions suffice to launch a project), here, the European Union supports both European and foreign partners in full.

The Fifth Framework Programme

While stressing the progress made with the fourth RTD framework programme in terms of European research policy, the Commission considered that it would be inappropriate simply to extend it. The challenges awaiting Europe at the dawning of the new millennium call for innovation and decision making in the setting of priorities and the organisation of research. The globalisation of the economy is not the least of these challenges. If Europe as a whole wishes to reverse the unemployment trend on a lasting basis and face up successfully to outside competition, it will have to harness the technologies needed for tomorrow's world wide markets as quickly as possible.

The European Commission had launched its initial discussion paper on the shape of the Fifth RTD Framework Programme,[24] due to start in 1999, entitled "Preliminary Guidelines for the Fifth Framework Programme of RTD Activities", and adopted by the Commission, by last July. The purpose of the document was to open a debate with the European Parliament, the Council of Ministers and all those concerned by or interested in European research. This includes the EEA countries, the future accession countries and those with whom the Commission has been, or is in discussions for specific S&T Agreements. On the basis of the results of this debate, the Commission launched a formal proposal for the Fifth Framework Programme in spring 1997.

The Fifth Framework Programme cannot be a mere continuation of its predecessor. Although many elements and the basic principles will remain the same, the Fifth Framework Programme must attempt to consolidate research efforts, **concentrate on problem oriented topics**, and change the way in which research is organised. The new programme must strive to put research at the service of people by improving the basis of European competitiveness within a perspective of sustainable development. This can be achieved by providing better support for the production of new ideas, taking better account of the realities of demand and reinforcing links with organisations which can help to exploit European research results.

The Commission has identified three priorities for future research:

- **Unlocking the resources of the living world** and the ecosystem: this will cover the acquisition and use of knowledge about fundamental mechanisms affecting human life, especially in the fields of health and food. In addition it will cover the development of advanced technologies to safeguard the environment.
- **Creating a user-friendly information society**: research should aim at developing technology, infrastructure, services and applications that are interoperable at world level, in order to give people easier access to information and education throughout their lives, help share cultural heritage and preserve linguistic diversity.
- **Promoting competitive and sustainable growth**: this will cover manufacturing and design of new products and materials. Sectors to be targeted include energy, transport of people and goods, agriculture and fisheries.

A number of horizontal activities have also been identified which are designed, to meet common needs and provide general co-ordination and to support the three priorities mentioned above. These horizontal activities concern:

- **Improving human potential**: the emphasis is on training and mobility of scientists, including those in industry.
- **Innovation and participation of SMEs**: easier access for SMEs to all research activities and their results.
- **Confirming the international role of European research**: this is to be achieved by improving the involvement of certain outside participants in research programmes, and by defining specific international scientific co-operation projects.

There is an important concept to be implemented in the Fifth Framework Programme for the first time with respect to International Technology Co-operation. In recognition of its utmost importance, and to emphasise the characteristics of scientific and technical excellence two methods of co-operation will be available:

- Each specific action will in the Fifth Framework Programme be responsible for implementing its own programme of international technology co-operation, based on the scientific and technical criteria of the subject matter.
- There will be a specific horizontal INCO programme to deal with other criteria.

These two activities will probably be co-ordinated by a single administrative entity in order to ensure synergy and managed overlaps.

Three categories of activities would be implemented that are specifically designed to facilitate long-term international technology co-operation at all levels:

- Specific co-operation activities with certain categories of countries (Central and Eastern European countries not associated with the Framework Programme; NIS; Mediterranean third countries; developing countries; "emerging economy" countries). These activities, related to very specific problems faced by these countries (e.g. in health and environment) and therefore outside the scope of the other programmes, would be financed by the international co-operation programme.
- Training of researchers: a system of grants would be established whereby young researchers from third countries could be given a chance to spend time in European laboratories and participate in Framework Programme projects. This would be financed by the international co-operation programme, just like the grant system for young European researchers in Japan and Korea.
- Co-ordination with COST and with the EUREKA initiative, and with other European science and technology co-operation organisations (e.g. CERN, ESA, EMBL, ESF).

A budget of 16.3 billion ECU has been proposed by the Commission to finance activities under the Fifth RTD Framework Programme for the period 1998-2002 representing a real growth in the proportion of Community GNP devoted to research, compared to the 13.2 billion ECU allocated to the Fourth Framework Programme (1994-1998).

This very recent budget proposal completes the Commission's formal proposal for the Fifth Framework Programme enabling Parliament and Council to now press ahead with the adoption of a legislative decision which is scheduled for the first half of 1998. The Commission's original proposal only gave a percentage breakdown of resources – as opposed to actual amounts – in anticipation of the new Community financial perspectives for the period 2000-2006 which were adopted on 15 July in the "Agenda 2000" document.

Of the ECU 16.3 billion proposed, a sum of ECU 14 833 billion is to be reserved for RTD activities under the EC Framework Programme with the remaining ECU 1 467 billion going to research and training activities in the nuclear sector under the EURATOM Framework Programme. These proposed figures represent the maximum level of funding available for activities under the Fifth Framework Programme. Resources would be allocated each year under the Community budget within these limits.

The explicit aspects of International technology co-operation are scheduled to receive some 500 MECU of that – 3 per cent of the overall total. This will be mainly additional or incremental funding for third party participation in the mainstream FP projects. As many projects are less than or at most 50 per cent funded, the total leverage value of this funding may exceed 1 BECU.

European industry

The Commission regularly surveys the nature of international company alliances in the technology (ITAs) sector. In this day and age, international alliances make sense. Within the last decade, even a country we tend to think of as "introvert" like China has jumped into sixth place world-wide[25] for participation in ITAs.

The European Union's largest economies[26] have a ratio of eight for international/national alliances,[27] which rises to above 20 for small technology oriented states (like NL, but this is also similar to Korea). Contrast this with the data for the United States (where there are three internal alliances for every one involving an international element – but then the internal market is so big!), and Japan where the ratio is much below the non-US global averages.

Within the European Union, it is now *de facto* that there is a single market in technology products. Only one in 12 alliances involve only national partners. Ninety-two per cent involve other EU-established companies. Also, two in three now also involve partners from outside of the European Union – and this is data purely outside of the public supported framework programme domain. Table 4 below shows the evolution of technology alliances in European industry over the past decade.[28]

There is some evidence that EUREKA[29] based collaborative alliances though – for which clear data is available – are decreasing in volume terms, from ca 40 MECU/project a decade ago to 1/10 of that today.[30] EUREKA has a clear "space" between the European Union's FP and the market, but must assert itself more clearly in the future if it is to remain a model of close-to-market international technology co-operation involving enterprises.

Member states

The European Union undertakes policies which have a clear European dimension, or can be pooled and more effectively undertaken at European level. However, this does not preclude many European Union Member States from making individual technology agreements with extra-European partners.

Europe has not been alone in this trend of course – Korea has in the past decade publicly financed some 625 international collaborative projects[31] – and their annual numbers have doubled during that time. But at an average support of just 60 KECU, are they critical and strategic, or pointers to good intentions?[32]

Conclusions

- International co-operation with third countries has been a founding element from the earliest days of European RTD co-operation. It is based on the principle of mutual interest. The Commission is ready for partnership even if the rules are a little imbalanced, if the goodwill exists.
- As a result of strengthening RTD articles in the founding treaties of the European Union, in recent RTD framework programmes International Co-operation has been granted more visibility by being an identifiable key action. This will continue into the 5th FP, where more instruments than before will be available to broaden third country participation. There can be no question of a Fortress Europe approach.
- As Community Research focuses on what its MS cannot do individually, it is perhaps an optimal mechanism that consortia reach critical European mass before seeking complimentary third country partners. Or is it a natural manifestation of the fact that Europe as a whole can offer much more to third countries (especially in the developing regions) than any individual member state?
- A paradox is why the EU MS charge the Commission to engage in such an open engagement towards third countries in external relations (of which RTD is an important element), when national programmes are often less accessible? Could it be that they target slightly different objectives?
- As globalisation is seen as an opportunity and not a threat, individual countries are opening up programmes where research, mutual interest and market conditions permit.
- Progress in broader international technology co-operation is increasing, for the benefit of all.

Table 1. The main participations in RTD related activities, recorded between 1987-1996 in projects with a publicly available report of some kind

FRQ	Country Name
1027	Russia
981	Switzerland
837	Norway
478	Hungary
464	Poland
426	Czech Republic
230	Ukrainian SSR
230	Ukraine
222	Romania
212	Bulgaria
194	United States
177	Slovenia
148	Japan
146	Brazil
143	Mexico
123	Belarus
101	Estonia
100	Byelorussian SSR
99	China
97	Argentina
90	India
90	Slovak Republic
81	Lithuania
75	Latvia
69	Thailand
64	Israel
64	Iceland
63	Chile
62	Canada
60	Greenland
58	Morocco
56	Kenya
56	Tunisia
55	Kazakhstan
55	Yugoslavia
52	El Salvador
51	Georgia
48	Uruguay
48	Venezuela
47	Armenia
47	Senegal
41	Utd Rep of Cameroon
39	Colombia
38	Albania
38	Turkey
37	Indonesia
33	Utd Rep of Tanzania
32	Burkina Faso
32	Egypt
31	Malaysia
29	Peru
28	Cyprus
26	Algeria
26	Uzbekistan
25	Costa Rica
24	Jordan
23	Ethiopia
23	USSR
21	Bolivia
21	Niger
20	Ivory Coast
20	Nigeria
18	Benin
18	Guadeloupe
18	FYR Macedonia
17	Australia
17	Ecuador
17	Monaco
16	South Africa
15	Reunion
14	Pakistan
14	Vietnam
13	Sri Lanka
13	Zambia
12	Malta
12	Mozambique
12	Gaza & Palestine
11	Azerbaijan
11	Cape Verde
11	Guatemala
11	Moldova
11	Malawi
11	Singapore
10	Bangladesh
10	Congo
10	Eritrea
10	Ghana
10	Croatia
10	Nicaragua
10	Rwanda
10	Turkmenistan
10	Zaire

Source: Author.

Table 2. Political entities with some recent participation in the EU RTD activities

Participations	Countries participating				
9	Gabon	Gibraltar	Montserrat	Guinea-B	Sudan
8	Burundi	New Caledonia	Eq. Guinea	Kyrgyzstan	Oman
	Paraguay	Sierra Leone	Togo	Uganda	
7	Anguilla	St. Pierre & M.	Guyana	Neth. Antilles	Tajikistan
6	Angola	Botswana	Gambia	Honduras	Somalia
5	Christmas Is.	Martinique	Madagascar	Panama	Syrian Arab Republic
	Trinidad & Tobago				
4	Jamaica	New Zealand			
3	Myanmar	Taiwan	Wallis & Futuna	Iran	Kuwait
	Saint Lucia	Nepal	Chad	American Samoa	
2	Antigua & Barbuda		Barbados	Brunei	FaeroeIs
	French Polynesia		Falkland Islands	Jersey	St. Kitts-Nevis-Anguilla
	Lebanon	Mauritania	Maldives	Namibia	Papua New Guinea
	Macau	Qatar	Sao Tome & P.	Swaziland	Vanuatu
1	Andorra	Afghanistan	Antarctica	CocosIs	Heardand McDonald Is.
	Bahrain	Bhutan	Belize	Cuba	Djibouti
	Dominican Rep.	Fiji	Mayotte	St. Helena	Turks & CaicosIs
	Haiti	Is. Man.	Kampuchea	Korea	
	Republic of Korea		Republic of Lao	Liechtenstein	Liberia
	Lesotho	Mongolia	Mauritius	Bouvet Is.	Cook Is.
	Pacific Is.	Philippines	Puerto Rico	Saudi Arabia	Solomon Is.
	Seychelles	Suriname	Tonga	Yemen	Zimbabwe

Source: Author.

Table 3. Programme STD-3 participation by country grouping

Number of participants 1991-94

Country Group	Programme participations		European counterparts in numbers	
	Agriculture	Health		
Africa, Caribbean, Pacific	163	114		
Latin America	86	56		
ASIA	93	49		
Mediterranean	21	3		
TOTALS	343	222	427	360

Source: European Report on Science and Technology Indicators (due 1998), PREST, Data: DGXII -AS4 and XIIB.

Table 4. EU technology industry alliances: intra-extra EU

	Years		
Alliances	1984-87	1988-91	1992-5
Within EU	1	38	158
Between EU	12	170	394
Inc. Ext EU	37	438	1 166

Source: Author.

Table 5. Bilateral EU MS and extra-European technology agreements

EU Member States	Partner					
	United States	Canada	Japan	Korea	Australia	New Zealand
Italy+United Kingdom	*	*	*	*	*	*
France+Germany	*	*	*	*	**	
Belgium+Denmark+ Ireland+Netherlands+ Spain	*	*				
Switzerland+Finland+ Spain			*	*		
Portugal	*					

Source: REIST II, Table 13b.1, to be published early 1998, based on data provided by PREST, United Kingdom.

NOTES

1. SDME 11/36, European Commission, 200 Rue de la Loi, B-1049 Brussels, Belgium, e-mail mike.rogers@dg12.cec.be or m.w.r@eurokom.ie.

2. *Centre Europeenne de Recherche Nucléaire* – CERN.

3. The then *Bundes Republik Deutschland* (West Germany).

4. Though somewhat ironically – in the sense that basic research has usually unpredictable impacts – it is responsible for the idea and development of the WWW-World Wide Web concept that made the Internet use explosion of the 1990s possible.

5. 1 ECU (European Currency Unit, is frequently computed from a basket of currencies from the EU Member States currencies) is, as of noon on 9/10/97 about US$ 1.11, Y 134 , £0.688, SF 1.62, DM 1.968, FF 6.61, and just over 1010 (Korean) Won. It is fixed twice daily.

6. *Diario Europe*, 1970-76, published by Il Mulino, Bologna, in Italian.

7. MS-Member States, governments participating in the legal structures of a process.

8. FAST – Future Assessment in Science and Technology.

9. Unofficially an abbreviation of "EUropean REsearch [K]oordination Agency", the secretariat is also in Brussels, and it is often confused as being an EU programme.

10. Often known as the Maastricht Treaty after the Dutch town where it was agreed.

11. The programme covers the whole of Europe, including the independent states of the former Soviet Union, the non-European industrialised countries and the developing countries; as well as international agencies that have a wide remit.

12. Council Decision: Official Journal L 334 of 22.12.1994, Duration: 23 November 1994-31 December 1998 with an EU contribution: ECU 575 million. The Aims are to add value to Community RTD activities and improve the Community's scientific and technological base through targeted co-operation beyond the European Union and to better co-ordination of co-operation between Member States and third countries, to avoid overlaps.

13. This agreement extends co-operation to non-nuclear energy, information and Communications technology, transport, environment and climate work, bio-medicine and AIDS and other infectious diseases, drug abuse, natural resources and marine sciences, biotechnology and training and mobility of researchers.

14. "US-EU S&T Agreement Concluded", Ken Jacobsen, *New Technology Week*, 29 September 97.

15. Such as those financed directly by the EU RTD FPs.

16. Subcontractors are usually not full contractual partners in the sense that their partnerships are not recorded, so this is the minimum case scenario. However, subcontractors often have restricted IPRs.

17. INTAS-International Association for the promotion of co-operation with Scientists from the NIS of the former Soviet Union. More information from Christine Walcher on walcher@intas.be.

18. IN-ternational [RTD] CO-operation. Abbreviation for the European Union's international RTD programme.

19. ACTS-Advanced Communications and Telematics.

20. TESS-Total Environment Surveillance Sensors programme.

21. INCO-COPERNICUS is the strand of the "International Cooperation" programme of the Fourth Framework Programme dealing with co-operation with the Central European Countries and the NIS. This strand has an overall budget of ECU 247 million, i.e. 43 per cent of the total budget of the INCO programme. Contact rudolf.meijer@dg12.cec.be.

22. PECO-from the French abbreviation for *Pays de l'Europe Centrale et Orientale*, i.e. the CEEC countries.

23. Science and Technology for Development (STD) Programme: 1991-94.

24. The 5th Framework Programme: European research for people, jobs and competitiveness. EC Press Release, 10 July 1996.

25. REIST II, Table 11b.1, to be published early 1998.

26. France, Germany and the United Kingdom.

27. REIST II, Table 11b.2, to be published early 1998.

28. REIST II, Table 11b.3, to be published early 1998, IFR/SDC:HAA Analysis.

29. Covering European Union plus a further 9 MS.

30. Evaluation Report, 1995 and Annual Impact Report 1996, Eureka Secretariat.

31. Wilson and Wilson 1996, adapted from MOST data 1996, p. 67.

32. Korean Co-operative Grants from the INCO programme are currently soliciting applications, with a closing date of 1 March 1998.

BIBLIOGRAPHY

PAVITT, K. (1972), “Technology in Europe’s future”, *Research Policy*, Vol. 1, N°3.

SALOMON, J.J. (1968), “European Scientific Organisations” in *S&T in Europe*, p. 78, Penguin.

SERVAN, J.J. and SCHREIBER (1969), *The American Challenge*, Avon, New York.

ENHANCING FOREIGN ACCESS TO TECHNOLOGY PROGRAMMES: TRENDS AND ISSUES

Ken GUY, Technopolis Ltd., United Kingdom

Introduction

The issue of foreign access to Research and Technological Development (RTD) programmes around the world is currently the subject of much debate. In the European Union (EU), where the form and content of the next RTD Framework Programme is being discussed, bodies such as the Industrial Research and Development Advisory Committee (IRDAC), an industrial advisory body of the Commission, have held a Round Table on the topic and developed a specific position with regard to foreign access to EU RTD programmes. In the United States, too, the National Academy of Engineering (NAE) published the findings of a commissioned study on foreign participation in US research and development (R&D). The NAE study notes that US interest in the topic arises in part out of a concern that US companies have experienced difficulties trying to access markets and innovation systems abroad. This, it seems, has had a profound impact on public perceptions and federal policies related to foreign participation in R&D.

Most EU RTD activities are carried out within the context of Framework Programmes. The current one is the Fourth Framework Programme. It commenced in 1994 and runs through to 1998. Policy discussions concerning the shape and context of the Fifth Framework Programme are also well advanced. The structure of the Fourth Framework Programme is shown in Table 1.

Factors important in decisions to fund projects include the:

- existence of cross-border co-operation;
- relevance to community and programme aims;
- quality of the proposed work;
- competence of the organisations involved;
- type of research carried out;
- aid intensity;
- intended beneficiaries;
- accessibility of the results.

Cross-border co-operation is the basic condition for support for research from the European Union. There must be at least one partner from a Member State and another either from a Member State or from a country associated with the Fourth Framework Programme. Access to these programmes is, in general, open to all relevant organisations operating within the member states, e.g. academic institutions, public and private research organisations and commercial enterprises. Relevant organisations are those with the capacity to conduct RTD capable of being exploited within a European context. Partners must have adequate basic resources (technical, financial and managerial) at their disposal. They should also be capable of utilising the results of their work themselves, or of contributing to their dissemination and utilisation.

Table 1. Fourth Framework Programme, 1994-98

		MECU
1.0	**Research and Technological Development and Programmes**	**11421**
1.1	Information	2035
1.2	Telematics	898
1.3	Advanced Communications Technologies and	671
1.4	Industrial and Materials	1722
1.5	Standards, Measurement and	184
1.6	Environment and	567
1.7	Marine Science and	243
1.8	Biotechnolog	588
1.9	Biomedicine and	358
1.10	Agriculture and	647
1.11	Non-Nuclear	1030
1.12	Nuclear Fission	171
1.13	Controlled Thermonuclear	846
1.14	Transport	256
1.15	Targeted Socio-Economic	112
1.16	Direct Measures (Joint Research	1095
2.0	**Cooperation with Third countries and International**	**575**
3.0	**Dissemination and Optimisation of**	**312**
4.0	**Training and Mobility of**	**792**
	Total	**13100**

Source: Author.

Finance for projects generally follows GATT and WTO guidelines, with funding ceilings (expressed as aid intensity) for specific categories of RTD. EU regulations limit the support available to industry via RTD programmes, and this support is restricted to RTD potentially capable of benefiting the European Union as a whole. Programmes are usually only able to support 50 per cent of the cost of **industrial research** (research aimed at the acquisition of new knowledge relevant to the development of new and improved products, processes and services) and up to 25 per cent of the cost of **pre-competitive development** (configuration of the results of industrial research into a plan, design or prototype for a new product, process or service). As the activity gets closer to the market place, the Commission looks for even lower levels of aid, though support for SMEs to conduct applied RTD (i.e. pre-competitive development) has a ceiling of 35 per cent. In rare instances, where **fundamental research** is carried out by or for a firm, funding ceilings of 100 per cent are possible if the results are widely available for exploitation on a non-discriminatory basis and at market rates.

The existence of sound plans for the utilisation and dissemination of the results of projects is also an increasingly important selection criterion. Contractors are also urged, once a project has been accepted, to draw up a consortium agreement among themselves which, *inter alia*, stipulates the details concerning utilisation and exploitation of the results of the project. These arrangements must not, however, conflict with the provisions of the Community standard contract. These general rules aim to guarantee the legitimate business interests of all contractual partners and their rights to the utilisation and commercial exploitation of R&D results, and to facilitate the use of the results in the interest of the Community. The following principles apply:

- knowledge gained from work directly carried out by the Community or fully financed by the Community is fundamentally the property of the Community (e.g. any fundamental work funded at the 100 per cent level);
- knowledge arising out of work carried out as part of a cost-sharing contract (e.g. work supported at the 50 per cent level) is fundamentally the property of the contractual partners, and details of the rights to this property must be organised and agreed by the partners themselves;
- knowledge which could be put to industrial or commercial use must be suitably protected in the interests of the Community and its contractual partners;
- the Community and its contractual partners are obliged to make use or allow use to be made of any knowledge gained, with account taken of the following;
  - the aim of increasing international competitiveness and the economic and social cohesion of the Community;
  - the funding of research activities for other Community policies;
  - the agreements on scientific and technical co-operation concluded with various third countries or international organisations;
- the Commission also urges contractual partners to publish the results of Community projects.

It should be noted, however, that the above provisions are flexibly applied by the Commission. They stand as strong exhortations rather than as rigid imperatives.

Foreign enterprises with R&D and production facilities located in the European Union – so-called Domiciled Foreign Companies – create wealth, carry out research, offer employment to European citizens and exploit the results of their work in Europe. As such there is no formal objection to their participation in EU RTD activities, and they are subject to the same rules relating to access, finance and exploitation as any indigenous firm – insofar as all participants are expected to conduct R&D and exploit it within the European Union.

Specific programmes within the 4th Framework Programme fall into two types (see Table 2). Type I programmes are termed “Strategic” – they include most of the more industrially oriented programmes such as Industrial and Materials Technologies or Telematics. Type II programmes are termed “Global” and generally have a more fundamental flavour. A typical example is the Environment and Climate programme. In general, Type II “Global” programmes are open to both European and non-European partners, subject to certain restrictions. In contrast, Type I “Strategic” programmes are closed to the majority of non-European participants at present. The programme on Information Technologies is an interesting anomaly. Although it is an industry-oriented programme, it is classified as “Global” rather than “Strategic”, thus enabling firms from non-European countries to participate, but only if it is in the interest of Community policies and provided that the firms contribute effectively to the implementation of the project, taking into account the principle of mutual benefit.

Table 2. Strategic and global EU programmes

Type 1 Programmes (Strategic)	Type II Programmes (Global)
• Industrial and Materials Technology	• Marine Sciences and Technologies
• Agriculture and Fisheries	• Standards, Measurements and Testing
• Telematics	• Information Technologies
• Dissemination and Optimisation of Results	• Communications Technologies
• Training and Mobility	• Transport
	• Environment and Climate
• Non-Nuclear Energy (except R&D part)	• Non-Nuclear Energy (R&D part)
• Nuclear Fission Safety (except radiological impact, mastering events)	• Nuclear Fission Safety (radiological impact, mastering events)
• Biotechnology (except prenormative research, biodiversity, social acceptance)	• Biotechnology (prenormative research, biodiversity, social acceptance)
• Socio-Economic Research (except evaluation of S/T policy options)	• Socio-Economic Research (evaluation of S/T policy options)
• Biomedicine (pharmaceutical research and research on biomedical technology and engineering)	• Biomedicine (except pharmaceutical research and research on biomedical technology and engineering)

Source: Author.

Currently, non-domiciled foreign companies are only supposed to participate in EU RTD programmes if specific programme decisions allow such co-operation. The majority of programmes allow for the participation of firms from prescribed sets of European third countries (i.e. countries in Europe which are not member states of the European Union), and a more restricted set of programmes allow access to firms from non-European countries if there is a co-operation agreement of one form or another between the European Union and the countries concerned. The participation of non-European firms is also acceptable if there is sufficient Community interest to justify their inclusion and the potential for reciprocal benefit exists, e.g. the opportunity for European firms to participate in other nations' R&D programmes.

Pan-European Research Ventures (PERVs)

There are a large number of Pan-European Research Ventures in Europe. These include research networks and international organisations with specific science-related missions. The Fourth Framework Programme of the Commission promotes co-operation and interlinking with all of the following: COST, EUREKA, CERN, ESA, EMBL, ESO and ESF. Some of these are aimed primarily at academics, while others encourage the participation of private sector firms. The rules covering access, finance and exploitation vary from one PERV to another. Generally, governments are signatories to framework agreements which allow indigenous firms and other organisations to participate and specify funding ceilings and exploitation rights. The two examples provided below illustrate that few overt distinctions are made between indigenous and domiciled firms, but that non-domiciled foreign companies are specifically excluded except in exceptional circumstances.

CERN

CERN – the European Laboratory for Particle Physics – is an inter-governmental organisation set up in 1953 to conduct fundamental research in the field of particle physics. It currently has some 20 European member states, with negotiations underway with some non-member states (United States, Canada, Japan, Russia and India) concerning the provision of equipment.

CERN's relationship with industry is mainly limited to the purchase of equipment, though some opportunities for the joint development of equipment do exist. As a general rule, only firms from member states (including domiciled foreign companies) are allowed to develop these relationships. Exceptions are made when firms within member states are unable to supply or develop the required products, or where there is the possibility for CERN to derive substantial technical or financial advantages. In practice, non-domiciled foreign companies have been involved in the supply and development of advanced computers and electronic instrumentation.

There are no fixed rules concerning the conduct, finance and exploitation of joint development projects. They vary in detail from one case to another. Normally, however, CERN attempts to retain a share of the intellectual property rights and the revenues which arise from the development work, but agrees to grant exclusive exploitation rights to its industrial partner, subject to its being entitled to use the technology free of charge for its own research needs and to its receiving a share of revenues generated.

EUREKA

EUREKA is a collaborative research venture involving some 25 member countries (the EU member states and the Commission, former EFTA members, Russia, Slovenia, Turkey, Hungary, Poland and the Czech Republic). Projects are generally more near-market than in Commission Framework projects and are aimed at improving technology bases and industrial competitiveness. Each project must involve at least two partners from two different member states. Created in 1985, by 1996 a total of 14.5 billion ECU had been invested in more than 650 projects involving 2 400 firms and 1 100 other participants.

Firms from all EUREKA member states can propose collaborative projects on a bottom-up basis. Decisions on funding and funding levels for individual participants in a project are then made by their respective governments. In some countries EUREKA projects have a preferred status, in others there are special EUREKA funds, but in all cases national rules apply. Community resources are also available if projects are in line with Commission aims.

Exploitation agreements are negotiated between the members of the consortia. A Co-operation Agreement spells out the objectives of the project, the contribution of each partner, plans for the exploitation of results, a business plan and confidentiality and ownership arrangements. This agreement may be simple or complex, depending on the structure of the partnership, and may be adapted, subject to the consent of all partners, during the course of the project. Following general EUREKA principles, however, the use of a co-operation agreement is not a legal requirement to attain EUREKA status.

The bottom-up nature of EUREKA means that it is perfectly feasible for potential participants to propose consortia containing domiciled and non-domiciled foreign companies. Indeed, many of the former do participate, and EUREKA rules have allowed the participation of non-domiciled foreign countries since the late 1980s – as long as there are at least two other firms from member states involved in the consortia. Given that EUREKA was set up specifically to improve European competitiveness and productivity, however, it is not surprising to find that the presence of non-domiciled foreign companies is a rarity. Consortia seeking support from national governments are quite aware that the presence of a foreign firm from a non-EUREKA country could count against them, unless exceptional circumstances apply.

National programmes

The rules relating to access and finance for indigenous companies in the national RTD programmes of member states of the European Union are broadly comparable and mirror those concerning participation in EU RTD programmes. All support for industry has to comply with EC state aid rules. This ensures that aid granted by one member state does not distort trade or affect competitiveness throughout the rest of the Community. All aid is notified to and approved by the Commission in advance.

Access, therefore, is open to all indigenous academic institutions, public and private research organisations and commercial enterprises able to conduct R&D exploitable within a Community context generally, and within a national context specifically. Finance, too, is normally sanctioned with indicative aid intensity ceilings of 50 per cent for industrial research and 25 per cent for pre-competitive development. In some circumstances, however, these levels can be boosted considerably. Research conducted by SMEs merits higher aid intensities, as does research conducted in designated regions of the Community (e.g. the new Länder in Germany). Greater support is also available for work undertaken in accordance with the objectives of a specific programme of the Community's Framework Programme; for work involving cross-border co-operation between firms and public research bodies, or between at least two independent partners in member states; and for research leading to the widespread dissemination and publication of results. Exploitation arrangements vary across countries and programmes. In most instances support is granted in the expectation that exploitation will benefit the home economy. Ownership arrangements for IPR, however, differ considerably.

Just as the access and finance rules for the participation of indigenous companies in national RTD programmes resemble EU practices, so the corresponding rules for domiciled foreign companies also mirror the rules for EU RTD activities. Outwardly, these firms are treated much the same as indigenous companies. Access is ostensibly unrestricted and the same funding ceilings apply. In practice, however, consideration of eventual exploitation routes and net know-how flows does influence selection practices in different settings. Exploitation arrangements in different programmes also act to constrain these flows if the participation of domiciled foreign companies is sanctioned.

Table 3. Access rules in Germany

The provision of grants to German enterprises in which non-residents hold a majority interest is governed by overall economic policy. The grants are expected to:

- enhance the competitiveness of German industry;
- develop technology-intensive and future-oriented production centres in Germany;
- develop the German research community by involvement of foreign (R&D-intensive firms);
- develop international cooperation in research which supports the transfer of know-how to Germany via the foreign
- enterprises concerned;
- encourage foreign firms to invest in Germany.

All grants must fulfil the requirements set out in the NKFT 88 (Auxiliary terms and conditions for grants on a cost basis from BMBF to industrial companies for R&D projects). Regarding the utilisation of R&D results, firms have to fulfil Sections 13 and 14 of the NKFT 88. These stipulate that:

- the awarding authority must be granted irrevocable, free and non-exclusive rights of use within Germany and abroad;
- the awarding authority is entitled to transfer rights of utilisation to third parties';
- third parties must be granted access to rights of use within Germany.

Section 18 seeks to prevent the uncontrolled flow of R&D results. This regulation stipulates, *inter alia*, that the transfer of R&D results to countries outside the EC shall require prior official approval. The transfer of industrial property rights, the granting of licences, the transfer of know-how and other knowledge or documents concerning the R&D results require the prior approval of the grant-awarding agency. If such approval has not been obtained, the notification of grants can be revoked.

To be eligible for grants, firms in which non-residents hold a majority interest are expected to demonstrate:

- A sustained capacity for engaging in R&D. It is not enough for a firm to have its headquarters in Germany and be registered in a German commercial register.
- That the project will be implemented in Germany during the entire running period.

In addition, the following questions concerned with the utlisation of R&D results are important in assessing the ability of firms to comply with NKFT 88:

- Is the firm sufficiently autonomous and independent of the parent company to exploit results in Germany?
- Has the firm clearly expressed its inention primarily to utilise the R&D results in Germany?
- Is the envisaged R&D support likely to consolidate the firm's position in Germany and the independence of the firm vis-à-vis the foreign parent company, e.g. by intensifying specialisation?
- Is the support expected to exert a favourable influence on the further development of the R&D capacity of the firm in Germany?
- Does the firm have sufficient production capacity in Germany to be able to exploit the results?
- Is the R&D capacity of the firm linked to a production system in Germany which can, if necessary, also be assessed as technology-intensive and future-oriented?

Auxiliary terms and conditions for grants from the BMFT to companies for R&D projects (NKFT 88), October 1988.

In Germany, the BMBF recognises that R&D is an international activity and that it is important to involve foreign companies and research institutions. There is a natural reluctance, however, to support foreign companies in work which does not support German economic activities. The rules which govern the participation of domiciled foreign companies in Germany's BMBF are thus quite explicit (see Table 3). They specifically require R&D capability in Germany and subsequent exploitation beneficial to the German economy. One project proposal submitted by Hewlett Packard to conduct research in Germany was rejected because the associated business plan made it clear that Hewlett Packard intended to exploit the research mainly in the United States. In another instance, when the recipient of a grant transferred licence rights to Hitachi in Japan without written governmental permission, the grant had to be repaid.

The Dutch BTS Programme – Business-Oriented Technological Co-operation – supports R&D in Information and Communication Technologies, Biotechnology, Environmental Technology and New Materials. Domiciled foreign companies are welcome to participate, but only if they can demonstrate that exploitation will occur in the Netherlands. To this end, exploitation agreements have to specify that IPR and production based on project results remain in the Netherlands for set periods of time, e.g. one year after the completion of the project. Proposals involving large MNCs are scrutinised with particular care because of leakage fears.

In the UK LINK scheme, MNCs are able to participate provided that they have a significant manufacturing and research base in the United Kingdom, and that the benefits of the research are used for wealth creation within the United Kingdom or the European Union. Exploitation outside of the European Union within the first five years of a project's completion requires written permission from the Department of Trade and Industry (DTI).

In other settings, however, the participation of domiciled foreign companies in national programmes is warmly welcomed. This is particularly so in small, less developed economies eager to catch-up. Ireland has long had a policy of attracting inward investment in high technology areas. It also encourages domiciled foreign companies able to demonstrate significant manufacturing capabilities in the country to participate in national R&D programmes such as the PATs (Programmes in Advanced Technology). The expectation is that benefits will flow to Irish firms working in collaboration with foreign-owned firms, thus strengthening indigenous capabilities and making Ireland an even more attractive home for footloose international hi-tech capital. Via successive reiterations, Ireland thus hopes to bootstrap local capabilities.

A number of European countries have programmes specifically geared towards scientific and technological collaboration between indigenous firms and non-domiciled foreign companies. Often these involve bilateral agreements between two countries. The Netherlands, for example, has bilateral agreements with Israel and Indonesia, and France has similar arrangements with Canada, the United Kingdom and Germany. For the most part, these agreements encourage collaboration via information exchange, the formation of networks and attendance at workshops. Collaborative projects are less frequent under the umbrella of these programmes.

Project-based collaboration can occur in other contexts, however. Foreign firms can sometimes be found in programmes set up primarily to improve technological capability and industrial competitiveness in host countries, i.e. "normal" national RTD programmes involving multiple R&D consortia and projects. Access, finance and exploitation arrangements vary widely across countries and across programmes.

In the United Kingdom, for example, consortia bidding for projects within the Department of the Environment's Partners in Technology (PIT) programme of construction-related R&D are welcome to submit proposals which include non-domiciled foreign companies, as long as these are not put forward as project leaders. In theory they are even eligible for funding, since there is nothing in the programme's protocols to prevent public funds going to foreign-based firms. Needless to say, however, this rarely occurs. In Sweden, too, non-domiciled foreign companies are allowed to participate in industry-oriented NUTEK programmes, but not as project leaders. In complete contrast, companies located abroad are specifically excluded from participation in the UK LINK programmes – a series of programmes supporting academic-industry research linkages, even though companies in general – even Indigenous Companies – receive no public money (academics receive 100 per cent support; industry pays its own way).

In Germany, access is allowed if there is a reasonable chance of "mutual interest". The BMBF allowed one Swiss firm to participate in its New Materials research programme despite the fact that a substantial part of the research was to be performed in Switzerland. Germany still stood to benefit, however, for the firm involved collaborated closely with the University of Heidelberg, donated valuable technical equipment, and had plans to set up a production unit in the area. In the German Civil Aeronautics Research programme, various foreign-owned and foreign-based firms are allowed to participate if they are also members of European consortia such as Eurocopter or Airbus. Access to programme funding and exploitation rights outside of Germany are allowed on the grounds that "What's good for these consortia is also good for Germany."

Strategic need can also dictate governmental attitudes to access. Earlier it was noted that the participation of domiciled foreign companies in national programmes was welcomed in the Netherlands as long as subsequent exploitation took place within the country. With non-domiciled foreign companies this is obviously less easy to arrange. Nevertheless, firms such as these can still be found in Dutch programmes. Leakage fears are countered by the very real need to keep abreast of technological frontiers, and for a small country this invariably means participating with leading-edge firms resident in other countries.

In France, Ministry of Industry programmes require firms to have significant R&D and production capabilities in the country in order to be eligible for funding. Exceptions arise only when foreign companies bring specific skills to consortia which cannot be accessed in any other way. One UK body was asked to submit a research proposal to the French Ministry for Housing. The disadvantages of leakage were outweighed by the experience and complementary assets the UK participant was able to bring to the party. Direct invitations to participate in another country's national programmes are comparatively rare, but instances do occur when the strategic need is great.

Generic rules governing the participation or non-participation of non-domiciled foreign companies in national RTD programmes *per se* are rarely specified in a clear, unequivocal fashion in the nation states of Europe. Sometimes rules exist which allow firms from countries with bilateral arrangements to participate in national RTD programmes, but national rules relating to the exclusion or inclusion of firms from other nations generally are difficult to find. Certainly national policy-makers and programme administrators in European countries are often unaware of the existence of such rules.

The lack of clear guidelines expressing national imperatives *vis à vis* the eligibility of non-domiciled companies is accompanied by a widespread belief in the presumed right of policy-makers to evolve rules at a programme level on an *ad hoc* basis. This gives rise to the wide variety of situations described above, with some programmes explicitly denying access and others permitting it, subject to certain riders. There is a consensus, however, on the factors which determine the choice of which rules to implement, though not on the weights attached to each factor. Foremost amongst these factors is the fear of leakage. When this is strong it can lead to the complete exclusion of foreign-based firms, and it certainly moderates conditions of entry. Strategic need, on the other hand, is a countervailing pull. A desire to access particular skills and technological assets on a one-off basis, or even to entice firms to embed these more permanently into local technological and economic infrastructures, can help quell leakage fears.

In reality, practice lies nearer "closed doors" exclusion than "open arms" acceptance, with participation permitted in principle, but only justifiable if it can be demonstrated on a case-by-case basis that mutual benefit is a likely outcome. Conditions on subsequent exploitation are often imposed to ensure that this benefit is captured in local economies. This situation ensures that a welcome can be extended to potential participants when a strategic need has to be satisfied, but that doors can remain closed if strategic need is deemed slight and expected net benefits appear tenuous.

One consequence of the patchwork of *ad hoc* selection procedures in place across Europe is that the participation of non-domiciled companies (especially non-European companies) in national programmes is still comparatively rare. When it does occur, financial arrangements tend to be *ad hoc* too, unless stipulated or constrained by a bilateral agreement. Not surprisingly, given the reluctance of most governments to be seen to be supporting the work of foreign-based companies with taxpayers money, foreign firms often pay their own way in collaborations of this nature. Exploitation arrangements vary, but some form of insistence that IPR and exploitation are tied to the host country is common. Subject to such provisos, however, individual partners in consortia are generally allowed to make their own arrangements *vis à vis* IPR, patents, licensing etc.

Conclusions

At the level of the European Union, there are few significant problems associated with the participation of domiciled foreign companies in RTD programmes. For the most part their participation is welcomed if they can fulfil the same conditions as indigenous companies. The situation with regard to the participation of non-domiciled foreign companies has also improved in recent years. The establishment of the Fourth Framework Programme saw access extended, and bilateral agreements continue to be negotiated with an increasing number of countries. Access is still restricted in key areas, however, and considerations of mutual benefit act both as a safeguard against leakage and as a deterrent to the participation of foreign-based firms. Current calls by European industrialists for a more open system, providing foreign firms with even greater access to EU RTD programmes, are also being accompanied by calls for reciprocity agreements guaranteeing greater access for European firms to national programmes elsewhere.

At the national level, there are no blanket restrictions on the participation of domiciled foreign companies in national RTD programmes. Their presence is welcomed in some quarters, notably in the peripheral nations eager for skills to rub off on local firms, but deterred in others via stringent mutual interest considerations. As regards non-domiciled foreign companies, however, the status quo is for doors to be closed – opened only when strategic needs are pressing or mutual interest implies significant benefits for the host economy. Some reciprocity agreements exist which affect both foreign-owned and foreign-based firms, but there is little call at the level of the nation state for a significant increase in their use.

The current situation in Europe throws up two issues which have to be considered in a global context, particularly in the light of the imperatives created by the phenomenon of globalisation. These are reciprocity and mutual interest.

The NAE study of foreign participation in US R&D highlighted two facets of globalisation:

- a deeper integration of the world’s major national innovation systems through the activities of MNCs and individual scientists and engineers;
- a corresponding convergence of the industrial and technological capabilities of industrialised countries.

A corollary of these trends is the increasing need of MNCs and other leading edge technology firms to drink from and replenish the global pool of technological know-how. There is thus growing support in the industrial community for a more open global system for the conduct of scientific and technological research, the exchange of know-how and access to complementary assets. In response, the United States has increasingly passed legislation insisting on reciprocity as a condition for the participation of foreign firms in publicly-funded technological activities.

In Europe, too, globalisation is recognised as a reality rather than a challenge. As a consequence, there is increasing industrial pressure for the opening up of EU RTD activities to participants from non-European Union countries, particularly the United States, Japan and countries in the Far East (India, Korea, Taiwan, Singapore, China, Indonesia and Malaysia), with Community interest, localised exploitation and reciprocal access as riders. In the October 1995 IRDAC Round Table on Scientific Co-operation with Non-EU Countries, the view was strongly expressed that consortia should be able to include Japanese or US participants in R&D projects if this would benefit project progress. The Round Table also agreed with the Commission, however, that projects should only be sanctioned if:

- there were clear indications that they would also be in the interests of European competitiveness as a whole, rather than just the competitiveness of the specific companies involved;
- the involvement of non-European firms did not threaten to lead to a flow of expertise and know-how from Europe;
- reciprocal access to publicly-funded RTD programmes in the non-European countries concerned was ensured.

It was agreed that the way forward was to open up existing and new EU programmes along these lines, rather than create new global co-operation initiatives such as the Intelligent Manufacturing Systems (IMS) programme. The IMS, launched as a result of a Japanese proposal made in 1989, was an attempt to promote research collaboration on advanced manufacturing systems on a global scale, involving participants from Australia, Canada, the European Union, five EFTA countries, Japan and the United States. Although the Round Table agreed that the programme had had many beneficial impacts, there was greater support for more open access to existing and new EU programmes, with bilateral agreements, covering reciprocal access paving the way for expanded participation in RTD projects and programmes.

BIBLIOGRAPHY

BARBALAT, O. (1996), *Opportunities for Industry with CERN*, CERN, Geneva.

BMFT (1988), *Auxiliary Terms & Conditions for Grants on Cost Basis from the Federal Ministry for Research and Technology to Companies in Industry for Research and Development Projects*.

BUNDESANZEIGER (1993), *Verdingungsordnung für Leistungen*, Köln.

CANADA/EUROPEAN COMMISSION (1996), *A Guide to Negotiating and Managing Canada/EU Research Contracts.*

CANADA/EUROPEAN COMMISSION (1996), *A Guide to Submitting Project Proposals*.

CANADA/EUROPEAN COMMISSION (1996), *Agreement for Scientific Co-operation Between Canada and the European Commission*.

DTI (1996), *Sector Challenge: Building Guidance*, London.

DTI/EPSRC (1994), *LINK Initiative Surface Engineering Programme, Conditions and Procedures*, DTI, London.

DTI/EPSRC (1996), *LINK Sensors and Sensor Systems for Industrial Applications Programme, Guidance Notes for Outline Applications*, DTI, London.

DTI/EPSRC (1996), *LINK Personal Communications Programme*, DTI, London.

EUROPEAN COMMISSION (1992), *Official Journal of the European Communities*, No L 209, Vol. 35.

EUROPEAN COMMISSION (1993), *General Terms & Conditions Applicable to Contracts*, Office of Official Publications of the European Commission, Luxembourg.

EUROPEAN COMMISSION (1994), *EC-Funded Research and Technological Development: An Insight into the Handling of Project Proposals, An Introduction to Contract Negotiation,* Office of Official Publications of the European Commission, Luxembourg.

EUROPEAN COMMISSION (1994), *Official Journal of the European Communities*, No L 126, Vol. 37.

EUROPEAN COMMISSION (1994), *Official Journal of the European Communities*, No L 306.

EUROPEAN COMMISSION (1994), *Scientific and Technological Co-operation with Eastern Europe,* Office of Official Publications of the European Commission, Luxembourg.

EUROPEAN COMMISSION (1995), INCO, *Overall Statistics on Third Country Participation in Specific Programme of Activities 1, 3 and 4.*

EUROPEAN COMMISSION (1995), *Perspectives for International Cooperation in Research and Technological Development*, Office of Official Publications of the European Commission, Luxembourg.

EUROPEAN COMMISSION (1995/96), *INCO-COPERNICUS, Information Package*, Office of Official Publications of the European Commission, Luxembourg.

EUROPEAN COMMISSION (1996), "Financial Supplement for the Fourth EC Framework Programme", *Research-Industry Task Forces: An Overview*.

EUROPEAN COMMISSION (1996), *Fellowship Programmes in Japan*, Delegation of the European Commission, Japan.

EUROPEAN COMMISSION (1996), *Preliminary Guidelines for the Fifth Framework Programme of Research and Technological Development Activities*.

EUROPEAN COMMISSION (1996), *EC Research Funding: A Guide for Applicants*, Office of Official Publications of the European Commission, Luxembourg.

EUROPEAN COMMISSION (1996), *RTD Info*, No 13, October 1996.

EUROPEAN COMMISSION (1996), *Innovation & Technology Transfer*, Vol. 5, September 1996.

EUROPEAN COMMISSION (1996), *Official Journal of the European Communities*, No C 45.

EUREKA (1991), *The Report of the Eureka Assessment Panel*, Eureka Secretariat, Brussels.

EUREKA (1993), *Evaluation of Eureka Industrial and Economic Effects*, Eureka Secretariat, Brussels.

EUREKA (1994), *Annual Progress Report*, Eureka Secretariat, Brussels.

EUREKA (1995), *Annual Report*, Eureka Secretariat, Brussels.

EUREKA (1995), *Evaluation Report*, Eureka Secretariat, Brussels.

EUREKA (1996), *Eureka News*, No 31, January 1996.

EUROTECHNOLOGY (1996), Issue No 73, Catermill Publishing, London.

INVEST IN BRITAIN BUREAU (1995), *Japanese Companies Involved in Research*, Development and/or Design in the UK.

IRDAC (1996), *IRDAC Opinion Towards Framework Programme V*, Office of Official Publications of the European Commission, Luxembourg.

IRDAC (1996), *Science & Industry News*, No 8.

MINISTRY OF ECONOMIC AFFAIRS (1996), *Knowledge in Action: Knowledge and Know-how in the Dutch Economy*.

NATIONAL ACADEMY OF ENGINEERING (1996), *Foreign Participation in US Research and Development, Asset or Liability?,* National Academy Press, Washington.

OECD (1997), "Foreign Access to Technology Programmes", OCDE/GD(97)209.

OFFICE OF SCIENCE & TECHNOLOGY (1994), *Collaboration into the 21st Century. The UK/Japan Relationship*, HMSO, London.

SCHMOCH, U., R. BIERHALS, and V. PETER (1995), *Technology Transfer in Germany*, FhG-ISI, Karlsruhe.

SCMOCH, U., C. KNORR, P. KEEN and D. AGRAFIOTIS (1996), *Legal and Institutional Constraints and Opportunities for the Dissemination and Exploitation of R&D Activities*, Report to DG XIII VALUE 2 Programme, FhG-ISI/Infogroup, Karlsruhe/Athens.

THE PUBLIC SERVICES CONTRACTS REGULATIONS (1993), HMSO, London.

DESIGNING NEW INSTITUTIONS FOR CO-OPERATION BETWEEN GLOBALISED FIRMS AND PUBLIC RESEARCH

THE HOECHST MARION ROUSSEL MODEL IN FRANCE

Alain QUEVREUX, French Ministry of Education, Research and Technology

Introduction

The international face of research is changing, as is the organisation of institutional research in France. We are living at a time of sweeping change. As R&D spreads throughout the world, each country's share in it becomes more relative. The organisation and international division of intellectual labour is being professionalised and industrialised as a result of interdisciplinary needs. The contract research sector and its markets are growing fast. The world's extraordinary intellectual progress, and the very dynamic development of the Asian NICs, in particular Korea, are making traditional research development and technology diffusion policies obsolete since they are based on the transposition of national formulae to the international front.

A large and growing number of scientists and engineers are now able to assimilate new scientific findings rapidly and integrate them in new products. This ability to do so is no longer exceptional and it explains why the traditional concept that science precedes basic industrial research which in turn precedes innovation is no longer applicable. A great many researchers may arrive at the same findings at the same time in many firms. This is why the way the process leading to innovation has become the most important issue. Although it is still necessary, the traditional approach no longer provides a sufficient competitive advantage.

This generalised use of high-level knowledge as a basis for growth is quite new. The globalisation of industrial research cannot be seen simply as an extension of the geographical coverage of good internationalisation practices. As indicated by the title of this submission, the issue is globalisation in knowledge-based economies.

The new organisation of industrial research

Globalisation accompanied by concentration

We have to be precise about what is meant by internationalisation and globalisation. In practice, the choices for the location of corporate research facilities do not concern a country as a whole but always particular poles of activity, which are usually in the form of clusters. To take a concrete example with which everybody is familiar, the map of industrial research locations in the United States does not cover the entire country; instead, it shows certain well-known areas where all the countries in the world invest. These poles of activity are located in 10 to 15 states, not in the 50 states of the federation. The message is clear, and the areas in which the manufacturers of the various countries invest show a very marked cognitive and business specialisation.

A number of authors have noted that investment in R&D is no longer being stepped up simply to accompany corporate industrial and commercial activity but also to keep abreast of the latest developments in research, take advantage of an environment more conducive to research in a particular field, co-operate with other research units in the same region, obtain access to leading universities and facilities, facilitate the recruitment of the ablest young people, and influence the programming of the universities' and research centres' scientific priorities. The reasons for investment are increasingly connected with corporate strategy for the production of knowledge.

It is becoming increasingly complicated for a firm to acquire a technology. A partnership with the public R&D sector may, since it makes it possible to maintain a technological watch, also help with corporate decisions, particularly by contributing to the co-ordination of the choices to be made. In the new partnerships, technology transfers are being replaced by "recursive loops" which enrich, consolidate and influence the knowledge content of public and corporate research on a two-way basis. The partnerships for more interactive research which are being set up under co-operative research programmes also define a new process of producing knowledge which incorporates learning ways of conducting research in various innovation systems.

This set of new characteristics is connected more with globalisation than with internationalisation. Research activities are located at certain sites, sometimes exclusively to obtain knowledge with a high economic value. Globalisation is therefore not a form of internationalisation. It is in fact another way of organising research, or most probably even a new way of assembling and preparing scientific and technological knowledge. It includes everything which can and must be sought and found in every field of corporate operations. The main goals are to meet needs on markets with different cultural and behavioural patterns, to act more quickly and cut the times needed to market products, increase production flexibility and reduce costs. In a word, we are not referring to firms which simply have a more modern outlook and extra research facilities, but to new kinds of firms, one of whose basic management characteristics involves the ongoing production of innovation flows and the knowledge underpinning them.

France too is confronted with this paradigm shift, and with the opportunities and risks resulting from the streamlining and relocation of research activities. There is much to be gained from the shift, but at the same time, if the old countries are not careful, they could lose a part of their existing research base.

A model of transnational innovation

A German study conducted by the Institut ISI of Karlsruhe presents a number of corporate research models. They are related to specific national conditions and their impact on the ability of firms to implement transnational innovation procedures. The Karlsruhe researchers consider that the change is due to a new pattern of transnational innovation which differs significantly from the old model of the internationalisation of technology, transfers and innovation. The "traditional paradigm" can be defined as the adoption of technology: pre-determined technical solutions will be generated at one site (mostly a central laboratory), and then replicated at other peripheral sites; this process can be interpreted as outward-oriented learning, and it is usually synonymous with a one-way technology transfer (typically a flow of information running from the centre to the periphery).

In a striking contrast with this traditional model, the new model of transnational innovation is defined by:

- intensive interactions between markets and technologies;
- a large number of learning centres (comprising different parts of the value chain);
- inward- as well as outward-oriented learning as opposed to exclusively outward-oriented learning;
- a two-way technology transfer between the different locations but also between the different functional units.

From the viewpoint of French firms, the questions which are now being asked are as follows:

- How can technological knowledge be obtained on world markets in order to optimise development potential?
- How can the lack of know-how in highly advanced technologies be remedied?
- How can high-tech training facilities on the periphery of the educational system be increased?

Here we see the emergence of new reasons for choosing a particular location now that the focus is on achieving complementarity between know-how and knowledge. The current trend is such that the search for knowledge is in itself sufficient as a factor in site selection. The greater diversity of reasons for choosing research site locations reflects the search for a new balance between the possibilities provided by the market and those resulting from the asymmetrical distribution of scientific and technological knowledge within a system of intensive innovation. The link between the two and their joint development pattern is now a decisive factor in general performance, which is based not only on excellence in research, but also on market gains and the distribution of growth at world level. In practical terms, the aim is to organise simultaneously, or as simultaneously as possible, product design, manufacture and use. If nobody is prepared to launch manufacture of a product or if its manufacture requires operators with skills that are not available on the labour market, the system does not work. A need is now emerging for dynamic and simultaneous interactions between the different corporate functions and between the various forms of research, i.e. fundamental, basic industrial and development research and innovation-oriented research.

Regarding the characteristics of the ISI categories of innovators, companies in major countries with an extensive research base, such as France, tended to concentrate their research activities in their home country; in the example I shall be discussing today, Roussel, one of the oldest firms in the French pharmaceutical sector, had concentrated the bulk of its research in France. Roussel's main site is in Romainville in the Paris region. Originally, the idea was to branch out abroad from this site by transferring know-how from the upstream to the downstream sectors, i.e. from the centre to the periphery. It is obviously not this type of approach with which we are concerned. As they are now integrating their functions, groups are setting up a number of centres of activity in order to develop complementary assets that generate competitiveness. Major firms are seeking access to highly concentrated, extremely efficient centres which, it seems, are vital for multipolar operations. They are using extremely effective, internally developed procedures in order to transfer technologies, share them internally and devise shared learning projects for the new development activities that will add to their competitiveness.

It was for those reasons that the French Ministry of Research opened talks with Hoechst Marion Roussel, a pharmaceutical subsidiary of the Hoechst Group. The French authorities are convinced that the relationship which will be formed by major transnational enterprises with the government research sector in various countries will become a key factor in maintaining product diversity, diversification and increased competitiveness. This relationship will have to be much more interactive than in the past in terms of integrated functions, entailing interdisciplinary activities and the continuous updating of consumer and customer behaviour. Efficiency increasingly means dynamic efficiency and is not based only on economies of scale or on a link between special individual activities. Innovation efficiency is partly based on the contribution made by the general operational context with its possibilities of interchangeability and association, i.e. balancing, in an original way, rigidity and flexibility, change and stability, customer satisfaction and preparation of the company's future.

Hoechst Marion Roussel in France

The French pharmaceutical industry invests about $3.5 billion (FF 20 billion) a year in R&D. Along with the aerospace and car industries, it is one of the three leading sectors in French industrial research. It and the car industry have been the most dynamic sectors in the 1990s. The statistics for 1996 are not yet available, but the pharmaceutical industry is expected to overtake the aerospace sector and move into the lead in the French industrial research field for the first time in history.

In 1995, the pharmaceutical industry accounted for 14 per cent of total investment in industrial research in France. Government aid for pharmaceutical research amounts to very little as it covered only 1.3 per cent of expenditures on such research in 1995. Like all the dynamic sectors in French industrial research, the pharmaceutical industry is having more and more research carried out by partners (30 per cent in 1995), and in particular by public sector partners. It is in this particularly dynamic field that the French Government has carried out an institutional experiment with the aim of taking into account to a greater extent the constraints and benefits of globalisation in the research field.

Roussel Uclaf, a French subsidiary of Hoechst Marion Roussel, is one of the oldest French pharmaceutical firms. HMR accounts for 12 to 15 per cent of pharmaceutical research in France, and the Romainville site is the second biggest laboratory in the French pharmaceutical industry. Romainville alone accounts for 10 per cent of French pharmaceutical research and has a workforce of about 1 200. Why was the Roussel case so important to the French Ministry of Research? Quite simply because its impact on the French research system could have been very serious and given rise to major structural problems.

The particulars of the case clearly reflected the new trends in research activity. The decision by Hoechst Marion Roussel (HMR), a German-owned firm that is well-established in France, to streamline its research activities at world level resulted in the creation of a central laboratory which was to become the Group's centre of excellence and to assemble the best research staff. This streamlining operation reflected the Group's strategic objective of moving on from the conventional pharmaceutical field to specialisation in life sciences and biotechnologies. To carry out this change involving a major scientific input, HMR did not opt for a site in Germany, where the parent company is headquartered, or in France where the Group has a strong tradition in the research field, but for a site in the United States where its activities are more recent. Also the choice went to New Jersey, and not to Ohio or Kansas where the Group's largest laboratories in the United States are located. HMR decided to set up a laboratory in Bridgewater near Princeton to work in a field devoted to pharmaceutical research applied to human disease but far removed from its pharmacological interests. The site was seen as the best-placed for the implementation of this major shift in long-term policy. Its advantages included the fact that many competitors are located in the New Jersey-Pennsylvania cluster, which is conducive to a dynamic labour market and more or less requires pharmaceutical firms to be present there.

The turn taken by events caused some concern at the Ministry of Research in Paris. We obviously considered that public sector research was an asset for the HMR sites in France, but their future was rendered somewhat uncertain as a result of the HMR Group's relocation policy. Talks were started with the Hoechst Group on the initiative of the French authorities. They focused on two issues:

1. Did the Group intend to reduce the volume of complete research programmes in France?

2. Would the Group remain committed to maintaining the scientific excellence of its research activities in France?

A favourable response was not long in coming. France was to remain a centre of excellence in HMR's research activity. The multinational was frank and did not attempt to avoid the issues. It stressed the industrial rationale of its decision, and the talks could not have been held if the all-importance of that rationale had not been recognised. Research had to be streamlined, but it was also necessary to go on developing centres of excellence distinct from those of competitors. It was therefore advantageous to work in other special fields at sites other than Sommerville. France offered good opportunities in this respect.

The high standard of French scientific research was certainly a basic factor in this decision, as was the position of Roussel Uclaf as a well-established firm, but nothing was settled in advance. Regulatory and market access problems, which are of a very specific kind in the pharmaceutical field, financial rationalisation at world level and the tax system for research activities in France may also have contributed to the Group's positive reaction to the questions asked by the French Government, but not to the point of swaying its decision. It must be considered that the combination of high-level public research and an advantageous tax system in France provided an extremely attractive package.

The Hoechst Marion Roussel fund

HMR firstly undertook to maintain the volume of industrial research at the Romainville site in France through new research projects. This decision fitted in well with the Group's new technological rationale, for the Ile de France (Paris region) is by far Europe's main industrial research centre. The volume of industrial research carried out in the Paris region exceeds that of large countries like Italy or Canada. But the main subject of the agreement was the creation by the French Government and Roussel of a Hoechst Marion Roussel Research Fund run on the basis of a Public Interest Partnership (GIP), whose sole purpose is the funding by HMR of contracts and grants for the French public research sector. Research sponsored by the GIP in fields relevant to HMR's activities will benefit from the best scientific knowledge and resources available in France in genetics, molecular biology, pharmacology and chemistry.

A GIP (Public Interest Partnership) is a special kind of institution that was set up in 1982. It serves as a bridge between public and private bodies, which are usually subject to different legal and regulatory standards, so that their resources can be pooled more easily. The GIP manages the contributions by the partners. The accounting side and cost control are governed by private law, while expenditures incurred by the firm in connection with this Fund are governed by ordinary French law applicable to research activities. A GIP can exist only in connection with the Ministry of Research or in direct connection with a university. By opting for this solution, the HMR Group's French research facility confirmed its importance at world level. The GIP is a kind of agreement between the public and private sectors which aims to reconcile the advantages of private enterprise with the imperatives of representing the interests of taxpayers as a whole. Since 1982 research bodies have been using this particular formula, among others, to develop their relations with industrial partners.

The GIP under consideration can be seen as a type of contract which gives the Government a greater say than in a conventional contract and which requires all decisions to be taken jointly: neither the enterprise nor the Government can have a decision approved on a majority basis. There is either agreement or deadlock. The Management Board is chaired by the Managing Director of HMR's French subsidiary, the

Vice-Chairman is the Director of Technology in the Ministry of Research, and the GIP is managed by a University of Grenoble professor.

The contractual provisions concern:

- The co-operative arrangements between HMR, the Government, and the research bodies comprising the CNRS, the INSERM and the CEA. The object of the Fund is to promote research within the laboratories of French bodies, the exchange of knowledge and the practical application of this research.
- The rules for the selection of research projects by a scientific committee which is chaired by a leading scientist who is a professor at the *Collège de France*.
- A programme of activity which defines each year the origin of the funds, the list of potential beneficiaries, the research fields covered and the kind of research.
- The rules on the confidentiality and publication of results, which are not intended to shackle researchers but are simply a precautionary measure.
- The procedures for use of the results and the intellectual property system.

In return for the knowledge provided by the public research sector, the firm is expected to draw on all its resources world-wide to ensure that the research findings are exploited and, when they concern industrial activities already under way in France, to keep at least some of the new production work in France. The economic objective of this type of contract is to develop advanced research and provide a basis for diversification by the firm. In the case of HMR, the GIP offers a quality partnership including staff with a world reputation in life sciences. The GIP is a multiannual contract under which the practical applications will be decided on every year. In keeping with the GIP's objectives, the initial activities will be aimed at strengthening existing technical resources for integrated interdisciplinary projects. A limited number of projects is to be financed for three years. The funds allocated by the GIP will be managed by the research bodies employing the staff selected.

Under its research policy, the HMR GIP can also conclude 18-month contracts for research-based training with individual researchers. A hybrid system is to be used for the supervision of projects. The director is a public sector scientist and his deputy is a top-level manager from the firm. Decisions have to be taken with the agreement of the three parties, the parent company, the French Government which protects the taxpayers' and the country's interests, and the main public research bodies in the field concerned (three in the case of HMR). The questions underlying this institutional innovation obviously concern the research findings. To whom do they belong and how are they distributed? The firm which provides the funds has a potential monopoly as it is entitled to the first look at the findings. In no other programme are knowledge and interests so closely connected. Whether in the case of bottom-up industrial research programmes or the selection of priorities by the authorities following consultation with the manufacturers, the processes are more sequential and linear.

The Hoechst Marion Roussel GIP inaugurates a high-quality, interactive partnership in a field in which the industrial partner invests heavily in research in France with a view to effecting rapid technological and scientific change. Given the specific kinds of activity of French Government research bodies and the competition between them, the HMR GIP will ensure the co-ordination and convergence of knowledge in a way which is quite unprecedented. This can be expected to provide an original and pragmatic approach to the selection of the most promising areas of therapeutic research and to consolidate rapidly HMR's positions on the related markets. In time, this kind of system could very probably play a very important role in the development of new technologies by HMR.

The economic rationale of research in a public interest partnership

The overall objective is to increase returns on investment for both the private and public partners. The advantages for the private sector are patents and head starts on the most rewarding new markets. In the case of the public sector, they are a clearer view of the major technological challenges, integration of capabilities within the national innovation system and, in particular, the development of high-level skills and adaptability in partnership management activities.

The effect of this should be to boost research clusters in France and strengthen budding know-how which may not be very obvious and not have attracted much interest, but which could contribute substantially to the firm's diversification and specialisation potential. In this newly privately funded private-public partnership, the joint selection of priorities, the varied application of the findings (private marketing, roles as a catalyst for new activities or new research in France) and the development of a balanced supply of specialised human resources will create a new pattern of technological innovation simultaneously generating new knowledge in several different fields.

The benefit to the firm

Firstly, the Board and shareholders are given a clear message that the Group is doing everything it can to address the challenges of life sciences and biotechnologies. In addition, the approach taken by HMR bolsters its access to leading-edge technologies via close contact with the main research centres working on its specialities. Keeping very close to the research teams capable of making important advances is a necessary move that is carefully organised.

Highlighting the particular capacity of a site to generate a particular category of innovation based on more dynamic interactions is a function which HMR will now be able to develop more extensively with French public research facilities. It will enable the Group to maintain preferential access to a recognised source of innovation breakthroughs. Outside the Group's main research co-ordination centre, this function will give a self-sustaining impetus to the competitive differentiation of the firm's intellectual assets.

Direct involvement with France's high-level research facilities puts the Group in the position of being first off the mark, which translates in economic terms into intellectual property rights and their use. As the first firm to show the way into a new form of highly innovative partnership, HMR will have an advantage in terms of its image and therefore be able to attract the best scientists. Lastly, the HMR Group can become, like its Roussel Uclaf subsidiary, an accepted member of the French scientific community.

On a complementary basis, this programme will allow the Group to diversify its international technological co-operation procedures, since as a rule innovation breakthroughs are not made in major international programmes, which always focus on multi-partnerships and consensus rather on excellence. This new transnational system of public research, however, provides a great opportunity for a partnership aimed at technological excellence. The GIP is a structure which establishes a scientific and technical forum capable of maximising the use of specialised know-how and of increasing the economic leverage effect of the firm's intellectual assets.

The benefit to the host country

An initial point should be stressed. At a time when the volume of fundamental research conducted within firms is declining in France, the formula of investment by a firm in fundamental research and basic industrial research carried out by the public sector is an alternative method of achieving the same long-term objectives. The GIP provides what are really additional funds that are allocated on a selective basis without any commitment to their ongoing distribution among the receiving bodies and institutions, and therefore cannot step in to cushion a possible decrease in government appropriations. There is no connection between the two funding procedures.

Investment by the host country, France, in basic research is a long-standing tradition. The cumulative costs of this effort are very high. But science alone cannot strengthen a country's competitiveness. A dynamic link with technology and demand formation is absolutely essential. It is this link which associates technology, growth and employment. The GIP serves as a bridge between public research in France and the technological developments directly connected with the sale of products on world markets.

It is an approach consistent with the globalisation of public research financed by the French Government. It stimulates the learning capacity of public research bodies with regard to transnational innovation, and contributes to the development of a knowledge base for the strategic fields in which HMR must be a front runner and extremely competitive at world level. In return, research by HMR must be geared by this learning process to a research and training network that is dense enough to deter the firm from transferring research findings to other sites without providing any feedback for the intellectual ecosystem from which it has benefited.

In order to strengthen the economic impact of its investment in research, the Ministry concerned considered that some stability must be guaranteed for the intellectual property rights of the private body investing in this research. To some extent, the industrial investor chooses the patents it wishes to take out. This operation could be turned to good account with other firms. It can be replicated with all the major transnational enterprises. France has a recognised scientific and technological potential which could be converted into investment potential.

In addition, the globalisation and development of technologies will have very important implications, as yet unknown, with regard to running the scientific system and maintaining a very high scientific potential. The GIP may also be applicable to fields in which there are no major industrial operators in France but with whom international technological co-operation is possible. The private sector must support long-term public research so that it will continue to build up potential for long-term competitiveness and incentives for the creation of new activities.

The GIP: a transnational research arrangement

The optimal organisation of public/private co-operation is a must, an idea that has long been promoted in France. There is now a general demand on many markets and from many firms for the know-how developed by bodies conducting or managing research activities. This encourages a positive attitude to investment in research.

The GIP is also an institutional form of public research which bolsters access to technology for major groups and, for this reason, may lead in some cases to private funding of public research. Sharing very advanced knowledge with firms in order to increase the volume of available knowledge in a country is a practical objective for a government. This kind of partnership is to pave the way for new technological developments and the creation of knowledge as a public good that will generate new activities and business. The spin-off from this new style of public research is one more way of developing potential business opportunities.

The GIP can be seen as an initial experiment in setting up a new co-operative policy in advanced industrial technologies, particularly in two cases:

- when the aim is to explore new fields and new types of co-operation;
- when the aim is to improve international firms' understanding of institutions, procedures and the public policy environment in France and apply it as effectively as possible to stepping up their innovation flows.

Compared with other simpler forms of medium-term contracts between the public research sector and certain firms, the Government can expect greater transparency from the GIP. This greater transparency results in closer scrutiny by an international firm's managers and shareholders and therefore in a firm resolve to make the most of investment in research and relate it to the firm's commercial activities. Steadiness of purpose and a dynamic attitude to innovations are expected of the partnership system. It is also expected to provide greater mobility for researchers and to keep the authorities abreast of the changes taking place in the needs for training and the standards of excellence which have to be met by the educational system.

The GIP must also be analysed in the European context. Europe has an R&D framework programme in which the rules for the dissemination of results exclude access to the most advanced industrial research. Quite a careful analysis of the statistics led us to the conclusion that the framework programme mainly stimulates the commercial application of useful research findings. Countries with an outstanding tradition of research must therefore provide another kind of institutional system geared to the excellence of partnerships and results in order to renew their technological assets.

The HMR GIP must be seen as the first sign of a renewal of the R&D system in the field of advanced technologies. The Government provides access to invaluable intellectual assets in return for financial investment by the firm. In practice, it also guarantees that it will be able to train the young scientists who will be taking up the jobs generated by the success of the technologies derived from its innovation system. The programme is also meant to have catalytic effects on scientific and technological creativity and it is assumed that new forms of partnership will create new industries. The aim is to promote research productivity, i.e. to ensure that any new knowledge will be incorporated in transnational team work to increase the cumulative leverage effect on other knowledge.

We now realise that each organisational structure has characteristics that are more adapted to coping with certain types of uncertainty – with regard to the technical or commercial fields, established custom and social values - than with others. External investment in research is a cost-effective approach to reducing the disruptive effects of uncertainty on the parent company's long-term basic strategy, exposed as it is to extreme turbulence.

To identify the theoretical anomalies which may foreshadow a paradigm shift and therefore generate financial catastrophes or very high profits, a firm must be in very close contact with very high-level research, even if it is not completed, in order to be able to assess before everybody else its potential impact on business. The qualities of the businessman, manager and expert must be combined for this purpose.

A basic research GIP is therefore also a means of influencing practices. It is a source of very substantial savings which dispenses with the necessity of continually amassing documentation and analysing every piece of scientific and technical information. In a GIP with a world reputation for excellence, the knowledge produced incorporates very extensive information which is analysed and streamlined by integrating the faint signals foreshadowing new intellectual thrusts. It enables a firm to target the skills it needs and to rationalise the production of its intellectual assets throughout the world, with the objective of continually pushing ahead to obtain a competitive edge.

The HMR GIP will also be an incubator for infra-technologies by pooling methods of assessing results. Such infra-technologies are a prerequisite for the development of joint research and hive-offs into mutually-reinforcing and self-catalysing clusters.

Conclusion

Transnational research involves much more than simply working out research topics or exchanging information among researchers. It is becoming identifiable and definable: this type of innovation materialises when a number of interdisciplinary teams in different countries and possibly in different kinds of organisations or bodies work on globalised projects. It is on this form of innovation that the competitiveness of firms and countries will depend. In response to this challenge, institutional innovation is a means of boosting the efforts of partnerships so that they will excel in innovation and create new activities within existing firms.

The assumption behind the Public Interest Partnerships (GIPs) set up in France is that the use of various institutional arrangements will generate growth owing to the competitiveness and variety of the innovations and activities developed. The objective is that of a win-win game in which the production of knowledge is the main factor in economic and social development and cohesion, thereby preventing dislocation as a result of growing system entropy.

It is a mix of existing forces that is now being produced. Appropriate institutional formulae have to be worked out. As more and more areas of knowledge are opened up world-wide, the need for those in charge of R&D to create global R&D networks will become increasingly acute. The creation of a GIP with HMR is a response to this highly polarised globalisation which is making such rapid inroads and calling into question the institutional basis of national public research systems.

It is to be expected that this approach will continue to be developed and used in France since it incorporates many aspects of a response to the challenges of internationalisation and globalisation in industrial research. Lastly, it is very likely that, owing to this type of initiative, Hoechst Marion Roussel will very soon be able to play a leading role in life sciences and biotechnologies, although it already played a key role in this field, for the good of our health and the benefit of the firm’s shareholders.

INCREASING PARTICIPATION BY SMALL AND MEDIUM-SIZED ENTERPRISES IN INTERNATIONAL TECHNOLOGY CO-OPERATION: THE ROLE OF PUBLIC POLICY

Dermot O'DOHERTY, FORFAS, Ireland

Introduction

The process of globalisation is gaining momentum on a daily basis, with no company or country now able to operate in a totally independent fashion. Globalisation now has a direct impact on firms operating in different industrial sectors and territories. Together with policies aiming at the deregulation of protected sectors, globalisation imposes an intensification of competition on firms and a strong pressure to speed up the rate of technological change. In this new economic scenario, company and general economic performance depends increasingly on the learning capabilities of individuals, firms, regions and countries. Learning is necessary in order to adapt to fast changing market and technical conditions and to engage in innovation in products, processes and forms of organisation.

The concept of a "knowledge-based economy" highlights the fact that in the post-war period the production of both goods and services has increasingly become information and technology-based. The proportion of the workforce that handles tangible goods has become smaller than that engaged in the production, distribution and processing of knowledge. The expansion of "knowledge-intensive" sectors *vis à vis* other routinized and physical production processes seems to be one of the major trends in economic development during the period. It is therefore better to talk about "a learning economy" than about a "knowledge-based economy". The pace of change makes specialised knowledge irrelevant and so it is the capacity to learn which mainly determines the performance of firms and countries.

In one sense, this may mean less differences between small and large firms (as well as small and large nations), in that they are faced with the same problems and challenges, but the difference in their capacities to deal with such problems remains the same or has even grown. Large firms and nations can adopt the forms and structures of their smaller counterparts, e.g. through devolved business units and the downstream empowerment of their managements and regions, but this option is not open to their smaller counterparts, except through collaborating and co-operating in a very direct way with each other to achieve the benefits of greater size and scale.

Small firm innovation is becoming increasingly important both for the small firms themselves and for governments. Operating in global, highly networked markets means that innovation in products and processes and in the management of small and medium-sized enterprises generally is no longer optional but a necessary activity for growth and increasingly for survival. The "internal" characteristics of innovative firms have been researched over a long period and the emphasis has, to a large degree, moved to the differences between large and small firms and, for small firms in particular, how they interact with the outside world, including their interactions with each other and with government. It is clear that interfirm co-operation – on a vertical level with larger firms but also on a horizontal level with each other – is now becoming the norm. The essential role of the public authorities as a mediator of market forces, facilitator of change and broker between the various parties is also becoming clearer, with the dying away of much of the old rhetoric about interference/intervention by government, "picking winners", etc.

The role of small firms

An integrated approach to these interrelated but disparate elements of the global technological and industrial environment for small firms is what this paper generally sets out to achieve, particularly in terms of the impact of these elements on innovation performance and on the potential for international technological co-operation. Realising that potential depends on both utilising and enhancing innovation performance. The aim is to assist the Korean and other OECD Governments in reaching conclusions on how to characterise both international technological co-operation and different types of SMEs in the context of globalisation – leading to a number of proposals as to how government should address the identified characteristics and help small firms respond to the different factors and circumstances that are impacting on them.

More specifically, the main issues are:

- Should policy address small firms individually or as part of wider networks?
- What barriers do companies face that discourage them from getting involved in international co-operation and what obstacles do they have to overcome when they actually get involved?
- What are the best institutional arrangements and specific policy mechanisms for facilitating SME involvement in international technological co-operation?

Both Ireland and Europe overall are very much "small firm" economies (here defined as having less than 500 employees). As far as international technological co-operation is concerned, however, it is the nature of the SMEs rather than their overall number that is important. Unless the small firm has some technological, market or other asset to offer – and, just as importantly, recognises what that asset and/or capability is – then both it and the public authorities are wasting their time in attempting to engage in any form of interfirm co-operation, not to mention international technological co-operation.

R&D and innovation performance offer at least a proxy measure of basic capability to engage in international technological co-operation. The recently published FORFAS ***Survey of Product and Process Innovation in Irish Industry 1993 - 1995*** and in particular the results of a ***Scale of Innovativeness*** analysis of different types of firms (employing 10 or more) gives some indication of both potential and actual co-operation. The objective of the survey was to assess innovation in Irish industry using a number of indicators of product and process development. At an aggregate level, it was found that:

- 50 per cent of the 3 450 manufacturing and internationally traded services companies with 10 or more employees in the country claimed to have developed or introduced at least one technologically changed **product** between 1993 and 1995. Products which were introduced or significantly improved between 1993 and 1995 accounted for 18 per cent of 1995 sales revenue in industry generally.
- 52 per cent of companies claimed to have developed or introduced at least one technologically changed **process** between 1993 and 1995.
- Overall, 64 per cent of companies claimed to have developed or introduced at least one technologically changed **product or process** between 1993 and 1995.
- 52 per cent of companies claimed to have engaged in some form of research and development activity between 1993 and 1995, half of whom (26 per cent of all companies) claimed that their involvement in R&D was continuous in nature (i.e. these companies would have spent money on R&D in each of the years 1993, 1994 and 1995).

Table 1. SMEs in Europe

	Enterprises (1 000)	Size-class dominance*
Austria	145	SME
Belgium	410	Large
Denmark	150	SME
Finland	340	Large
France	1965	Large
Germany	2670	Large
Greece	690	Very small
Ireland	**130**	**SME**
Italy	3365	Very small
Luxembourg	15	SME
Netherlands	390	SME
Portugal	580	SME
Spain	2200	Very small
Sweden	415	SME
United Kingdom	2565	Large
European Union	**16040**	**SME**

* A country is said to be very small, SME or LSE dominated if either very small enterprises, small- and medium-sized enterprises (taken together) or large-scale enterprises have the largest share in total employment.

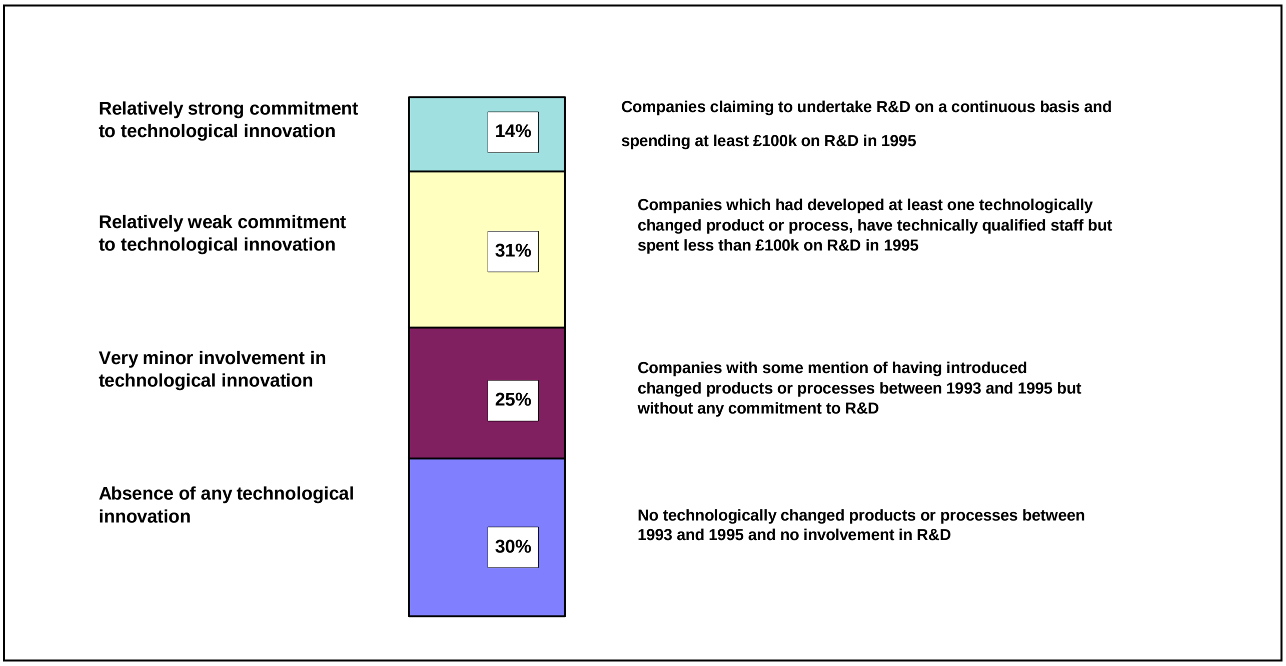
Source: Author.

However, not all of the companies with a "continuous involvement" in R&D are investing very large amounts of money. While in overall terms, companies in Ireland spent almost £400 million on in-house performed R&D in 1995 (and, over the period from 1986 to 1995, R&D spending has grown at a rate of 15 per cent per annum in real terms - bringing R&D expenditure as a percentage of GDP from less than 0.5 per cent in 1986 to just over 1 per cent in 1995 - the survey suggests that there are approximately 480 companies in the country spending £100 000 or more per annum on in-house R&D on a continuous basis.

Behind the aggregate indicators, there is also a rather complex picture of technological innovation in different branches of industry. Firstly, there is wide variation in the indicators across companies of different size and across different industry sectors. In general terms, however, larger companies and companies operating in more "advanced" sectors (electronics, software, pharmaceuticals, etc.) are more likely to engage in product and process innovation. At the same time, not all indicators tell precisely the same story. There are some branches of industry which appear to have a low commitment to innovation if one looks, for example, at their level of R&D spent as a percentage of sales but which appear much stronger on other indicators (e.g. the proportion of companies introducing new products or the share of sales from new products).

To deal with the complex messages being communicated by the different indicators, an **overall *"Scale of Innovativeness"*** model (Figure 1) was applied to a combination of indicators. It is clear that firms fall into very different categories with regard to R&D and innovation performance. The significance of this is the view that a similar grid can be applied to the potential for international technological co-operation. Most of the current participants in international technological co-operation are in the top 14 per cent of innovation performers while some of the 31 per cent of firms in the second category are candidates for both higher levels of innovation performance and (on the national level at least) technological co-operation.

Figure 1



Source: Author.

Table 2. Patterns of collaborative R&D

	Base of firms	Proportion of firms engaged in collaborative R&D
Small Irish traditional	1394	10%
Small Irish advanced	431	17%
Large Irish traditional	478	21%
Large Irish advanced	109	33%
Small foreign traditional	129	8%
Small foreign advanced	181	19%
Large foreign traditional	177	30%
Large foreign advanced	275	33%
Total	**3174**	**17%**

Source: Author.

Table 3. Sectoral patterns of collaborative R&D

	Base of firms	Proportion of firms engaged in collaborative R&D
Food/Drink/Tobacco	627	18%
Textiles	107	22%
Clothing	177	6%
Leather/Footwear	24	14%
Wood/Wood products	100	3%
Paper/Paper products	73	15%
Printing/Publishing	198	7%
Chemicals	74	34%
Pharmaceuticals	114	31%
Rubber & Plastic products	126	20%
Non-metallic minerals	159	21%
Basic materials	127	11%
Fabricated metals	241	13%
Machinery nec	196	18%
Computer and office	108	21%
Electrical machinery	122	31%
Electronics	65	21%
Instruments	101	23%
Motor vehicles	90	23%
Other transport	34	21%
Furniture/Other man.	204	8%
Financial services	79	2%
Software	121	21%
Other	187	17%
Total	**3454**	**17%**

Source: Author.

Larger firms are more likely to be involved in a co-operative arrangement, with an estimated 40 per cent of firms of over 200 employees being involved in such an arrangement. The overall propensity to co-operate is about 17 per cent of all firms. There is a small but discernible tendency for more higher-technology firms to be involved in such arrangements. Previous studies have shown that larger and more technologically advanced types of firms are more likely to engage in R&D in the first place, so it might be expected that this would give rise to more co-operative R&D arrangements involving these firms. Sectors displaying an above-average propensity to co-operate are Chemicals, Pharmaceuticals, Computers, Electronics, Instruments and Software. Larger firms are more likely to involve themselves with an overseas co-operation partner.

While generalisations such as these can be drawn from the data, it is important to note that there are major exceptions to the rule. For example, not all companies operating in so-called "high-tech" sectors are necessarily highly innovative themselves and likewise, not all companies in "low-tech" sectors show an absence of technological innovation. Also, large companies are not always more innovative than small companies – there is a subset of small firms that score higher on all indicators of product and process innovation than their larger counterparts. Overall, there is a clear need for a targeted approach to identifying potential players and to providing publicly-funded assistance for such activities.

International co-operation involving small firms

Having examined some initial data on potential and actual participation by SMEs in technological co-operation we now go on to look at what is involved for SMEs in engaging in international co-operation in general. The study on which this section is based was commissioned by the Directorate-General of the European Commission responsible for Enterprise Policy, Distributive Trades, Tourism and Co-operatives (DG XXIII). The study examined the problems and obstacles faced by craft industries and small enterprises when they endeavoured to establish co-operation arrangements with enterprises from other Member States. The research was carried out by a team of consultants who interviewed a total of 84 small companies in four countries of the European Union: Belgium, Denmark, Ireland and the United Kingdom.

The vast majority of companies interviewed employed less than 50 people, with 53.6 per cent having less than 10 staff. Only 2.4 per cent of the companies interviewed employed more than 50 people. This was consistent with the objective of concentrating on the problems of the really small companies. The companies also represented a fairly broad cross-section of sectors and products. In all, manufacturing was the most important sector (64.3 per cent), followed by distribution (31 per cent) and service/repair (23.8 per cent). Specific product areas ranged from standard consumer goods, to medical products, plastics, suppliers to the space industry, telecommunication services, industrial engraving and foundry products.

The overall results (see Table 4) reveal that when a small company enters into a co-operation arrangement with a small company from another Member State, it is more likely to involve an agency arrangement, an export sale, or a distribution or marketing agreement. However, the more developed forms of co-operation are slowly gaining ground, with 22.6 per cent of the companies surveyed being involved in subcontracting, 16.7 per cent in a joint venture and 11.9 per cent equally, in manufacturing/production and research and development. It is common for the small companies to be involved in more than one co-operation arrangement.

Table 4. Type of co-operation

Agency	31.0%
Export sales	38.1%
Distribution/Marketing	27.4%
Joint venture	16.7%
Subcontract	22.6%
Manufacturing/Production	11.9%
Import	22.6%
Franchising	0.0%
Research/Development	11.9%
Other	6.0%

Source: Author.

There are a number of reasons why the simple forms of co-operation were more prevalent in the study than the more developed ones, such as joint venture, manufacturing/production, research and development, licensing, etc. Firstly, SMEs tend to adopt a step by step approach to this type of co-operation, preferring, for example, to start with a simple export sale or distribution arrangement and then working up to a joint venture, or joint-production arrangement. The final step might be the transfer of technology or know-how to the company's foreign partner or to the joint venture company. This gradual approach is very much in line with the emphasis many SMEs put on the importance of building up a personal relationship with the party they are doing business with. It allows them time to get to know their foreign partner and to assess his/her performance before any substantial investment is made.

A second reason is that the depth of management and international experience is simply not present to develop this type of arrangement. This is particularly the case in companies in the low to medium technology bracket, which employ less than 50 employees. The more advanced forms of co-operation are more likely to be found in the computer/new technology fields.

The small companies interviewed tended to use a variety of methods to locate their partner, without necessarily confining themselves exclusively to one method or another. However, as can be seen from Table 5, the most widely used methods and the most successful, according to the companies themselves, were the informal ones, such as personal recommendations and professional contacts. Of the companies interviewed, 44 per cent used this method to find their partner. The next most popular was the trade fair, used by 36.9 per cent of the companies interviewed. Less popular were the more formal and impersonal methods of search, although quite a few companies used the services offered by the chambers of commerce and the embassies. These results are not surprising, given the importance the managers of small companies attach to developing a relationship with their prospective business partner and the fact that co-operation arrangements are rarely formalised. Under these circumstances, it is normal that the owner/manager would prefer to use a method of search that relies either on a personal recommendation from a trusted source, or one which allows him/her the opportunity to meet the target company beforehand and assess its products and performance.

Table 5. Methods used to locate partners

Trade fairs	36.9%
Chamber of Commerce	16.7%
Embassy	13.1%
BC-Net	11.9%
Trade mission	9.5%
Search consultant	8.3%
Government agency	8.3%
Professional/Trade Association	8.3%
Overseas Trade Office	7.1%
BRE Network	4.8%
Euro Info Centre	4.8%
Bank network	4.8%
Europartenariat	3.6%
Accountant/lawyer	2.4%
Interprise	1.2%
SPRINT network	0.0%
Other	44.0%

Source: Author.

The more technical the co-operation becomes, the more likely it is that the SME will utilise the services of a specialised search consultant. One of the surprising results of the survey was how few of the small companies had actually used the partnership search facilities offered by EC instruments such as the Euro Info Centres, BC-NET advisers, Sprint Network, Europartenariat, Interprise, etc. The major reason appears to be lack of knowledge. As can be seen from Table 6, 56.1 per cent of the companies had little or no knowledge of the various instruments or the services offered. However, companies may have actually used these services without actually being aware of it. For example, many Euro Info Centres are run by local chambers of commerce and the users therefore, may not be able to differentiate clearly between the two organisations. The same is true for the BC-NET system which is often run by local advisers, banks and development agencies. These organisations are more likely to promote their own services rather than those of the EC Commission.

The overall impression is that the co-operation arrangements are set up very quickly, with 36.9 per cent of the companies establishing their agreements within 1-3 months and 26.2 per cent took one month or less. Fairly obviously, the more complex the agreement, the longer the time it took to set up and establish. For example, one company from the UK survey, took over 12 months to establish their co-operation but this involved setting up a joint venture with a Dutch company and applying for grants from the local Dutch regional development organisation. The fact that the majority of the co-operation arrangements were set up in a comparatively short space of time, bears witness to the time pressures under which the majority of small businesses operate. A return on investment has to be shown in the shortest possible time. Another factor, may be the general attitude of the owner/manager.

Table 6. Time spent setting up co-operation

Less than one month	26.2%
1-3 months	36.9%
3-6 months	9.5%
6-9 months	7.1%
9 months +	11.9%
Unquantifiable	3.6%

Source: Author.

Most companies surveyed had experienced some problems or difficulties when setting up their co-operation arrangement. The majority of companies interviewed admitted to more than one problem. The percentages shown in Table 7, are based on the total number of companies interviewed but may best be regarded as indications of distribution rather than true percentages. The survey revealed that the main problems and difficulties encountered were; language and communication problems, lack of resources and costs, closely followed by payment problems, business culture, and finding a partner.

As can be seen from Table 7, 20 per cent of the companies experienced language or communication difficulties when establishing their co-operation. In some cases the problems were quite acute.

Another 20 per cent of the companies interviewed indicated that one of the major problems they faced was the lack of adequate resources to develop their co-operation effectively. When responding to the survey, the companies concerned highlighted two particular aspects of the problem – the first was the lack of adequate financial means – the second was the lack of manpower resources. A number of small companies interviewed had developed some excellent products and services but could not develop them sufficiently because they could not afford the investment involved.

Table 7. Problems encountered

Finding a partner	16.0%
Legal	6.0%
Administrative	14.0%
Costs	20.0%
V.A.T.	11.0%
Lack of resources	20.0%
Standards/norms	10.0%
Difference/unclear objectives	8.0%
Language/communication	20.0%
Organisational	7.0%
Business culture	17.0%
Lack of information	10.0%
Payment problems	18.0%
Wrong combination of companies	6.0%
Lack of commitment/co-operation	14.0%
Other	8.0%

Source: Author.

Lack of adequate financial resources may also affect the co-operation arrangement in other ways. Many companies did not use a lawyer to assist them in setting up their co-operation arrangement because they said they could not afford it. Other companies stated that one of the reasons they could not get involved in research and development work was because of the high costs involved. Inadequate manpower resources is also a key area and goes to the root of many of the problems and difficulties faced by small businesses. In nearly all of the companies which were interviewed, international business and co-operation was handled by the Managing Director or the owner/manager of the company concerned. This particular side of the business had to be fitted in with all of his/her other duties. Lack of time and resources also meant that decisions were likely to be taken quickly without the necessary checks and research having been done beforehand. For example, small businesses when entering into an international co-operation, would more than likely choose the first candidate to come along, rather than take the time to carry out more extensive research on the company concerned.

The problem of lack of resources is complicated by another issue, which is the inability or unwillingness of the owners of small businesses to delegate responsibility or decision-making tasks to key employees. Sometimes, the reason is that these employees just do not exist, or the owner/manager's desire to keep all decision making power firmly under his/her control.

Twenty per cent of the companies interviewed, identified costs as being one of the major obstacles they encountered in setting up their co-operation arrangement. The most common area of complaint was that relating to travel costs. Very often, the co-operation could only be set up after a number of visits to the prospective partner in his/her own country. These preliminary visits were regarded as essential by the companies, especially seeing the importance they attach to building up a relationship and trust with their foreign partners.

As has been seen above, the number of visits may have to increase drastically if there are language and communication problems between the partners. Many small companies tried to reduce the travel costs as far as possible, by picking the cheapest method of transport, even if this meant increasing significantly the number of hours spent travelling. In the majority of cases, most small companies did not apply for grants to cover travel costs, even though they were available in some countries. Another area mentioned as a problem as regards costs were legal fees. This seemed to be a particular issue where the more complex and technical co-operation arrangements were concerned. Costs could be quite significant, especially for a small company. One Irish company, for example, spent over 10 000 Irish pounds in setting up its co-operation. Some small companies also cited high legal costs as a reason not to seek legal advice in the first place.

Eighteen per cent of companies experienced payment problems of one form or another. The most common complaint was the widely differing payment conditions existing in the various EC countries where the companies were doing business. In many cases, it was ignorance of these conditions which gave rise to problems.

Quite a number of companies experienced difficulties in the area of business culture, with 17 per cent of the firms surveyed stating it to be a problem. Clearly, difficulties were more likely to occur where differences in language and culture existed between the companies involved in the co-operation. This is the reason why Irish companies stated they had no problems in this area because they were mainly doing business with firms situated in the United Kingdom. The type of problems encountered were fairly wide and varied, but nearly all revealed a lack of appreciation of the differences between the cultures in the various member states.

Somewhat surprisingly, given the number and variety of methods available to small companies, nearly 16 per cent of firms interviewed had problems finding a partner. There would appear to be a number of reasons for this. Firstly, as has been mentioned earlier, small companies prefer to use informal methods of search, such as personal recommendations or trade contacts, rather than the more formal, impersonal methods. The preferred methods, which can sometimes involve attending trade shows and fairs in order to make the right contacts, can take a long time to bear fruit.

Over 14 per cent of the companies surveyed stated that they had experienced problems relating to their foreign partners lack of commitment towards the co-operation arrangement. What the companies meant by this, was that either they found it difficult to get their foreign partner to devote sufficient time and resources to the project, or there were problems getting them to do the necessary work. The problem seemed to be more acute when the arrangement concerned co-operation between partners in the North and South of Europe. In many cases, the companies that complained of problems in this area, were also those which had not spent a great deal of time in researching their respective partners background and had adopted a “first come, first served” attitude to their co-operation.

Lastly, administrative/Bureaucratic difficulties were cited as a problem by over 14 per cent of the firms. This is not surprising, given the number of countries covered by the various co-operation agreements.

Major barriers to international technology co-operation

What makes SMEs different revolves around their size and scale. We have seen that participation in international co-operation generally and in international technological co-operation in particular increases with size, even within the SME category – although this also depends on the position regarding market dominance.

Given their problems of size and scale, and perhaps most importantly, isolation, networking capability and experience can often be a prerequisite for SMEs entering international technological co-operation – whether at a regional, national or international level. Otherwise they face major barriers. Networking and networks can be viewed both as processes and as outputs. Either way, what is involved is a mix of formal and informal contacts between business, professional, social and personal counterparts that have a major influence on the ability to innovate in individual firms and to co-operate in national and regional economies. These relationships are a key aspect of what have become known as national and regional systems of innovation. Not only have inter-organisational contacts and networks grown in significance but organisations themselves have become networked internally. At the same time, in the context of globalisation, networks and contacts are becoming increasingly international or global in character. As a generalisation "the further away the point of contact" the more difficult it is for small firms (and small countries?) to create and maintain such contact networks and to make the necessary investments in intangible knowledge assets.

One of the major manifestations of smallness is the deficiency experienced in management numbers and capability. This means that the owner-managers of the smaller companies often have to carry out most of the day-to-day managerial functions – not to mention the more strategic, longer-term aspects of management. International technological co-operation is certainly a strategic management issue and again a minimum management capability is a prerequisite.

The Community Innovation Survey revealed that financial barriers were generally the most significant for enterprises of all sizes. These include difficulties related to perceived risk; lack of innovation finance; high innovation costs; long pay-back periods for innovations. By virtue of their relatively limited financial resources, SMEs are particularly affected. Specific problems relating to participation in international technological co-operation, and the EU Framework Programme in particular, include:

- The high investment needed in proposal preparation – entering directly into a full-scale shared cost research and technology development project is a major investment not without risk.
- The high cost of documenting and presenting overhead expenses – ensuring that all costs of the consortium are correctly recorded and all invoices, receipts and travel ticket stubs are retained, imposes a significant administrative burden, which SME contractors find particularly heavy.
- The difficulties experienced by SME's in finding matching funds; also cashflow problems relating to delays in payments: smaller firms generally have greater problems than large ones in relation to cash flow. Therefore, any delays in the payments process impact on them very directly.

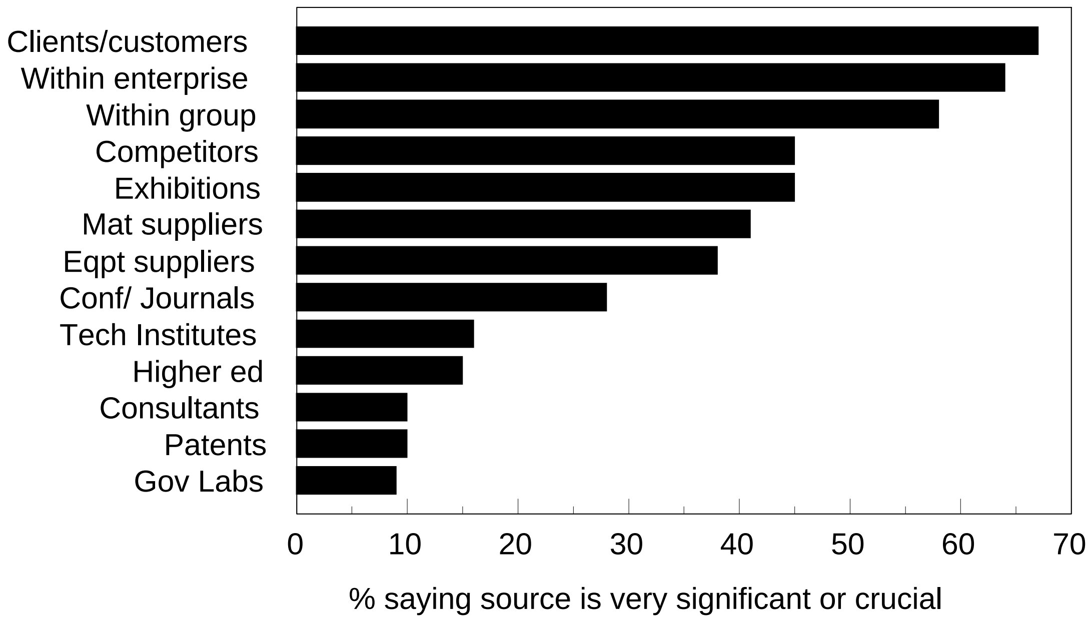
Lack of suitable information (and, particularly, the capacity to analyse it) on potential areas for technological co-operation and possible partners poses major problems for small firms. The vast majority of small companies rely on a variety of external sources in order to access information and technology. For this large section of the enterprise sector, the important issue is efficient processing of the most appropriate sources of supply. The Irish results for the 1992 Community Innovation Survey (FORFAS, 1994) show that the means of acquiring new technology range from the hiring of skilled personnel to the purchase of other companies. Sources of information include customers, suppliers and third parties such as consultants, third-level colleges and state organisations.

As a recently developed country, Korea needs to acknowledge: *(i)* the size of the exploitable knowledge base available world-wide and *(ii)* the need for a national capacity to access these external sources. In summary, knowledge is available to companies through a variety of sources and means, both nationally and internationally. Enterprises – with the assistance of the state where appropriate – must be able to decide which sources and means are most suited to their requirements.

The Community Innovation Survey in the Irish context showed that innovating companies rated "other companies", whether customers, suppliers or competitors, as the most important sources of information. Apart from customers, the main external source of knowledge for Irish innovating enterprises is contact with other enterprises. Figure 2 shows that Irish innovating companies gave ratings of 45 per cent to competitors, 41 per cent to suppliers of materials and 38 per cent to suppliers of equipment in relation to their significance as a source of external information for innovation.

A very significant source of information is trade fairs and exhibitions (45 per cent rating). It is important therefore that companies be encouraged to avail fully of the opportunity afforded by visits to overseas fairs as a fruitful source of ideas and contacts. Conferences and journals received a 28 per cent rating. There is a wealth of information available to companies in the form of magazines, books, patent databases, conference publications, trade brochures, etc. Companies need to examine published medium-term trends in technologies relevant to their sector. They also need to know what international standards are relevant to their products or what public procurement tenders are current in their area. All of this can be described under the heading of having an adequate "information processing" capability in the firm.

Figure 2. Sources of information for innovators
All developing new products/processes 1990-92



Source: Author.

Public policies in the context of globalisation

Some guidelines for Best Practice in devising policies for SMEs in the context of internationalisation/globalisation strategies have emerged from recently published OECD work in this area. These confirm the need for measures aimed at enhancing capability and access at firm (and national) level and reducing barriers, particularly financial barriers. Facilitating the development of company capability and ensuring access to information and other “enabling” resources is seen as the new paradigm for public policy. Within this paradigm a number of recommendations for public policies regarding international technology co-operation are outlined below. These are not intended to be a comprehensive set of policy initiatives but to be an indication of the direction in which policy might go if Korean SMEs, and particularly smaller firms within that category, are going to become seriously involved in international technology co-operation.

International technology audits

There is a clear need for appropriate policies to assist companies in the crafting and implementation of coherent strategies. This has been addressed in Ireland and a number of other European countries through mechanisms such as the Technology Audit Programme. This involves a team of consultants, drawn from both the public and private sectors, going into the firm, debriefing the management, assessing product and process needs and capabilities and coming up with recommendations for change at both an operational and a strategic level. A specific Audit, or at least a module added to the more general approach, would be an important starting point for identifying candidate firms for further public assistance. We know that larger firms, those in higher technology sectors and those already engaged in some form of external linkage have the most potential but public policy might wish to focus either on these or on those that are less likely to do it themselves.

Brokerage/facilitation

The core competences of “candidate” firms having been identified through the Audit process, it is important to be able to match them with the complementary competences of potential collaborators. Assistance with this “match-making” may be funded by the public authorities but a range of public and private sector institutions and individual consultants can be involved in the actual implementation of brokerage or facilitation programmes e.g.:

- Large firms, higher education colleges and research institutes can act in both formal and informal ways (e.g. R&D clubs) to encourage SMEs to get involved with them in national and increasingly international co-operation, as well as with third parties at home and abroad.
- Industry associations, and particularly research associations, constitute informal networks that, of their nature, bring firms together. Specialist societies and organisations, such as the Licensing Executives Society (LES), which has a sizeable Korean chapter and a world-wide membership, also offer useful partner “search” vehicles.

Identifying and evaluating potential partners and the technologies on which the firm might want to co-operate, as well as subsequently entering into negotiations on an international basis – even engaging in “enabling” local and national networking – are, however, all difficult processes, themselves requiring specialist expertise. Sources of information, means to co-operate and acquire technology and support mechanisms are complex. Companies are wary of exchanging information with potential competitors. The small size and scale of SMEs makes the prospect of accessing the world-wide availability of information appear daunting. Given the significance of access to information and know-how for the large majority of companies there is a major role for state agencies in helping companies to recognise gaps in their technical know-how and to access and use information effectively.

For this reason many countries have initiated programmes such the Irish Technology Transfer/Brokerage Programme (as well as a unique scheme of Technology Acquisition grants to reduce the cost of licensed technologies) aimed at gaining access to international technology as well as encouraging participation in EU R&D Programmes. The Irish public authorities have recently introduced a Pilot Interfirm

Co-operation Initiative, known as the Networks Programme. This puts in place the resources needed to facilitate and establish a number of formal networks, to help them to devise joint solutions to common problems and to evaluate the result as well as assessing existing networks – both formal and informal. Formal networks should normally consist of at least three firms (SMEs) and not more than eight. Where necessary a network can include one multinational or large-scale Irish firm, or one college if it can contribute to the objective of the network.

The following costs are funded in the pilot phase:

- the training of brokers, whose function it is to promote and facilitate the formation of networks;
- participation of Danish experts in the detailed negotiations on the formation of a network;
- purchase/modification of diagnostic software to identify firms/activities suitable for networking;
- cost of setting up networks (e.g. facilitation session, formation/legal costs);
- promotion/awareness seminars, etc.;
- travel/information gathering, etc. to develop and share experience with established networks;
- management of the programme.

The following are examples of activities which funded networks can undertake:

- collaborative research;
- technology transfer/acquisition;
- technology management;
- technical training;
- collaborative product design;
- development of standards;
- technology scan and market developments;
- innovation assessment and planning;
- participation in European networks;
- project management;
- purchase of equipment;
- quality assurance;
- joint financing of innovation.

Technology co-operation fund

International technology co-operation is an expensive business for all companies, and particularly SMEs. There is therefore a need to reduce and even minimise the costs if SMEs are to be encouraged to participate. Travel costs, at least in the initial phases, are probably the biggest disincentive but international technological co-operation is a long-term commitment and is not seen by SMEs as having immediate or perhaps even medium-term benefits.

The public authorities must therefore provide continuing project funding if they are serious about getting SMEs involved. This can be provide on a regional, national, bilateral or, as in the European Framework Programme case, on a shared cost (50 per cent) multilateral, collaborative basis. This offers a model for the Korean authorities, perhaps through the mechanism of APEC or a subset of the OECD, which would certainly be a new departure for the Organisation. It should be possible to have many of the advantages of the Framework Programme without necessarily having a Single Fund – in the initial stages of some form of multilateral co-operation at least.

The need for actions to increase the extent of SME involvement in EU R&D programmes was embodied in the decision regarding the fourth Framework Programme. This observed that "*SMEs ... should play a* *substantial role in the implementation of Community RTD activities; therefore particular attention should be paid to the specific needs of such undertakings in order to ... encourage them to take part in Community programmes*".

However, the Framework Programme continues to have relatively little relevance to many SMEs, because of their low technological capability or their main innovation needs being at the level of modest incremental development of existing products, processes or services. The EU *Green Paper on Innovation* calls for a range of actions at Community level to encourage innovation in enterprises, particularly SMEs. In particular it identifies the need to "*bolster the mechanisms which allow SMEs to be involved in and benefit from Community research*" and to "*pay better attention to ... the most relevant experience gained from current SME actions in preparing the fifth Framework Programme.* As clearly recognised by the Commission, e.g. in the Green Paper, European Community level initiatives will continue to be complemented by appropriate innovation support measures taken at national or regional level.

Training

The Irish Pilot Networks Programme has an important training component, as had the Danish Programme – the first of a number of public policy initiatives in the area of networking. It is anticipated that both the overall Irish programme and the training element will be strengthened in the next few months. Such a programme would address the problem that the formation of successful networks requires the inputs of skilled brokers who can:

- identify network opportunities;
- introduce partners;
- point out new co-operation opportunities; and
- mediate the co-operation through its critical phases.

The network broker has a crucial role to play in the successful formation and development of networks. Virtually all of the SME development agencies in Ireland, for example, currently lack the skills and expertise to act as network brokers. The results of the Danish networking programme indicated that, for each government-initiated inter-firm network established, two networks were spontaneously established within the private sector without any public sector input. This points to the need to train a range of SME service providers and SMEs themselves to undertake the role of network broker and network manager respectively. Furthermore, a number of sectors in which inter-firm networks may be established are not eligible for state assistance and therefore would not benefit from the networking broker expertise that might exist in the state sector.

For firms participating in networks, there is a need for managers to receive training to effectively and efficiently manage networks. To date a small number of informal and formal interfirm networks have been established, but there is currently a lack of training resources available for managers to learn about network management. Such a training programme could have the following components:

- introduction to interfirm co-operation;
- definition of networking;
- origins of small firm networking;
- structure of interfirm networks;
- forming a network;
- the role of the network broker;
- internationalisation of the network.

In addition to networking training, technology management courses at both the operational and academic levels have an increasing role in building firm capability for technology development activities generally and, the "information processing" capabilities of SMEs in particular.

Placements

In order to supplement technology management resources in particular, placement programmes can play a major role. These can take two main forms:

- placements in "partner firms" as part of co-operative agreements/arrangements or,
- the placing of technical graduate/experienced managers in candidate or "threshold" firms who could act as "receptors" of information and technologies.

Protecting innovation

For SMEs, protecting their intellectual property, by whatever means are most effective, is a major consideration in getting into and staying in innovation and technological co-operation. Irish firms have provided information on the effectiveness of a range of methods for protecting the competitiveness of their products and process innovations. While Chemicals, Pharmaceuticals, Electrical machinery and Software firms all make use of secrecy as a means of protecting product innovations, electrical/computer-related sectors such as Computers, Electrical machinery, Electronics, Instruments and Software rate "complexity of design", and "lead time advantages" as important. In general, the higher-technology industries employ methods of protection on a more frequent basis, except in the case of the use of lead-time, which seems to be a tactic popular with all firms. 40 per cent of Irish innovators use lead-time as a method of protecting innovation.

Sectorally, process-intensive industries such as Chemicals, Pharmaceuticals, Rubber and Plastic, Minerals, Machinery and Instruments tend to make use of all forms of protection. Foreign firms tend to avail of all of the methods of protecting innovation to a greater degree than their indigenous counterparts. It is notable that firms who protect their products and processes through patents and registration also tend to use patents as a source of information for innovation. Also, while product innovations may be protected by more innovators, process innovations are more widely protected by innovators.

If the existing international intellectual property system is to be used by small innovators, and in particular those entering the vulnerable area of international technology co-operation, adequate funding mechanisms for both protection and enforceability will have to be made available. One aspect of a National Inventions Programme could be a reduction in national patent office fees to new small-firm users. Due however, to the complexities of the patent systems it cannot generally be accessed without professional help. Assistance with the fees of patent agents and attorneys may therefore be required.

But it is the cost of international protection and enforcement that is particularly prohibitive. Given the increasing complexity of technology, the number of patents which have to be searched before patents can be granted, and the international nature of trade in technical goods, it has become exceedingly expensive to acquire patent protection in a significant number of countries. This is a particular problem for firms operating out of small countries such as Ireland where the home market is very small and foreign patents must be obtained to protect export markets. It now costs about £50 000 to obtain granted patents covering the major developed countries.

The increasing complexity of the patent system has contributed over the years to its costs. Patent actions generally take place in the higher courts, and recent experience suggests that the cost of a patent action is seldom less than £100 000. Attempts in the United Kingdom to address this problem by allowing patents to be litigated in the Patents County Court have been shown to be counterproductive. In Ireland new short-term patents can be litigated in the Circuit Court, but because this is an unexamined patent, the Court has to determine the validity of the patent before it can make any judgements with regard to infringement.

In Ireland, the short term patent system introduced in 1992 provides the rapid grant of an unexamined patent which lasts for ten years. However, what is required is a real answer in reducing litigation costs. A National Patent/Intellectual Property Insurance scheme could have this effect. If a large company, particularly in a foreign market, were to challenge an SME's patent the costs would be underwritten by the SME "defence fund". Such a scheme might be difficult for one country to introduce but could offer a course of action that the Korean Government, and at a more global level, the OECD, might explore.

BIBLIOGRAPHY

O'DOHERTY, D., GRAHAM and TROTMAN (1995), *Globalisation, Networking and Small Firm Innovation*, pp 110-127, London.

THE ROLE OF GOVERNMENT IN S&T CO-OPERATION: THE CASE OF KOREA

Jae-Ik CHOI, Ministry of Science and Technology
and
Sung Chul CHUNG, Science and Technology Policy Institute

Introduction

According to traditional economic theory, the role of government in science and technology development is not very significant. The market system provides a self-adjusting mechanism to achieve an economically rational selection of technological priorities. Government intervention is justified only in cases where market failure is anticipated as science and technology development is left entirely to market forces. Indeed, the history of economic development in the developed industrial countries has been a process of interaction between scientific and technological innovation and the market.

Economic logic alone does not suffice, because market forces cannot provide the answers to the social consequences of scientific and technological progress in such areas as safety, ethics, protecting the environment, and long-term social concerns. There is a difficult but important balance that needs to be achieved. On the one hand, when scientific and technological development is left entirely to market forces, the environment, social fabric, and other important social concerns may be neglected in the course of economic development. On the other hand, excessive government intervention based on social logic may generate bureaucratic constraints and hinder scientific and technological activities. This tells what government can do and should do as the representative of public interests in science and technology development – a balance between scientific and technological advances and their social impacts.

Yet, the above argument does not offer a rationale for the role of government in the management of science and technology in the case of a developing economy. For developing countries in the early stages of industrial development, the central question is how to acquire the technologies that are required for industrial development. Thus, a major policy concern in the short-run is to facilitate technology acquisition, and in the long-run, the policy emphasis is, in general, put on building-up scientific and technological capability. In a developing economy, therefore, the role of government is more associated with the supply side of science and technology. Governments intervene in scientific and technological activities to a greater extent than theory indicates, simply because the private sector is unable to do its part because of the lack of scientific and technological capabilities.

Korea was not an exception in this respect. Science and technology development was initiated by the government in the 1960s and since then the government has been the moving force leading scientific and technological activities. In the early stage of development, the government was responsible not only for building up the scientific and technological infrastructure, which included human resource development, institution-building, and so on, but was even responsible for setting technological priorities and selecting the technologies to be acquired. This means that the Korean government has been involved not only in strengthening and expanding the domestic technological base, but in setting direction for international co-operation in science and technology as well. Some argue that the success of Korea in technological leapfrogging has been largely due to government intervention in the form of "strategic targeting", which fuelled technological development in the targeted industries (Acharya, 1991).

The general assessment of Korea's managed policy of science and technology has been positive, as has been the economic and technological performance of Korea. But, it is also clear that the policies of the past will not enable Korea to continue its past growth performance into the future because Korea has changed and so have the technological and economic environments in which Korea operates. Therefore, Korea is now at a turning point in its development. In response to the changes in policy environment, the Korean government has been shifting its policy toward market-orientation of economic activities. Despite such policy change, the government still has a heavy hand in guiding the economy, whose growth depends largely upon the new innovations coming from public and private laboratories and universities. This paper reviews the role of government in science and technology co-operation in the process of industrial development in Korea, and discusses policy issues lying ahead.

A review of the government role

1960s (1962-1971)

It was in the early 1960s when Korea's active industrialisation efforts, together with science and technology development, were first launched. From the early stage of industrialisation, the Korean government recognised the importance of science and technology as a fundamental source of economic growth. Therefore, it would be fair to say that the period of the 1960s was the take-off stage for the growth of Korea's science and technology.

The First Five-Year Economic Development Plan (1962-1966) and the subsequent second plan actually initiated an outward-looking development strategy, targeted at building up the light consumer goods industries for import substitution and expanding the export base of industrial goods to obtain the foreign exchange required for industrialisation. Other important objectives of the plans were to build the basic industrial infrastructure, electricity and transportation, for example, and to develop key material-supplying industries that included fertilizers, cements, petroleum refineries, and chemical fibres. These projects created enormous demands for mature technologies and the skilled labour needed to operate the technologies.

At the outset, however, Korea, lacking technological capability, had to rely almost completely on foreign sources for the technologies required. Thus, the government adopted a relatively open policy toward foreign technology and capital, as expressed in the Foreign Capital Inducement Act of 1962. However, beginning with the Second Five-Year Development Plan (1966-1970), the government opted for a restrictive technology transfer policy, especially in direct foreign investment (DFI) and foreign licensing (FL), in spite of the rapid increase in demand for technologies generated by the ambitious industrial development projects. The government turned to this rather contradictory policy because of both economic and political reasons: *(i)* a deteriorating balance of payment; *(ii)* general public sentiment against foreign capital; and *(iii)* the existence of alternative channels for technology transfer, say, learning through reverse engineering based on imported capital goods. Korea relied very much upon technology transfer through turn-key plant importation. Korean firms assimilated imported technologies rapidly enough to undertake subsequent expansions and upgrading with minimum technological help from abroad.

The expansion of the industrial production base resulted in massive imports of foreign capital goods, which became a major source of learning through reverse engineering by Korean firms. In other words, government policy preferred long-term foreign loans to DFI in financing industrial development. The government allocated large-scale foreign loans to selected big firms to secure the economies of scale in those mature industries that were selected as strategic industries. This means that the government was directly involved in international technological co-operation not only as rule-setter and regulator but also as financier.

Table 1. Technology policies and the role of the government

	1960s	1970s	1980s	1990s
Industrialisation	Government-led	Government-led	Adjustment	Market-led
Technology demand	Determined by the government industrial development plans	Determined by the government industrial development plans	Adjustment	Determined by market force
Technology supply	Capital imports Turn-key plant imports OEM DFI, FL Restricted	Turn-key plant imports Capital imports OEM DFI, FL Restricted	Indigenous R&D DFI, FL	Indigenous R&D DFI, FL Global sourcing Strategic Alliances
Policy stance	Regulation	Regulation	Deregulation	Liberalisation
Government role	Regulator	Regulator	Deregulator/ Facilitator	Facilitator

Source: Author.

1970s (1972-1981)

After succeeding in developing the labour-intensive light industries for import-substitution and export expansion in the initial decade of industrialisation, the Korean government turned its eyes to the heavy machinery and chemical industries, which are more capital- and technology-intensive. Many, in those days, were of the opinion that the plan was too ambitious, and that Korea was not really prepared for such an industrial shift. There were two important factors behind this rather drastic policy shift. In the early 1970s, the world experienced a major oil crisis, and securing a stable supply of raw materials emerged as a major policy issue. This posed a serious problem for Korea because it lacks natural resources, and prompted Korea to strengthen its industrial material-supply capability by developing the chemical industries.

The other factor was the Nixon Doctrine. Based on this new policy, the United States reduced its troops in Korea in the early 1970s, which in turn increased Korea's defence burden. In response, the Korean government decided to develop its defence industry, which in those days was mostly heavy machinery-oriented. The strategic industries under this industrial development plan included industrial machinery, electronics, shipbuilding, and metals. This again generated demands for more sophisticated technologies.

To facilitate industrial development, import protection was reinforced for strategic industries, lowering the import liberalisation ratio down to 50.5 per cent in 1976 from the 61.7 per cent level of 1968. In the case of the strategic industries, i.e. industrial machinery, electronics, automobiles, shipbuilding, and metals, the import liberalisation ratio was lowered even more from 55.9 per cent to 35.4 per cent during the same period.

However, the drive to develop the heavy machineries and chemical industries created enormous demand for technologies that were in no way available from domestic sources. Thus, the government had to ease its restrictive policy measures. The government then announced the “Guideline on Direct Foreign Investment” and the “Principles on Foreign Ownership”. To a certain extent, the new guidelines streamlined the DFI approval procedure on the one hand, but at the same time tightened the regulations on the operation of DFI firms. To put this into effect, the Foreign Capital Inducement Act was revised in 1973.

Around the end of the 1970s, the foreign exchange situation improved and the demand for foreign technologies increased such that a policy change was inevitable. The government therefore initiated a series of measures to gradually liberalise DFI and technology imports. As the first step in the series, the government classified technology imports into three categories: cases subject to automatic approval; cases subject to quasi-automatic approval; and cases subject to inspection prior to approval. The classification was made on the basis of the nature and price of technology, and other contractual conditions.

Further liberalisation measures followed. In 1980, the policy was revised again allowing all cases of technology import to be granted automatic approval if the contract period does not exceed ten years and the royalty is less than 10 per cent of sales. DFI was also rapidly liberalised. Many new industries were opened up to foreign investors and the DFI approval procedure was also markedly simplified. In summary, in the 1970s, the government intervened in international technology co-operation by tightening the regulation of DFI and FL, even though in the latter part of the period, it started to loosen those regulations.

1980s (1982-1990)

The government’s excessive protection of and assistance to strategic industries resulted in imbalances and distortions in the economy toward the end of 1970s. The excessive government involvement also brought about the concentration of credit in the heavy and chemical industries and also in several large firms, which again led to a high concentration of market shares in a small number of large firms. Moreover, the massive investment in the heavy and chemical industries left many of the plants with the severe problem of over-capacity.

To overcome these problems, the Korean government re-examined its role in economic development, and undertook a series of institutional reforms to promote the role of the market and reduce government intervention. The reforms included liberalisation of trade and DFI, which contributed to the creation of a more competitive environment and to an efficient allocation of resources. The policy for strategic industry was much devaluated. Consequently, the import liberalisation ratio rose from 50.5 per cent in 1976 to 84.8 per cent in 1984.

The government substantially loosened its regulation of DFI to improve the foreign investment environment in Korea. The Foreign Capital Inducement Act was revised in this vein in 1983. In 1984, a revised “Guidelines for Direct Foreign Investment in Korea” was announced. The new law contained two important changes. One was the introduction of a negative list system. Under the old positive list system, foreign direct investment was allowed only in those industries listed in the law. In 1984, the negative list included 297 of 957 five-digit KSIC (Korea Standard Industrial Classification) industries. Another important change was the elimination of ownership restriction on DFI firms.

Along with DFI, FL was also liberalised substantially during this decade. In 1984, the approval system was changed to a notification system, under which government approval was no longer required for technology import. In 1986, the government allowed the imports of trademarks, while reducing tax deductions on royalty payments. Thus, in a technical sense, Korea completely liberalised technology imports through the series of measures taken during the 1980s.

1990s

Entering the 1990s, the Korean government's policy-orientation underwent a drastic change. While pursuing the development of high-technology and knowledge-based industries, the government liberalised trade and investment and left industrial development in private hands. To promote domestic technology development and international technology flow, the government also strengthened the protection of intellectual property rights. Along with the liberalisation of DFI and FL, the government launched new policy programmes to promote the globalisation of R&D activities of both the private and public sectors. Thus, global sourcing and international strategic alliances have become major modes of international technology co-operation for many Korean firms and R&D institutions.

Notable actions taken in the 1990s include: *(i)* elimination of the notification duty for all technology imports except nuclear technologies (1997); *(ii)* elimination of the export duties of DFI firms (1990), *(iii)* change in the DFI approval system to a notification system; and *(iv)* launching of the Programme for S&T Globalisation as a sub-programme of the National R&D Programme of the Ministry of Science and Technology.

As a result of these liberalisation measures, DFI liberalisation was raised to 95.1 per cent, which means that almost 100 per cent of Korean industries are now open to international investors, except for a few services and agricultural sectors which include politically very sensitive industries. Liberalisation also enabled private business to go abroad for external R&D, production and marketing. The Programme for S&T Globalisation promotes the international activities of R&D institutions and universities, including the operation of local R&D centres around the world.

As discussed in the preceding sections, the Korean government's role in international technology co-operation has been changing gradually over the past four decades. In the 1960s and 1970s, the government set the goals and rules for Korea's international technology co-operation and very directly managed international technology flows. Entering the 1980s, the interventionist policy measures were gradually lifted and the role of the government as a facilitator in international technology co-operation was emphasized a great deal more than that of a regulator.

New policy issues

Many in Korea see the post-Uruguay Round international order as one hinging upon interdependence and globalisation. This is well reflected in the basic framework of the economic policy of the government. Current international economic policy pursues greater market opening, and further internationalisation of Korea's economic institutions and practices. The policy intention is to meet the emerging post-UR order by inducing DFI, liberalising the financial market, opening up domestic markets, expanding global sourcing of technologies, resources, and information. Thus, the policy shift Korea has adopted conforms with the current changes in international environments – the globalisation of markets, the emergence of a new knowledge-based competitive order, competitive co-operation and economic convergence.

With R&D and innovation becoming a critical source of comparative advantage, coupled with the rising costs and complexity of R&D, research institutions of all sizes, public and private, are looking at new strategies to optimise their existing technological strengths through which to create new opportunities for wealth. Alliances and partnerships are becoming an essential way of accessing key resources, personnel, know-how, and markets, and of keeping up-to-date on current trends. Transnational collaboration in the form of alliances and joint ventures have emerged as a business and technology strategy of first choice, leading to the wide geographic dispersal of activities, not only for production as observed in the past but for R&D, design, sourcing inputs, marketing, etc.

That globalisation is a process of positive sum benefits is now widely accepted. However, it is also important to recognise that globalisation challenges many areas of policy. A nation can no longer have its own policy that is independent of others' because globalisation is an international phenomenon. National strategies should, therefore, be built on co-operation and an agreed paradigm for the exercise of national power within an international context. Globalisation raises a variety of issues that require new perspectives and disciplines if we are to attain the benefits involved and minimise the associated problems. One of the issues is the possible divergence between global strategies of firms and national interests.

The most important implication here is that for Korea to promote globalisation, the government has to reorient its roles and reduce the disparities that exist between the domestic policy system and the international rules of the game. According to a recent report by the Institute of Management Development based in Switzerland (IMD, 1997), Korea is perceived as the least internationalised economy in terms of policy orientation. The report says that Korea is the most inward-oriented in trade, industry, direct foreign investment and other related policies.

Conclusions

In the face of a changing environment, it seems that Korea does not have many policy options. To survive the ever intensifying competition in the global market, Korea's products have to be better but cheaper, which only the best in technology can achieve. But, considering the complex and global nature of modern technology, one cannot be the best without joining forces with others. Further, in order to be an active partner in the global network of co-operation, we should be able to complement our partners scientifically and technologically, abiding by the rules of the game as set by the international community. This implies, in other words, that only those who are the best in their specialty areas of science and technology, and who are actively involved in the global network of co-operation as responsible members of the international community can remain competitive in the global market. And, this is what Korea has to achieve through the globalisation of its economy, science and technology, institutions, practices, and so on.

Then, what does the government have to do to achieve these objectives? Globalisation of science and technology can be accomplished only when it is pursued in an internationally accepted rational manner on the basis of internal scientific and technological capability, and by employing a system that facilitates competition in R&D among individual scientists as well as among research organisations.

More specifically, Korea has to have comparative advantage over others in certain areas of technology on the basis of which it can compete and co-operate with other countries. For that, the government needs to reinforce the implementation of the national R&D programmes for the development of the emerging technologies that will lead to industrial development in the coming century. Another area of policy priority is public welfare and social infrastructure, which constitute the foundation for sustainable development of the Korean economy.

Second, the government has to focus its policy on building a foundation for educating creative scientists and engineers who will lead scientific advancement and industrial development in the era of global competition. In this sense, the most pressing policy agenda is to upgrade the quality of university education and research. For this, the government recently launched the “Creative Research Initiation”, a new programme to promote basic scientific research.

Third, Korea should be an active partner in international co-operation in science and technology under the principles of reciprocity and mutual benefit. Considering the complex nature of modern technologies and the enormous cost requirements of R&D, no single nation is capable of attaining supremacy in each and every technology. Therefore, we believe a multilateral or bilateral co-operative scheme is required through which nations can complement each other technologically. Through such an arrangement, Korea will be able to harvest its share of the benefits that international co-operative efforts in science and technology will bring about. To facilitate active international co-operation in science and technology, the Korean government has to revise its domestic laws and practices so that they are internationally accepted.

At the same time, it is very important for Korea to pay more policy attention to creating a global network of R&D labs to conduct research abroad in co-operation with local scientists, and using local facilities and resources. For this, the government needs to encourage domestic R&D institutes, government as well as private, to go abroad to seek external R&D resources, and establish labs at the sites of major technological activities around the world through which to interact and co-operate with local R&D organisations. Together with this, it is important to create a domestic environment that can attract foreign research organisations. This is very important to Korea because Korean research organisations’ exposure to international competition and the presence of foreign research organisations in Korea will help create a climate that is conducive to competitive R&D at home.

Fourth, Korea, being a latecomer in science and technology, has been a recipient rather than a donor in international co-operation over the past several decades. In return for the benefits that it has received from the world science community, Korea needs to contribute to international, joint research programmes, addressing the issues of global concern. For the balanced development of the world, Korea needs to play the role of a catalyst in linking the developed and developing countries in the field of science and technology. Through these efforts, Korea should contribute to the advancement of science and technology.

BIBLIOGRAPHY

ACHARYA, R. (1991), *Science and Technology for Development: Industrializing Countries and New Technologies*, MERIT 91-023, Limburg University, the Netherlands.

IMD (1997), *The World Competitiveness Report*, Lausanne.