The IPTS REPORT

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ABOUT THE IPTS REPORT

The IPTS Report, launched in December 1995 on the request and under the auspices of the Commissioner for Science, Research and Development, Edith Cresson, has now completed its pilot phase. What seemed like a daunting challenge in late 1995, appears now in retrospect as a crucial galvaniser of the IPTS energies and skills.

The Report has published articles in a number of areas, keeping a rough balance among them and exploiting interdisciplinarity as much as possible. Articles are deemed 'prospectively relevant' if they explore issues which are either not yet on the policymaker's agenda (but due to be there sooner or later), or aspects of issues which although on the agenda their importance has not been fully appreciated.

The thorough drafting and redrafting process, based on continuous interactive consultation with our collaborating network of institutes, which will progressively become even more involved in the process, guarantees quality control.

The first, and possibly most significant, indicator of success is that the Report is being read. Issue 00 (December 1995) - of which 2000 copies were printed in what seemed to be an optimistic projection at the time - has become a collector's item. Since then circulation has risen to 6000. Requests for subscriptions have come not only from all over Europe but also from the US, Japan, Australia, Latin America, N. Africa, etc.

The positive comments our efforts have received have been highly gratifying and the constructive and engaging criticism of our readership has formed part of the ongoing process of improvement. The comments we have received range from the informal, formal communications (in paper or electronic form), and take in as well as a Reader Survey commissioned by IPTS.

Readers' direct engagement with the content of the report's articles has led us to include a Letters-to-the-Editor section, which started in the June issue.

The rising esteem in which the publication is held is also making it increasingly attractive for authors from outside the Commission. We have already published contributions by authors from such renowned institutions such as the TNO in Holland, the VDI in Germany, the ENEA in Italy, the Council of Strategic and International Studies in the US, etc.

The Report is produced simultaneously in four languages (English, French, German and Spanish), by IPTS, to these one could add the Italian translation volunteered by ENEA (yet another sign of the Report's increasing visibility). 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.

We will continue to strive to meet the expectations of our very diverse readership, to avoid the traps of oversimplification, encyclopaedic reviews or the inaccessibility of academic journals. The key is to remind both ourselves and our readers, that we cannot be all things to all people: that it is important to carve out our niche and keep on exploring and exploiting it, hoping to illuminate topics under a new, revealing light, for the benefit of the readers, to prepare them to manage the challenges ahead.

Preface

The Institute for Prospective Technological Studies (IPTS) plays a central role in establishing technology watch at a European level. Nevertheless, at the launch of The IPTS Report (December 1995) I underlined the need for a support structure, as envisaged by the Council Decision of 15 December 1994.

The European Science and Technology Observatory (ESTO) network was formally constituted as one of the pillars of the IPTS' technology watch activities in January of this year.

ESTO is a network of fourteen European organizations, all with experience in the field of scientific and technological assessment at national level. Its main role is to collect, select and codify information relating to scientific events and developments with a view to alerting European decision makers. The members of the network therefore share the responsibility of supplying the IPTS with up-to-date and high quality scientific and technological information drawn from all over the world, and the network's broad presence and linkages makes it possible for it to do so.

The network also allows the production base for articles to be broadened and so the overall quality of The IPTS Report to be raised, whilst drawing on a yet wider reserve of different areas of expertise. It also contributes directly to the drafting of the annual report on European techno-economic intelligence. The synergism resulting from working in a network also permits the generation of reports on the technological challenges facing the Union today and those it will face tomorrow.

The management structure is flexible and efficient, and permits organisations outside the ESTO kernel to participate in network activities on the basis of partnership agreements.

The IPTS is responsible for driving and managing the ESTO network and gives the necessary guidance to the different phases of the tasks undertaken. It gives a European dimension to the final product, helps identify the principal S/T events and developments and ensures that the information is expressed in the appropriate terms and framed within the context of strategic options, such that it is appropriate for presentation to European decision-makers.

At the level of internal organisation, technology watch activities have been structured around thematic networks such as: energy-environment-transport; life sciences, information technology; regional development and employment.

I am firmly convinced that the European Science and Technology Observatory (ESTO) network, set up by the IPTS, part of the European Commission's Joint Research Centre (JRC), is the tool that the European Union needs to strengthen its technology watch activities, and that it will be able to serve as a reference at national level for research and its applications.

THE IPTS REPORT

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EDITORIAL

The first article in this issue examines the possible remedies for congestion on the Internet. The impact of congestion and the slowing, and even breakdown of communications is mostly felt by those who cannot afford to migrate to expensive Intranet, private net solutions, among them academic researchers for whose benefit the Internet was originally intended. The positive spill-overs from research as well as for other actors who could not afford the higher fees that might be necessary for use of the 'fast lanes' of the information highway justify the exploration of solutions to the problem The article presents the US approach (dubbed Internet II), a pricing-based solution (with subsidies when spill-overs justify them) as well as the ultimate technological bandwidth boosting solution.

The second article presents the revolutionary potential of 'smart cards' and a series of applications in which they play, or are projected to play, a crucial role. These include a wide variety of applications ranging from financial transactions to health information. Issues of transaction security and the need to see it in a broader social context are highlighted as are other concerns which need the attention of the policy-maker. In this context the impact of smart cards digital money on policy making (taxation, banking, monetary policy, etc.) should not be overlooked.

The next article puts forth a broader view of sustainable development -full sustainability- which includes socio-economic and cultural goals as well as the traditional environmental ones. The article's point of departure is the need for regional development in the EU and the efforts to reduce the development gap, within the context of pursuing full sustainability. It argues that although innovation and technological development are the keys to growth, these need to be rooted in the region's cultural and socio-economic context and not blindly follow pre-established models. Full sustainability offers a means of integrating these factors, respecting local conditions The article presents an example of a pilot exercise involving less-favoured regions of the EU and the criteria elaborated in the context of that exercise.

The fourth article looks at the possible effects of climatic change, in particular global warming, on human health. Apart from the direct impact of more extreme weather conditions, the movement of 'risk areas' characterised by the conditions favourable to certain diseases. This combined with the effects of migration and mobility means that these problems are not limited to certain parts of the world. Thus, there is no place for complacency about threats to public health, and prevention and monitoring programmes remain a priority.

The last article in the current issue highlights the importance of multidisciplinarity, as evidenced in the case of nanotechnology. Nanotechnology has potential applications in many fields, but may suffer from co-ordination problems, at times precisely due to its multidisciplinary character. There may be room for exploring the creation of a space with more flexible disciplinary boundaries, or potentially for a nano-technology specific multidisciplinary approach.

Internet: The Academic Network Revisited

Ioannis Maghiros

Information and Communication Technology 5

Issue: The last 5 years have seen the gradual commercialisation of the Internet and a doubling of the user population each year, but also notoriously slow data transmissions and even, from time to time, break-downs. The Clinton-administration has announced that it will spend $500 million in the next five years for the creation of a high-speed Internet network for large research organizations and universities - ostensibly the reason for which the Internet was originally created.

Relevance: Considering that the most probable future pricing model for the continuous development of the commercialized Internet is a pay-per-bandwidth-used model, raising 'fast-lane' costs to levels affordable by businesses but not necessarily by researchers, it seems reasonable to explore the needs of the European research community if they are to use a reliably and acceptably performing 'Information Infrastructure'.

Analysis

The Internet, the global 'network of networks' was for the first 15 years of its operation, and remains today still, largely uncontrolled, free of charge, with no hierarchy and adhering to no ruling body. The high-speed backbone (NSFNET) created by NSF (National Science Foundation) in the mid 1980's to connect the U.S. supercomputer centres was the platform through which university campus networks and/or regional networks were linked to form the Internet nucleus. The rapid adoption by its users, currently about 50% academic and 50% business and home, of the World Wide Web (WWW) 'browser' interface, accounts for its spectacular growth in the last 5 years. The main factors that enabled this unprecedented growth are:

(a) the plunging of the prices of the equipment required (switching computers);
(b) the global connectivity achieved through protocol and application interoperability;
(c) the resulting efficiency of the services provided through the use of this medium.

Nowadays the academic, commercial and regional backbones all over the world are interconnected, so that traffic may flow freely at the so called NAPs (Network Access Points). It is commonplace for countries that have slow or low quality infrastructure to route their traffic through the efficient U.S. Internet backbone. The flood of new users on the one hand and the 500fold increase in the network traffic[2] over the last 6 years (approx. 10% a month) on the other, account for the congestion that has resulted in unreliability and slow performance, earning the net the nickname the 'World-Wide-Wait'.

The number of Internet users, currently about 50% academic and 50% business and home, continues to grow rapidly and in part the World Wide Web (WWW) 'browser' interface accounts for this spectacular growth in the last 4 years

Table 1. Internet Growth

Internet Usage Growth	1985	1995	1996
Number of Domains	400	120000	448000
Number of Internet hosts[1]	1961	6.6 million	12.8 million
Number of European Web Users	non existant	4.2 million	9.6 million
Number of U.S. Web Users	non existant	11.5 million	27 million

Source Network Wizards Survey 1996 (ftp //ftp nfs net/nsfnet/statistics/history hosts)

The combination of a flood of new users and a 500fold increase in network traffic over the last 6 years has brought about the congestion that has resulted in unreliability and slow performance

The current pricing model is one in which organizations pay a fixed fee in exchange for an unlimited usage up to a given bandwidth

The effects of traffic congestion are negligible until usage is very close to total capacity when all network traffic quickly halts almost completely

Lack of Bandwidth: the problem

The Internet provides a connectioneless packet-switched service, allowing very efficient use of a given capacity by means of statistical multiplexing on the communication lines. The current pricing model is one in which organizations pay a fixed fee in exchange for an unlimited usage up to a given bandwidth. Since the network was mainly used for research purposes real-time aplications and high reliability of transmission were not a requirement. As a result without any incentive to economize on usage, and with the availability of relatively inexpensive equipment producing ever greater numbers of bits, congestion problems arise.

Although U.S. Internet backbone connections have considerably increased their capacities -from 1.5 Mbps / T1 lines in the late 80's to 45 Mbps / T3 lines in the early 90's- the ever growing numbers of network users and providers and the increasing utilisation of bandwidth-hungry applications have been overwhelming, precisely because the power of the workstations connected to the Internet is increasing much faster that the capacity of the Internet to carry traffic, and standard applications utilized over the network have evolved from text only e-mail and file transfer to multimedia presentations and videoconferencing. As a consequence the number of bytes that are produced and need to be transported[3] is steadily increasing.

Although increased bandwidth is fundamental to satisfying increased user requirements, other provisions are needed as well, because the effects of traffic congestion are negligible until usage is very close to total capacity when all network traffic quickly halts almost completely. In fact AOL (America Online) one of the biggest Internet Service Providers, with 8 million members, issues regular warnings to its users not to use the net at specific intervals per day, while spending some $350m upgrading its network. As it is almost certain that bandwidth demand will grow, available capacity both at the local access level as well as at the national/international backbone infrastructure will have to be carefully allocated.

The Research Community

More than 10 years ago the academic networking community was working on enabling access to the Internet to the whole of the research and education community. This move finally resulted in services becoming widely available to the whole of society, based on open standards, and offered by competing providers in a commercial environment. The Web, which also originated from research, has become the 'star application' that has brought the Internet fame. In addition Internet usage by the academic community has since been constantly increasing, as both the number of scientific users and the number of bytes transferred per user constantly increases[4]. The cost per user for the installation and maintenance of the campus LAN has therefore increased considerably.

The research community is not the only sector that could benefit from a high performance network infrastructure. Notably the health care sector and SME's, which are often considered to be the motor for economic growth and employment in Europe, could also maximize their efficiency through networking. However, the privatisation of the U.S. Internet backbone and the frequent clogging up of its commercial replacement have had a negative impact on academic research. Because on the one hand researchers were used to a level of service they are not receiving anymore and on the other their network services requirements have grown beyond those available today. Reliable high-speed services would make it possible for researchers to develop systems for distance learning, digital libraries and on-line collaborative research (virtual laboratories). The more researchers are expected to link their deliverables to the societal and economic needs, the more is at stake for society in general; ie. meeting society's environmental, energy, medical and education needs.

As delays, breakdowns and unreliable transmissions bog down users of what during the last 20 years has been the vehicle for academic excellence, private companies are setting up their own 'Intranet' and 'Extranet' networks, linking themselves with branches and partners and bypassing the public Internet. Enhanced commercialisation of the network raises the need for both service reliability as well as some means of prioritisation of different types of traffic. Therefore technologies that may provide solutions to the bandwidth limitation problem as well as various forms of usage pricing will become crucial.

Pricing and Capacity: the solution

If lack of bandwidth seems to be the problem then an almost free Internet can only intensify the problem. Analysts of the Internet such as economists Jeffrey Mackie-Mason and Hal Varian argue that flat-rate pricing is placing unacceptable congestion costs on the Internet by encouraging inefficient use of the net. Therefore a usage-based pricing system will bring in evidence the value a consumer places on a particular service. Prof. Varian's own preference for Internet pricing is a system that only charges for priority routings. Nevertheless any scheme to charge for Internet usage would also involve non-trivial metering and accounting costs. As such it could create network overheads and basically contradict the very 'connectioneless' model that the Internet supports.

A consumer bidding system, which would prioritize speed at which packets are transmitted, to be used on top of existing flat-rate pricing, may also be of use. Also in a world of many parallel global Internets, interconnected at NAPs, each one providing different levels of reliability under different pricing schemes the interaction between pricing and market structure will have important policy implications. Available and future technology implementations, such as iPv6, ATM, RSVP as well as different pricing model mechanisms should therefore be studied further. This should be done in close correlation with the desired objectives to be fulfilled for various service categories (reliable delivery of packets, traffic prioritisation, almost free model for delay insensitive transmission), while trying at the same time to preserve as much as possible the Internet's dynamic nature.

Both possible solutions to the lack of bandwidth problem ought to be considered; firstly enhancing the network's **capacity** (considering current and projected peak-time requirements)

The health care sector and SME's, often considered to be the motor for economic growth and employment in Europe, could also maximize their efficiency through networking and so could benefit from a high performance network infrastructure

Reliable high-speed services would make it possible for researchers to develop systems for distance learning, digital libraries and on-line collaborative research (virtual laboratories)

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The extensive use of optical fibre unburdened by any accounting switching schemes coupled with the latest technological breakthroughs in optical switching may allow virtually free bandwidth

The U S administration hopes that setting up an exclusive research network will pilot new technologies and service delivery models which may then be taken up by commercial Internet providers, who are reluctant to innovate unless they see demand

and secondly to refine payment and scheduling algorithms that may more efficiently handle bandwidth and then **charge users accordingly.** Capacity is expected to grow both by the creation of alternative parallel networks and by increasing the existing use of a mixture of transmission and switching technologies based on both copper wire and optical fibre. The extensive use of 'dark fibre' -that is optical fibre unburdened by any accounting switching schemes belonging to private and regional service providers- coupled with the latest technological breakthroughs in optical switching may allow virtually free bandwidth (see box1). The newly arriving wireless, digital satellite technologies could also be important especially in the local access loop.

Box 1. The all Optical Network

If optical fibre were to be used, operating a system called wavelength division multiplexing and access, the electronic bottlenecks could altogether be overcome as with sufficient physical bandwidth, it is possible to create virtual (not intelligent) switches. Nearly free bandwidth would thus permit a transparent communications medium in which temporary channel allocations allow virtual circuit-switching and thus enable performance guarantees. Full penetration of optical fibre into networks down to the level of local access is probable within the next 15 years. At present optical networks, like the ones created by IBM under the RAINBOW project, connect computers at speeds of 1 Gbps.

A Solution made in the U.S.A

The U. S. administration seems to believe that the particular problems facing the academic community could be solved through the development of a network, exclusively for research, segragated from the currently available Internet (see Box 2). It is anticipated that the major advantage of such a scheme would be the early adoption of the newly elaborated technologies and service delivery models by commercial Internet providers. This is even more the case since Telecommunications' providers have been proven to be very reluctant to bring technological innovation to the market unless there is sufficient demand for it -both critical mass of potential customers and applications in the demonstration phase.

Box 2: INTERNET II The Next Generation Internet

A group of more than 30 research universities and technology companies are developing a new worldwide computer network, which President Clinton recently stated (Oct.96) he intends to fund, with $500 million in federal money over the next five years. The Internet II project, as it is known, will bring focus, energy and resources to the development of a new family of advanced applications that foster collaborative research projects among researchers (similar to the Internet when it first started). The project will address the following major challenges:

a) create and sustain a leading edge network capability for the national research community

b) enable a new generation of applications that fully exploit the capabilities of broadband network - ie. media integration, interactivity, real time collaboration aiming at fulfilling distance education and lifelong learning national objectives

c) it will also allow the much faster transfer of new network services and applications to all levels of educational use and to the broader Internet community.

It should be noted that the Internet II capacity creating solution will be built in parallel to that already planned and implemented by the NSF known as vBNS (very high speed Backbone Network Service), which is expected to provide a core network operating at 622 Mbps (1997) for the research community.

In Europe the European Commission (DGXIII-B) is playing an important role in the exploration of the establishment and operation of the Pan-European Next Generation Internet Initiative, which could eventually become the nucleus for a future European Information Infrastructure. The assembled infrastructure could be valuable as a testbed for small scale trial networks resolving such issues as interoperability among heterogeneous networks and testing different pricing mechanisms that would guarantee appropriate levels of service for different types of applications.

Conclusions

It is generally accepted that basic research needs to be publicly funded in order to advance the knowledge that eventually may enable industry to create new commercialisation opportunities in unexpected ways. Furthermore public funding could ensure that suitable technology is developed in such fields as education or health where the social benefits maybe higher than the 'return on investment' that a private entrepreneur would be seeking.

The research community will then develop criteria, such as quality of service, security, and possible technical solutions, ensuring performance as well as a methodology for measurement and reporting during the operation phase. It will also develop a new generation of applications that fully exploit the capabilities of broadband networks - media integration, interractivity, real time collaboration- and nourish the industry of the future by assembling a critical mass of potential customers, as well as applications in the demonstration phase.

In the long run it seems probable that all-optical network technologies, once made available to the end-user, will provide almost free bandwidth. In the short run and in order to fight congestion a plan may be developed exploring both adequate pricing methodologies and technical solutions that will expand available capacity -as the European Commission is already doing. It could also be desirable to formulate projects that would kick-start the development of a commercially efficient European broadband infrastructure through joint University-Industry R&D programmes. If that is the case, then Industry itself could take a long-term view and consider bearing funding costs. After all, what they will be obtaining is the user-testing and 'debugging' of the commercial high performance network of tommorow. While this mechanism ensures the continuity of the network's future utilisation by the academic community, one has to also consider some form of long term access possibly by intelligently subsidising use.

In Europe the European Commission (DGXIII-B) is exploring the Pan-European Next Generation Internet Initiative, which could eventually become the nucleus for a future European Information Infrastructure

It might be desirable to formulate projects that would kick-start the development of a commercially efficient European broadband infrastructure through joint University-Industry R&D programmes

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Keywords

ICTs, Information and Communication Technologies, Innovation, Competitiveness, Internet Pricing, R&D networking, Intranets, Extranets.

References

- *'Pricing congestible network resources'*, Jeffrey Mackie-Mason and Hal Varian, 1994 http://www.sims.berkeley.edu/resources/infoecon/Pricing.html
- *'The Economics of the Internet: Technology is only part of the challenge'*, Jeffrey Mackie-Mason and Hal Varian, Dr. Dobb's Journal, 1995 http://www.virtualschool.edu/mon/ElectronicProperty/InternetEconomics.html
- *'Prioritisation In The Information Society: Efficiency and exclusion'* Dimitrios Kyriakou, *The IPTS Report* issue 03, 1996; http://www.jrc.es/iptsreport/
- *'Technology Policy Strategy: Between Research and Development'* Dimitrios Kyriakou, *The IPTS Report* issue 12, 1997; http://www.jrc.es/iptsreport/
- *'The Economics of the Internet: Too cheap to meter'* The Economist, 19 October 1996
- *'Clinton Proposes $500-Million Plan to Improve the Internet'*: The Chronicle of Higher Education; October 18, 1996; http://chronicle.com/

Notes

1- A host is a domain name that has an associated IP address record.

2- According to NSF statistics -NSF ran the backbone service until 1995- there were on average 198 million packets transfered per month in 1988, 8540 million in 1991, and 64353 million in 1994.

3- As an example, a single A4 page of text takes up an average 5Kb (0.005 Mb) of disk space, a black and white A4 image in 300 dpi (1 bit per pixel) takes up 1Mb of disk space, an A4 page in 24 bits color (3x8 bits) in 600 dpi requires 102 Mb of disk space.

4- The bulk of the increase in the exchanged volume is attributed to the exchange of multimedia data formats especially among social science discipline users as they deal with qualitative information more than with factual ones.

5- Notes on prof. Hal Varian's April 21, 1994 talk on Internet Economic, by James Love in TAP-INFO, 4 May 1994; listserver@essential.org

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Smart is beautiful

Alois Frotschnig

Issue: The new era of smart products is beginning to revolutionize every aspect of society with smart clothes, smart houses, smart roads, smart cars, smart TVs, smart telephones. 'Smart' here means products with built-in intelligence using a microchip. Smart cards are one of the enabling technologies of the late 20th century, and they are just beginning to take off.

Relevance: Smart cards are regarded as a particularly European technology and both the technology and its application were stimulated in Europe more than elsewhere. Europe has made an effort to keep its lead and is still promoting progress by implementing new programmes and calling for proposals (CASCADE/ARM, SOSCARD/CRISP, CAFE, ETS). New applications in commerce, public transport and health care will bring about widespread use of smart cards, however, steps need to be taken to avoid users being adversely affected by their shortcomings.

Analysis

Introduction

This article provides an analysis of (1) the technology (standardization, security, design, programming, manufacture), (2) its applications and trials, (3) the market (present use, perspectives for the future) and (4) the issues (economic issues, organizational issues, psychological problems, social issues) associated with smart cards, including the security, privacy, legal, regulatory and economic impact of smart card applications. It is important not to be complacent about our ability to keep up with this technology, and to keep in mind the basic need to reassess security and policy assumptions, in particular given that the security offered by smart cards, although high, is not total.

This fact needs to be addressed by asking, in accordance with security policies, for limits to be placed on their applications. This includes quantitative limits (maximum values/times for card transactions) as well as qualitative limits (avoiding the control of transactions involving high monetary, commercial, social, or other values by a smart card alone).

What is a smart card?

The idea of using a plastic card as the support for a microchip was developed by Jürgen Dethloff in 1968. The concept of using a personal identification number to secure information on the chip led to the invention of smart cards by Roland Moreno in 1974.

The type and size of memory available distinguishes smart cards from other plastic cards. Read Only memory (ROM) is the lowest level memory type used on a smart card and contains the operating system for the card. Random Access Memory (RAM) is capable of interacting with a terminal during a transaction but the contents are

The fact that smart cards are not totally secure needs to be addressed by placing quantitative and qualitative limits on their use, particularly for sensitive data

Smart cards consist of a microchip mounted on a plastic card The microchip contains a processor and different types of memory for permanent and temporary storage of data

Multifunctionality allows the smart card to be used for more than one application and by more than one organization

Box 1: What Can the smart card Do?

Information can be freely distributed via a smart card, and yet only accessed by the people who are authorized to do so. Access to the information on the card can be controlled by the card and information issuer. Depending on requirements, the information can be accessed in one or more different modes:

• Read only

Once loaded, some information held on the smart card can only be read. The information is fixed, as in a book, such that information cannot be added, modified or erased. This information contains a unique number for each card, the number of units on the new card, and an indication of who manufactured it. This information is easy to read, but cannot be modified in any way.

• Add only

Some information held on smart cards can only be added to, just like engraving on a stone. Information can only be added while there is still room and once added it cannot be modified or erased, though it can be read. Units are used on a telephone card in this way; information is added, just like ticking off boxes. When all the boxes are ticked, no more units are left. Ticks can only be added and never erased, so nobody can refill the card.

• Modify or erase

Some information held on smart cards can be modified or erased like writing on a blackboard. This also implies that information can be added while there is room.

• No access

Some information held on a smart card can never be accessed. This information is stored in a security kernel. While this might appear rather useless, it is necessary for smart cards to be able to carry secrets that can never be revealed outside the internals of the card. On-board security and password processing are examples of this type of access. By means of careful use of passwords it is possible to avoid misuse of information, either by mistake or intentionally. Another example of this is that of digital signatures, whereby access is prevented so as to avoid the risk of misuse.

not retained once the card is removed. The most sophisticated memory type is Electronically Erasable Programmable Read Only Memory (EEPROM) which is used for permanent storage of application data. EEPROM is reusable and, at the moment, up to 8 Kbytes are available on the card.

Multifunctionality allows the smart card to be used for more than one application and by more than one organization. For example, a payment card issued by a bank could also be used as a loyalty card for a department store. Nevertheless organizational and security related issues may limit multifunctional applications: access control for sensitive data is embedded in a different application context than that for drinks vending machines, and therefore requires a certain level of security which the other context is not able to provide. Apart from the technical issues a pragmatic obstacle to multifunctionality is the limited space available for advertising on the smart card.

At present, there are two types of smart card in operation. The intelligent card has a central processing unit that allows for 'read and write' capabilities (ie. monetary value can be incremented and decremented as required). The memory card contains stored value which is decreased as the user makes transactions. Some smart cards are smarter than others. The simplest cards, such as payphone cards, are smart enough to be virtually impossible to copy or falsify, but offer no protection in the case of loss. Other smart cards have one password to restrict use to one person or machine, and the most sophisticated smart cards manage several applications and passwords and use authentication and ciphering techniques to combine total freedom with total security.

Security issues

Current outstanding market growth in both security applications and cryptocontroller-ICs underlines the significance of security aspects in modern information technology. This means security functions have to be at the core of future IT-products. However, different applications require different levels of security, and of course, there is no technical system in which absolute security can be guaranteed.

The basis to ensuring effective protection against manipulation of chip cards is given by well coordinated efforts involving:
(a) hardware security (physical means),
(b) software (operating system) security and
(c) system security (by means of intelligent communication between card, reader and background system). So security becomes a dynamic process changing over time. Furthermore it has to be taken into account that the overall level of security is only ever as good as that of the weakest element in the chain.

On the basis of the four points from which an attack may be directed -environment, operating conditions, functional requirements, security requirements- four security threats can be identified:
(a) loss of authenticity,
(b) loss of integrity,
(c) loss of confidentiality, and
(d) loss of availability. The fact that smart cards are coming into regular use despite their not being immune to aggressive analysis calls for application limits to be established in line with security policies. This includes quantitative limits (maximum values/times for card transactions) as well as qualitative limits (not

Smart cards come in a variety of types, and some are 'smarter' than others

A high level of security is achieved by coordinating efforts at the level of hardware, software and systems

Box 2: Contact-, Contactless-, and Combi cards

Smart cards are plastic cards - much like credit cards - that have a microchip embedded in them instead of a magnetic stripe attached to the back. This chip allows the card to replace or supplement the information on the magnetic stripe. Actual computations are made 'off-line' on the smart card (using stored power drawn from the controller) for any number of applications.

Not only are applications on the increase, but so is performance and convenience. Rather than having to insert the card into a reader (eg. in an automatic teller machine (ATM) with **contact cards**), it could become possible to just wave it near a controller (a box smaller than a pocket dictionary) to complete a transaction. The data is transferred back and forth using a radio signal so fast that all the elements of a transaction are completed in a split second. This new technology is known as the **contactless smart card.**

Another variant, the **Combi card** makes use of both technologies and is therefore compatible with each kind of terminal infrastructure.

Typical applications of contact cards are electronic purses/wallets and the telephone card (for which there is an existing infrastructure), whereas the contactless card is typically used in transport applications for fare collection (speeding up the boarding process). With the combi card both fields of applications are open to the card.

For electronic wallet applications it might be important from a psychological/security-perception point of view to use contact oriented technology. The combi card seems to be the best vehicle to lead from contact to the forward looking contactless technology.

A proliferation of different cards, each with a new PIN to remember, is inconvenient for users

controlling transactions with a high monetary, commercial, social, or other value by use of a smart card alone).

The User Interface

Although smart cards still have a long way to go in the struggle for acceptance, there are still obstacles with basic procedures, such as handling PIN codes. First of all, having too many PIN codes to remember for different cards is an obvious annoyance. This can be circumvented by:

- Letting the card-holder choose his/her own PIN codes. This is technically easy, although it usually reduces security, as users pick codes that are easy for them to remember, and consequently easier for attackers to guess.
- Reducing the overall number of cards in the consumer's hands. Co-branded and multi-application cards will help reach this goal. However, as commercial obstacles usually hinder the ability to group multiple applications on a single card, some compromises have to be found as to the appropriate clusters of services which makes sense on the same card (see also the remarks made above about multifunctionality).

Biometric identification is one possible way forward, but the current technology implementable within the limits of a smart card is not foolproof

Also, entering a PIN code obviously requires a keyboard, which the elderly and disabled are often uncomfortable with. Things get worse when devices are miniaturized, such as electronic wallets or in portable phones. Other interfaces, such as voice-control, are being investigated: human interfaces can be specifically built around voice input for portable devices and other apparatus where the classical screen-mouse-keyboard interface is irrelevant.

Voice can also be used as a **biometric identification** feature. The waveform characteristics of a voice signal can be used to positively identify the genuine card-holder. For privacy and security reasons biometric recognition must be handled locally by the smart card. The 'template', ie. the user's biometric reference pattern is one of the secrets to be held permanently in the card's memory. Apart from voice there exist other dynamic biometric methods such as signature recognition, as well as static methods like finger prints and eye recognition. These features have to be looked upon very sceptically due to the well know fact that their success rates in identification and verification processes are less than 100%; In particular a person's biometrics, such as voice, may vary over time.

Applications and trials

Smart cards have found widespread use in public phone systems around the world. More than 50 countries currently use smart cards in the form of a prepaid phone cards. Smart cards are now expanding into other areas such as health care, banking and transportation. The applications available to smart card users vary with the type of card held. A smart card with memory only has a more limited set of applications than one with a microprocessor. Smart cards are used in the applications listed below:

Telecommunications

Pre-paid telephone cards reduce fraud (compared to magnetic stripe cards), theft and credit losses; lower maintenance costs and reduce coin handling costs. Additional revenue is also generated through advertisements on the card and unspent values. In Germany there is a telephone card available which can be reloaded after use.

There are currently 850 million telephone cards in circulation worldwide -these cards have a simple memory with no processing function. The reasons why prepaid telephone cards are smart cards is because of their simple reader construction, elimination of cash handling problems, lower maintenance, lower reader costs, and the potential for multi-application payphones.

Digital Mobile Communications

Mobile telephones using 'Global System for Mobile Communications' (GSM) networks need to be equipped with a smart card identifying the user. This smart card, known as a SIM (Subscriber Identification Module), can be full size ISO-standard cards or a plug-in version consisting of just the chip surrounded by a few millimetres of plastic. The SIM is unique to each individual user and can be transferred between telephones to give them the same identity and telephone number as assigned to the subscriber.

Finance

A payment card authorizes the transfer of funds from the purchaser's account to that of the vendor. The high security levels which can be achieved using a smart card make this an attractive alternative, reducing the fraud made possible by magnetic stripe cards. A significant movement towards smart cards in banking is projected for 1997, the date set by the main international card issuers - Europay, Mastercard, and Visa (EMV) for issuing their first smart card onto the market. In Germany users of electronic purse cards issued by banks are already facing the problem that there are not enough devices for card processing installed at retail outlets. One major issue will be the considerable change required, as there are an estimated 1 billion magnetic stripe cards, 300,000 automatic teller machines (ATMs) and 6 million EPoS (Electronic Point of Sale) terminals worldwide

With 850 million cards in circulation, telephone cards are the biggest current application of this technology

GSM digital telephone networks use a smart card to uniquely identify each user, thereby offering flexibility and security

Box 3: Zolotaya Korona (ZK) Trial - Russia

Zolotaya Korona, operating in Russia with 120 banks, 200,000 cardholders, and 100,000 weekly transactions over the last a year and a half, is one of the largest Bank Smart Card Payment Systems in existence. The installation comprises 4,500 locations of PoS (Point of Sales) terminals, automatic teller machines (ATM), with self service terminals and local bank branches.

Within the system more than 10 types of smart card and associated products are issued (debit card, credit card, medical insurance card, pension fund card, filling station card). Moreover, the smart card system allows participants to promote new smart card-based financial services independently, one of which might be a bank owned currency. Also large industrial enterprises use these cards to transfer the salary of employees directly onto their smart card account, and thereby create a payment method for them. Employees can then purchase at ZK locations throughout Russia.

Plans to store medical data on smart cards has given rise to concerns about privacy and validation

Standardization is essential if interoperability is to be possible and maximum benefit achieved

Health

The use of personal health data is a very sensitive issue, users need be fully convinced that warnings of the 'transparent patient' are unfounded. The risks of health cards are difficult to assess, although supporters outline the many benefits such as reduced administrative costs and better patient care achievable with the availability of accurate information. The latter, however, is also a potential area of criticism because information in the form of plain data may give rise to new and as yet undiscussed problems for doctors, such as defining areas of responsibility: what parts of a card do they have to know about in order to prescribe correct treatment? Other uncertainties touch upon the issue of emergencies and the use of biometric functions, such as the possible difficulties in deciding if an unconscious patient has his/her own or somebody else's card in their pocket.

An analysis conducted by the European Commission (EUROCARDS action) has shown that in many European countries considering the introduction of smart cards in their health care systems, the card is not seen as a stand-alone element, but as an enabling technology for a more global communications system. EUROCARDS recommends the following priority levels for implementation:
(a) Administrative cards for administration purposes,
(b) Health care professional cards,
(c) Emergency cards, and (d) Patient cards.

Smart cards are, as indicated above, a key to the exploitation of telematics in the field of medicine. Interoperability between health card systems is intended 'to enable administrative and emergency clinical information stored on different health cards to be read by health professionals using different computer hardware and application software'. This is one of the concerns of G7 Global Health care Application Project.

Existing health card applications prove the administrative benefits of using information for patient identification, social security, health care insurance, etc. in Europe, in particular in Germany and France. The smart card is seen both as a key with which to access the existing telematic infrastructure, providing the necessary user identification and security requirements, and as a medium able to supplement and integrate the existing physical infrastructure for data transfer, where the carrier of information is the person holding the card and moving from one point of service to another.

Transportation

There are various applications of smart cards (mostly of the contactless variety) within the transport industry which will bring benefits, at different levels, for its operation.

- Smart cards are used to pay for parking meters and to identify the authorized occupant of resident parking spaces. With the introduction of toll roads, smart cards will be used to record and pay for travel along these routes.
- Road tolling trials are have started. Further trials will involve electronic devices fitted to vehicles which can be read without drivers needing to stop at toll points. Payment options range from prepaid accounts to post payment billing. Several of the schemes involve smart cards for ID and payment.
- Smart cards are also being used in public transport because they speed up boarding, and because less cash on buses means less crime. Magnetic stripe tickets are much more prone to fraud than smart cards.
- Smart cards are also being used in the airline sector for checking in, ticket vending machines, air miles, and other gratification programmes, as well as for use of in-flight telephones.

Box 4: Contactless smart card Technology in Seoul

The Seoul Bus Union, which represents 89 bus companies, is currently the world's largest user of contactless smart card technology. In all 8,700 buses are using contactless smart card terminals, and about 1,700 card reloading stations have been installed. By early January '97 the number of contactless bus cards issued in Seoul had already risen to 2.5 million with approximately two million transactions per day.

The fully operational system has already been extended to the surrounding Kyung Ki Province and the Korean island of Cheju. There exist plans and trials extending the functionality of bus cards to Seoul subways, ID, access control, retail and customer loyalty schemes, and an estimated 10 million cards will be issued within next 12 months.

The market

There is evidence that the widespread commercial use of the smart card is growing dramatically. Up until the year 2000 Europe will lead the market with more than 40% of the market. After 2000 the European, north American and Asian (including Japan) market regions will share the market equally, with around 30% each.

Considering the market on an application-by-application basis, prepaid telephone and mobile communications, payment segment and health care and pay TV are predicted to be the leading areas in the year 2000. Market studies predict telephone and mobile communication, the banking and health care sectors as the main application fields.

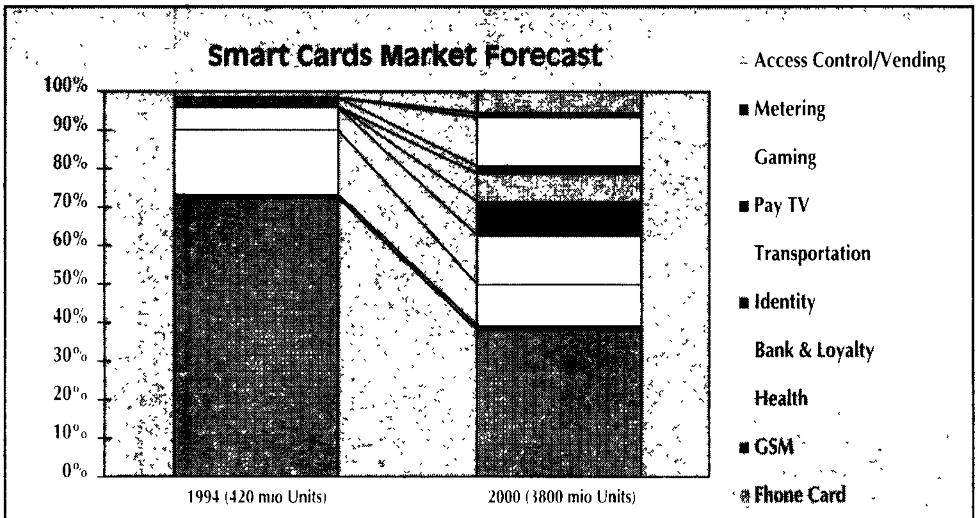
Remaining Issues

Society

Smart cards have the potential to exert a very strong influence on society: there are critical discussions about applications systems in health

Smart cards, particularly of the contactless variety, are finding use as a means of payment for public transport systems

Figure 1: Future Market by applications



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Public concern over who has access to data and what use can be made of it needs to be addressed if smart cards are to be widely accepted

One approach to privacy is the use of pseudonyms This technique means that information is related to single individuals, but the identity of these individuals is not known by those who have access to it.

The consequences of widespread digital money for national currencies could be far-reaching and need to be discussed

care (patient representatives oppose the patient card), and the electronic wallet (consumer groups are debating them) At the same time industry observers agree that a revolution is taking place in consumer information systems. Internet, which itself has opened up a debate on many topics (eg. electronic democracy, tele-education) is also a potential application of smart cards, both for charging and for access control.

The public has to be involved in a broad discourse right across society, in particular during the trials which are being defined within new application fields. The Danish Board of Technology has shown how to launch projects to assess the overall possibilities and consequences of technological development through providing an impetus to the popular debate on technology.

Data protection and the user

Concerns about privacy issues in smart card applications, particularly with respect to access to personal data, have been expressed by various stake-holders. In particular all kinds of 'data tracks' (ie. traces of financial or geographical movements registered using communications technologies) produced and data stored concerning users need to be acceptable to them. Can the bank or any card issuer produce your 'shopping profile', your 'movement profile', or can insurance companies create 'patient profiles' of their members?

The extraordinary advantages of the ICT 'revolution' will be valueless if appropriate measures are not put in place in order to protect privacy. The overall goal for implementing any tele-services will be to restrict personal data as much as possible. Smart technology is not tangible in the traditional way, thus it is essential that the infrastructure be created that builds user confidence.

One possible approach -but by no means a total solution- would be to render it impossible to follow data tracks by using the concept of a pseudonym. This technique means that information is related to single individuals, but the identity of these individuals is not known by the person or persons who have access to it. So the card issuer would be able to process the data, eg. to calculate the costs of the health system, but is not allowed to access to the full set of person-related information. Electronic pseudonyms can still be made secure in terms of certification/authenticity by using electronic signatures (either with a 'Trusted Third Party', or a 'blind signature').

Digital Money - Private Money

The development of information technology and data communications have led to increased opportunities for creating electronic services for business purposes as well as to the possibility of replacing traditional paper documents with electronic ones. Digital money can be stored on or created with several kinds of smart cards thereby replacing cash. Spending digital money from the smart card might be done sitting at a computer connected to the Internet.

Digital money raises yet another important issue: namely, who has the right to 'print' money, ie. who ultimately authorizes the digital 'Euros' that go onto the smart cards. In addition to the analogy of a coupon-based economy, digital money has the potential for transactions using microcurrency (ie. units of money smaller than any standard monetary unit). Would smart cards be able to become the vehicle for a single, global currency, and at the same time become specialized and differentiated for specific products such as Web pages? Does digital money offer new opportunities for criminals who want to launder their illegal funds? Moreover, how might existing currencies be affected by the emergence and adoption of digital money? Digital money has great potential for bypassing the transaction costs of the foreign-exchange market, perhaps generating the risk that digital money, using the vehicle of smart cards, could create its own grey market once it is no longer denominated in equivalents of national currencies.

Keywords
ICTs, Information and Communication Technologies, smart cards, Digital Money, Health Care

References

- Posch, R.: *Security in the Global Information Infrastructure.* Internal Report for IPTS, November 1996.
- Kaplan, J. M.: *smart cards. The Global Information Passport.* International Thomcon Computer Press, Boston, 1996.
- FIFF Kommunikation (Computer Professionals for Peace and Social Reponsibility): *Chipkarten.* Marz 1996, 1/96.
- Fluh, M. (Hrsg.): *Die Chipkarte: Eine Welt der Moglichkeiten.* Konferenzdokumentation OMNICARD 1997, Berlin, 15.-17. Januar 1997
- Smart card market forecasts: *http://www.cardshow.com/statistics/uk/gemplus.html*
- EU/G7 Healthcards - WG7 - Interoperability of Healthcard Systems: General Concepts. Prepared by D. Markwell. Website: *http://www.compulink.co.uk/~cic/euhci.htm*
- The Danish Board of Technology: *http://www.ingenioeren.dk/tekraad/*

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Technology deficits and sustainable development in Less Favoured Regions of the EU

James P Gavigan, Cecilia Cabello, François Farhi

Issue: The challenge of reconciling sustainable development ideals with the pragmatism of regional development policy may seem like a vain and unnecessary intellectual distraction. However, as the EU strives to narrow the development gap - and the even larger technology gap - between the most and least developed regions of the Union, an elaborate and differentiated policy framework for sustainable regional development may be precisely what is required to give new élan to the drive for cohesion. This article reports the results of some recent exploratory work carried out on this theme in an attempt to open the debate.

Relevance: The proliferation of policy actions invoking only certain, mainly environmental, notions of sustainability, calls for creative thinking and rigorous experimentation to see how the concept in its complete interpretation - carefully balancing economic, socio-cultural and environmental aspects - can be meaningfully incorporated into policy making at local, regional, or indeed any spatially limited reference level.

Introduction

The all-encompassing, though vague, definition of sustainable development given in the Brundtland Report (WCED, 1987) has meant that ever since, the notion has primarily been viewed and acted upon in a rather restrictive manner, mainly in terms of its environmental preservation aspects (global warming, resource management and depletion, etc.):

In essence, sustainable development is a process of change in which the exploitation of resources, the direction of investments, the orientation of technical developments and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations... (It) is development that meets the needs of the present without compromising the ability of future generations to meet their own needs,

Despite the fact that the theoretical discussions of the broad notion of sustainability continue behind the scenes (Kyriakou, IPTS, 1995), and policy actions like the EU's Fifth Environmental Action Programme -the Sustainable Cities initiative- and parts of the RTD Framework Programme purport to espouse the full extent of sustainability, the ways in which such initiatives are perceived is heavily marked by their essentially ecological/ environmental origins. As a result, many politicians and policy makers from other spheres, remain inculcated with an impression that sustainability is largely something of an intellectual luxury, and this, notwithstanding high-profile statements such as the new development model advocated in the Commission's 1994 White Paper.

Instead of an add-on feature of development to be grudgingly taken care of, sustainability in its full, complete, interpretation should be understood as an integral part of the foundations of development. To put it schematically, the full conception of sustainability implies that development will not be achieved in spite of, but rather in tune with and thanks to, sustainability.

It is thus rather unfortunate that, in the area of regional development policy, for example, where economic, social and environmental considerations have to be considered necessarily hand in hand, the full extent of complete sustainability thinking has failed so far to make significant inroads. The aim of this article is to try to open up a way into thinking about this issue by proposing a tentative framework based on criteria sets with which to assess the complete sustainability characteristics of technology and innovation-centred development initiatives in Less Favoured Regions. The ideas were elaborated around case-study work carried out for the agri-food industries in Andalusia, Ireland, South Brandenburg and Central Macedonia (CM International, IPTS, 1996) and were intended to stimulate further discussion rather than be operational.

The regional development context in the EU

Regional development policy in the EU is driven by the desire to establish converging levels of income and financial well-being for all citizens across the Union. However, the recognition that income is just one, albeit important, quality of life determinant, tempers the extent to which the rationale of income indicators should prevail in this endeavour. The challenge for policy is to find ways to instigate viable economic activities which generate wealth locally, which enhance local (not only cost-based) competitiveness, and which are compatible with the culture, customs and ethical values of the communities concerned.

The statistics which reveal the income gap between rich and poor regions, and the even wider technology gap (in terms of R&D and technology spending), have rightly focused increased attention on the role of technology in successive phases of the EU Structural Funds programmes. This has evolved from an emphasis on R&D and related infrastructure, to the currently emerging more rounded emphasis on innovation. Given that 'technology and innovation' are social constructions, and at the same time are the primary vectors of development, they provide the most appropriate focus for policy to encourage development initiatives from the ground up, with the guarantee that they will be more firmly embedded in the local / regional socio-economic system and culture.

Steps in this direction are also clearly consistent with the desire to preserve and build European international strength on the back of its deep and rich cultural and demographic diversity. Thus, recognition of the impracticality of applying a single innovation model across Europe can move the regional development perspective away from a monocentric to a more polycentric one. This, in turn, allows for the most appropriate development model and innovation system to emerge for each region or collection of regions.

Integrating sustainability

If the success and popularity of the Regional Innovation Systems[1] scheme run jointly by DGs XIII and XVI of the European Commission is

The notion of sustainable development has tended to be understood only in environmental terms, ignoring its social and economic dimensions

Pilot case study work has been carried out for the agri-food industries in a number of Less Favoured Regions

Regional development policy needs to find ways of enhacing local competitiveness that are compatible with local values

Technology and innovation are social constructions, hence the logical policy focus for ground-up development initiatives

Policy actions should avoid falling into the trap of equating regional development with simply universally imposing the development model evolved in the more industrially advanced regions

In the IPTS study a number of criteria sets were drawn up as part of a pilot exercise to study past, present and possible future technology and innovation initiatives

anything to go by (regional authorities from 40 different regions are currently engaged in this exercise), the above rationale captures well this heretofore latent need. However, in this light, perhaps the following critical question needs to be all the more carefully considered:

To what extent is the deployment of this action still marked - implicitly or explicitly - by the vision of implanting 'THE' business and innovation model that has proven its value in the industrially advanced regions of the EU?

Indeed, a similar but broader question might be posed in relation to the full set of the EU's regional policy actions. This serves to highlight the fact that approaches which are too marked by the vision of some uniform 'harmonised' or 'standardised' model, can easily miss the opportunity of tying the development of a region to its principal differentiating assets - the people, and their culture, traditions, strengths, etc. In our view, an attempt to capture some measure and balance of the three dimensions of complete sustainability - environmental, economic and social - can provide this missing input Moreover, starting from a 'regional' rather than a 'global' perspective, is conducive to a differentiation of approaches to sustainable regional development, which is what would be required to reflect regional diversity and context variability. But how might one proceed?

A recent IPTS technical report (M. Weber and G. Fahrenkrog, IPTS, 1996) identifies four policy strategies by which future technological change could be directed towards sustainability:

(1) a technology driven strategy;

(2) a demand-oriented and regulatory based strategy;

(3) a strategy addressing context conditions; and (4) a strategy based on criteria and procedures guiding decision-making. What follows below is a description of a preliminary attempt at a criteria-based approach (an example of the fourth option), which seemed to be best suited to the aim of the pilot study in question, of obtaining some overall full 'sustainability' measure of any given technology initiative - be it completed, underway, or planned.

Sustainability Criteria - a proposed approach

The following criteria sets were drawn up as part of a pilot exercise in a study of past, present, and planned, or possible future, **technology / innovation based initiatives** to develop the agri-food sector in four very different less-favoured regions (so-called objective 1 regions) of the EU - Andalusia, Ireland, Central Macedonia, and South Brandenburg (for full details see CM International, IPTS, 1996). The intention was to establish a framework for 'benchmarking' certain direct and indirect effects as well as contextual conditions, in order to **demonstrate to the policy maker through example how it might be possible to evaluate the complete sustainability characteristics of a given technology / innovation initiative through a three-way economic, environmental, and social optic.**

The criteria framework set up was based on a two-fold assessment at three different levels as depicted in the figure (Fig. 1).

The starting hypothesis was that sustainable development is only possible if based on successful long term economic performance at the firm level, and specific, reliable competitive strengths at the regional level. On this basis, adequate consideration was afforded to social and ethical level sustainability criteria such as minimising pollution or improving social relations within society. This led to a radical departure from the more usual 'global - long term, environmental' starting point for sustainability considerations, to a more bottom-up approach.

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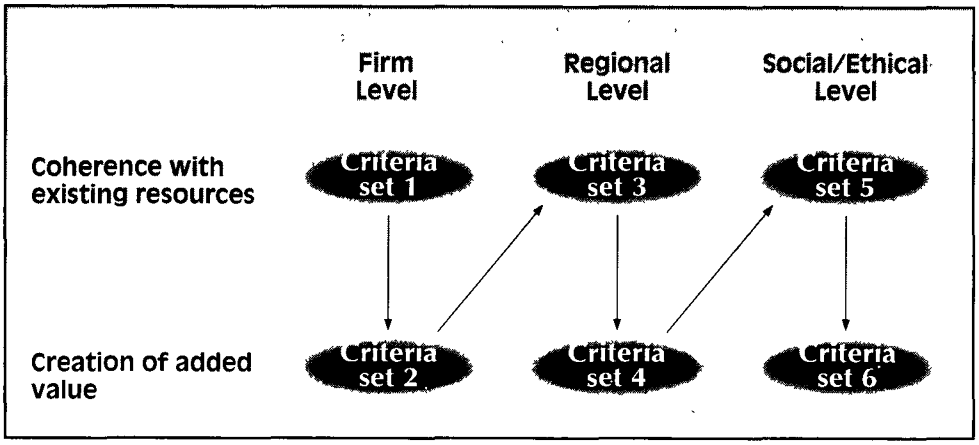
Figure 1: Future Market by applications



Thus, the chosen sustainability criteria assessment path began with the 'firm', and then moved to address issues at the more aggregate levels of the 'region' and 'society'. At each level a distinction was made between criteria of a more static nature - i.e. those designed to assess the level of coherence and compatibility of the technology / innovation initiative with the existing resources, and the use made of them, including those resources available within the company / region, and the external resources and competencies the company / region is capable of mobilising - and those criteria capturing more the dynamic effects - i.e. to assess the contribution of the initiative to the creation of added-value, in terms of its contribution to a cumulative process of resource and competence development, improving the receptiveness of a firm, the impact within a firm / sector, or the potential spill-over effect on other regional firms / actors.

At the **firm level**, the criteria should assess the appropriateness of a given technology / innovation initiative to the given capabilities of a firm, and the potential for improving its competitiveness (see Box 1).

At the level of the **region**, the proposed assessment scheme was designed to focus on the contribution of the technology / innovation initiative to the overall development of the region or to reshaping its comparative advantage, taking the latter to involve not only resource endowments, but also to include the stock of knowledge, the socio-cultural behaviour, and the propensity to initiate business and innovate (see Box 2).

Finally, at the **social and ethical level**, the proposed criteria should reflect how the technology / innovation initiative responds to the desire to maintain and enhance both current and future potential to satisfy societal needs at a more macro level. This includes the more usual environmental and societal sustainability concerns (see Box 3).

Lessons Learned and Conclusions

In the exploratory study undertaken, the above sets of criteria themes were used in a qualitative way without developing the quantitative benchmarks or indicators which a more rigorous study would require. Firstly, a retrospective assessment was made of the inventory of technology/ innovation initiatives made for each of the regions. Most of the initiatives were shown to have had as an explicit objective the 'overcoming' of short term immediate technological constraints, which, while satisfying the 'coherence' side of the

The starting hypothesis was that sustainable development is only possible if based on successful long term economic performance at the firm level, and specific, reliable competitive strengths at the regional level

At each level a distinction was made between static criteria, such as resources, and dynamic ones, such as the accumulation of know-how

In the study the criteria themes were used qualitatively, with the aim of pinpointing issues rather than finding definitive answers A more rigorous study would require quantitative indicators

Box 1: Firm level

Criteria set 1 - *Coherence with the existing resources of the firm* - was interpreted as primarily concerned with the firm's innovative capacity in terms of technology resources, human resources, financial resources, organisational and management capabilities. The proposed themes for criteria were:

- adaptation to the firm's current technology portfolio
- capability and competencies of human resources
- availability of the financial resources necessary for innovation
- organisational culture and interrelations between people within different areas of activity
- networking and relationships with clients and suppliers
- manager's vision or strategy of the future business and competitive strengths of the firm

Criteria set 2 - *Development of the competitive position* - the firm's ability to develop and apply new knowledge through a cumulative learning process assessed through measures of:

- effects on internal learning and/or organisational process
- improvement of external networking and partnership potential
- acquisition of embodied technological competencies which can be diffused within the firm
- introduction of new development and technical competencies (hiring technical expertise)
- learning the use of complementary assets such as innovation management techniques

Box 2: Regional level

Criteria set 3 - *Coherence with the innovative capacity of the region* - reflecting the innovative capacity of a region in terms of the R&D infrastructure available, internal and external networks between private and/or public actors. Furthermore, the innovative environment of a region was considered to be based on the economic, political and institutional relationships which in turn generate a collective learning process that may trigger diffusion of knowledge and best practice. Five main criteria could be taken as key measures of the innovative capacity of a region:

- availability of Research and Technology competencies (RTD centres)
- availability of support organisations (innovation -awareness centres -project management, training,...)
- availability of complementary resources (suppliers, innovation -management specialists - financing resources)
- entrepreneurial culture (the level of regional identity, collective confidence,...)
- openness of the regional innovation system (research co-operation, transnational inter-firm relationships,...)

Criteria set 4 - *Shaping a region's comparative advantage* - reflecting the notion that the technology / innovation initiative should contribute to the development of competitive and co-operative relationships within the region between the localised production system, the technical culture and the diverse local institutions and actors. Six main criteria themes could be taken into account:

- contribution to the networking of different players, in particular along the value chain
- diffusion of the new technologies or techniques beyond the scope of the action (i.e. demonstration effect)
- increasing market share of regional inputs in regional production
- increasing economic indicators for regional products (market share, exports, employment,...)
- increasing efficiency of regional support
- development of benchmarking and adoption of best practices

Box 3: Social/Ethical level

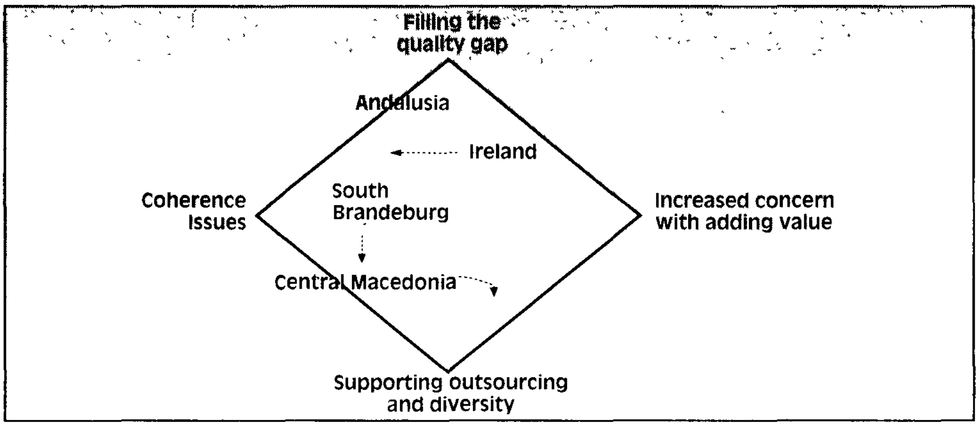
Criteria set 5 - *Coherence with the regional socio-economic fabric* - to measure compatibility at a social and ethical level with available regional resources (environmental, infrastructure - such as transport, energy, etc.). The main question addressed was whether the initiative could be implemented without detriment to the quantity and quality of the overall regional resources on which continued human activity and further development depend. Four main themes could be deemed important:

- Contribution to a sustainable production system
- Coherence with overall regional development strategy (if there is one)
- Social and ethical acceptability (recognition of social demands)
- Environmental impact (clean technologies, energy consumption, reducing pollution and degradation)

Criteria set 6 - *Positive dynamic within the socio-economic fabric* - was taken to reflect whether the initiative created a positive dynamic within the socio-economic fabric in terms of reinforcing the potential for current and future satisfaction of human needs both at a global and local level. This could be understood by:

- Integration of a trans-generation dimension (guarantee bio-diversity, improve quality of life, landscape,...)
- Articulating global and local dimensions
- Integration of social demand (new consumption patterns that integrate quality and environmentally friendly products, services,...)
- Added value attribution (wealth creation for the region in the form of goods, capital transfers, trained people, employment generation, ...)

Figure 2.



assessment path, scarcely reflected the more dynamic issues to do with creation of added value or a potential learning contribution.

While on one hand, the criteria part of the study drew the distinction between
(i) coherence and
(ii) increase of added value, elsewhere, it emerged that the main technological issues bearing on the agri-food business have to do with (iii) quality and (iv) diversity of products. The second figure represents an attempt to position the technology / innovation initiatives in the agri-food sector in each region with respect to these four aspects, with the arrow indicating the direction in which things are evolving.

About the authors

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The diversity which this figure captures and the obvious deduction that the indicated development paths and related policies for each region are different (while for one region it is more suitable to work on increasing added value and move towards trying to bridge the quality gap, another region is concerned with coherence issues and develops in the direction of more support for outsourcing and diversity of its products), furthers the argument for a 'differentiated' policy approach to fully sustainable regional development.

Secondly, the proposed criteria themes were used to tentatively pinpoint key issues to target in new or future technology / innovation initiatives with fully sustainable regional development in mind. The results of this described in the report (CM International, IPTS, 1996) have more an illustrative value than anything, in keeping with the experimental nature of the exercise.

Finally, in attempting to open up this debate, we feel that there are grounds for addressing, in a much more thorough and rigorous manner, ways to support both private and public decision makers in the design of sustainable regional initiatives, as well as to improve the assessment of the usefulness of support actions. Indeed, further work might demonstrate that a criteria sets based approach, similar to the reported experiment above, may find utility in this regard.

Keywords

regional development, sustainable development, technology gaps, agri-food sector

References

- CM International, IPTS, *Technology gaps and sustainable regional development: case of the agri-food sector in Andalucía, Ireland, South Brandenburg and Central Macedonia,* IPTS Final Report EUR 17278 EN, 1996.
- D. Kyriakou, IPTS, *Sustainable development: towards a synthesis* IPTS Technical Report Series EUR 16297 EN, 1995.
- M. Weber and G. Fahrenkrog, IPTS, *Sustainability and technology: a framework discussion.* IPTS Technical Report Series EUR 16457 EN, 1996.
- World Commission on Environment and Development (WCED), *Our common future.* Oxford University Press, 1987.

Notes

1- For more information, contact R Miège, DG XII.D.4 fax 352 4301 34544; http:/www.cordis.lu/innovation/src/3bar_int.htm

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Global Climate Change: Potential Impact on Human Health

Astrid Zwick

Issue: Predicted global warming may have an impact on human health along direct and indirect pathways. Recent reports of the Intergovernmental Panel on Climate Change (IPCC, 1996) and the WHO (World Health Organization) warned of potentially serious changes to disease distributions and patterns (McMichael et al., 1996).

Relevance: Present data and scenarios of future disease patterns capture worldwide attention. Studies show that certain diseases are climate-sensitive, so global climatic changes could have an impact on human health. Public health care systems may therefore have to deal with a range of emerging adverse health effects such as vector-borne and non-vector borne infectious diseases and illnesses related to increased thermal stress and air pollution, etc. These risks need to be better known by the public and call for the setting up of new mechanisms for monitoring and prevention of disease.

Analysis

The State of World Health and its Future Scenarios

The state of world health has generally improved over the last century due inter alia to the international effort to heighten awareness and stimulate action focused on the control of the outbreak of diseases and subsequent epidemics. Some of the world's most terrible diseases like poliomyelitis, leprosy, guinea-worm disease, Chagas disease and neonatal tetanus will probably join smallpox as diseases of the past. However, others like malaria, cholera, plague, tuberculosis or the hantavirus pulmonary syndrome are making a deadly comeback in many parts of the world and previously unknown diseases like the Ebola haemorrhagic fever and HIV/AIDS have emerged or re-emerged over the last 20 years. The reasons for their emergence are manifold. Singling out the factors responsible would help to control further outbreaks of diseases or to prevent them.

Future Scenarios

One of the factors favouring the occurrence of certain diseases is climate. Climate and, on a short term basis, the weather, has always influenced the state of human health either through direct thermal impact on the human body or via indirect routes such as favourable conditions for infectious agents, eg. viruses and their transmitters (so called 'vectors'). A recent assessment by the IPCC (1996) and a recent report by McMichael et al., (1996) predicted an increase in global temperature and a subsequent shifting of disease patterns with severe consequences (Tab. 1).

Although a number of deadly diseases could become things of the past, the spread of others means there is no room for complacency

Climatic change could create favourable conditions for the spread of viruses and their vectors

Tab. 1: Emerging health-related impacts due to climate change and stratospheric ozone depletion (after IPCC, 1996, McMichael et al., 1996)

Mediating process	Health outcomes
TEMPERATURE AND WEATHER CHANGES:	
Direct:	
Exposure to thermal extremes	➡ Altered rates of heat- and cold related illness and death
Altered frequency and/or intensity of other extreme weather events	➡ Deaths, injuries, psychological disorders; damage to public health infrastructure
Indirect:	
DISTURBANCES OF ECOLOGICAL SYSTEMS	
Effects on range and activity of vectors and infective parasites	➡ Changes in geographic ranges and incidence of vector-borne diseases
Altered local ecology of waterborne and food-borne infective agents	➡ Changed incidence of diarrhoeal and other infectious diseases
Altered food (especially crop) productivity, due to changes in climate, weather events, water quality and quantity, associated pests and diseases	➡ Malnutrition and hunger, and consequent impairment of child growth and development
Sea level rise, with population displacement and damage to infrastructure	➡ Increased risk of infectious disease, psychological disorders
Levels and biological impacts of air pollution, including pollens and spores	➡ Asthma and allergic disorders; other acute and chronic respiratory disorders and deaths
Social, economic and demographic dislocations due to effects on economy, infrastructure, and resource supply	➡ Wide range of public health consequences: mental health and nutritional impairment, infectious diseases, civil strife
STRATOSPHERIC OZONE DEPLETION	➡ Skin cancers, cataracts, and immune suppression; indirect impacts via impaired productivity of agricultural and aquatic systems

According to the reports published, direct effects on health due to climate change and an increase in extreme weather events may include increases in (primarily cardiovascular) mortality and illness due to an anticipated growth in the intensity and duration of heat waves. A three to fourfold rise in the number of cases of cardiovascular diseases is estimated under a CO_2 doubling scenario. Indirect effects of climate change may include the potential spread of 'vector-borne' diseases -for example, malaria- as well as some non-vector-borne infectious diseases including salmonella, cholera, and giardiasis. Climatic impacts on agriculture (eg. malnutrition) and fisheries could also impact human health on a secondary basis, as could freshwater supply limitations (eg. salination of ground water due to the expected sea level rise). Furthermore, the problems of ozone depletion (eg. risk of skin cancer, immunosuppression) and air pollution, winter and summer smog (eg. allergic disorders) are interrelated to climate change as a consequence of numerous interactions between them.

How Serious is the Threat to Human Health?

The findings of the reports raise the question of how serious this threat is, taking into account the fact that the linkages between climate and health follow a rather complex path, involving a multitude of factors (eg. the interrelationship between atmospheric events and human behaviour) as well as synergistic relationships. Other factors influencing human health might be superimposed on causes of change in the patterns of infectious disease.

Changes in human health are associated with environmental circumstances such as the degree of pollution. Socio-economic development plays an important role. Poverty and poor health care could worsen a population's health status. Thus, access to health care services is an important precondition to controlling the outbreak of diseases. The state of hygiene, (eg. lack of proper sanitation), the nutritional and immune status of a population as well as population density and growth are relevant parameters which have a significant influence on the occurrence of diseases.

Other factors are related to the geographic extension of diseases, such as migration, increased mobility and tourism. Reinforced mass migration to places whose climate is perceived to be safer could overlap with the transfer of disease patterns. If not carefully controlled, new regulations for international trade and improved world wide transport are other interacting factors that could facilitate the spread of diseases on a global scale. The consequent mixing of disease agents which could occur might favour gene swapping between pathogens and the emergence of new strains. On the other hand, the resistance of infectious agents could also lead to the re-emergence of certain infectious diseases.

Quantification of the impact of climate change on health is made rather difficult by the fact that climate and the ecosystem interact in a non-linear way and the disturbance of one factor can have a destabilising effect, such that it is even more difficult to predict the effects on the system as a whole. A change in climate might also act as a lever for the outbreak of a disease, such that small changes trigger relatively large events.

Added to this is the fact that in most people adjustment to the weather and climatic events proceeds in subtle and largely unnoticed ways, just as it has done during past centuries as part of normal adaptation to the local climate. The warming up of countries in the temperate regions would probably be perceived as a positive change and would contribute to both an increase in physical and mental well-being and hence a

Extreme weather events, such as heatwaves, can have a direct impact on health Other effects from ozone depletion, sea level rise, etc are less direct

The linkages between climate and health follow a rather complex path, involving a multitude of factors

Migration, international trade and global mobility are other interacting factors that could facilitate the spread of diseases world wide reduction in cold-related mortality or diseases, such as respiratory diseases, as well as in an increase in agricultural productivity.

Recent research suggests that mortality due to heat wave stress is probably not as significant as figures suggest, since some of the cases would have died shortly afterwards anyway. Even so, a significant excess mortality still remains (McMichael et al., 1996). Adaptation to successive heat waves with fewer casualties is also considered possible. Studies have shown that in cold and temperate locations, daily cold-related deaths increase as daily wintertime temperature decreases. Thus, an increase in wintertime temperature would result in a decrease of cold-related deaths that might partially offset the heat-related mortality. However, the rate of increase appeared to be considerably less steep than that accompanying increasing temperature in summer, according to (McMichael, et al., 1996). On the other hand, dryer and hotter conditions might also hamper the spread of infectious agents in previously affected regions.

The effect of warming on mortality is by no means straightforward, increased mortality due to heatwaves in summer may be offset by decreased mortality related to the cold in winter

Some Striking Evidence of Climate Impact

The foregoing discussion highlights the uncertainties involved. Thus, the seriousness of the threats of a climate-related impact on human health is in doubt. In spite of the above-mentioned uncertainties and speculations, there is some statistical evidence that human health may be at risk.

A change in the distribution of infectious agents and their carriers may be among the first signs of the threat due to climate change. Regional climatic changes have probably already caused outbreaks of certain diseases and suggest that such indicators may begin to appear, taking into consideration the anticipated global warming of about 0.5^{o}C over the last 150 years (Fig. 1, 2). These cases might foreshadow the hazards of living in a warmer world.

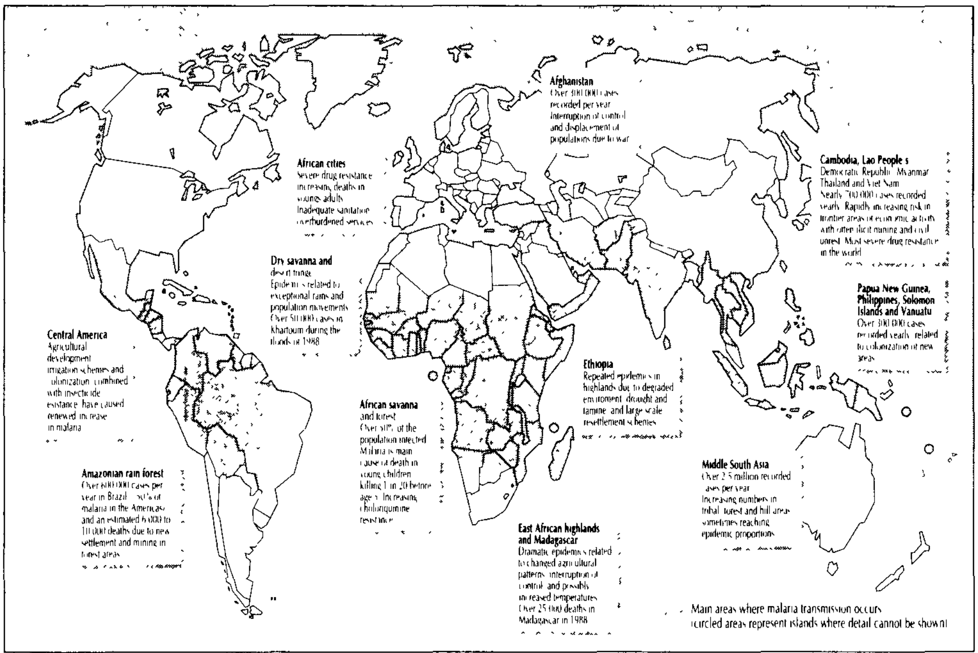
Global warming is predicted to bring warmer winters to many places, therefore increasing malaria transmission at higher latitudes and higher elevations

Malaria, for example, generally extends only to places where minimum winter temperatures reaches no lower than 16^{o}C. Global warming is predicted to bring warmer winters to many places, therefore increasing malaria transmission at higher latitudes and higher elevations. New cases directly related to local climate in Rwanda (1987) have recorded after record high temperatures and rainfall. This has also occurred in Ethiopia, parts of Asia, but also in the USA during hot humid periods in New Jersey (1991) and in Queens, New York (1993) (Epstein, 1996).

Dengue fever has recently been reported in Central America Mexico and in the Colombian Andes at higher altitudes than ever before. Following a Mexican epidemic three cases of dengue fever were reported in Texas in October 1995. Incidences of different cases of arboviral encephalitis, in particular of St. Louis encephalitis, have been reported in Florida, Mississippi, New Orleans, Texas, Arizona, California and Colorado since 1980. Cases of amoebic meningoencephalitis caused by the warming of overland water pipes in Australian summers have been reported.

Some outbreaks of cholera in Central and South America in 1991-1992 could be related to the latest unusually long El Niño event (Sprigg, 1996). El Niño refers to climate changes that occur every two to seven years when warm surface waters flow a long way south down the Peruvian coast and interrupt the normally north-flowing cold Humboldt-Stream, causing local climate changes. Huge amounts of rainfall occur, whereas in other regions all over the world the weather is affected by climate anomalies similar to the case mentioned above.

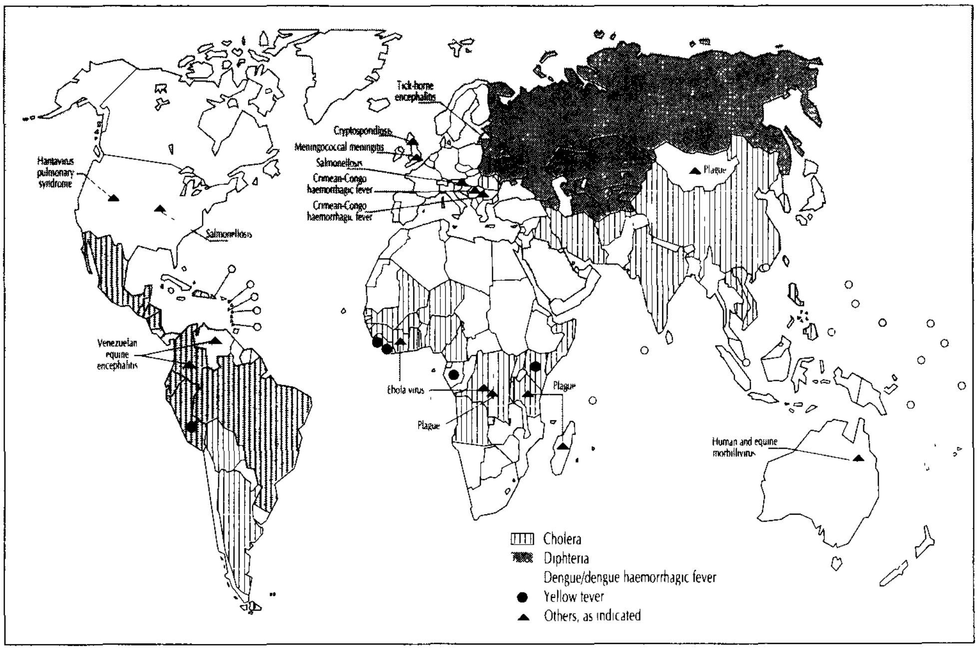
Fig. 1: *Present malaria distribution and problem areas (McMichael, et al., 1996)*



Source WHO, 1993a

> The outbreak of the hantavirus pulmonary syndrome was believed to be related to the 1992-1993 El Niño event. A prolonged drought prior to the outbreak appeared to have reduced rodent predator populations while at the same time the heavy spring rains that followed provided a crop of grasshoppers and pine nuts which served as food for the deer mice that carry hantavirus. The rodent population multiplied ten-fold and the deadly disease broke out (Epstein, 1996).

Fig. 2: *Overview over relevant disease outbreaks in 1995 (McMichael, et al., 1996)*



Source WHO, 1996

In some cases climate-induced epidemics may not be being made public by governments fearing damage to the tourist industry

The assessment of the costs to the health sector resulting from climatic change is rather speculative, however, insurers already estimate that health related and environmental restoration claims over the next 30 years may reach $50 to $120 billion

Another striking phenomenon was the emergence of the hantavirus pulmonary syndrome with a number of cases in Europe, in particular in former Yugoslavia, and in the south-western US in 1993 with 130 incidences resulting in a 50 % mortality. Its outbreak is also an example of synergistic interaction of climate change and a subsequent change in the biosystem. In some cases climate-induced epidemics may not be being made public by governments fearing damage to the tourist industry. This was seen in the case of a Turkish cholera epidemic. The only way it was known of outside Turkey was as a result of the occurrence of a number of cholera cases in Germany, the persons affected having returned from a journey to Turkey. This case further demonstrates the risk and the relevance of infectious diseases for regions in Europe.

Extreme weather events, which are expected to increase with climate change as in the case above, play an important role in the reduction or growth of disease carrier populations such as rodents or insects. Floods, for example soak agricultural land creating pools and filling ditches, thereby increasing fungal growth and providing new breeding sites for disease carrying insects. Droughts and heat waves in the summer of 1995 increased deaths from heat waves across the world. Warmer soils are a good basis for tetanus bacteria and warmer summers could increase cercarial dermatitis, so called swimmers itch, in particular in North America and Europe.

How Much Might Climate-Related Diseases Cost?

The assessment of the costs to the health sector resulting from climatic change is rather speculative. However, some statistical data about hospital admission rates and casualties exists that could be used as the basis for calculations of the economic costs of climate impact on human health.

Hospital admission rates and subsequent mortality will increase in more vulnerable regions. For example, a study of ten Canadian cities yielded a significant summer mortality relationship in three of them (Toronto, Montreal and Ottawa). The heat wave in Athens, Greece, in 1987 increased the rate more than five-fold. Heat-related deaths in Shanghai were estimated to be likely to increase from the present 6 per 100000 to about 45 per 100000 population during an average summer under 2 x CO_2 conditions. This mortality rate is over seven times the present death rate (ECO Newsletter, 1996). People most affected will be the very young and the elderly.

The cholera epidemic in Peru in 1991 cost a total of $1 billion through the losses in seafood exports and tourism. The Indian plague in 1994 cost the airline and hotel industry over $2 billion and an outbreak of dengue fever in the Caribbean threatened the region's $12 billion, 500,000 employee tourism industry. Insurers already estimate that health related and environmental restoration claims over the next 30 years may reach $50 to $120 billion (Epstein, 1996).

What Could Careful Prevention of the Threat Look Like?

Taking the scientific assumptions and the already recorded cases into account, there is a serious, though perhaps under-perceived, threat of a significant climate-related impact on human health. Moreover any increase in incidence might remain veiled by the lack of standardization in the compilation of figures on the extent of morbidity, disability or death in different populations making it impossible to compare information. Efforts may also be hampered by the shortage of routinely quantified data on the health problems of populations. Moreover, the WHO's role as overseer of the state of human health has been hotly debated recently (Brown, 1997). Critics think that its policy, such as the enhanced programme for the promotion of environmental health under the WHO's global strategies, is too broad and lacks specific targets. Industrialized countries that are largely providing funds for the WHO, in particular some Nordic countries and even some developing countries are among the critics. The points given below that should be on the hit-list for prevention are not related to climate change alone but also fit into the new requirements for modern world health status.

- The prevention of the outbreak of diseases should be high on the priorities of international policy. This means as well that an anthropogenically induced climate change as one of the factors threatening human health should be avoided.
- The majority of studies performed on the issue of climate change and health have criticized the deficit in monitoring and surveillance systems as well as the insufficient and unreliable forecasting of future regional climates. A surveillance and monitoring system is important for the world, particularly for the vulnerable countries (Murray & Lopez, 1996).
- Inter-sectorial collaboration could be strengthened so that public health considerations are incorporated into the development process via environmental management techniques. The health sector could use information from regional climate forecasts in its programmes, enabling more proactive health care planning. Advances in telecommunications could make it possible to monitor disease incidents and to co-ordinate data collection.
- International networks (eg. ProMED) could contribute to communicating the monitoring of the impacts of climate change and a simple international disease-counting protocol could form the basis of the information needed for rapid and accurate counting of cases.
- Extended prevention programmes (ie. vaccines and new antibiotics) for the most vulnerable populations is recommended, although it has to be taken into account that no suitable vaccines exist for some of the diseases most sensitive to climate change (eg., dengue, schistosomiasis) or for many of the newly emerging infections.
- The education of populations is of importance in terms of hygiene and behaviour during climatic extremes. In this context, the provision of protective technology is important (eg. housing and insulation, air conditioning, water purification, heating). Medical aspects should therefore be taken into account in technology-transfer policy for developing countries since their risks will be higher and a geographic transfer of diseases into usually 'safer' countries cannot be excluded considering the presently high degree of international mobility.
- A recently discussed method of prevention is to control the outbreak of diseases by genetically altering the organism that transmits the disease as investigated on a laboratory scale for the case of dengue fever and its transmitting agent, the mosquito Aedes aegypti (Olson et al., 1996).

Conclusions

Cautious optimism about world health status has turned into complacency resulting in a reduced effort toward maintain higher levels of global security in health. In order to combat emerging and re-emerging diseases their causes have to be acknowledged and controlled. The outbreak of diseases is ruled by a complex interplay of different interacting factors. Added to this is the fact that migration, improved world wide transport, trade and tourism might expose regions that were considered to be safe, such as the European countries to a higher risk of infectious diseases, although the maximum impact of these diseases would be observed in the developing countries.

The role of the WHO has been questioned recently; critics think that its policy tends to be too broad and lacks specific targets

The direct impact on the temperate regions like the European countries may mainly consist of the thermal effects of heat waves, in an increase of infection transmitting agents due to extreme weather events and the interrelationship of atmospheric pollution and climate change. Thus, the temperate regions might suffer an increase in heat deaths, cardiovascular diseases, special infectious diseases and more allergic disorders. Signs of these developments can already be perceived. The risk for human health from climate change might not yet be quantified but the perception of partly climate-sensitive cases gives this issue a certain degree of importance, suggesting that it would be wise to put it onto the community's research agenda. Research focused on the relationship between human health and climate change could provide greater insight into these issues.

Acting according to the 'precautionary principle', thus avoiding further anthropogenically induced climate change would certainly be the best solution. Nevertheless, some other points are frequently discussed, namely the installation of a better international surveillance and monitoring system in addition to ensuring that national health care systems are well prepared, people are well informed and that extensive prevention programmes are in place. These conditions have clearly not yet been met, according to recent criticism of the WHO. Beginning to think about this issue would be wise on the basis that it is much less costly to manage diseases preventively than to react to a crisis.

Keywords
climate change, extreme weather events, infectious diseases, health care, surveillance

References

- Brown, P. *The WHO strikes mid-life crisis. New Scientist,* 11 January 1997, 1997, p. 12-13.
- ECO Newsletter, *Climate change makes you sick.* AGBM 3 - Geneva, NGO Newsletter, March 7, 1996, Issue No. 3, 1996.
- Epstein, P.R. *Climate changes... our health.* Report published by the WWF, p. 6, 1996.
- IPCC, *Human population health.* In: Climate change 1995. Scientific-technical analysis of impacts, adaptations and mitigation of climate change. Contribution of. to the Second Assessment Report of the Intergovernmental Panel on Climate Change, WMO, p.24, 1996.
- McMichael, A.J., Haines, A., Slooff, R. & Kovats, S. (ed.) *Climate change and human health.* An assessment prepared by a Task Group on behalf of the WHO, WMO & UNEP, Geneva, 1996.
- Murray, C.J.L. & Lopez, A.D. *Evidence-based health policy - lessons from the global burden of disease study.* Science, Vol. 274, 1996, p. 740-743.
- Olson, K.E., Higgs, S. Gaines, P.J., Powers, A.M., Davies, B.S., Kamud, K.I., Carlson, J.O., Blair, C.D. & Beaty, B.J. *Genetically engineered resistance to Dengue-2 virus transmission in mosquitoes.* Science, Vol. 272, 1996, p. 884-887.
- Sprigg, W.A. *Doctors watch the forecasts.* Nature, Vol. 379, 1996, p. 582-583.
- WHO, *The world health report.* 1996. World Health Organization, Geneva, 1996.

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The Importance of Interdisciplinary Approaches: The Case of Nanotechnology

Ineke Malsch

Issue: Interest in nanotechnology among researchers and policy makers is again on the increase and a number of initiatives for research programmes and networking activities have recently been undertaken. At the same time, obstacles have been identified, many of which concern the co-ordination of activities.

Relevance: Nanotechnology promises to yield important advances with applications in many different areas, and could even spawn whole new industries. However, although intrinsically multi-disciplinary, it suffers from a lack of co-ordination both between nanotechnology RTD infrastructure and researchers in different disciplines, and between the applications for which these resources could be used. New policy initiatives are needed to ensure the creation of a space with more flexible disciplinary boundaries, the centralisation and exchange of information concerning progress in the various relevant disciplines and to organize appropriate interdisciplinary training.

Nanotechnology is basically a set of techniques for making things smaller Two approaches are usually distinguished top-down miniaturisation of micro-technologies and bottom-up controlled building up of materials and devices from individual atoms and molecules

Nanotechnology and its importance

Nanotechnology basically comprises an assortment of techniques with potential applications in most currently existing industrial sectors, and with the potential to help create new industries. These techniques share the aim of making things ever smaller, smaller in fact than the expected physical limit on the size of features in micro-chips (100 nanometres, or 100 millionth of a millimetre) though bigger, of course, than the individual atom (0.1 nanometre). Often two approaches are distinguished: top-down miniaturisation of micro-technologies and bottom-up controlled building up of materials and devices from individual atoms and molecules. Nanotechnology can be used for research in materials science, physics, chemistry, biology and medicine. Additionally, nanotechnology is sometimes looked upon as a future option for development, and indeed is in some cases already in use in industrial RTD in materials and industrial production (ultra precision technology), catalysis, electronics, pharmaceuticals (intelligent drugs), biomedical technologies (artificial organs), energy (new photovoltaic materials, batteries) and environmental sensing. Some products are currently on, or close to being on, the market. These products are mainly new nanostructured materials and instruments and techniques for their fabrication. Examples include lasers in CD players, high quality mirrors and lenses and even lipstick (see STOA, 1996, part 2).

During the 1990s a number of countries, including Germany, France, the UK, the USA and Japan, have organised national foresight exercises to identify priorities for technology policy (see C. Cabello et al, 1996). There would seem to be an undercurrent of concern for nanotechnology when defining priorities, although it is not always addressed as a subject of importance in itself. The obstacles to realisation identified by the experts are mostly technical, followed by product costs. In these exercises German respondents in particular, but also French ones, saw problems with the RTD system. In a later mini-Delphi (BMBF, 1996) conducted in Germany and Japan 'Nanotechnology and Microsystem technology' was selected as one of the 8 leading themes. Nanotechnology fabrication processes and materials are expected to become available here between 2005 and 2015.

European RTD: results and resources

There appears to be a consensus among researchers and RTD policy makers that European RTD into nanotechnology is of high quality. The available technological infrastructure, human capital and funding are also competitive with the USA and Japan. The research base is particularly strong in the UK, Germany, France, the Netherlands, Belgium, Scandinavia and -outside the EU- in Switzerland (see STOA, 1996). However, nanotechnology in other European countries, both inside and outside the EU, should not be neglected.

Nanotechnology in Europe is being funded both through national programmes (see Table 1) and by the European Commission under the Fourth Framework Programme for RTD, via a number of specific programmes, mainly Biomedicine and Health (BIOMED), Biotechnology (BIOTECH), Industrial and Materials Technologies (BRITE/EURAM), Information Technologies (ESPRIT), Standards, Measurements and Testing (SMT) and Training and Mobility of Researchers (TMR). A few of the currently ongoing national activities are listed in Table 1 (see STOA, 1996, part 1 for an overview).

Obstacles identified

A number of obstacles to the development of nanotechnology are often mentioned by researchers and policy makers with a specific interest in it (e.g. European Nanotechnology Initiative conference, Copenhagen, April 1996. However, researchers'

Although there would seem to be an undercurrent of concern for nanotechnology when defining priorities, it may not always be given the importance it deserves as a subject in its own right

There appears to be a consensus among researchers and RTD policy-makers that European RTD into nanotechnology is of high quality

Table 1.

Country	Ongoing national programme or centre	Organizer	Time table
Finland	Research programme Nanotechnology	Academy of Finland & Technology Development Centre	1997 - 1999
France	Research programme Ultimatech	CNRS (centre national de recherche scientifique)	ongoing
Germany	Sonderforschungs-bereich Molecular Electronics	DFG (Deutsche forschungsgemeinschaft)	ongoing
Netherlands	facilities in Delft, Amsterdam, Twente, etc	several funding bodies	ongoing
Spain	Centro Nacional de Madrid Microelectrónica		ongoing
Sweden	Nanometer Structure Consortium	Univ Lund & Research Funding Agencies	1990 - 2000
UK	no single programme, relevant work is funded under other headings (see POST, Nov 1996)		since Foresight exercise

In the area of nanotechnology in Europe there are many limited research project oriented networks, and there are sufficient funding opportunities

interest in nanotechnology varies considerably, ranging from a few nanotechnology adepts to the majority who think it is merely one possible header for their own research.

A number of factors are said to be slowing down the development of biotechnology. Firstly, there is a need for two types of nanotechnology networking activity; both vertically oriented towards applications in distinct industrial sectors and multi-disciplinary horizontal networks for exchanging information on progress and for organising education and training. Also, there is a need for co-ordination of national research activities at a European level. Key topics for multi-disciplinary research programmes are not always identified and the links between the relevant disciplines are sometimes weak. Lastly, high tech spin-off SMEs from academic nanotechnology research dgo not always find the funding they need (eg. high risk venture capital for developing products).

Nanotechnology-related networking

Networking for nanotechnology can be classified under various rubrics (see Table 2 below):

(a) in terms of the **primary aim** of the networking activity: ie. either technological, focusing on the eventual development of a particular technology, or organizational, focusing on rearranging the context in which technological development takes place. Every networking activity consists of elements of both technological and organisational aims, but the emphasis differs; and

(b) on the **level** at which activities take place: ie. micro, meso or macro, progressively involving more different types of actors. Micro-level: almost exclusively actors active in research; meso-level: all participants in the RTD system (including industrialists and government regulators); macro-level: representatives of all interested stakeholders (including politicians and interest groups).

Micro-level

Two types of networks are located at the micro-level:

1) networks around a research project, and
2) those aiming to form a new discipline.

Both are normally initiated by actors involved in RTD, as and when they see a need. In general, no specific new intervention from policy makers is necessary in order to support these types of networks. In the present situation in the area of nanotechnology in Europe there are many limited research project oriented networks, and there are sufficient funding opportunities as mentioned above, although the industrial other societal relevance of some initiatives is not clear.

Industrial sector

Networks oriented towards applications in one industrial sector are similar to those around one research project. However, they are generally organized around a broader research programme and involve more types of actors, but not users and representatives of societal interests.

In general, the actors in industrial sectors are very well able to organize networks to help them fulfil their perceived needs. At the moment industrial priorities do not include nanotechnology which is still categorized as 'fundamental' rather than applied research. However, a growing number of such industrial-sector-oriented networks are being set up,

Table 2.

	technological	organisational
micro	research project	new discipline formation meso
industrial sector		flexibilising disciplinary boundaries
macro	societal need	general S&T priority setting

though not for all relevant industrial sectors (see Table 3 below). Other such industry oriented networks will probably be established in the future when nanotechnology becomes more mature: in which case no strong new intervention of RTD policy makers should be necessary.

Table 3.

Acronym	Area	Organiser	Industry	Since
PHANTOMS	mesoscopic physics & tech	EC ESPIRIT	ICT	1992
NANO	materials & energy	European Science Foundation	materials & energy	1995
ECNM	nanomaterials	consortium academics & industrialists	various	1996

Societal needs

Involvement of representatives of users and potentially affected interests (environment, health, employment) is at present only practised for mature (Information Technologies) or controversial (biotechnology) technologies. Nanotechnology is neither mature nor controversial at the moment. However, some scenarios in which nanotechnology may find applications do involve considerable potential positive and negative impacts on the environment and on society. For instance:

- intelligent drugs could be developed which can be targeted to a particular organ or cell,
- the latest trend is to improve the link between structural biology (e.g. DNA) and control of matter at the molecular level, involving both potential benefits and ethical questions,
- more futuristic still is the idea that very small programmable nanomachines could clean up waste-dumps or human arteries.

Still, at such an early stage in development the technology which will eventually emerge is highly speculative. Research could lead to a better insight into possible developments and help to articulate demand for, and increase acceptance of, nanotechnology applications, by involving representatives of users and potentially affected interests.

Political level

At the macroscopic political level networking activities take place around priority setting for S&T policy in general, and it has been claimed that there is no strong nanotechnology lobby, although such claims seem often to be made by the very people who are engaged in exactly such a lobby. Recent reports on nanotechnology by the UK Parliamentary Office of Science and Technology and the EP Scientific and Technological Options Assessment unit are tangible indications that nanotechnology is fighting its way onto the political agenda in Europe. Also, at this political level, negotiations on co-ordination of national activities in the area of nanotechnology at a European level are already taking place within the COST framework, which should lead to new actions in the not too distant future.

Flexibilizing disciplinary boundaries

It is not obvious that there is a need for a meso-level in the organizational branch between scientific and technological disciplines and general S&T priority setting. In fact, initiatives have been criticised by actors involved in nanotechnology for being too general in scope to be practical yet too specific for general policy making. However, some initiatives may have merits that outweigh criticism. In 'The new production of knowledge' (Gibbons et al, 1994) a hypothetical new mode of knowledge production has been outlined, with the claim to being a new

At the moment industrial priorities do not usually include nanotechnology, which is still categorized as 'fundamental' rather than applied research

Nanotechnology is not currently a subject of debate, although some scenarios in which nanotechnology may find applications do involve considerable potential impacts on the environment and on society

Nanotechnology could well benefit from a transdisciplinary mode, bringing together temporary clusterings of know-how, for a number of reasons

trend in RTD. One of the characteristics of this 'mode 2 knowledge production' described is transdisciplinarity:

"A transdisciplinary mode consists in a continuous linking and relinking, in specific clusterings and configurations of knowledge which is brought together on a temporary basis in specific contexts of application. Thus, it is strongly oriented towards and driven by problem solving.....The transdisciplinary mode of knowledge production ... does not necessarily aim to establish itself as a new, transdisciplinary discipline.... it is essentially a temporary configuration and thus highly mutable..." (Gibbons et al, 1994). Examples of such a transdisciplinary mode mentioned by them are environmental science, biotechnology and technology assessment.

Nanotechnology could well benefit from such a transdisciplinary mode for a number of reasons. At this moment it exists mainly in the form of the possibility for an important future technology, which may lead to applications in many different industries, and which is said to even offer the possibility of creating new industries. The core of nanotechnology, which is relevant to many if not all possible application areas, consists of fabrication techniques and instrumentation at nanometre scale, new materials and human skills for making things small. What is needed for the efficient development of nanotechnology is a flexible framework in which information on technological progress can be stored and exchanged, and in which interdisciplinary training can be organized. There should not be an a priori selection of the relevant disciplines on any basis other than the interest of working at nanometre scale. Priority setting and clustering of disciplines around specific problems or applications (bottleneck 3) can subsequently be left over to those present in the transdisciplinary framework, including funding bodies such as the European Commission.

A precedent for a transdisciplinary framework of this kind in the area of nanoscale science is the successful NATO Advanced Science Institutes series, which has resulted in about ten volumes of papers on advances in research at a nanometre scale. This series is now coming to a close, and a follow-up is not being planned on a world scale. There may thus appear to be room for a new initiative at European level.

Conclusion

Inadequate networking activities around nanotechnology are considered by actors involved in RTD policy making to be holding up the development of nanotechnology. Moreover, there seems to be a gap in policy relating to flexibilizing disciplinary boundaries around nanotechnology, and to storing and exchanging information on technological progress in the distinct disciplines and to organizing training, as well as possibly to setting up concerted nanotechnology-specific multidisciplinary action.

Keywords
nanotechnology, RTD policy, networking

References

- BMBF: *Delphi-bericht 1995 zur Entwicklung von Wissenschaft und Technik; mini-Delphi,* Bonn, 1996.
- Cabello, C., Scapolo, F., Sørup P., & Weber, M., *Foresight and Innovation: The role of initiatives at European level,* in IPTS-report 7, EC JRC, September 1996.
- Gibbons et al: *The new production of knowledge. the dynamics of science and research in contemporary societies,* Sage Publications, London, 1994.
- POST, UK Parliament, *Nanotechnology,* London, 1996.
- STOA, EP: *Nanotechnology,* part 1,2,3, Luxembourg, 1996.
- Tolles, W., *Nanoscience and technology in Europe,* in Nanotechnology, vol 7, no. 2, June 1996, p 59-105.

Notes

1- The abovementioned bottleneck of horizontal multidisciplinary networking, should be split up into two activities: the normal formation of new disciplines and another meso-level activity, which is tentatively labelled *flexibilising disciplinary boundaries.* Below, the meaning and relevance of this term will be clarified.

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The **IPTS** is one of the seven institutes of the Joint Research Centre of the Commission of the European Communities. Its remit is the observation and follow-up of technological change in its broadest sense, in order to understand better its links with economic and social change. The Institute carries out and co-ordinates research to improve our understanding of the impact of new technologies, and their relationship to their socio-economic context.

The purpose of this work is to support the decision-maker in the management of change, pivotally anchored on S/T developments. In this endeavour the IPTS enjoys a dual advantage: being a part of the Commission, the IPTS shares EU goals and priorities; on the other hand it cherishes its research institute neutrality and distance from the intricacies of actual policy-making. This combination allows the IPTS to build bridges across EU undertakings, contributing to and co-ordinating the creation of common knowledge bases at the disposal of all stake-holders. Though the work of the IPTS is mainly addressed to the Commission, it also works with decision-makers in the European parliament, and agencies and institutions in the Member States.

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1. Technology Watch. This activity aims to alert European decision-makers to the social, economic and political consequences of major technological issues and trends. This is achieved through the European Science and Technology Observatory (ESTO), a European-wide network of nationally based organisations. The IPTS is the central node of ESTO, co-ordinating technology watch joint ventures with the aim of better understanding technological change.

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