April/2000

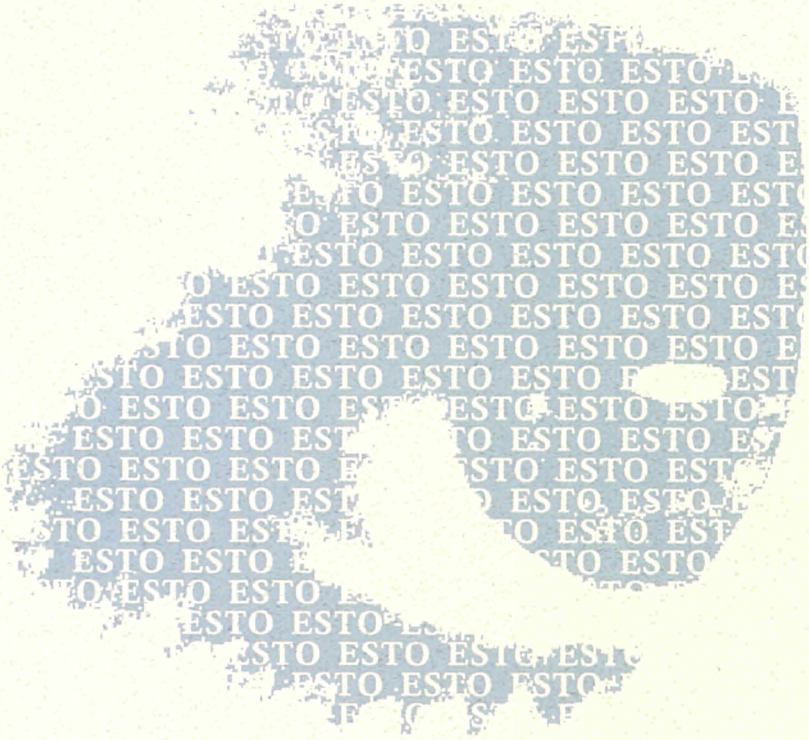
43

ISSN: 1025-9384

5 EURO
ΕΥΡΩ

The IPTS REPORT

EDITED BY THE INSTITUTE FOR PROSPECTIVE TECHNOLOGICAL STUDIES (IPTS)
AND ISSUED IN COOPERATION WITH THE EUROPEAN S&T OBSERVATORY NETWORK



2 **The Seattle World Trade Organization (WTO) impasse**
Dimitris Kyriakou

5 **Managing Uncertainty and Public Trust in Technology Policy**
Oliver Todt

12 **Technology Foresights Need to Look Backwards**
Lars Olsson

18 **Economic Impacts of the Euro-Mediterranean Association Agreements**
Sergio Gomez y Paloma and Mario Zappacosta

26 **Patenting as a Protection Tool: A Reassessment**
Nikolaus Thumm

32 **Participation of European Union Companies in US Research Joint Ventures**
Albert N. Link and Nicholas S. Vonortas

EUROPEAN COMMISSION
Joint Research Centre

ENGLISH VERSION

ABOUT THE IPTS REPORT

The IPTS Report is produced on a monthly basis - ten issues a year to be precise, since there are no issues in January and August - by the Institute for Prospective Technological Studies (IPTS) of the Joint Research Centre (JRC) of the European Commission. The IPTS formally collaborates in the production of the IPTS Report with a group of prestigious European institutions, forming with IPTS the European Science and Technology Observatory (ESTO). It also benefits from contributions from other colleagues in the JRC.

The Report is produced simultaneously in four languages (English, French, German and Spanish) by the IPTS. The fact that it is not only available in several languages, but also largely prepared and produced on the Internet's World Wide Web, makes it quite an uncommon undertaking.

The Report publishes articles in numerous areas, maintaining a rough balance between them, and exploiting interdisciplinarity as far as possible. Articles are deemed prospectively relevant if they attempt to explore issues not yet on the policymaker's agenda (but projected to be there sooner or later), or underappreciated aspects of issues already on the policymaker's agenda. The multi-stage drafting and redrafting process, based on a series of interactive consultations with outside experts guarantees quality control.

The first, and possibly most significant indicator, of success is that the Report is being read. The issue 00 (December 1995) had a print run of 2000 copies, in what seemed an optimistic projection at the time. Since then, readership of the paper and electronic versions has far exceeded the 10,000 mark. Feedback, requests for subscriptions, as well as contributions, have come from policymaking (but also academic and private sector) circles not only from various parts of Europe but also from the US, Japan, Australia, Latin America, N. Africa, etc.

We shall continue to endeavour to find the best way of fulfilling the expectations of our quite diverse readership, avoiding oversimplification, as well as encyclopaedic reviews and the inaccessibility of academic journals. The key is to remind ourselves, as well as the readers, that we cannot be all things to all people, that it is important to carve our niche and continue optimally exploring and exploiting it, hoping to illuminate topics under a new, revealing light for the benefit of the readers, in order to prepare them for managing the challenges ahead.

THE IPTS REPORT

43

APRIL 2000

EDITED BY THE INSTITUTE FOR PROSPECTIVE TECHNOLOGICAL STUDIES (IPTS)
And issued in Cooperation with
the European S&T Observatory Network

PUBLISHED BY THE EUROPEAN COMMISSION
Joint Research Centre
ISSN: 1025-9384
Catalogue Number GK-AA-00-003-EN-C
DEPOT LEGAL: SE-1937-95

DIRECTOR
Jean-Marie Cadiou

EXECUTIVE EDITOR
Dimitris Kyriakou

EDITORIAL BOARD
G. Fahrenkrog, P. Fleissner, J. Gavigan, M. González, H. Hernández, D. Kyriakou, I. Maghiros (Production Manager), P. Sørup, A. Soria, C. Tahir.

PRODUCTION
CINDOC-CSIC/L&H Spain

PRINT
Graesal

TRANSLATION
CINDOC-CSIC/L&H Spain

THE IPTS REPORT
is published in the first week of every month, except for the months of January and August. It is edited in English and is currently available at a price of 50 EURO per year, in four languages: English, French, German and Spanish.

SUBSCRIPTIONS
For a subscription to The IPTS Report, or to amend an existing subscription, please write with full details to:
The IPTS Report Secretariat
IPTS, JRC Sevilla
World Trade Center
Isla de la Cartuja
E-41092 Sevilla, Spain
Tel: +34-95-448 82 97
Fax: +34-95-448 82 93
E-mail: ipts_secr@jrc.es
Web address: www.jrc.es/iptsreport/subscribe.html

CONTENTS

2 **Editorial. The Seattle World Trade Organization (WTO) impasse**

Methods and Foresight

5 **Managing Uncertainty and Public Trust in Technology Policy**

The social conflicts surrounding certain technologies have highlighted the need for new strategies for making technology-related decisions. Some recent developments have shown interesting, if ambiguous, results.

12 **Technology Foresights Need to Look Backwards**

Many countries in Europe and elsewhere now carry out foresight exercises. However, while predicting the future is fraught with dangers, a look at failures of forecasting in the past may suggest were common pitfalls lie

Regional Development

18 **Economic Impacts of the Euro-Mediterranean Association Agreements**

Over the next ten years the Euro-Mediterranean region is set to evolve into a free trade area. While this will bring overall benefits to all the countries involved, structural reforms and technology changes are needed to smooth the transition.

Innovation and Technology Policy

26 **Patenting as a Protection Tool: A Reassessment**

Patents are often held to be an important incentive for research and development. However, they are increasingly being used in ways that differ sharply from the original intention of protecting inventions and encouraging innovation

32 **Participation of European Union Companies in US Research Joint Ventures**

European companies frequently participate in US research joint ventures (RJVs). An examination of their characteristics gives useful information that may help the European Commission support its own RJVs.

EDITORIAL

The Seattle World Trade Organization (WTO) impasse

Dimitris Kyriakou, *IPTS*

The abortive Seattle WTO meetings signalled a failure of a kind unseen in previous trade negotiations. In past rounds impasses reached usually involved technical/legal issues, which specialists could (and did) revisit, in order to sculpt a carefully worded, consensus-seeking text.

Such impasses did not question the fundamental continuity of the process. In Seattle however, there were serious political divisions, with the less developed countries (LDCs) appearing uncharacteristically united.

There was denunciation of the procedures, and not just the texts. There was little scientific and technical (S/T) preparation, both overall as well as on specific issues, (e.g. foodstuffs), to help clarify the terms of the debate, the stakes, the repercussions of alterna-tives considered. Science and governance did not meet to allow policy choices to ground their legitimacy on an S/T-informed process, to be more than the arbitrary selection resulting from power struggles, untamed by facts and cool-headed analysis. Reduced legitimacy facilitated attacks on the organization itself, and even public outcry on the streets by groups which descended on the city, stinging the WTO like a swarm of bees.

The impasse was far from an unexpected turn of events. Unlike previous trade rounds the preparatory work for this one found little common ground. People close to the process warned that the complexity of the agenda boded ill for its outcome. The failure of the multilateral negotiations on investment in 1998 was a portentous omen. The Group77 of 130 LDCs had stated back in September 1999 that they would not acquiesce to new liberalization drives, before the implementation issues still pending from the Uruguay round (UR) were addressed – what they dubbed the need to review, repair and reform the WTO. This ran contrary to the desires of the large players. The LDCs saw themselves as having abided by the WTO dispute-settlement mechanism, and its unprecedented power, during a very painful period for them, due to the Asian crisis and its aftermath. They were thus loath to accept what they perceived as a cavalier attitude on the part of both the US and the EU, vis-à-vis complying with WTO rules (cf. tax-shelters for export profits in the US, bananas an beef cases for the EU). The insistence of the US to include issues such as labour standards (the EU proposed more tactfully a joint WTO-International Labour

Organization (ILO) study) on the agenda, further cemented the LDC front. The public reference by the US President to using trade sanctions against those who flout labour standards confirmed LDC fears.

The awkward way in which the US Trade Representative amassed the roles/titles of host, chairman, and leader of the US delegation did not help either. The coup de grace was given by the continued use of the 'green-room' process. This entailed bringing the large players in small meetings to carve out deals/texts on specific issues, groups in which certain LDC delegates, chosen *ad hoc*, were invited while the rest were left wandering around the corridors. Besides infuriating LDC delegates such methods highlighted another cause of failure: inadequacy of procedures for a 135 member WTO. Given the power wielded by the WTO, all members understandably want to vet decisions /documents which may strongly impinge on their welfare/sovereignty.

The fierce battle for the election of the WTO Director-General last September, not only left a sour taste among LDCs, it also allowed the new WTO management little time for preparation. Moreover, the compromise reached in September included appointing the LDC favourite to run the WTO in 2002, perhaps making foot-dragging less costly for the LDCs.

Beyond LDC reactions and procedural tensions, the EU-US differences played a key role, too. The US claims to favour elimination of agricultural subsidies; the EU favours gradual subsidy reduction, and the consideration of the environmental, cultural and social aspects of agriculture. The dispute on trade of genetically modified products reared its head again. US proposals for a WTO panel to study the issue were ultimately not accepted when EU environment ministers reacted tersely to anything that may antagonize the discussions on biosafety, under the auspices of the UN. On another bilateral front the Japanese objection to the use of anti-dumping measures arbitrarily and frivolously, according to Japan, by the US, also exacer-bated tensions.

US actions motivated by domestic considerations were crucial to the outcome. The insistence on having an early 'Clinton' round involved political legacy considerations. The comments/positions that alienated LDCs and the reluctance to discuss sensitive issues such as textiles, catered to influential US interest groups, labour unions, environmentalists, farmers, in an election year.

The role of organized political protest, of an intensity unseen in the US for a generation, the successful swarming of the WTO by non-governmental organizations (NGOs) and the technical/legal assistance they offered to often beleaguered LDC delegates should not be neglected. The successful use of technology for coordination, the emergence of impromptu coalitions among unlikely bedfellows such as environmentalists and labour unions, raised the political cost of pursuing the meeting. Protest was catching the attention of too many bystanders. When these bystanders, in a US election year moreover, start weighing the lofty righteous messages of the protestors against supporting an arcane international bureaucracy, and at the cost of ugly street violence, the WTO and the talks may not seem very attractive after all.

This reduced attractiveness reveals a deeper problem: past rounds were easier because targets were numerical and hardly something against which to rally wide support. Reducing tariffs from 20 to 10% does not touch on what a country stands for; labour standards, food safety, environmental treatment come much closer to the hard core of sovereignty, the values by which a society lives. Past rounds (especially the previous one) conveniently postponed thorny issues for future rounds. As we reach the hard core of resistance to making everything secondary to trade expansion, the cost of going that extra liberalization mile rises very steeply.

Managing Uncertainty and Public Trust in Technology Policy

Oliver Todt, *University of Valencia*

Issue: Changes in technology policy-making or regulation have so far had only limited success in bridging the different points of view between social actors. In fact, the social resistance and increasing public debate with respect to certain technologies has made their introduction into the market or their industrial application rather difficult.

Relevance: Recent developments in strategies like the broadening of stakeholder access to decision-making or precautionary regulation have shown some interesting, albeit ambiguous results. Further analysis of these policy approaches is needed since they could have the potential to overcome one of the most fundamental problems of current technology debates, i.e. the lack of trust among social actors. Moreover, EU technology institutions could play a key role in building trust-enhancing networks.

Introduction: Technology and Society

Technology is a social activity, as research in the area of the social studies of science and technology (STS) has pointed out. Any technical system can be described more accurately as a socio-technical system, not only because technology design and development is based on human decisions, but also because human actors form an integral part of any technical system and its operation. This point of view, which interprets technology as social practice, integrated with other societal activity and subject to (mutual) influence, has important consequences for the approach to technology management. In fact, in response, the policy process has been starting to change in the last two decades.

Fundamental to the social conflicts in relation to modern technology is the debate concerning the uncertainty of its possible future effects. Many traditional approaches to technology policy base decision-making on specialized expertise alone and tend to interpret uncertainty as manageable through expert knowledge. However, these policy approaches have come into conflict with the views and values of other social groups in recent decades. An important by-product of this conflict has been a certain erosion of public trust in the policy-making process, as demonstrated by a number of recent cases at both the European and international levels.

Technology is a social activity, not only because technology design and development is based on human decisions, but also because human actors form an integral part of any technical system and its operation

Traditional approaches to technology policy based on specialized expertise tend to consider uncertainty to be manageable. This has recently come into conflict with the view held by other social groups

The Social Debate: Uncertainty and Trust

A crucial element of most technology-related conflicts has been the question of up to what point the possible effects (environmental, health, social, etc.) of a new technology can be reliably predicted. Two concepts (Wynne 1992) can be distinguished here: uncertainty, the lack of knowledge about the

Public trust has become one of the key issues facing modern technology. The conflict over uncertainty has been one of the sources of erosion of that trust

Public trust in certain technologies may be influenced more by confidence in the decision-making process than in the technologies themselves

future behaviour of new technical systems (for instance, of the failure rates of components); and indeterminacy, the impossibility of predicting the behaviour of socio-technical systems because of the impossibility of predicting human behaviour (of all the human actors who form part of any such system). In a number of technology-related debates, the questions of uncertainty and indeterminacy have played an important role, for instance regarding failure probabilities of complex systems such as nuclear power plants, or regarding the behaviour of genetically modified organisms (GMOs) in the environment. Some social actors, critical of certain technological applications, have built their case around the argument that uncertainty and indeterminacy make it necessary to proceed with precaution when authorizing and commercializing these technologies. They have criticized policy and regulation for not sufficiently reflecting these future uncertainties in decision-making. And they have demanded more transparent procedures for risk assessment.

Public trust in technology, and in the related decision making processes, has turned out to be one of the key issues facing modern technology. Not only has the development of various technologies been influenced in recent decades by the level of trust they commanded in civil society and in the wider public; the question of trust has become an decisive issue, for instance, in the Europe-wide conflicts concerning genetic engineering or food safety. Among others, the issues of the insufficiency of common European regulation, institutions and policy responses as well as questions concerning public openness of the decision processes were factors which led to a degradation of public trust.

One of the sources of the erosion of public trust in certain technologies and their regulation, a process which has been going on for several decades now, is the conflict over uncertainty. And even more important here has been the conflict about the involvement of the different social actors in decision-making. Recent research suggests that the erosion of trust cannot be explained by simple public ignorance about the scientific and technical questions at hand. Rather, gains or losses of trust are the result of very complex social processes, in which the perceived level of control over the decisions is one important factor (e.g. Grove-White *et al.* 1997). This becomes especially important in the light of the evidence that the level of confidence in the technology itself may actually not be the most important issue, but rather the level of confidence in the decision-making processes (for policy, regulation, etc.). In some cases it can be inferred from the data that the lack of trust in the process is negatively affecting the level of trust in the technology itself.

Technology Management Responses

An effective policy process must therefore respond to these two questions: it must manage uncertainty while building trust among all stakeholders in the technology itself, as well as in the related decision-making processes. Current policy-making is not always effective in this regard. The debate about genetically modified (GM) products, for instance, shows that the social acceptance of this technology is intimately related to the question of trust in the policy processes and regulatory institutions at both European and national levels (EC, 1997; Grove-White *et al.* 1997).

Several strategies have been developed to try to integrate the management of uncertainty and trust in technology policy. Among these (like organized social debate, continuous social technology assessment or user-oriented technology design), the most important ones from a public policy point of view at the EU level are precautionary (ex-ante) regulation and participatory decision-making in policy and foresight.

The theoretical justification of these two strategies responds clearly to the problems of uncertainty and trust raised above. According to the precautionary regulation concept, in order to manage the uncertainties and indeterminacy with regard to the future behaviour of socio-technical systems, regulation should proceed based on the precautionary principle. That is, in the case of serious doubts, certain actions should be subjected to especially rigorous controls, or should not be undertaken at all (O'Riordan and Cameron 1994). Public participation, on the other hand, derives one of its most important justifications from its potential for trust building among social actors by permitting them to have a voice in decisions. Both precaution and participation aim at channelling conflict over technology into productive dialogue among stakeholders. These approaches clearly do not pretend to eliminate this conflict, which has been described as one of the driving forces of innovation (see, for instance: Hård, 1993).

Precaution and Participation in European Public Policy Practice

In practice, both strategies have seen some (albeit limited) application in recent years in European (and international) policy. Participatory decision making has been applied to policy-making and regulation for a number of years now, especially in environmental decision-making, on a local level, and in relation to specific technical projects (especially in infrastructure planning). Precautionary approaches have found some application in environmental regulation in the last decades, but their application to technology policy and regulation is more recent.

The influence of both strategies on technology management and policy has remained ambiguous, even though they have shown some encouraging results in specific areas. The most relevant European (and international) case in recent years to analyse the implications of these strategies is the social debate which has developed in relation TO genetically modified foods.

The centrepiece of the European regulatory basis of genetically modified organisms (GMOs) (Directive 90/220, see: EC, 1990) implicitly embodies precautionary and participatory elements. The Directive 90/220 prescribes a complex authorization procedure for GM products as well as for pre-marketing experiments, and went into effect well before any such product was ready for marketing. Thus, in many ways, the Directive incorporates precaution. It also opens up possibilities for direct participation of representatives of civil society in the regulatory bodies. Despite these provisions, this regulatory framework did not discourage the social conflict and social resistance from developing which during 1999 led to a de-facto moratorium on GM products in the EU. In this sense, neither the indirect precautionary provisions nor the possibilities for participation have had the desired overall effect of building public trust. However, the provision for participation has only been put into practice in very few member states, and even there only to a very limited degree. And while the Directive's approach is precautionary in regulating GM technology comprehensively, and already during the development phase, it does not explicitly define precaution nor state its specific application in regulatory practice. It is therefore unclear if a more explicit precautionary formulation of the regulation and more widespread direct participation in regulation could have built more confidence among stakeholders, minimizing the social conflict.

However, on a smaller scale, the implicit participation-precaution approach of the Directive has helped to bring about changes in

Precautionary (ex-ante) regulation and participatory decision-making in policy and foresight represent two public-policy approaches to managing uncertainty

Whereas the precautionary approach seeks to regulate strictly where there is any doubt about impacts, public participation builds trust by giving social actors a say in decisions

In the case of GMOs, neither the indirect precautionary provisions nor the possibilities for participation have had the desired overall effect of building public trust

Overall, the precautionary and participatory elements in GMO regulation have not hindered the development of this technology

If conflicts are to be avoided, global markets need common regulatory frameworks. Moves in this direction run in parallel with the emergence of a global civil society focussing on the social and environmental effects of modern technology

the regulatory process which can be interpreted as a first step towards trust building through social learning. Despite the limited putting into practice of public participation (and information), this still helped to create direct contacts and some constructive interchange between regulators, policy-makers and civil society, in some cases even before the beginning of the marketing of the technology's products. Regulators and policy-makers have developed more understanding for public concerns, which is reflected in their decision-making (Todt, O. and Luján, J.L., 2000). Furthermore, GM regulation and policy have been relatively dynamic, able to adapt to the changing social demands and technical background. In at least one case the regulation has even changed some of its basic philosophy by enhancing its precautionary approach in response to the social debate. The case in point is the transformation of a debate on the possible long-term effects of the cultivation of GM maize into a policy decision to introduce post-marketing monitoring for this crop in the field. This decision allayed some stakeholder concerns about future uncertainties, while at the same time permitting the marketing authorization for the crop.

Overall, the precautionary and participatory elements in GMO regulation have not hindered the development of this technology. All applications (with very few exceptions) for GMO field trials and marketing of products have been granted in all member states to date (with the important exception, of course, of the current de-facto moratorium agreed to by a majority of member states). But, on the other hand, these precautionary-participatory elements have led to a certain degree of social learning, increased sensitivity and responsiveness of the policy-makers and regulators to public concerns, and more intensive formal contacts between the different social actors.

Trans-European and International Dimensions

A common EU technology policy which includes precaution and participation could go a long way towards minimizing intra-European conflicts, like the ones on food safety mentioned above, and strengthen the single market. But it could also be a decisive policy in international trade policy. Global markets need common regulatory frameworks. If not, trade conflicts are likely to erupt, like the ones between the U.S. and the EU on GMOs or hormone-treated beef. They are born out of, among other things, different approaches to precaution or policy regarding cultural factors and civil society. A good example is the international effort to agree on an international biosafety protocol, which would regulate GMO trade. Failure to reach agreement has aggravated the conflict on genetic engineering which is leading to a backlash against biotechnology agriculture with high costs for industry. On the other hand, a global civil society is emerging which is focused on the social and environmental effects of modern technology in global markets. Common policy and regulatory responses, which take full account of this situation, could minimize conflicts.

Implications for European Policy-Making

The experience from the first applications of policy strategies focused on participation and precaution suggests, despite some ambiguous results, that they might have a real potential for minimizing the lack of public trust in the policy process while responding to the challenges posed by the social debate about the future uncertainties of technology.

The underlying philosophy of such a policy approach would be attaining long term social backing for new technologies through trust-

building by way of social sensibility, precaution, etc., even at the costs of a higher complexity of the process of technology development and management. Civil society would in practice serve as a constant informational link between policy and wider society (equal to other social actors like industry representatives, trade unions, etc.). In practice, policy-makers and NGOs would enter into a permanent formal dialogue through advisory bodies (which include all relevant social actors) in all fields related to technology management, regulation, policy, and forecasting. The ultimate decision-making authority would of course have to remain in the hands of bodies with democratic legitimacy, even though a more direct participation of stakeholders in the preparation of decisions could be achieved.

This policy would have to take account of a number of key points:

- Especially important would be to ensure debate among all the involved social actors, not only about the technology itself but especially about the processes used to promote, manage and regulate this technology. A set-up of the regulatory procedures and institutions supported by all stakeholders from the outset is crucial to allow for a successful social integration of the technology, once it has entered the market. Trust of stakeholders in the outcomes (decisions, technology) needs trust in the process. This also points to the need that any such policy process would have to be continuous over the entire life cycle of the technology.

- The process must remain open to constant revision. The legislation as well as any procedures must be inherently flexible to be able to respond not only to the social environment but also to new scientific evidence. This dynamic aspect is extremely important because not only the technology itself evolves. As pointed out by Grunwald (1999), the entire social framework is constantly changing. Only a constant feedback with civil society as well as wider society on R&D financing, regulation, market authorization, etc. can maintain long-term social backing. Experiences like the ones with GMO and BSE demonstrate that otherwise the feedback might take the form of open conflict and resistance, entailing high costs to the development of the technology and its markets.

- The feedback between technology development, policy-making and society is especially important in the early phases of the R&D process. Many aspects of the technology and its effects, as well as the position of social actors, only become clear as the R&D process and the social debate proceed. It is crucial to minimize the risk of hardening of opposing positions of the different social actors, in parallel to the locking-in of conflictive technology options (which is what happened in the GMO case). For the same reasons, precaution has to go into effect concurrently with (or even better before) the corresponding technology is being applied. This could be achieved by starting social participation as well as the design of the regulatory framework early on in the process, e.g. already during the decision making on financing of R&D programmes. That way, the development of a technology could be accompanied from the start by a regulatory and social framework in order to build trust, while directing technology towards socially acceptable goals.

- Related to this point is the need for technology forecasting and assessment to respond to the objectives and values of all sectors in society. This could be achieved through more social participation. One of the aims would be to

generate comprehensive proposals for regulatory frameworks for new technologies even before they enter the development and market phase (similar to the GMO Directives).

- There also is the need for a more standardized, transparent and systematic risk assessment strategy with respect to new technology. A risk assessment which includes all aspects relevant to the social debate, and which gains EU-wide stakeholder support (to avoid conflicting assessment results in different member states). Again, a higher level of social participation would be one way of achieving this.

- Also very important is the unification of criteria on the European level. In this sense, the recent adoption by the European Commission of operational criteria for the precautionary principle (EC, 2000), for instance, is an important step forward.

- Technology policy would need to be more sensitive to local and specific cultural issues which are important for a technology's social integration. European-level institutions could play a central role and respond very specifically to the needs and concerns of European citizens. The creation of the Institute for Health and Consumer Protection (IHCP) of the Joint Research Centre (JRC) of the European Commission, for instance, is an important step in that direction.

Overall, an important element in EU strategies seeking to build trust are precisely EU and technology institutions, such as the Joint Research Centre, which can play a central role in networks of institutions providing 'reference' quality information for such debates, eventually resolved at the policy level. Such networks animated by the JRC can help overcome the facile accusation of specific national or private interests and build a European system of reference information provision in a way that is open, credible, accountable and thorough. This will facilitate the debate between actors at the policy level and will provide a counterpart for interaction with non-EU agencies (as mentioned above, trade conflicts tend to erupt when regulatory frameworks diverge).

Integration of Technology Promotion and Regulation

Moreover, one could explore integrating the processes for promoting and regulating technology, overcoming the current split of these two activities, which is a major source of social conflict. Technology policy would then be understood as decision making in a rather seamless web of forecasting, financing of R&D and promotion of certain technology trajectories, regulatory frameworks, social integration, etc., which proceeds from the original research phase along the entire life cycle all the way to the dismantling phase. This could be achieved by stronger integrating different administrative responsibilities for the design of technology programmes (like the European Framework Programmes). The design of this integrated policy would not only include sections of the European administration responsible for consumers, health, or environment; it would also give civil society an important voice in the decision-making. Administratively, this might, for instance, be accomplished by the creation of a separate administrative entity, charged with managing technology through its research, development and market phases.

Such an integration of promotion and regulation of a new technology into one unified process would help to minimize the potential for conflict, while making possible a mutual social construction of technology, related policy, and acceptance through social learning.

Keywords

technology policy, regulation, technology assessment, novel foods, participatory decision making, uncertainty

References

- EC - European Commission *Council Directive 90/220/EEC on the Deliberate Release into the Environment of Genetically Modified Organisms*, Official Journal of the European Communities, L117, 8/5/1990.
- EC - European Commission *Eurobarometer 46.1: The Europeans and modern biotechnology*, Luxembourg, 1997.
- EC - European Commission *Communication from the Commission on the Precautionary Principle*, 2/2/2000.
- Grove-White, R. *et al. Uncertain World. Genetically Modified Organisms, Food and Public Attitudes in Britain*, Lancaster: Centre for the Study of Environmental Change, Lancaster University, 1997.
- Grunwald, A., *Technology Policy: From Acceptance to Acceptability*, The IPTS Report 34, 1999, p. 23-29.
- Hård, M., *Beyond Harmony and Consensus: A Social Conflict Approach to Technology*, Science, Technology and Human Values, Vol. 18, No. 4, 1993, p. 408-432.
- O'Riordan, T., and Cameron, J., (eds.) *Interpreting the Precautionary Principle*, London, 1994.
- Wynne, B., *Uncertainty and Environmental Learning*, Global Environmental Change, June 1992, p. 111-127.
- Todt, O., and Luján, J.L., *Commercialisation drives public debate and precaution*, Journal of Risk Research, February 2000 (in print).

Contacts

Oliver Todt, University of Valencia, Department of Philosophy of Science/ Institute for the Research on Science and Technology (INVESCIT)

Tel.: +34 96 386 4437/4433, fax: +34 96 386 4809, e-mail: **todt@uv.es**

Hector Hernández, IPTS

Tel.: +34 95 448 82 92, fax: +34 95 448 83 26, e-mail: **hector.hernandez@jrc.es**

About the author

Oliver Todt holds a systems engineering degree. He is currently working as a researcher at the University of Valencia (Spain) on the regulation of genetic engineering and the influence of public debate on the development of that technology. His other research interests include public control of decision-making in technology development, and technology assessment.

Technology Foresights Need to Look Backwards

Lars Olsson, *NUTEK*

Issue: During the 1990s many countries, in Europe and elsewhere, have carried out technology foresight projects. Unlike earlier studies of the future, which often concentrated on prediction, modern foresights usually strive to consider alternative visions of the future or just to create preparedness. However, the task of dealing with the future is a hazardous one. Historical research into failures of forecasting in the past may offer guidance on pitfalls.

Relevance: When using the results of technology foresight projects for drawing up policy it is essential for the policy-makers to be able to assess the results. Here a historical perspective may be of great help in questioning ingrained lines of thought and broadening the outlook. Often the same errors tend to recur in forecasts from different times. Furthermore, it is essential to consider what different groups have been involved in foresight work.

Foresight has acquired increasing importance in the formulation of science and technology policy. But to assess its results it may be helpful to look at the errors of the past

Introduction

With the many technology foresight projects carried out in the 1990s European policy-makers have gained improved means to assist in the formulation of science and technology policies. However, to be able to assess and use the results of foresight exercises it may be helpful to learn from errors in past future studies. This article looks at some of the difficulties in forecasting identified by historians (of course there are many more; see Olsson, 1999). It will also discuss what groups have been involved in forecasting and what incentives and interests they may have had.

Excessively sweeping changes have been expected

The historian of technology Joseph Corn has identified several common mistakes in connection with prediction (Corn, 1986). One such mistake has been to form a picture of excessively far-reaching changes, with an expectation that a new technology will entirely replace an existing one in a particular field. The view taken of atomic power in the 1940s and 1950s is a case in point. The American press, in particular, described enthusiastically how this apparently inexhaustible source of free energy would completely replace traditional sources (Del Sesto, 1986). The days of producing electricity in large hydroelectric power stations were past -

instead there would be small, compact atomic power plants for use both at work and at home. The fact that the technology could be created on a small scale would also enable it to be used as a source of power for vehicles, ships and aircraft. The predictions included atomic cars, which would never need to stop for petrol because a small tablet of atomic fuel would last for years.

Corn also points out that in predictions of total change it has often been assumed that these processes will take place quite quickly. In reality it has taken a long time for a new technology to be sufficiently developed to become widely diffused. Another factor which may delay the triumphal march of a new technology is that earlier technology may improve considerably when exposed to competition. One example of this is the improvement in the efficiency of sailing ships during the second half of the nineteenth century in response to the challenge of the new steamships (Rosenberg, 1976).

Solve old problems

Another common mistake, according to Corn, is to believe that a new technology will be applied only to old problems, an error which has often been made when forecasters extrapolate the historical course of events into the future. This approach, unlike the previous one, tends to result in the new technology being credited with far too little potential for producing change. The problem here is that these forecasters do not realize that a particular technology may, in the different social context of the future, fulfil quite different functions. A historical example of this is radio, which was seen initially as a wireless telegraph for point-to-point communication in situations where there was no access to a cable, for example between a ship and stations on shore. The new technology was to function as a complement to existing telegraphy systems. What could not be anticipated was that within a couple of decades this wireless telegraph would have found its most important area of application - as a one-way communication channel for entertainment, advertising and news distribution (Douglas, 1987).

Another, more topical, example is the computer. Computers were originally developed for advanced mathematical calculation. The designers of the first computers in the 1930s and 1940s saw them as scientific instruments - useful primarily for research or for military purposes. The fact that the technology might find a broader area of application - for example in word processing and games - could not be anticipated. In those circumstances pronouncements such as that it would be possible to meet the USA's entire future need for calculating capacity with four or five computers become quite understandable (Ceruzzi, 1986).

Several technologies can be combined

The economic historian Nathan Rosenberg has also noted the difficulty of envisaging the future of a technology. One important problem in his opinion is that development in one area of technology is often dependent on development in other areas. He cites the example of laser technology (Rosenberg, 1994). When this first saw the light of day in the 1960s its potential usefulness was far from clear. As fibre optics developed, however, an important area of application emerged, namely in telecommunications. The impetus behind current development in both these areas comes from the realization of the possibility of combining the two. Such connections, often unexpected, between two different technologies are naturally very hard to predict.

Locked into the spirit of the time

Another researcher who has studied visions of the future is the economist Steven Schnaars. He

One common mistake is to form a picture of excessively far-reaching changes, in the expectation that a new technology will entirely replace an existing one in a particular field

Predictions often underestimate the time a new technology will take to get established. One reason is that, faced with competition, the existing technology may improve to meet the challenge

On the other hand, the potential of a technology may be underestimated by assuming that it will only be used to tackle existing problems

points out that predictions are often set in the framework of a particular time and that studies of the future dating from the same period tend to focus on the same things. This is because the people who have devoted themselves to forecasting have been permeated by the prevailing spirit of the age (*Zeitgeist*). As a result, the visions of the future say more about the time when they arose than about the future as such (Schnaars, 1989).

Every period has its ethos, which Schnaars sees as "marked by a predominant feature that characterizes the intellectual, political and social trends of that era." Examples of themes which predominate in the predictions from different periods in time are atomic power in the 1950s, the space race in the 1960s and energy questions in the 1970s.

The case of lasers and fibre optics shows how technologies can be combined in unpredictable ways with far-reaching effects

The big problem when studies of the future are coloured by the spirit of the age is that the people who have drawn a picture of the future often believe that the important questions of today will also be those of tomorrow, which usually turns out not to be the case.

Predictions about the future often say more about the concerns of the age that made them than about the shape technologies finally took

Price has to be weighed against performance

Schnaars goes on to say that the commonest reason for the failure of forecasters to predict the future is that they have been too fascinated by the technology itself and more or less fallen in love with it, while tending to neglect economic and marketing aspects altogether. The predictions have failed because they have concerned innovations which did not offer the customer any real advantages and which were, in addition, more expensive than the technology they were intended to replace. One example is the picturephone, for which a bright future was predicted in the late 1960s. It was expensive and did not give the customer anything of real value. In most cases the conventional telephone was entirely satisfactory and if one nevertheless wanted to see the person with whom one was talking it was probable that one wanted to meet them personally.

Forecasters often become too fascinated by the technology and forget that in most cases it has to offer the user real, and affordable, advantages

It is therefore very important for people working on visions of the future to carry out cost-benefit analyses, i.e. to weigh the advantages of a technology to the users against the price they are going to have to pay. Schnaars emphasizes here that relatively few products have failed as a result of technical problems; failure is usually due to inadequate appraisal of the market situation. One difficulty in the application of strict cost-benefit analyses, however, is that most products are initially primitive and expensive. The question then is how soon the product may be expected to fall in price sufficiently to compete with existing products. A further difficulty is to come to grips with the way advertising affects the relation between competing products (Phillips, 1999).

As a comparison, it should be noticed that assessments of the Japanese technology forecast surveys of 1971 and 1976 show that the main factor why predicted topics have not been realized was, in fact, technological problems. Of course, here too financial and social factors have been important (NISTEP, 1997).

Symbolic values are strong incentives

Schnaars' emphasis on economic aspects is of course very important. However it must be pointed out that these considerations have not always played a vital part in technical change. The historian of technology Svante Lindqvist has made the point that technology is often a product of considerations other than the rationally economic (Lindqvist, 1989). The American space programme of the 1960s provides an example. The official

justification for this programme was its presumed scientific and technological value to mankind, but the most important driving forces were symbolic and military. More specifically it was important during the Cold War to show the world that the USA was the leading nation in the technoscientific field. Once the goal - of being the first to put a man on the moon - had been attained, the balloon of the space programme burst.

According to Lindqvist, predicting the future is made more difficult by the fact that a large part of all technological development takes place within the military sector. Even in a democratic society the necessary knowledge is not available to forecasters.

Who carried out the future studies and what were their underlying interests?

Who are the people who have tried to foresee the technology and the society of the future? To return to the example of atomic power in the 1940s, it may be said that those who painted the most magnificent visions were often laymen: usually journalists but sometimes leading officials and politicians. One mistake they made was in failing to visualize the problems in developing atomic power - they underestimated the safety risks and overestimated the simplicity of developing small lightweight units.

Scientists were generally more sceptical. Many stated in the late 1940s that the vision of providing cars, locomotives and houses with small atomic power plants for energy production was totally unrealistic - not least because of the radiation risks. One physicist wryly observed that nobody would need a car that ran for a whole year on a little uranium pellet because spending just five minutes in the car would be enough to give the driver a fatal dose of radiation (Boyer, 1985).

The fact that experts have sometimes had a fairly realistic view of the potential of various predictions must not mislead us into believing that all scientists and engineers have seen clearly the probable course of future development. One writer who is critical of the ability of experts to visualize the technology of the future is Arthur C. Clarke. Unlike Corn, he claims that the trouble with most forecasts is that they have been far too conservative (Clarke, 1973). It is possible that his opinion reflects the fact that he has for the most part studied how leading scientists have viewed the future. Clarke considers that scientists have often lacked imagination. They have said, for example, that aircraft and space rockets were unrealistic, although they have possessed enough knowledge to have suspected what was going to happen, says Clarke. Expert knowledge has therefore almost been a handicap: "It is not the man who knows most about a subject, and is the acknowledged master of his field, who can give the most reliable pointers to its future. Too great a burden of knowledge can clog the wheels of imagination."

Predictions concerning the future have in other words been made by both laymen and experts of various kinds. Naturally different groups have had different underlying interests, which should be remembered when assessing their predictions. Corn says that journalists and writers of popular science often have more reason to indulge in sensation and exaggeration because then they can obtain greater attention and a wider audience for what they write. For scientists the situation has been the reverse: they have often had an interest in being cautious in their visions - not least to avoid earning a bad reputation among fellow-scientists. According to Corn, scientists' "training, their work experience, and their professional culture all [...] tended to dispose them toward more restrained and less utopian expectations for the future" (Corn, 1986).

Despite their cost, some technologies may nevertheless be developed for strategic or symbolic reasons

Predictions made by laymen tend to be more utopian than those made by scientists, whereas experts are often overly cautious

Conclusions

People working with technology foresights today usually have different perspectives, methods and aims than their predecessors in the field. However, on a basic level they face a similar set of problems in trying to present views of the future. Even though they may have learned from past experiences and avoided some common errors it is reasonable to assume that they will have encountered difficulties at some other points. Since the results of technology foresights among other things will be used as the basis in determining priorities and drawing up policy, to European politicians and policymakers is essential to have knowledge of often recurrent mistakes of past visions of the future.

People working with technology foresights today usually have different perspectives, methods and aims than their predecessors in the field

This article has outlined a number of factors, which have contributed to the fact that predictions have failed. While the seven factors below are not sufficient for assessing present-day future studies they offer a point of departure. Reasons for failure have been:

- The belief that new technology will completely replace existing technology and do so relatively quickly. In reality, competing technologies usually co-exist for a long period.

- The belief that new technology will only solve old problems and supplement existing technical systems. Instead it is common for new technologies to form the basis of entirely new systems.

- The difficulty of seeing important links between different areas of technology where it is actually the combination of fields that offers the greatest potential for development.

- Forecasters have been caught in the spirit of a particular period and tended to believe that the great issues of today will also be those of tomorrow.

- Forecasters have been seduced by the technology itself and thus neglected important economic aspects. They have not considered potential markets and whether a particular technology offers users anything more valuable than existing alternatives - there has been an absence of cost-benefit analyses.

- Rational economic considerations are not the only factor influencing the choice of a new technology. Other considerations such as symbolic values often tip the scales.

- Studies of the future have often been based on inadequate information. Much technological development takes place in secret - especially in the military sector.

It may well be valuable to policy-makers to familiarize themselves with these factors and to examine today's visions of the future critically. In doing this one should bear in mind what different groups of actors have been involved in the foresight projects and what have been their underlying interests, assumptions and perspectives.

It should be noted that the factors suggested above are based on earlier experience of visions of the future. Experience of foresight activities of the 1990s still need to be studied critically and here the current ESTO-project on the monitoring of European foresight activities can play an important role, offering additional tools to aid in the assessment of such exercises. In doing this the ESTO-projects will have to deal with the, in many respects, difficult task of studying the present time or the recent past. Not least, it may be useful to stop and reflect on the spirit of the current age and on the questions which absorb us at the present time. To obtain a perspective from which to view today's projects we should ask ourselves what future historians - perhaps working in the 2040s - will write about the European technology foresights of the 1990s.

Keywords

technology foresight, technology forecasting, technology assessment, history of technology, economic history

References

- Boyer, P., *By the Bomb's Early Light: American Thought and Culture at the Dawn of the Atomic Age.* New York, 1985.
- Ceruzzi, P., *An Unforeseen Revolution: Computers and Expectations, 1935-1985.* in Imagining Tomorrow, 1986. p. 188-201.
- Clarke, A.C., *Profiles of the Future: An Inquiry into the Limits of the Possible.* London, rev. ed. 1973.
- Corn, J.J., (ed.) *Imagining Tomorrow: History, Technology, and the American Future.* Cambridge, MA, 1986.
- Del Sesto, S.L., *Wasn't the Future of Nuclear Energy Wonderful?* in Imagining Tomorrow. 1986, p. 58-76.
- Douglas, S.J., *Inventing American Broadcasting 1899-1922.* Baltimore, 1987.
- Lindqvist, S., *Teknikvärdering i ett historiskt perspektiv: Exemplet raketteknikens utveckling.* Polhem: Tidskrift för teknikhistoria 7.1989, p. 80-120.
- NISTEP, *The Sixth Technology Forecast Survey – Future Technology in Japan Toward The Year 2025.* NISTEP Report No. 52, Tokyo, June 1997.
- Olsson, L., *Teknisk baksyn: Om svårigheter att förutse framtiden.* NUTEK/Tekpol, Stockholm, 1999.
- Phillips, F., *Assumption Drag and the New Millennium.* Technological Forecasting & Social Change. Vol. 62:1/2. 1999.
- Rosenberg, N., *Perspectives on Technology.* Cambridge, 1976.
- Rosenberg, N., *Exploring the black box: Technology, economics, and history,* Cambridge, 1994.
- Schnaars, S.P. Megamistakes: Forecasting and the Myth of Rapid Technological Change. New York, 1989.

Contacts

Lars Olsson, Technology Policy Studies, NUTEK

Tel.: +46 8 681 92 42, fax: +46 8 681 92 80, e-mail: **lars.olsson@nutek.se**

Hector Hernández, IPTS

Tel.: +34 95 448 82 92, fax: +34 95 448 83 26, e-mail: **hector.hernandez@jrc.es**

About the author

Lars Olsson is an analyst at the Department of Technology Policy Studies at NUTEK, and involved in the Swedish Technology Foresight project. He has an M.Sc. degree in engineering and is just about to finish his doctoral dissertation in the field of history of technology at the Chalmers University of Technology. He has published several historical articles on engineers and their role as carriers of knowledge in technological systems.

Economic Impacts of the Euro-Mediterranean Association Agreements

Sergio Gomez y Paloma and Mario Zappacosta, *IPTS*

Issue: Following the worldwide tendency to negotiate regional preferential trade agreements, a Euro-Mediterranean Free Trade Area is due to be created by the year 2010. This will be the outcome of the coming into force of bilateral agreements between the EU and Mediterranean Partner Countries.

Relevance: With several agreements still under negotiation, it is worth noting the importance of implementing accompanying measures in terms of structural reforms and technology changes in order to boost benefits and to reduce the costs of the new regional scenario.

As the recent WTO meeting in Seattle showed, it is often extremely difficult to achieve a general consensus on multilateral free trade. One alternative approach is to implement agreements at regional level

Introduction

The troubled start of the recent WTO Millennium Round in Seattle shows how difficult it is to achieve a general consensus on multilateral free trade and market liberalization. A frequent way around this problem is to implement preferential trade agreements at regional level. Some significant examples of this approach are the European Economic Area between the EU and EFTA countries; the NAFTA agreement between Mexico, Canada and the US; the MERCOSUR treaty in South America; and the Free Trade agreements between the EU and Central and East European countries.

Under the auspices of the Euro-Mediterranean Partnership, the Mediterranean region will also increased liberalization of the exchange of goods and services. By the year 2010 the implementation of a series of bilateral agreements will lead to the creation of a free trade area (FTA) comprising the EU and the Mediterranean Partner Countries (MPCs). Negotiations towards these agreements began in 1995 and have grown out of from the previous system of regional trade preferences already in place between EU and the MPCs.

In order to be compatible with GATT and WTO rules on liberalization, regional free trade agreements must include at least two non-discriminatory conditions: (i) they have to be implemented gradually and (ii) they have to cover substantially all exchanges.

Preferential trade agreements may have different impacts at global level. Viewed as second-best solution to a completely free market, they are seen as an initial step toward a more general liberalization. In fact, building on closer relationships between neighbouring countries,

they could induce a broader reduction of tariffs and duties. In some cases, regional free trade agreements have also led to deeper integration, including competition policies and antitrust laws (Hoeckman, 1998). On the other hand, they may create strong regional blocs that may turn protectionist, reducing access from the outside world (Krugman and Obstfeld, 1994).

Trade patterns and agreements in the Euro-Mediterranean region

The MPCs' trade is mainly directed to EU, accounting for approximately 60% of total flows, with the exceptions of Israel and Jordan whose exports are more oriented to the USA and the Gulf countries, respectively. Maghrib countries are substantially more dependent on trade with the EU than Turkey and Egypt. Internal exchanges between MPCs represent less than 10% of the total volume, due in particular to similarity in endowments and to political barriers. In 1997, MPC exports to the EU amounted to Euro48,797 million, while imports were Euro67,630 million. In absolute monetary terms, the group's largest trade partners with the EU are Turkey, Israel, Algeria, Libya and Egypt.

On a global scale, MPCs specialize in exporting minerals, fuels and manufactured goods (about 70% of total exports) and importing manufactured goods and raw materials (about 70% of total imports). Agricultural trade between the MPCs and the EU is particularly important, representing approximately 50% of the total exchanges. This trade specializes in fresh and perishable goods, such as fruit and vegetables.

The beginning of economic cooperation between the north and south of the Mediterranean basin dates back to the sixties when eight association agreements were signed. Their economic impact was essentially limited due to a lack of real coordination and the influence of nationalist interests resulting from former colonial ties.

In the seventies, the EU launched the Global Mediterranean Policy. It granted preferential access to the EU from some Mediterranean

By the year 2010 the implementation of a series of bilateral agreements will lead to the creation of a free trade area (FTA) taking in the EU and the Mediterranean Partner Countries (MPCs).

The EU already accounts for approximately 60% of MPC trade, with the exception of Israel and Jordan

Table 1. MPCs trade with EU-15 (values, million Euro, year 1997)

	Exports	%	Imports	%
Malta	1,997	2.95	701	1.44
Cyprus	1,931	2.86	373	0.76
Turkey	22,262	32.92	11,835	24.25
Morocco	5,307	7.85	4,738	9.71
Algeria	4,338	6.41	8,370	17.15
Tunisia	5,276	7.80	4,005	8.21
Libya	2,765	4.09	7,629	15.63
Egypt	6,715	9.93	2,578	5.28
Lebanon	3,085	4.56	151	0.31
Syria	1,345	1.99	1,995	4.09
Israel	11,418	16.88	6,250	12.81
Jordan	1,191	1.76	172	0.35
TOTAL	**67,630**		**48,797**	

Source: Eurostat, 1998.

products, such as citrus fruits, olive oil, melons, grapes, of which at the time the EU (then without Greece, Spain and Portugal) was a net importer. New negotiations of additional protocols began in the early eighties in order to mitigate the negative impacts of the southern enlargement of the EU on the MPCs. In general, all these agreements were characterized by giving duty free access to EU markets for the MPCs' industrial goods and preferential access for their agricultural commodities under the principle of the "most favoured nation", a guarantee that MPC exports are charged with tariffs no higher than those of the nation paying the lowest tariffs.

In November 1995, the new Euro-Mediterranean Partnership was established by the Conference of Foreign Ministers held in Barcelona. The initiative brought together 27 Partners from both sides of the Mediterranean

In November 1995 the new Euro-Mediterranean Partnership was established by the Conference of Foreign Ministers held in Barcelona. The initiative brought together 27 Partners on both sides of the Mediterranean: the 15 EU Member States and Algeria, Cyprus, Egypt, Israel, Jordan, Lebanon, Malta, Morocco, Syria, Tunisia, Turkey and the Palestinian Authority. The Barcelona Declaration is based on three main chapters:

- The policy chapter, on defining a common area of peace and stability.
- The economy and finance chapter, on building an area of shared prosperity.
- The society and culture chapter, on bringing together people.

The main features of the economy and finance chapter are the creation of a Free Trade Area (FTA), to be completed by year 2010, and the establishment of the MEDA programme as a specific financial assistance measure. The FTA will be achieved by establishing Euro-Mediterranean Association Agreements (EMAAs) between each Mediterranean Partner Country (MPC) and the EU member states. Table 1 shows the current status of negotiations and it is worth noting that by the end of 1999 only EMAAs with Tunisia and Palestinian Authority had come into force. This delay is mainly due to the long ratification process by EU member states: for example, by the end of 1999, the agreement with Jordan signed in November 1997 had been ratified only by 7 member states.

Although each EMAA is independently designed and negotiated, they have the following common characteristics.

Table 2. Progress of negotiations on Euro-Mediterranean Association Agreements

Partner	Conclusion	Signature of Negotiations	Entry intoForce of Agreement
Tunisia	June 1995	July 1995	March 1998
Israel	September 1995	November 1995	-
Morocco	November 1995	February 1996	-
Turkey	March 1995	December 1995-	-
Palestinian Authority	December 1996	February 1997	July 1997
Jordan	April 1997	November 1997	-
Egypt	June 1999	June 1999	-
Lebanon	In progress	-	-
Algeria	In progress	-	-
Syria	In progress	-	-

Source: European Commission, 1999

- Their duration is unlimited and their content may be modified only by subsequent amendments.

- They envisage a progressive elimination of all tariffs on industrial goods, which will be completed by the year 2010.

- Bilateral trade liberalization of agricultural products is gradual and limited. Further negotiations on agricultural concessions are expected to start in the near future (in the year 2000 for Tunisia and Morocco and in the year 2002 for Lebanon and Jordan).

- They include measures to liberalize services and the right of establishment of foreign direct investments (FDI).

- They consider the adoption of a wide range of trade-related EU regulations, such as Competition Policy, Intellectual Property Rights regulations, standards harmonization and customs administration procedures.

In reality, tariff reduction will be almost unilateral, concerning mainly industrial products of EU origin, given that the majority of Mediterranean products already have free access to EU markets. Goods that will first experience tariff abolition are generally intermediate and capital goods that are not produced in MPCs and have the lowest average tariffs, while consumer goods and products with the highest tariffs will be liberalized more gradually (see table 3 on the Tunisian case). Although fresh agricultural products are almost excluded from the agreements, processed foods are included in product groups with the longer transition period (up to 12 years for total tariff abolition).

Reviewing major economic impacts

Mainstream international trade theory holds that countries with large import-substitution programmes, which can lead to inefficient diversification, can increase their national welfare by moving to export-oriented production in a more liberal market. Capital and human resources would be reallocated to sectors and firms able to pursue higher productivity levels and, consequently, compete on international (unprotected) markets. Several authors have analysed the economic impact of EAAs on the MPCs' economies and their major findings may be summarized as follows:

- *Trade diversion.* This is a negative effect which occurs when granting preferential treatment to specific countries as the

The aim of trade liberalization is to increase national welfare by moving away from inefficient diversification toward export-oriented production. However, among the direct negative consequences are transitional unemployment and loss of tax revenue

Table 3. Tariff liberalization commitments by Tunisia

Year 1994	Share of trade Export	Share of trade Import	Share in domestic output	Share in total tariff revenue	Import weighted average tariff
Immediate liberalization	1	10	14	3.6	21.6
5 years transition	16	24	20	12.5	26.7
12 years transition	7	29	22	9.2	30.4
8 years transition starting from year 5	75	36	43	32.9	33.8
Exempted	1	1	1	n/a	n/a

Source: Hoekman and Djankov, 1996

The relatively high level of tariffs has meant a long (12-year) transitional period is necessary, although this may create biases in investors' decisions as different sectors are liberalized at different rates

elimination of tariffs may induce consumers and firms to prefer suppliers located in a partner country that are less efficient than those located in non-member countries[1]. In the case of the EAAs, the dismantling of import tariffs on EU products may negatively affect import flows from other MPCs (Hoekman, 1998). Trade diversion losses may be limited by two factors: (i) greater competitiveness of EU suppliers (i.e. their production performance is closer to that of the most efficient country and the distortion introduced by the EAAs is minimum), and (ii) lower import tariffs on EU products that will be eliminated by EMAAS (Tovias, 1997).

- *Trade creation.* This is a positive effect and refers to the replacement of higher-cost domestic production with lower-cost imports. It counterbalances the trade diversion effect if there is similarity between MPCs and EU economies and, consequently, there is scope for improvement in resource allocation.

- *Transitional unemployment.* In the short run, capital reallocation and consequent enterprise closures will affect MPCs' job markets. In particular, MPCs with high unemployment rates and inefficient state-owned enterprises would be the hardest hit. In the case of Tunisia, for example, one estimate of the costs of shifting and retraining workforce places it at 4% of national GDP and the whole restructuring process will involve approximately 8% of the active workforce. (Rutheford *et al.*, 1995).

- *Tax revenue loss.* Granting duty free access to imports of EU origin implies a reduction in total governmental revenue. In general, it would be quite significant, depending on the pre-agreement amount of fiscal revenue drawn from international trade taxes. For example, when the EAAs will be fully implemented, losses are estimated to be 5.4% of total government revenue for Algeria (1.5% of GDP), 4.4% for Egypt (1.4% of GDP), 11.1% for Morocco (2.9% of GDP), 24.3% for Tunisia (6.0% of GDP) (Tovias, 1997).

- *Attracting domestic and foreign investments.* The bilateral nature of the EMAAs may create incentives to locate firms in the EU in order to have simultaneous access to all MPCs, according the so-called "hub and spoke" strategy. To reduce the isolation of the "spokes" and to upgrade some of them to regional "hubs", intra-MPCs trade should be improved by reducing trade barriers between individual countries (Petri, 1997). For this purpose, 18 countries of the Arab League launched the "Arab Free Trade Area" aiming at gradually lowering regional custom duties by 10 percent per year. This process started in February 1998 and it should be fully implemented by 2008. In addition, several bilateral agreements are under negotiation, such as for example, those between Jordan and Egypt, Morocco and Lebanon, Syria and Jordan. The reforms that are expected to accompany the EMAAs will contribute to reducing market uncertainty, enhancing the credibility of local government and the commitment to a fully market-based and open economy and, consequently, help attract foreign direct investments (Ghesquiere, 1998).

- *Bias in capital allocation due to gradual tariff liberalization.* The long period for tariff abolishment (12 years) is due to the high level of import duties in MPCs and the need to smooth out fiscal losses. In comparison with CEECs (Central and Eastern European Countries), the average level of MPCs protection is almost double (6% as compared with 15%). The gradual liberalization process

may have some negative effects due to the increasing relative protection for highly protected sectors in the earlier period. It might bias potential investors' decisions and delay investments in export-oriented industries. In particular, the higher protection granted to MPCs' agriculture may induce new distortions resulting in resources flow from the industrial sectors with dismantling protection. In addition, the sequencing of tariff reductions may strengthen resistance to future market opening.

- *Harmonization of standards.* Although the harmonization with EU standards is achieved through bilateral agreements, the whole set of EMAAs will *de facto* provide the Mediterranean region with common standards, bypassing long and frequently difficult intra-MPCs negotiations.

Accompanying measures: structural reforms and technology changes

Sound reallocation of capital and human resources and attracting investments need more than just tariff abolition on a bilateral basis. In order to enhance the positive impacts of EMAAs and reduce the negative ones, MPCs need to implement some accompanying measures in terms of structural reforms and technology changes.

The impact of EMAAs on government revenue may be partially offset by public expenditure reduction and by introducing alternative revenue sources, such as the introduction of value added taxes. On the other hand, government should provide safety nets and re-training programmes to workers displaced by the restructuring process.

The negative effects of trade diversion may be reduced if greater integration of MPCs is promoted. The implementation of bilateral and diagonal "cumulation of origins" rules would reduce the isolation of "spokes", improving market access for MPCs to the EU, increasing trade among MPCs and enlarging sourcing possibilities for materials and products. In the case of bilateral cumulation, products originating in the EU could be processed by an MPC and then get duty-free access the EU. When there are more than two countries involved, all of them participating in the Free Trade Area, although on bilateral basis, diagonal cumulation may take place: products originating in an MPC could be processed by another MPC and be sold duty free either in the EU or in another MPC even without proof of sufficient transformation. For example, Tunisia may buy phosphates from Morocco in order to produce complex fertilizers to be sold duty free to the EU. It is important to note that cumulation rules apply only to "originating products", a feature that, except for the majority of agricultural products, is often difficult to assess.

The development of regional trade would also have effects in terms of technology. By granting access to MPCs' suppliers who might provide machinery more suitable to local skills and factor endowments than those from the EU, technology diversification may be encouraged. On the other hand, greater market competition may devastate MPCs' industrial fabric, which is based on networks of small and medium enterprises, losing the so-called "social capital" in terms of locally developed systems of firm organization and management. Standardization in the production process due to the growing presence of multinationals in MPCs could result in the gradual loss of local management culture and technologies (Zghal, 1998).

National and foreign investors would favour locating in MPCs only if they find a sound business environment there, in addition to a relatively cheap labour force. The implementation of reforms of legal and regulatory systems is a basic requisite. At the same time, it is important to upgrade the quality of local

One feature of a regional agreement based on bilateral agreements is the creation of a "hub and spoke" arrangement in which there is little trade between the MPCs themselves. Difficulties can also arise in terms of determining the origins of tariff-exempt goods

Investors will not be induced to locate in the MPCs by low labour costs alone. They also require a sound business environment, making legal and regulatory reform essential

infrastructure and services such as banks, finance, insurance and telecommunications. In particular, the reduction of local monopoly power in ICTs will contribute to enhancing the adoption of new technologies.

The location attractiveness for export industries in MPCs will be increased by the elimination of several non-tariff barriers such as the existence of complex and wide-ranging customs administration requirements, diverse testing and certification procedures, numerous documents for customs clearance, and the lack of coordination and cooperation on linking customs computer systems.

An important role has been played by the EU MEDA programme, which progressively replaced previous financial instruments, mainly the Financial Protocols, and currently represents about 90% of total financial commitmentsfrom the EU budget in the Mediterranean. This programme supports MPCs' economic transition and structural adjustment, with particular emphasis on private sector development. An important feature of the MEDA programme is that the fund allocation per country is not predetermined, as under 1970s and 1980s agreements, but it will be determined on the basis of the pace of the reforms implemented.

Conclusions

The EMAAs may become a catalyst for MPCs' economic reform and modernization strategies if local governments commit themselves to implementing a set of complementary and supplementary economic policy measures. In this framework, economic and technical cooperation from the EU may play a pivotal role. Drawing on its vast experience, the EU should help MPCs in the harmonization of diverse regulations, making available internationally accepted rules and procedures, e.g. customs and standards requirements.

The EMAAs, as with any other preferential free trade agreement, may be seen as the first step towards a greater regional and worldwide integration that would reduce the costs of trade diversion and reduce the "hub and spoke" phenomenon between MPCs and EU. Evidently generalized trade liberalization would imply further losses in fiscal revenues and would need extra compensating measures.

In order to adapt to stronger competition on international markets the upgrading of MPCs industrial enterprises and the environment where they operate is needed. Programmes aimed at facilitating technology change, vocational training and retraining, improvements in legal and regulatory framework, especially on standards harmonization and export possibilities awareness, are measures which would benefit from cooperation between national governments and the EU.

Keywords

Euro-Mediterranean association agreements, Free Trade Area, economic impact

Notes

1. The preferential agreements signed by the EU with Central and East European Countries are a clear case of trade diversion away from MPCs economies.

References

- European Commission, *Annual report of the MEDA Programme 1998*, pub. 1999.
- Eurostat, *External and Intra-European Union Trade*, Statistical Yearbook 1958-1997, Luxembourg, 1998.
- Ghesquiere, H., *Impact of European Union Association Agreements on Mediterranean Countries*, IMF Working Paper n.98, August, 1998.
- Hoekman, B., *Free Trade Agreements in the Mediterranean: a Regional Path towards Liberalization*, Journal of North African Studies, vol.3, n.2, 1998.
- Hoekman, B., Djankov, S., *The European Union's Mediterranean Free Trade Initiative*, World Economy, vol.9, n.4, 1996.
- Krugman, P., Obstfeld, M., *International Economics. Theory and Policy*, Harper Collins, New York, 1994.
- Petri, A.P., *Trade Strategies for the Southern Mediterranean*, OECD Development Centre, Technical Papers n.127, Paris, OECD, 1997.
- Rutheford et al., *The Free Trade Agreement Between Tunisia and the European Union*, Washington, The World Bank, 1995.
- Tovias, A., *The Economic Impact of the Euro-Mediterranean Free Trade Area on Mediterranean Non-Member Countries*, Euro-Mediterranean Conference, November 1995, Barcelona, Spain, 1997.
- Zghal, R., Globalisation, Culture and Management Systems, *Journal of North African Studies*, vol.3, n.2, 1998.

Contacts

Sergio Gomez y Paloma, IPTS

Tel.: +34 95 44 88 358, fax: +34 95 44 88 326, e-mail: **Sergio.Gomez-y-Paloma@jrc.es**

Mario Zappacosta, IPTS

Tel.: +34 95 44 88 232, fax: +34 95 44 88 326, e-mail: **Mario.Zappacosta@jrc.es**

About the authors

Sergio Gomez y Paloma (Ph.D, M.S.) is a Scientific Officer at the IPTS where he is currently dealing with S&T issues within the Euro-Mediterranean area. Formerly he was the coordinator of the IPTS project on Mediterranean-Regional Prospects. Before joining the IPTS, he was a Lecturer at Roskilde University and a Visiting Professor at the Universities of Cosenza (Dept. of Political Economy) and Bari (Institute of Modern History).

Mario Zappacosta holds a Ph.D. in Agricultural Economics from the University of Modena, Italy. Since July 1998 he has worked at the IPTS in the Mediterranean and Regional Prospects project of the Technology, Employment, Competitiveness and Society Unit.

Patenting as a Protection Tool: A Reassessment

Nikolaus Thumm, *IPTS*

Issue: Patents are often said to be an important incentive for research and development. However, patents are nowadays being used in ways that are very different from their original concept and aims of protecting inventions and fostering their distribution.

Relevance: Strategic uses of patenting are predominating over the idea of protection and distribution of knowledge. In a time of rapid changes in the legal framework of patenting and doubts about the patentability of many inventions, for example in biotechnology, the original policy aim of the patent instrument seems to be more and more neglected.

Patents are generally held to create an important incentive for innovation by providing a means of recouping large investments in research and development

The economic argument for patent protection is the apparent market failure in that intellectual property would otherwise be too easy to exploit in ways which do not benefit its creator

The aim of patenting

Patents are widely held to be an important incentive for research and development. Like other intellectual property rights they are a necessary provision for science and technology to progress. Without patents there would be no incentive to spend large amounts on research and development (the so-called innovation effect of patents). In the absence of intellectual property rights (IPRs) pirates can copy inventions, meaning little or no original development would be undertaken, which would have disastrous consequences for the general development of science and technology.

The economic argument for IPRs is that there is a market failure in the case of technological knowledge. Technological knowledge is a public good. Producers of knowledge cannot prevent others from using it (the so-called non-excludability characteristic). Intellectual property can be used and enjoyed jointly by as many as care to make use of it without affecting the level at which others use it (the so-called non-rivalry characteristic). In economic terms, the marginal costs of providing intellectual objects to an additional user are nil. Under free-market conditions the public good features produce an 'overuse' of intellectual property and a loss of incentive for investment in activities which create intellectual property (R&D investments). This is the usual argument why government intervention in the form of intellectual property rights is required. Through publicly accessible publications, intellectual property rights (IPRs) ensure a wider distribution of technological knowledge (**positive distribution effect of patents**).

Economic analysis, however, also makes it clear that from a welfare point of view that IPRs are only a second best solution. They give rise to sub-optimal production levels and monopolistic market prices. Nevertheless, there is a need for this second best solution, and a certain deviation from optimality is the price paid for innovative activity.

Table 1. Knowledge classification (Georghiou and Metcalfe, 1990)

	Codified	Tacit
Public	e.g. Publications	Generic, e.g. Skills
Proprietary	e.g. **Patents**	Firm-specific skills e.g. Know-how

Are patents suitable for the technologies of the new millennium?

Patents cover per definition only the codifiable dimension of knowledge (see table 1).

With the rise of the "information society" the quantity of codified knowledge looks set to increase. Knowledge is becoming more and more the essential resource in what is called the "learning society", where learning is the most important process for wealth creation. This is increasingly placing IPRs at centre of the public debate.

Nevertheless, IPRs refer only to codifiable knowledge and it is not always clear what the proportion of codifiable knowledge is in any new invention (in comparison with the tacit dimension of knowledge). With the rise in importance of knowledge and skills, the tacit dimension for new and high-tech technologies is probably increasing more than the relevance of codified knowledge. This is mainly due to an ongoing increase in the complexity of technologies that require deeper understanding and problem solving capacity from trained staff[1]. Consequently, the importance of IPR is not necessarily rising in a knowledge-based society, rather this depends on the kind of knowledge involved.

The business of patenting

Industry understands patents above all as an instrument for making money. Patents are used for licensing and the aim is to exploit them as far as possible for economic gain.

More and more companies are realizing that aggressively asserting their patents can generate considerable business advantages. Many businesses spend large amounts of money in identifying the economically relevant patents out of their patent portfolio (Portfolio audit), as well as in cluster and bracket analysis, where clustering around the core technology has to make sure that a core technology has been protected. Efforts have to be made to oversee the patent's ageing process (i.e. the number of years left on a company's patents) tracking which inventors are still with the company or if they work with a competitor, and of course most importantly, identifying candidates for out-licensing. Therefore, different licensing approaches are followed. Either through personal in-depth contacts or through a "shotgun approach" -flooding all the competitors in a particular technology with patent license solicitation letters, licensees are identified.

Barriers to patenting

Patenting is an expensive business; the cost of maintaining worldwide coverage for a single patent has been estimated to be as much as $250,000 (Derwent,1999). This cost, which includes the fees of patent lawyers plus the application and maintenance fees, makes patenting an exclusive instrument available only to those who can afford it. In addition to the cost, the in-depth knowledge needed to understand and use the patenting process creates a barrier which is especially difficult for smaller companies to cross. It is therefore not surprising to see that the relative importance of patenting related costs (procedural

Patents, and Intellectual Property Rights (IPRs) in general, are only able to protect the codifiable part of any invention or creation and do not cover tacit knowledge

Businesses are finding new ways to use patents to protect their technologies and exploit them through licensing agreements

costs, patent lawyer's fees etc, annual renewal fees etc, litigation costs) for the decision to apply for patent protection decreases with the size of the firm (cf. Thumm, 2000). Costs are in general of greatest importance for small firms, whereas larger firms naturally find them less of a burden.

Also the costs of litigation can be very high, especially in the United States. This burden may often not be taken into account when deciding to patent. European firms usually assume that they will not get into legal battles over infringement and in practice indeed cases are rare in comparison to the United States. In general, all the administrative costs are secondary to the large sums spent on patent lawyers and translations[2]. High translation costs are one reason for the difficulties of adopting a community patent for the European Union. Usually companies do not hesitate to file a priority application at national level. Costs start to come up only later, after twelve months of priority time together with the decision to apply for international protection. There, smaller and medium sized enterprises usually have to be very selective about the choice of countries in which to apply for protection.

Applying for, maintaining and, if necessary, defending a patent is an expensive business; often beyond the means of small and medium-sized enterprises

The complexities of the patenting system create a situation that encourages strategic uses of patents to predominate over the idea of protection and distribution of knowledge

Box 1: Example of how patent-holders can manipulate the system

After 18 years the patent claim is withdrawn by simply not paying the 19th yearly fee. The patent office sends off a reminder letter after a period of 6 months with an additional fee of 10%. Until the status of expiry is in the databases, 19,75 years will have passed. Thus the public (including competitors!) become aware of the dropped patent more or less after the full length patent protection period of 20 years. The firm however, saves the expensive patent fee (Euro1,000 per country for maybe 10 countries). In the case of large firms with many patents per year strategies such as this can save a huge amount of money overall.

Costs for international applications, especially when a patent gets into the national phase are tremendous. Hence firms tend to look for ways in order to reduce these costs, as in the example in Box 1.

The complexities of the patenting system create a situation encouraging strategic uses of patents to predominate over the idea of protection and distribution of knowledge. Thus, Heller and Eisenberg (1998) warn of the negative consequences of excessive patenting, in particular for the biotechnology industry, a situation they refer to as "the tragedy of the anti-commons". All these considerations make it clear that patents are probably an indicator of a number of things, but not necessarily innovation.

Strategic reasons for patenting

"Even within the domain of patenting, there are almost infinite variations of patent strategy: what to protect and when, where to file, how to improve competitive position, etc." (European Commission, 1999).

The purposes for which companies make use of their patent portfolios are very diverse, but generally fall into the following categories:

- Protection from competition;
- Complementary protection;
- Safeguarding future technologies;
- Basis for alliances.

The first of these purposes is the closest to the original intention of patents, i.e. to prohibit those others than the inventors from commercializing the patented technology.

Complementary protection is the protection around a core technology which itself has no direct commercial purpose but aims to protect a key patent that needs a higher degree of protection. The

associated area can be safeguarded by patenting all possible varieties of one original invention. Examples are patents on all possible mixtures of a highly efficient chemical substance. Another example is a firm that tries to patent the entire production process, and hence applies for as many patents as possible for one product. As a result, competitors have to approach this firm and apply for licensing whenever they want to produce something in this area. Large pharmaceutical companies follow another, similar strategy. They file for as many patents as possible in one technological field. The intention is to occupy the entire field, even though individual patents may not be of interest ("blocking scenario"). Such behaviour makes the technological field unattractive for any potential market entrant. In fact, this is strongly recommended by experts, since otherwise firms may be locked out of future technological development by their competitors. The principle of protecting the associated area of an invention is also an economic need since, if it is not done by the inventor him or herself, any competitor can take the initiative and place a patent in the technological niche.

Similar strategies are recommended with respect to the protection of future technologies. Here, the company has to make sure that it has a prior claim to a specific area of technology and that it will participate in the future commercialization of this technology without relying on the patent portfolio of a competitor.

Patents as a basis for alliances are patents that aim at moving the holder into a better negotiating position against competitors (swap patents). An example is the patenting of diverse mixtures of an invented chemical substance. In order to prevent the patenting of an invention by a competitor, the inventor includes in the patent file the name of all substances invented, a cross dependency is created and thereby a better negotiation position for cross licensing is established. Another example therefore is a combination therapy for AIDS. In this case the virus cannot be combated in an efficient way with single therapies, but only with the right combination of therapies. Hence, a patent application for one therapy would designate all the competitors' inventions (therapies).

Another more aggressive way of swap patenting is the case where a basic technology is already patented and a competitor intends to obtain as many patents as possible on secondary applications of this technology, so that the first patent owner finds him or herself in a dependent position. One example is the case of research into a new drug against cancer in which a competitor patents any combination of the anti-cancer compounds, whether useful or not, and independently of whether there is a synergistic effect or not. The competitor could build up a large patent portfolio without any evidence to support the potential development of any of his proposed inventions into a marketable product. This is particularly the case since patenting itself does not necessarily mean that somebody brings a product successfully onto the market.

All the mentioned purposes can be used in a defensive way as well as in an offensive way, aiming more at hindering competitors than protecting one's own inventions. This depends very much on the coherent patenting strategy of a single firm. The various strategic uses of patenting are not limited to large firms. Small and medium-sized biotechnology businesses, naturally restrained by their economic resources, also use strategic patenting in order to achieve competitive advantages without expending too much of their own resources. In a way, small companies depend even more on patenting than larger ones, since often their patent portfolio is the only economic asset they have.

In an aggressive form of what is known as swap patenting a competitor tries to obtain as many patents as possible on secondary applications of an existing basic technology

The various possibilities for strategic uses of patenting include:

- Offensive use;
- Defensive use;
- Negotiation;
- Improving the image of the company.

The first prerequisite of strategic patenting is the active observation of competitors' patenting portfolios, which is already necessary in orderto identify market niches and to place products in the right place in the market. The outcome of one survey was that 89 per cent of the survey respondents agree that monitoring the patents of competitors is an effective way of obtaining competitive intelligence (Derwent, 1998).

Offensive use of patenting normally tries to exclude competitors from making use of a technology by patenting numerous combinations or variations of it

Offensive use of patenting normally tries to exclude competitors from making use of a technology. An example of an offensive use of patenting is again that of patenting various mixtures of a chemical substance. An expert in the field will observe economically useful mixtures and will file a patent on each of them. If this is done by a competitor and not the original inventor, the inventor will depend on a secondary patent. Conditions for cross licensing will be established and even though the competitor cannot make any direct use of his secondary patent, it will at least disturb the original inventor and place the competitor in a favourable negotiating position. This behaviour also demonstrates how this "gap management" is practised. It assumes the active control by the patenting portfolio of the competitor and looks for niches in which to place a patent (a pure "desk patent" to be put somewhere in the neighbourhood of a first "inventive" patent). Against such practices, firms list all compounds and possible mixtures in the patent specifications annexed to their patent application in order to block them against third parties.

The defensive use of patenting, on the other hand, is more faithful to the protective element of patenting. Broad patent portfolios make sure that technologies can be used in the future. A patent-portfolio in a specific technology can be a strong asset for negotiating cross-licensing agreements and the mere existence of a broad portfolio can intimidate a negotiating company. Finally, a strong patent portfolio boosts the image of a company even though the times where patent files served as office decoration are supposed to be over.

Conclusion

There are already serious concerns about over-patenting and its negative effects. Heller and Eisenberg warns of too much biotechnological patenting, in particular of the deterrent effect of high transaction costs and the resulting "under-use" of patented biotechnological information. Although ethical issues are not under discussion here, it has to be asked whether certain classes of knowledge ought to be in the public domain rather than in private hands where they are used for economic purposes. For example, patents on medical procedures have come in for a great deal of criticism. Society at large also has an interest in having certain technological knowledge publicly available for educational reasons.

Although it is clear that patents are an important incentive for research and development, it is also clear that, in addition to their initial purpose of protection, patents are nowadays used in many different ways. The original idea of what patents are and should be, the intention of protecting inventions and fostering their distribution, is becoming less and less important in comparison with many secondary uses of patents. Property rights in general offer their owners a variety of strategic uses in the market place that are no longer conforming with the original idea of IPR as a remedy against market failure. "Intellectual

property rights have a dangerous inner logic .... Rational actors might use them to plan against the market" (Drahos, 1995). These secondary purposes of IPR dominate and take away from the original idea of supplying inventiveness and creativity. Nevertheless, they stimulate the innovator's interest in the property rights themselves and in the related payoffs. "Property rights in abstract objects push the invisible hand away; self-interest is released in ways that threaten the negative liberties of others" (Drahos, 1995).

The time may have come for a wholesale reassessment of the patent-system (cf. Thurow's 1997 article on the issue) especially with respect to new technologies.

Keywords
patent protection, strategic patenting, incentive structures, reassessment for the new millennium

Notes

1. For example, computer programs include codified knowledge in ideal form where each step should be comprehensible throughout the programmed code. Size, the complexity of the program and individual freedom in the way of programming nevertheless often make individual programs incomprehensible and understanding them requires more than simply going through the lines of code.
2. According to one evaluation (Strauss, 1997) the average cost of a European Patent with 8 designations comprises 22% external patent lawyer costs and 33% translation costs.

References

- Derwent: Scientific and Patent Information. by Richard Poynder; Paul Goslinger; Meg Carter: *Hidden Value, How intellectual property know-how can make or break your business*, London, Washington, Tokyo, 1999.
- Derwent: Science and Patent Information, *Managing Patent Information: The Gulf between theory and practice*, May 1998.
- Drahos, Peter: *A Philosophy of Intellectual Property.* Aldershot, Brookfield, Singapore, Sydney, 1996, pp. 136 and 139.
- Georghiou, Luke; Metcalfe, J.S.: *Public science, intellectual property rights and research administration.* in: Science, Technology and free Trade, De la Mothe, John, Ducharme, Louis, Marc (Ed.), London New York, 1990, p 43.
- Heller, Michael; Eisenberg, Rebecca: *Can Patents Deter Innovation? The Anticommons in Biomedical Research.* Science, Vol. 280, May 1998, pp. 698-701.
- Straus, Joseph: *The present state of the patent system in the European Union as compared with the situation in the United States of America and Japan.* Luxembourg, (EUR 17014), 1997.
- Thurow, Lester C.: *Needed: A new system of intellectual property rights.* Harvard Business Review, September-October 1997, pp. 95-103.
- Thumm, Nikolaus: *Management of Intellectual Property Rights in European Biotechnology Firms.* Technological Forecasting and Social Change, Spring 2000, forthcoming.
- European Commission: ETAN Working Paper, *Strategic Dimensions of Intellectual Property Rights in the Context of Science and Technology Policy.* (EUR 18914) June 1999, p20.

Contact

Nikolaus Thumm, IPTS
Tel.: +34 95 448 83 33, fax: +34 95 448 82 79, e-mail: **nikolaus.thumm@jrc.es**

About the author

Nikolaus Thumm joined the IPTS in 1998 where he works in the fields of single market regulation, medical devices, outsourcing trends in European industries and all intellectual property right related issues. Before obtaining his PhD he worked as a research fellow at Europa-Kolleg Hamburg and at the European University Institute in Florence. He holds a diploma in Industrial Engineering from the University of Hamburg and a "European Master in Law and Economics" from the Universities of Hamburg, Lund and Stockholm.

Participation of European Union Companies in US Research Joint Ventures

Albert N. Link, *University of North Carolina at Greensboro* and Nicholas S. Vonortas, *The George Washington University*

Issue: European Union (EU) companies frequently participate in US research joint ventures (RJVs). There has been, however, little systematic work on the characteristics of the EU companies that are involved, about the RJVs themselves, or about the research objectives of the EU companies compared to those of US partners.

Relevance: Recent work has examined the extent of involvement and the basic characteristics of EU organizations that have participated in a distinct group of RJVs established in the United States during the past 15 years[1]. Information about the nature of EU participation in US RJVs could be useful to the European Commission in its support of its own RJVs through the Framework Programmes for Research and Technological Development.

According to data gathered by the US Department of Justice, EU companies participated in approximately a third of research joint ventures in the US. Moreover, EU participation has been fairly evenly spread across technology areas

Introduction

The National Cooperative Research Act (NCRA) of 1984, and its extension, the National Cooperative Research and Production Act (NCRPA) of 1993, offered antitrust protection to members of registered research and production joint ventures (RJVs). By registering with the US Department of Justice, firms decreased the probability of being prosecuted for antitrust violations that stem from their cooperative research relationships (Hagedoorn, Link, and Vonortas, 2000). Even though EU companies have been involved in about one-third of these US RJVs, there is a conspicuous lack of descriptive information on EU companies participating in these ventures.

Description of EU Participation

Since January 1 1985, 746 RJVs have been registered. As illustrated in Figure 1, the total number of new RJVs registered each year has followed a bell-shaped distribution, increasing on average during the first eleven years, reaching a peak in 1995, and decreasing dramatically thereafter. About one-third of the total number of RJVs (251) have involved at least one partner based in the EU (Figure 1). The extent to which EU entities[2] have participated has varied considerably over the fourteen-year period, ranging from less than 20 percent of the newly registered RJVs to over 60 percent in a given year.

EU-based entities have tended to participate relatively more in larger RJVs. Figure 2 illustrates this. EU companies have participated in not less than sixty-six percent of the registered RJVs with more than ten members and in more than fifty percent of the RJVs with more than five members. In contrast, they have participated in only seventeen percent of RJVs with two to five members.

Figure 1. New RJV Announcements

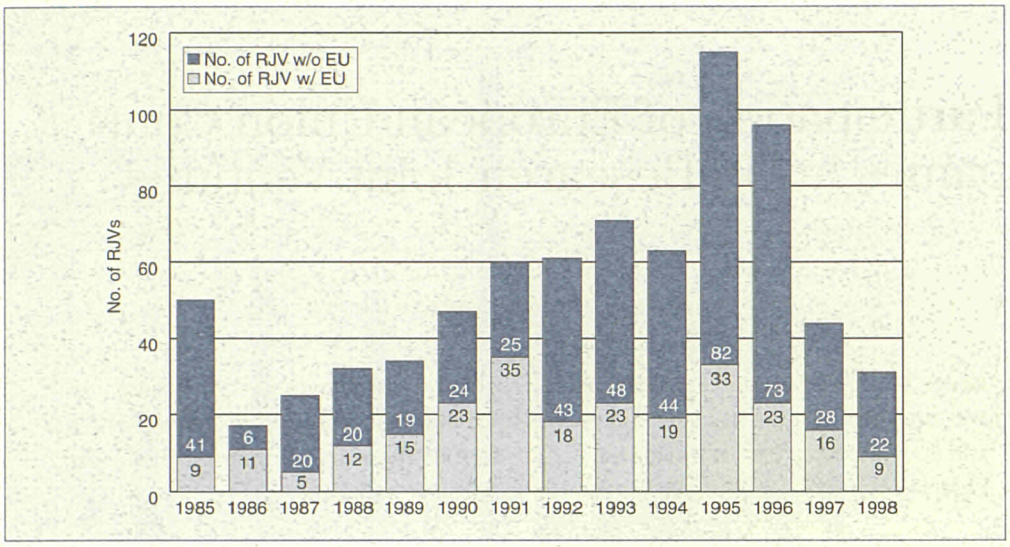
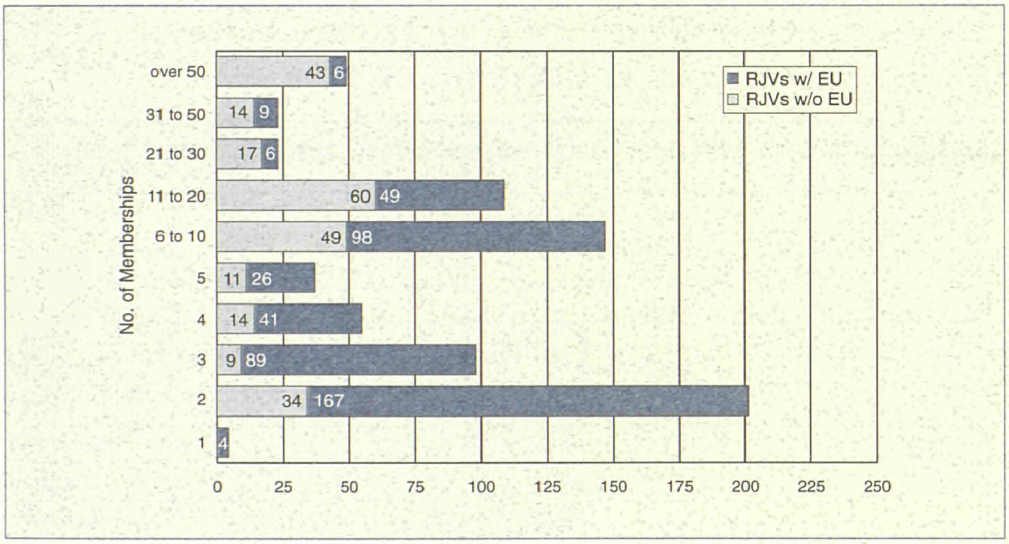


Figure 2. Total Number of Participants in Newly Registered RJVs



EU participation in RJVs has been fairly widespread across technology areas. Nine of the technical areas in Table 1 had ten or more RJVs with EU partners. Most of these are areas of market strength for the European industry.

Figure 3 divides the 251 RJVs with EU participants into two groups, those involving only US and EU entities and those involving entities from other regions as well. Exclusive US-EU collaboration accounted for forty-five percent of the cases, and there is no evidence of a change in preference of EU-based participants for one membership mix over another.

There are 3,819 fully identified entities represented within the 746 RJVs. Table 2 shows that 2,677 (75%) are US-based entities, followed by

Figure 3. RJVs with US, EU and/or Other Foreign Participants

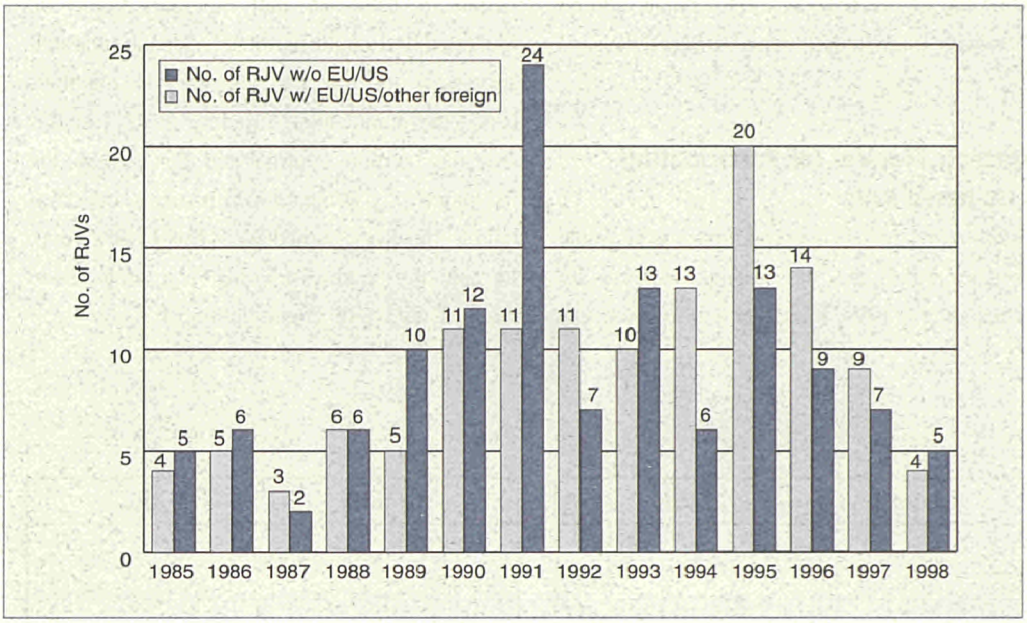


Table 1. Primary Technical Areas of RJVs with EU Participants

Technical Area	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	Total RJVs	%
Teleco-mmunications	3	1		3		5	5	3	5	6	2	3	3	1	40	15,94
Energy			1		3	2	8	8	3			3	3	1	32	12,75
Environmental		1				5	6	1	2	1	9	6		1	32	12,75
Computer Software			1	2	3	1	3	1	4		4	3	3	2	27	10,76
Chemicals	1	1		1	5	4	5	3		1	1		2	2	26	10,36
Transportation	1	3	1				4			5	2	2	2		20	7,97
Advanced Materials	2	4	2	1	2	1	1		1	1	3	1			19	7,57
Subassemblies & Components	1					1	1	1	1	1	4	1	1	2	14	5,58
Factory Automation	1			1	1				3		2	2			10	3,98
Test & Measurement				1			2	1			1	1			6	2,39
Biotechnology				2		1			1		1				5	1,99
Computer Hardware									2		1	1			4	1,59
Manufacturing Equipment		1			1	1					1				4	1,59
Photonics						2				1	1				4	1,59
Medicals										2	1				3	1,20
N/A				1						1			1		3	1,20
Pharmaceuticals									1				1		2	0,80
Total RJVs	**9**	**11**	**5**	**12**	**15**	**23**	**35**	**18**	**23**	**19**	**33**	**23**	**16**	**9**	**251**	**100**

180 being UK-based and 169 being Japan-based. Taking the EU as a whole, 562 separate entities (15%) have participated in the US-based RJVs.

Strategic Motives for Participating in US-Based RJVs

Two case studies were conducted as an initial effort to understand the strategic motives for participating in RJVs. To facilitate this exploratory investigation, the case studies dealt with RJVs that begun in 1996 (so that members could be identified and could reasonably identify research successes) and that had less than 15 members (since the organization structure of RJVs of this size may be more informal and thus increase the likelihood of participation in a survey questionnaire). The RJVs studied were MIPS ABI Group, Inc and the Southwest Research Institute Clean Heavy Duty Diesel Engine II Project.

Two research joint ventures (RJVs) were looked at; one in the software field and the other in engineering. A survey instrument was developed to obtain information on the strategic motives for participation

Table 2. Identified Participating Entities by Country

Country	Entity
US	2.677
UK	180
Japan	169
Canada	146
Germany	116
France	78
Italy	48
Australia	47
Sweden	39
Netherlands	33
Switzerland	32
Korea	24
Taiwan	21
Norway	20
Mexico	18
Belgium	15
Finland	14
Singapore	14
Denmark	14
Israel	14
India	11
Spain	9
Hong Kong	7
South Africa	7
Austria	7
Brazil	6

Country	Entity
Hungary	5
Ireland	5
China	5
New Zealand	5
Greece	4
Portugal	4
Saudi Arabia	3
Colombia	2
Venezuela	2
Russia	2
Luxembourg	1
Argentina	1
Costa Rica	1
Czechoslovakia	1
Estonia	1
Europe	1
Indonesia	1
Kenya	1
Malaysia	1
Poland	1
Romania	1
Rwanda	1
Tanzania	1
Turkey	1
West Indies	1
Yugoslavia	1

Total **3.819**

The nature and objectives of the MIPS ABI Group was to develop and endorse UNIX binary interface standards for MIPS processor-based systems. In the late 1980s, leading US companies in the computer industry relied on processor technology licensed from MIPS Technology, Inc., but the companies were using it on a variety of different UNIX systems. Because each user niche was small, there was no market movement to standardize software. The RJV developed a standardized interface to facilitate the use of software from multiple vendors. All needed standards were developed by the eight participating members (four from the US and two from both the EU and Japan) in early-1999.

The aim of the Southwest Research Institute Clean Heavy Duty Diesel Engine II Project was to develop key technologies to assist in meeting environmental exhaust emission standards applicable to diesel engines. All required technologies were developed and successfully implemented by the eleven participating members in mid-1999.

A survey instrument was developed to obtain information on the strategic motives for participation in each of these RJVs. The instrument was pre-tested and then administered to the members of each RJV by the RJV's research coordinator. In order to ensure confidentiality, each respondent was asked to identify only if his company was US, EU-, or Japanese-based.

The survey responses from the participants in the MIPS ABI Group are summarized in Table 3. To generalize on the basis of the reported means:

- the Japanese partners have the most experience in joint venture research and the US companies have the least;
- the US companies did not seem to have an overriding strategic objective for participating in the MIPS ABI Group;
- the EU companies did have an overriding strategic objective, namely to enhance their existing technological capabilities to thus enhance their domestic/regional competitive position;

Table 3. MIPS ABIT Group, Inc. (mean responses are shown, n=6)

Survey Statement	US	EU	Japan
My company participates in many research joint ventures (RJVs).	3.5	4.5	6
My company participates in many RJVs with participants from various countries.	3.5	4.5	6.5
My company participates in RJVs such as this one to enhance its domestic/regional competitive position.	5.5	7.0	5
My company participates in RJVs such as this one to enhance its global competitive position.	5.5	5.5	6
My company participates in RJVs such as this one to enhance its existing technological capabilities.	5.5	6.5	5.5
My company participates in RJVs such as this one to gain access to new technological capabilities.	3.5	4.5	6.5
My company's research objectives from participating in this RJV were met.	3.5	6.5	4.5

- the Japanese companies did have an overriding strategic objective, namely to gain access to new technological capabilities to thus enhance their global competitive position.

The EU companies participating in this joint venture reported that their research objectives were met more completely that those of the U.S. or Japanese companies.

The survey responses from the participants in the Clean Heavy Duty Diesel Engine II Project are shown in Table 4. To generalize:

- the EU companies have more experience in joint venture research than their US partners, especially joint venture research involving international participants;

- the US companies have more domestic strategic goals compared to the global strategy for EU companies to participate in the joint venture;
- the US companies are more uniform in their overriding strategic objective, namely to enhance their existing capabilities and to gain new technological capabilities.

The US companies participating in this RJV reported that their research objectives were met more completely than those of the EU companies.

Concluding Remarks

The study revealed several interesting insights. First, European companies have got extensively involved in the US-based RJVs examined. The more frequent participants from Europe tend to be larger companies that also have a significant presence in the EU Framework Programmes. The technological areas in which US RJVs with European participation are concentrated are broadly similar to those supported by the EU Framework Programmes. These results imply that, for larger European firms at least, the RJVs supported by the EU Framework Programmes should be viewed as one of the available mechanisms to reduce technological and market uncertainty and to access resources. Put differently, EU Framework Programme RJVs should not be exclusively considered as policy instruments to fill up a gap of otherwise unavailable R&D (market failure argument) –

One finding was that European participants often also have significant presence in the EU Framework Programmes, implying that the RJVs supported by the EU Framework Programmes should be viewed as a mechanism for reducing technological and market uncertainty and for giving access to resources

Table 4. SWRI Clean Heavy Duty Diesel Engine II Project (mean responses are shown, n=7)

Survey Statement	US	EU
My company participates in many research joint ventures (RJVs).	4.8	6.0
My company participates in many RJVs with participants from various countries.	2.5	5.0
My company participates in RJVs such as this one to enhance its domestic/regional competitive position.	5.0	3.0
My company participates in RJVs such as this one to enhance its global competitive position.	4.8	7.0
My company participates in RJVs such as this one to enhance its existing technological capabilities.	6.0	4.5
My company participates in RJVs such as this one to gain access to new technological capabilities.	5.3	4.5
My company's research objectives from participating in this RJV were met.	4.5	3.0

although this is a clear possibility for smaller firms and for technologies that are still far removed from the market. They apparently play a different role for firms of different sizes and types.

In order to continuously improve the design of Framework Programmes, it would be necessary to better understand how the supported collaborative R&D relates to the R&D companies undertake collaboratively with different partners and under different circumstances (e.g., non-subsidized collaboration) as well as to the R&D they undertake in-house. Our exploratory investigation of two RJVs revealed important differences in members' perception of objectives of R&D collaboration and the success of RJVs in meeting these objectives. An indication of positive correlation between well defined objectives of individual partners and the perception of RJV success could not be unequivocally substantiated due to the limited size of the sample. Apart from more extensive experience of EU-based companies in R&D collaboration compared to US-based companies, no consistent pattern was indicated by the mean responses of the surveyed RJV members on the basis of national characteristics (EU versus US) – again possibly because of the limited size of the sample. Further investigation of (a) the nature of related R&D projects that firms undertake through different mechanisms and with different partners, and (b) the perception of management regarding the way such projects inter-link and affect overall business success, would in our opinion be a worthwhile endeavour.

About the authors

Albert N. Link
is professor of economics at the University of North Carolina at Greensboro. His research focuses on science and technology policy and research evaluation, recently co-authoring Public Accountability: Evaluating Technology-Based Public Institutions (Kluwer 1998). He is also the editor of the Journal of Technology Transfer.

Nicholas S. Vonortas
is Professor of Economics in the Economics Department and in the Center for International Science and Technology Policy of The George Washington University, Washington, DC.

Keywords

research joint venture, collaboration

Notes

1. A.N. Link and N.S. Vonortas "Participation of European Corporations in US-Based Research Joint Ventures", June 11, 1999 (Report). The study was commissioned by the European Commission's Research Directorate under the supervision of the Commission's Washington Delegation.

2. The term entity is used generically to refer to all types of participants, including firms, universities, and other research organizations. Eighty-one percent of the identified EU entities are companies, fourteen percent are non-profit-making organizations (mainly universities), and the remaining five percent are government organizations.

Reference

- Hagedoorn, J., N.S. Vonortas, and A.N. Link., "Research partnerships", *Research Policy*, Vol 29, forthcoming 2000.

Contacts

Albert N. Link, University of North Carolina at Greensboro
Tel.: +336 334-5146, Fax: +336 334 5580, e-mail: **al_link@uncg.edu**
Nicholas S. Vonortas, The George Washington University
Tel.: +202 994 6458, fax: +202 994 1639, e-mail: **vonortas@gwu.edu**
Dimitris Kyriakou, IPTS
Tel.: +34 95 448 82 98, fax: +34 95 448 83 26, e-mail: **dimitris.kyriakou@jrc.es**

IPTS publications

- Gameson, T. Natural Resources and The Environment Panel Report EUR 18970 EN Jun-99
- Scase, R. (J. Gavigan, ed.) Demographic and Social Trends Issue Paper: Mosaic Living EUR 18969 EN Jun-99
- Mercer, D.(J. Gavigan, ed.) Demographic and Social Trends Issue Paper: The Future of Education in Europe until 2010 EUR 18968 EN Jun-99
- Coomans, G. (J. Gavigan, ed.) Demographic and Social Trends Issue Paper: Europe's Changing Demography Constraints and Bottlenecks EUR 18967 EN Jun-99
- Kyriakou, D., Císcar, J.C., Lievonen, J., Salo A. 1998 Techno-Economic Analysis Report EUR 18964 EN Jun-99
- Papameletiou, D. Study on electronic payment systems EUR 18753 EN Jun-99
- Münker, T., Sorup, P., Schmitt, A., Rosén, K. Life Sciences and the Frontier of Life Panel Report EUR 18743 EN May-99
- Fahrenkrog, G., Scapolo F. The Futures Project: Overview EUR 18731 EN Apr-99
- Ducatel, K. Information and communication technologies and the information society panel report EUR 18730 EN Apr-99
- Gavigan, J., Ottitsch, M., Greaves, C. Demographic and social trends panel report EUR 18729 EN Apr-99
- Bobe, B., Bobe, A.C., Gavigan, J. (ed.) Benchmarking innovation practices of European firms EUR 18726 EN Mar-99
- Bontoux, L. The incineration of waste in Europe: Issues and perspectives EUR 18717 EN Mar-99
- Heller, C. Tracking & tracing in trans-European combined road/rail freight transport: A comparison of the basic technological options: AEI, GPS, GSM and train-integrated systems EUR 18716 EN Mar-99
- Hemmelskamp, J. Wind energy policy and their impact on innovation - An international comparison EUR 18689 EN Dec-98
- Zoboli, R., Leone, F. (ed.) Implications of environmental regulation on industrial innovation: The case of End-of-Life vehicles EUR 18688 EN Dec-98
- Riesco, P., Zwick, A. (ed.) The challenge of climate change for water technologies: an institutional perspective EUR 18687 EN Dec-98
- Sørup, P., Romero, L., Tils, C., Wolf, O. (editors) Biocatalysis: State of the art in Europe EUR 18680 EN Dec-98
- Weber, M. , Board, A., Craye, P., Mathieu, M. Strategic management of sustainable transport innovations EUR 18679 EN Dec-98
- Gameson, T. Private sector methods for weighting environmental indicators EUR 18655 EN Nov-98
- Kyriakou, D., Císcar, J.C., Luukkanen, H., Salo, A. Technoeconomic Analysis Report - Baseline EUR 18134 EN Sep-98
- Aguado, M.A. Use of bibliometrics as a technology watch technique. Application to the analysis of the recent developments of the photocatalysis EUR 18131 EN Aug-98

- Moncada, P., Peinado, F.J., Aguado, M.A., et al. Feasibility study aimed at creating a regional bioenergy technological support centre for the diffusion and transfer of R&D results EUR 18120 EN Aug-98
- Neven, B., Schuber, R. (ed. L. Bontoux) Comparison of regulatory requirements for the notification of new chemical substances in the European Union, the USA and Japan EUR 18119 EN Aug-98
- Aguado, M.A. Evaluation of the socio-economic impacts of renewable energies: global survey to decision-makers EUR 18113 EN Jul-98
- Richards, MJ., Barham, PA., Oxley, PR. (Ch. Heller) Public transport in perspective EUR 18112 EN Jul-98
- Hemmelskamp, J. , Leone, F. The impact of EU regulation on innovation of European industry EUR 18111 EN Jul-98
- Gavigan, J., Hernández, H. SWOT Overview of Manufacturing Industry in Europe: Background to a European Strategy for IMS EUR 18103 EN Jul-98
- González, M. (Editor) 1997 IPTS Annual Report EUR 18062 EN Jun-98
- Zwick, A. Climate change research and policy: Updates n° 11. Recent results of global climate change research and assessment of carbon sequestration under the joint implementation scheme. EUR 18088 EN Jun-98
- Ribeiro, J., Spiewak, I. Desalination research priorities: a european survey EUR 18087 EN Jun-98 Vega, M. , Bontoux, L. Current activities and trends in plant biotechnology research in Europe EUR 18074 EN Apr-98
- Soria, A. Energy Technology Strategy 1995-2030: Opportunities arising from the threat of climate change EUR 18063 EN Mar-98
- Aguado, M.A. Importance of the socio-economic impacts of the renewable energies for the Southern Mediterranean countries. Weighting the impacts EUR 18061 EN Feb-98
- Aguado, M.A. The environmental impact of photovoltaic technology EUR 18060 EN Feb-98 Aguado, M.A. Socio-economic characteristics of the INTERSUDMED sites EUR 18059 EN Feb-98
- Waerras, G., Císcar, J.C., J. Leal, Aguado, M.A. The socio-economic impact of renewable energy projects in Southern Mediterranean Countries EUR 18058 EN Feb-98
- Císcar, J.C. Quantification of the socio-economic effects of renewable energy technologies in Southern Mediterranean Countries: and Input-output ev aluation EUR 18057 EN Mar-98
- Bessant, J., Rush, H.(J. Gavigan) Approaches to Benchmarking: the case of "framework conditions" and ICT-Os SPI.98.40 Mar-98
- Caratti, G. (ed.) Perspectives of development of partial-oxidation gas turbines for cogeneration EUR 17753 EN Jan-98

ABOUT THE IPTS

The Institute for Prospective Technological Studies (IPTS) is one of the eight institutes making up the Joint Research Centre (JRC) of the European Commission. It was established in Seville, Spain, in September 1994.

The mission of the Institute is to provide techno-economic analysis support to European decision-makers, by monitoring and analysing Science & Technology related developments, their cross-sectoral impact, their inter-relationship in the socio-economic context and future policy implications and to present this information in a timely and integrated way.

The IPTS is a unique public advisory body, independent from special national or commercial interests, closely associated with the EU policy-making process. In fact, most of the work undertaken by the IPTS is in response to direct requests from (or takes the form of long-term policy support on behalf of) the European Commission Directorate Generals, or European Parliament Committees. The IPTS also does work for Member States' governmental, academic or industrial organizations, though this represents a minor share of its total activities.

Although particular emphasis is placed on key Science and Technology fields, especially those that have a driving role and even the potential to reshape our society, important efforts are devoted to improving the understanding of the complex interactions between technology, economy and society. Indeed, the impact of technology on society and, conversely, the way technological development is driven by societal changes, are highly relevant themes within the European decision-making context.

The inter-disciplinary prospective approach adopted by the Institute is intended to provide European decision-makers with a deeper understanding of the emerging S/T issues, and it complements the activities undertaken by other Joint Research Centres institutes.

The IPTS collects information about technological developments and their application in Europe and the world, analyses this information and transmits it in an accessible form to European decision-makers. This is implemented in three sectors of activity:

- Technologies for Sustainable Development
- Life Sciences / Information and Communication Technologies
- Technology, Employment, Competitiveness and Society

In order to implement its mission, the Institute develops appropriate contacts, awareness and skills for anticipating and following the agenda of the policy decision-makers. In addition to its own resources, the IPTS makes use of external Advisory Groups and operates a Network of European Institutes working in similar areas. These networking activities enable the IPTS to draw on a large pool of available expertise, while allowing a continuous process of external peer-review of the in-house activities.

The IPTS Report is published in the first week of every month, except for the months of January and August. It is edited in English and is currently available at a price of 50 EURO per year in four languages: English, French, German and Spanish.

S.P.I.00.03

GK-AA-00-003-EN-C

The European Science and Technology Observatory Network (ESTO):
IPTS - JRC - European Commission
W.T.C., Isla de la Cartuja s/n, E-41092, Sevilla, Spain
tel.: +34-95-448 82 97; fax: +34-95-448 82 93; e-mail: ipts_secr@jrc.es

- ADIT - Agence pour la Diffusion de l'Information Technologique - F
- ARCS - Austrian Research Center Seibersdorf - AT
- CEST - Centre for Exploitation of Science and Technology - UK
- COTEC - Fundación para la Innovación Tecnológica - E
- DTU - University of Denmark, Unit of Technology Assessment - DK
- ENEA - Directorate Studies and Strategies - I
- INETI - Instituto Nacional de Engenharia e Technologia Industrial - P
- ITAS - Institut für Technikfolgenabschätzung und Systemanalyse - D
- MERIT - Maastricht Economic Research Institute on Innovation and Technology - NL
- NUTEK - Department of Technology Policy Studies - S
- OST - Observatoire des Sciences et des Techniques - F
- PREST - Policy Research in Engineering, Science & Technology - UK
- SPRU - Science Policy Research Unit - UK
- TNO - Centre for Technology and Policy Studies - NL
- VDI-TZ - Technology Centre Future Technologies Division - D
- VITO - Flemish Institute for Technology Research - B
- VTT - Group for Technology Studies - FIN

ENGLISH VERSION