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AND ISSUED IN COOPERATION WITH THE EUROPEAN S&T OBSERVATORY NETWORK

EUROPEAN COMMISSION
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CONTENTS

(such as caricature and oversimplification). Two examples which stand in many ways as opposites were Ronald Reagan's 1980 caricature of activist government, which captured the mood of the US public at the time: " What are the most frightening words an American can hear?" "Hello, I am with the government and I am here to help you"... Twenty years earlier John Kennedy's famous: "ask not what your country can do for you, ask what you can do for your country" found very receptive ears in a prosperous and optimistic country at a prosperous and optimistic time.

Ideally, however, mobilizing human energies should involve more than merely sound-bites expressing existing hopes/frustrations in condensed form. As in the case of firms and the introduction of technologies, success involves suggesting an appropriate vision, charting a feasible course towards it, and building the social and political consensus, which will sustain the boat on its course. But indirectly the importance of consensus building has brought us back to the science and governance nexus which we have discussed in the past and will occupy us again in our next issue.

The analysis that follows concentrates on three main issues of policy relevance:

- The technology-driven factors that stimulate the transformation of the operational environment of ports.
- The competition issues that arise from the consolidation of the port sector.
- The limits on state intervention in the context of EU port policy.

Technological and organizational trends

The 1990s witnessed the rise to dominance of container transport worldwide. What was once a trade limited to a handful of large seaports is now the main activity of the majority of seaports and an increasing number of inland ports (i.e. ports on inland waterways). Containerized goods now account for the bulk of international maritime trade, and container traffic represents the main source of income and profits for the majority of ports. So much so, that in practice the number of containers moved has replaced total cargo throughput as the measure of a port's activity, size and importance.

The dominance of containers has stimulated a continuing trend towards larger containerships. The newest generation of containerships have capacities of over 6000 TEU[1]. The purchase of such vessels, along with the terminal infrastructure and equipment needed for the port to be able to serve them, brings economies of scale but requires significant capital investments that only large shipping companies or large ports can afford. In addition, the efficient operation of containerships is economically feasible only if a small number of ports are used as central hubs for an international shipping network. An extended system of feeder services that connect the hub ports with feeder ports and inland distribution systems is required for the system to operate efficiently.

Optimizing the operation of the whole transport chain also entails the use of advanced information and communication systems such as tracking and tracing applications, Electronic Data Interchange (EDI), scheduling systems, etc. Most of these applications give optimum results if used by all actors in the transport chain; moreover, these systems often use proprietary technologies. The use of common information and communication technologies along the whole length of the transport chain is a driving factor for cooperation between transport service providers and the formation of strategic alliances.

Another main factor affecting the organizational characteristics of modern ports is the globalization of the port community. Port services address the world market in this highly competitive context. Given the extensive use of information and communication technologies and the fact that the Internet allows producers, shippers and consumers to access information with minimal delays, port hinterlands can no longer be considered captive and the role of the port in the market cannot be considered to be immutable. On the contrary, in order for a port to survive competition it would seem to be essential for it to adopt the practices followed by the leading actors in the freight transport and other industrial sectors.

The organizational culture of modern ports has also changed with the changing perception of their role in the supply chain. The leading port authorities in Europe, of which Rotterdam is a typical example, are in practice not simply port operators but logistics services providers. As already mentioned, modern ports have become integrated with the other elements of the freight transport system and their role cannot be easily distinguished from the seamless services offered to the actors at the two ends of the chain. The concept of the port itself is also becoming vague;

The predominance of containers is making the investments in containerships and infrastructure that companies need ever greater, thus favouring large companies that can afford the capital outlay and so benefit from the economies of scale

The use of common information and communication technologies along the whole length of the transport chain is another factor encouraging cooperation between transport service providers and the formation of strategic alliances

The organizational culture of modern ports has also changed along with their role in the supply chain. The leading port authorities in Europe are increasingly logistics services providers rather than simply port operators

the already extensive operations of the Danish company, will form a giant that will control a large share of international container traffic.

The integration of transport chains and the application of new technologies are in principle beneficial for users, since they increase the quality of transport services and can lead to cost reductions. But, on the other hand, the need for an efficient operation of the extended transport networks implies that in the future the actors in the field will be fewer in number and larger in size. This raises the question as to whether this will make it possible for a company, or a group of companies, to acquire near-monopoly control of the market.

Theoretical and empirical research results suggest that the benefits from the improved operation of the transport system can outweigh the potential risks that may result from the market being controlled by a small number of players. The standardization and optimization of transport services, which to a large extent are stimulating consolidation in the port and shipping sectors, increase efficiency and so are beneficial to users. However, consolidation also entails the risk of the small number of participants that remain in the market indulging in collusive pricing, for instance, and thereby distorting market conditions.

Policy intervention may therefore be required to ensure that such a risk is minimized. Especially since transport activities are being deregulated at national level and the globalization of economic activities is becoming more pressing for the transport sector, the need for suitable legislation at EU level is evident. However, four main conditions have to be met in order for competition to remain healthy and lead to short- and long-term benefits for both users and the port sector:

- The number of actors remaining in the market and their respective market shares should be such as not to encourage or allow monopolistic practices to arise in relation to prices or services offered. This condition should be satisfied as regards the number of actors operating on both a global scale (e.g. mega-carriers offering word-wide coverage) and at the local level, such as port operators or shipping lines serving a particular area.

- The entrance of new competitors in the market should not be limited by the existing competitors' effective control of the market. Access to port infrastructure should be guaranteed for all potential users, shipping lines and terminal operators.

- Users should be able to enjoy a fair share of the benefits, in terms of price and quality of service, that result from the consolidation of the market. New mergers and acquisitions should not harm users' interests.

- The competitive environment should be such that it promotes the adoption of new technologies. In a market controlled by a few large players, competitive pressure could eventually stop being intense enough to stimulate innovation. At the opposite extreme, a dispersed market of small actors would not be competitive enough and port operators would probably lack the necessary funds to invest in new technologies.

The European Commission is already working on measures aimed in this direction. Current EU competition policy comprises three main areas, namely restrictive agreements and practices (antitrust), the regulated or monopoly sectors and state aid. In particular, restrictive practices include certain types of vertical agreements and/or distribution systems and unjustified refusal to allow third parties non-discriminatory access to essential infrastructure.

The integration of transport chains and the application of new technologies can increase the quality of transport services and lead to cost reductions. However, over-concentration can lead to monopolistic behaviour and price mark-ups

For competition in the port sector to remain healthy the number of actors in the market needs to remain sufficient to avoid monopolistic practices arising and the incumbents should not be able to prevent new competitors from entering the market

Keywords

Ports, transport, competition, state intervention

Note

1. TEU: Twenty feet Equivalent Unit (the standard measurement of container traffic)

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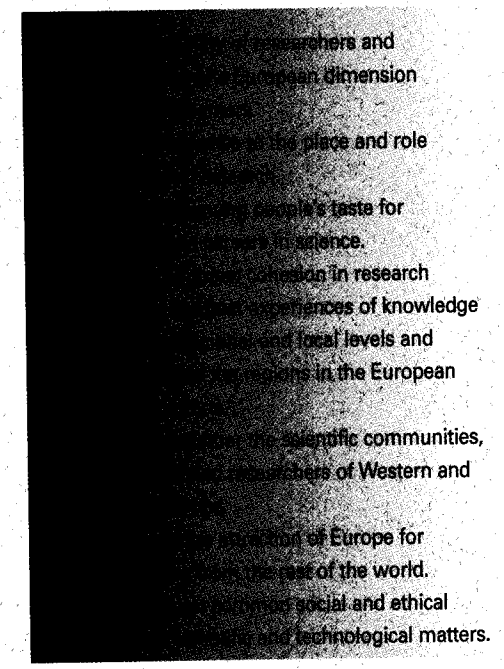

Research and growth

A large part of economic growth is explained by increases in total factor productivity. In simple terms, this means that the same inputs (i.e. labour and capital) can be combined more productively to generate output. The way this is achieved is through the innovations that allow us to combine the same basic inputs in ever more efficient forms. The direct role played by research in this simplified model is that it creates the knowledge on which such innovations increasingly often rely. Some of the knowledge produced by research may find its way into products after undergoing further refinements (and investment) in the development phase of the cycle. However, the creation of such knowledge may in practice be hindered by the fact that incentives have to be limited, so as to allow benefits from inventions or discoveries to accrue to society as a whole, after a reasonably short period of time, rather than to an individual inventor.

The results of basic science are usually sufficiently removed from immediately marketable results for it to be conducted in academic settings where ideas are exchanged freely and both the private sector and other researchers can benefit from them. At the other end of the spectrum, development work with obvious immediate market impact is usually undertaken or funded by individual firms. What has at times proved more difficult is funding efficiently intermediate types of research.

Turning ideas into concrete products is generally protected by patent and other intellectual property rules, which provide a mechanism whereby firms can recoup their investments through the unchallenged exploitation of their innovation thanks to temporary monopoly power over it in the market place. Obviously the balance between the interests of consumers and of producers has to be watched closely and is not always without friction (witness the recent developments in biotechnology and pharmaceuticals).

However, as we signalled in Issue 12 of the IPTS Report (Kyriakou, 1997), there is potentially a grey area between basic research at one end of the scale and product development at the other encompassing problems that have an impact on an industry as a whole (and not merely individual firms) where research is needed to deal with certain bottlenecks in translating ideas into marketable results, but is often not forthcoming given the difficulty the firms investing in it have in securing the benefits of their investment to themselves. Indeed, although individual firms might in fact benefit from undertaking the research at their own expense (despite the possibility of "free-riders" in the industry getting the benefit without the investment) they may be encouraged to wait to see if one of their competitors will take the first step, with the possible outcome (if all the firms apply the same reasoning) that the industry as a whole is held up.

Research is sometimes needed to deal with certain industry-wide bottlenecks but is not forthcoming because an individual firm cannot see how it will recoup its outlay if solutions are available to all firms

sales and the tax rate decided upon, the allocation of each firm's contribution to each of the various IIBs set up in the sector is for it to determine – i.e. it would be able to decide what proportion to devote, for instance, to the design IIB, safety IIB, testing IIB, etc.

Equally important is the fact that there is an element of competition between IIBs. If firms are not satisfied with the performance of a specific IIB they can start a new one, either addressing the same issues or issues the firm(s) starting it consider more relevant. If disappointed, firms could vote to abolish any or all their IIBs and rescind the tax.

Past examples of similar approaches

Although the IIB proposal is as yet untested, it is not without precedents. One of the oldest forerunners exists in the USA as a result of the enactment of the Agricultural Marketing Agreement Act of 1937. This act provided for setting up 'marketing orders', given a two-thirds majority approval and periodic referendums (every 6 years) to gauge continued support. Although marketing orders were also used as vehicles for output restrictions, about three quarters of them collect funds for R&D and market promotion. What they lack compared to the IIB proposal is the provision for free entry of new boards and the possibility of competition among them.

The most obvious, and possibly most successful example of an idea of this kind is that of Bell Labs in the USA, which was supported by payment of a small percentage of the revenues of operating companies to AT&T. To the extent that this 'support' was permitted by the regulators to be part of the rate base of operating companies, the government, in effect, sanctioned a tax to be used for industry-wide research. Since AT&T controlled the vast majority of the operators, free-riding behaviour was not a problem.

Perhaps the most recent example comes from the US pharmaceutical industry. The US Food and Drug Administration was persuaded to raise the fees it levies when drugs are submitted for approval, so that more evaluators can be hired with the extra revenue, leading to a reduction in the "approval-pending" time.

In Europe similar efforts have also been undertaken. These include cooperative research projects dedicated to industrial sectors, using a bottom-up approach and taking ideas for research projects which reflect the needs of the industry. Industry commonly finances cooperative research, in some cases with the help of public co-sponsorship. Research results are available for all participating companies, and they are supposed to be strictly pre-competitive. In some countries such as Germany, Belgium, France and the UK, there are established structures of cooperative research; in other countries efforts depend on more spontaneous actions. Institutional examples include, but are not limited to, the AiF in Germany (The National Body for Industrial Cooperative Research), FEICRO (The European Body for Industrial Cooperative Research), and the EU Commission's CRAFT (The European Programme for Industrial Cooperative Research) (AiF, 1992).

What the IIB approach offers that is new is that all these examples have not included the element of competition between the research entities set up by industries.

Most efforts to date (in Europe and elsewhere) have not included the competition element among such research entities set up by industries. In the examples described here, only one entity has usually been set up per industry, and it therefore exercises an effective monopoly. The multidimensional competition allowed by the proposal presented here is absent in

Competition between IIBs is an important factor. If firms are not satisfied with the performance of a specific IIB they can start a new one, either addressing the same issues or another issue the firm starting it considers more relevant

Possibly the most successful example of an idea of this kind is that of Bell Labs in the USA, which was supported by payment of a small percentage of the revenues of operating companies to AT&T

The whole process of setting up an IIB begins with an application, which needs evaluated by the relevant official body to assess its merits. This entails a risk of the build up of bureaucracy, and may make it hard to rescind IIBs once they have been created. Safeguards therefore have to be built into the scheme to guarantee the effective right of the participating firms to rescind the tax and abolish the IIBs.

One potential criticism is that, foreign consumers will reap the benefits of the higher quality and/or lower prices which have been achieved thanks to taxes paid by domestic consumers. This could be alleviated if such mechanisms are not limited to individual states. This is one area where the European Research Area (ERA) initiative to create a common European space for research activities can play a key role.

Finally, the location of the R&D centres receiving funding from IIBs is also an important issue. Governments are not likely to be indifferent to where Bell-labs look-alikes are situated. Furthermore, even if foreign firms participate in the IIB approval and funding process, it is likely that spillovers will most readily benefit domestic research centres rather than foreign ones, giving incentives to countries to adopt the IIB scheme early on. Thus, once started such a scheme is likely to spread quite quickly.

Conclusion

All in all the IIB proposal deserves attention as it provides a way to empower firms to solve collective action problems of a kind which are bound to emerge when providing industry-specific public goods. The scheme combines both government aspects (taxes to eliminate 'free-riding' behaviour) and market mechanisms (free entry, competing industry investment boards, etc.). Moreover it provides a way of reinforcing the relevance of science, by placing it in contact with practical challenges, without sacrificing the free exchange of ideas and the positive spillovers arising from them.

To avoid the build up of bureaucracy, safeguards have to be built into the scheme to guarantee the effective right of the participating firms to rescind the tax and abolish the IIBs when they are no longer useful

Keywords

R&D, investment, innovation, public goods, collective action

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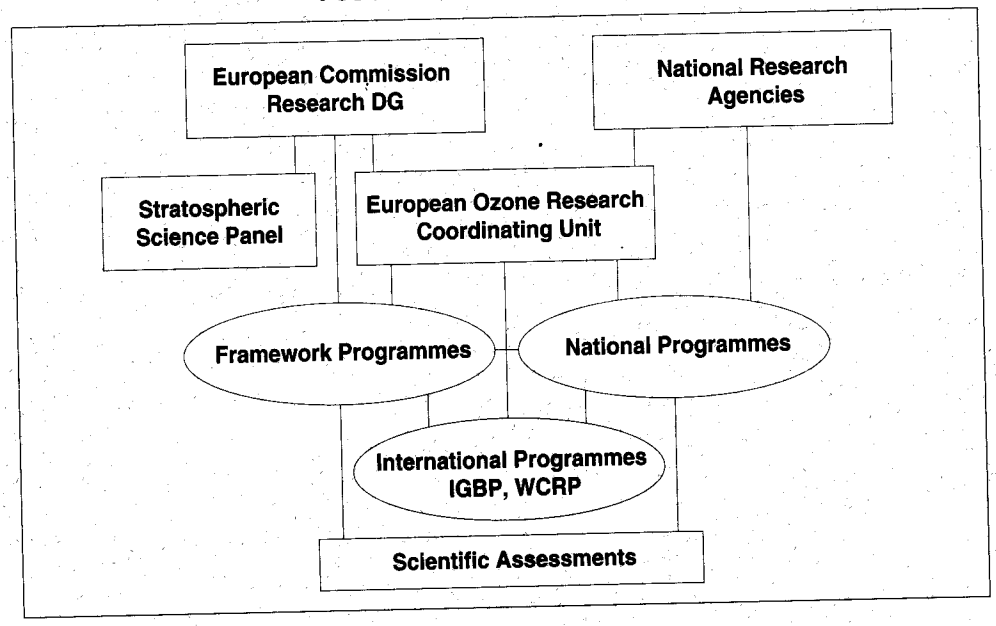
- the 1992 Rio Convention on climate change and the 1997 Kyoto Protocol on substances that alter the radiative forcing of the climate system,
- and, the International Civil Aviation Organization (ICAO), which is responsible for regulation of international air traffic (including environmental regulation).

The European Union (EU) has taken its part in this worldwide effort. A number of research projects on stratospheric physics and chemistry were initiated through the European Commission (EC) Environment Programme back in the early 1980s. As a response to the ratification of the Montreal Protocol, which came into force in 1989, the EU and the individual Member States set up a stratospheric research programme in 1989. This initiative was strongly endorsed by the scientific community, as despite the existing bilateral cooperation between Member States, considerable scientific benefits could result from better coordination at the European level. To strengthen the coordination between European and national activities, both a Science Panel on Stratospheric Ozone and a European Ozone Research Coordinating Unit were established (see Figure 1 for an overview). These scientific bodies helped in the definition of a balanced programme, which was developed further within the framework of the environmental part of the EC's 3rd, 4th and 5th Framework Programmes for Science, Research and Technology. The main elements of this programme, which have been continuously implemented over the last decade, are:

- Laboratory measurements of chemical and micro-physical processes.
- Development of new instruments.
- Coordinated field measurements.
- Ground-based observation networks for long-term monitoring.
- Deployment of research aircraft and balloons for *in situ* and remote-sensing instruments.
- Analysis of satellite data from Earth observation systems.
- Improvement in theoretical and modelling work.

Long term declines in stratospheric ozone have been observed at both mid and high latitudes, the best known manifestation of the human impact on the ozone layer being the Antarctic ozone hole, which occurs each austral spring in the southern hemisphere

Figure 1. Overview of European stratospheric research and its links



albedo. When these factors do not change, it is clear from both measurements and models that an ozone reduction results in an increase in UV-B radiation. Similarly, assuming all other things to be equal, it is possible to calculate the UV trends that have resulted from the observed ozone trends. However, in order to increase our confidence in these calculations, it was important to improve our understanding of the relative contributions of all the factors under different conditions. Thus, the scientific response to the ultraviolet radiation problem has been based on a strategy involving instrument development, field experiments, databases and model calculations to improve detailed understanding of the processes in the atmosphere which attenuate and scatter solar ultraviolet radiation. Within this framework, European-wide research projects were best suited to investigating regional aspects of solar ultraviolet radiation.

The upper troposphere and lower stratosphere (UTLS) remains a region of major concern for both climate impact and the surface environment. Because much of the ozone column resides in the lower stratosphere, small changes in ozone in this particular region have a large impact on the surface UV flux. In addition, because of the radiative properties and temperature structure of the atmosphere, changes in ozone have their largest impact on climate when they occur in the upper troposphere and lower stratosphere. Therefore, our lack of knowledge of the processes taking place in the UTLS makes it impossible to predict the future evolution of the atmospheric composition of this region with any degree of confidence. Furthermore, this occurs in a situation where the UTLS has been directly perturbed by increasing emissions from both subsonic and supersonic aircraft. Indeed, the impact of aviation is of special importance within the context of other emissions, as emissions from aircraft are made directly into the atmosphere and not at the earth's surface. While aviation emissions have been regulated through the implementation of standards agreed by ICAO, these regulations have mainly been introduced to address local pollution issues. Direct injections by aircraft of nitrogen oxides (NO_x), water vapour (H_2O) and particle precursors into the UTLS have global effects and are likely to increase substantially over the next twenty years. The main questions related to the impact of aviation on climate change and UV-B include the effect of NO_x on stratospheric and tropospheric ozone, the climate and chemical effects of contrails and cirrus clouds, and the role of water vapour emissions in the stratosphere. The relative climate impact of these emissions compared to that of CO_2 is also a critical issue.

Finally, one of the key questions concerning future changes in the ozone layer is the amplitude of the potential recovery which may start to occur at the turn of the century, after the peak chlorine loading in the stratosphere should have been reached. As signs have begun to emerge of stratospheric trends in temperature, aerosol abundance and water vapour, the post-2000 stratosphere will be different from the one studied in the past decade. The synergistic effect of all perturbations is still to be quantified in terms of their impact on the ozone content. Indeed, climate change could profoundly alter the future composition and variability of both the stratosphere and the troposphere. Temperature and water vapour variations would clearly have radiative, dynamic and chemical effects. For example, increased tropospheric temperatures and water vapour might lead to stronger stratospheric wave driving, to colder tropical tropopause temperatures and hence to reduced water vapour in the lower stratosphere. At the same time, the lower stratospheric cooling associated with CO_2 concentration increase and ozone depletion might in turn lead to enhanced formation of PSCs and cold aerosols and hence additional ozone losses. Several such mechanisms can thus be suggested, and moreover unexpected feedback may arise from an interactive coupling of dynamics and chemistry.

The lack of understanding of the processes taking place in the upper troposphere and lower stratosphere (UTLS) makes it impossible to predict the future evolution of the atmospheric composition of this region with any degree of confidence

Direct injections by aircraft of nitrogen oxides (NOx), water vapour (H2O) and particle precursors into the UTLS have global effects and are likely to increase substantially over the next twenty years

1999-2000, the
further extended in a
THESEO 2000. In a
collaborative exercise,
2000 joined scientists
SAGE III Ozone
Experiment (SOLVE)
field measurement
to measure
changes in the Arctic
the THESEO 2000-
international
from 500 scientists
Canada, Iceland,
Russia, Switzerland

European cooperation in
field, and particularly
increased the added
these efforts. During
2000, operational
in order to
plan the
facilitate data
with public awareness
depletion and UV
experience from the
stratospheric research
the advances in
tools that have taken
the 1990s. These
capability of ground-
techniques for arctic
validation of
models, improvements
other airborne
advances have been
ways, but possibly the
development of a
who understand the
operating on an
In this perspective,
monitoring in particular is
many young scientists
from the additional
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leading scientists
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Future stratospheric research and policy relevant issues

A number of important changes in atmospheric composition will occur over the next few decades. Stratospheric halogen loading should have peaked in 2000, and by 2020, it is predicted that it will decline by about 10%, returning to 1993 levels. Also by 2020, the globally averaged radiative forcing will probably have increased from ~1.8 Wm^{-2} to ~2.5 Wm^{-2} compared with 1750 levels, with noticeable regional differences resulting from different contributions from long- and short-lived gases and aerosols. During the same period, ground sources of NOx, volatile organic compounds (VOC) and other pollutants will continue to change significantly, as will the amount of such pollutants reaching the free troposphere. The impact of aviation will be of special importance within this context, as aircraft emissions (e.g. particle precursors, NOx and H_2O) occur within the upper troposphere and lower stratosphere and are likely to increase substantially (the amount of aviation fuel burnt is predicted to rise by 70-150% by 2020).

For stratospheric ozone, the main question will thus change from being "what effect will changes in halogen loading have?" to "what effect will other atmospheric changes have on stratospheric ozone given the existing high halogen loading?" and "how will the effects of ozone change combine with other atmospheric changes?" These questions bring into play a number of issues, which are in line with the general framework of sustainable development currently driving environmental policies in Europe. They also imply new directions in atmospheric research, which include a stronger emphasis on the coupling between the lower stratosphere and the upper troposphere, the interaction between ozone depletion, global pollution and climate change, and the need to observe and model the atmosphere in different latitude areas (e.g. the tropical regions).

The use of new short-lived compounds which are partially destroyed in the troposphere as a substitute for CFCs requires a quantitative understanding of the processes governing the amounts reaching the stratosphere

Keywords

stratosphere, atmosphere, ozone depletion, global change, research strategy

Note

1. The research activities and scientific advances conducted by the European scientific community from 1996 to 2000 within the EC 4th Framework Programme and EU National Programmes are described in detail elsewhere (EC, 2001). This article is based on the introduction of the cited report written by the same authors and is focussed on the research strategy of the European stratospheric programme, key areas for future research and issues for formulation of environmental policy in the near future.

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require a revision. We cannot understand this situation in terms of continuity OR change. We need to take both aspects into account". This statement was not made by an Information and Communication Technology (ICT) planner, but it is an important message from a psychologist, with extensive experience in her domain of expertise (Viorst, 1987). We should learn from the examples of the past.

The layered infrastructure model we will use was proposed by Abe Mamdani at Imperial College, UK. His model includes three broadly defined layers (Fig.1). The lower layer is the communication transport layer. This is the "plumbing", which deals with communication pipes and links. The upper layer is concerned with the applications. It deals with society and people. The middle layer serves two purposes: to take care of the management and control of the transport layer and to provide support to the higher layer services. In practice, it is not always possible to have very precise lines of demarcation between them. As such, we will use it only as a quick reference model to support the understanding of the message, rather than aim for it to be complete or exact.

Transport layer

Originally, telecommunications networks (mainly voice networks) and computers occupied two separate worlds. One of the parts of a computer is a pathway or channel for data and instructions between hardware devices, namely the computer-bus. The time came when there was a serious gap between the computer-bus, with its high speeds over a short distances, and the telecommunications network, with its low speeds over long distances. The Local Area Network (LAN) provided the missing link, bridging the computer-bus and the public or private Wide Area Network (WAN).

Several attempts were made towards early integration and important questions were raised. How would it be possible to take advantage of the sophisticated computer functions and still operate the widely distributed telecommunications network with a guaranteed quality of service? How would it be possible to evolve from corporate towards national and international networks, using private, public or mixed networks?

The telecommunications world prior to large-scale data transmission was characterized by well-developed and internationally agreed standards and well-trained people, driven by a philosophy based on ***order***. The computer world was less interested in worldwide standards. It was more market driven and implied fewer rules. The abilities and qualifications of computer specialists varied greatly. There was a lot of ***freedom***, sometimes to the point of chaos on the worldwide network.

Within a specific computer-network however, there was a form of dictatorship, inflexible formats, commands and obstinate *de-facto* standards. The terminals were strictly designed to be connected to a specific mainframe computer in a master-slave relationship. What freedom there was mainly existed in the way the system developed on the supply side and the choice of a specific system on the user side. Once the system had been chosen, users would be locked into the specific system or family of systems. The concept of modular families of systems, offering a range of service capabilities, was developed by the manufacturers to tie their customers to their products. User choice on the hardware side was limited to looking for the optimal package.

The mainframe computer became the basic element of the physical infrastructure on the computer side. In order to provide better access to information for data users, mainframes (from the same manufacturer) started to be interconnected

Telecommunications and computing started out as two separate worlds. It was therefore possible to transmit at high speed over short distances and low speed over long distances, but with no intermediate option

In the days of the mainframe, computers were characterized by rigid standards ensuring customers were locked into a particular supplier's hardware

One of the aims of the ICT world was to push the functionality of an automated industry, including the design offices, towards the macro scale. Instead of using a computer bus, a sort of wide-area computer bus is used. Instead of serving the product line of a corporate business, it serves an economic value chain. If we mirror this process in soft format, we create the environment for the electronic market place. Optimizing the system at the macro level should make it possible to optimize the control of inventory.

On the programming side there has been a shift towards object-oriented programming. The wide area computer-bus carrying the objects is the Object Request Broker (ORB). Some of these objects were designed to be able to act autonomously, socalled agents. A "family" of agents, a Multi Agent System, is thus created to serve the users and their applications (*KIMSAC*). Some RTD projects built an interaction-agent architecture, an implementation of generic managerial principles (*GAIA*). The foregoing examples show a conscious implementation of intelligence in the infrastructure, thus mimicking human organization.

Traditionally the regulator starts by defining the lower layers. The reason is perhaps the analogy with the power supply. However, it is striking that even regulatory hard-liners accept that the upper layers need to be kept free from all regulation. Nevertheless, the need to regulate certain aspects of the upper layers has been apparent for several years now. With the advent of the Internet, rules of conduct governing servers became important (Poullet, 1995). Last but not least, if agents in a multi-agent system environment where the agents are drawn from different sources take actions autonomously, who is liable if things go wrong? Thus, rules governing the conduct of agents are no mere luxury.

Application layer

The applications layer benefits from the powerful capabilities of the lower layers. Sometimes however, there can be drawbacks. Consider, for instance, the home platform. Television, and broadcasting in general, was a separate world from ICT and therefore TV and telephony have evolved very different legal frameworks. Digital Television changes the picture dramatically. Here too, we see a strong tendency to use economies of scale and to provide the highest possible level of service to the end-user. Even in the very recent history of digital television, we are beginning to see vertical integration, from the delivery of the programmes, access control, the ownership or lease of transmission channels, up to the specification of the receivers. In some cases, broadcaster even control supply of equipment to the customer. Only a couple of years ago the customer was free to purchase a receiver, independent from the service provider (Reimers, 1998). Again, we notice the recurrent trend towards vertical integration and the tendency to seek *order* on the infrastructure-side and seeking *freedom* on the user-side[1].

ICT architecture and policy

The conscious implementation of intelligence in the infrastructure deserves the attention of the policy-maker. "*Now, there is a need from the very beginning for a creative legislative thinking from the "law provider or legislator" for a juridical guidance in a lot of problems. So, no helpless running after the facts, but joined thinking and putting it in correct channels, just like a seismograph to measure the pace of society*" (Prof. Dillemans, President of the Flemish Research Policy Council). This statement was made in the context of ethical questions in biotechnology. However, it would seem to be perfectly valid in relation to the delicate question of the growing intelligence in the communications infrastructure.

There is also unconscious implementation of intelligence in the infrastructure. This development may be the result of the unconscious internal drive

In software, object oriented programming represents a shift towards enhancing the level of intelligence built into the objects, enabling them to act with increased autonomy

Conclusion

In this article, we have tried to use a number of examples to highlight aspects of trends in the development of technological infrastructures that are likely have an impact on future policies. Non-technical issues will increasingly influence managerial decisions in technology about development choices. However, "*Electrons, photons and bits do not know whether they are working in a regulated or an unregulated business*" (A.G. Chynoweth, USA). In other words, it is better to remain realistic; to monitor carefully what happens in the market place, to understand the business and to anticipate in a well thought out way. To anticipate, it can help to investigate what happens consciously and try to understand what happens unconsciously, knowing that every model and every metaphor has its limitations. Thus, to summarize:

- The quest for freedom on the users side and the quest for order on the infrastructure side tends to be both technology independent and time independent.
- The open systems environment can be seen as a technical representation of a form of organization, reconciling the freedom of the individual and the order of the organization.
- Multidisciplinary groups are needed to reflect on these issues. They should be equipped with the latest technological means, to investigate the interaction of the infrastructure and its users, to help policy in its efforts to safeguard the rights of the actors involved.

It is hard to demonstrate the impact of social science research in ICT (Burgelman, 2000). Nevertheless, it is to be hoped that a task force, or other initiative by a multidisciplinary team, can be set up to reflect on these issues.

Keywords

Information technology, infrastructure, ICT, intelligence, model, simulation, telecommunications

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Notes

1. The Digital Video Broadcasting (DVB) project not only provides an efficient coding mechanism to allow more programmes to be transmitted over the same channel, but also compatibility with other applications, particularly Internet-based ones. Users will even have the freedom to interact with the objects on the screen, i.e. look at them from different angles and so shoppers could for instance check if what they are looking at is the right product to buy. The availability of massive storage capabilities, at home and at work, will change the content industry forever. The consumer of multimedia content can even act as a content provider. Further support will be provided by increasing visualization, verbalization and even "emotionalization" of the human interface with the infrastructure. Policy-makers need to be aware of these developments.

About the author

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Cultural Heritage and Advanced Information Technology: a Promising Outlook

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Issue: Advanced information technologies are opening up possibilities enabling greater access to Europe's cultural heritage for both Europe's citizens and the world as a whole, with the attendant potential for study, conservation and economic exploitation this brings.

Relevance: The use of advanced information technologies in the cultural sphere constitutes a valuable tool for generating new opportunities for business, education and training. However it also raises policy challenges, such as the need to create the conditions enabling these new activities to develop, so as to make the most of the potential of Europe's cultural heritage.

Introduction

The application of advanced information technology –often drawing on artificial intelligence techniques– to those areas connected with studying, preserving and exploiting our cultural heritage has grown in recent years. Many problems have been approached and dealt with using neural networks, fuzzy logic, expert systems, etc. Over the last few years, archaeology has particularly benefited from this kind of technology. A joint research project being undertaken by archaeologists and architects working together with information technology experts has made it possible to deal with a range of problems in novel ways. Recent applications of display techniques and virtual reality (VR) have contributed to developing software tools capable of helping archaeologists carry out their work. An interesting experiment in the field of managing the art collections held by museums has been developed using multimedia systems. Recently, "multimedia tours" provide a number of new ways to exploit museums, making it possible, for instance, to utilize new archiving methods and new types of visitor services.

Libraries have also been able to put this technology to good use. The use of information technology by libraries is spreading rapidly and intelligent digital libraries are currently being developed. Libraries of this kind use special purpose search engines to locate information and offer a range of user-oriented functions.

Digital heritage and cultural content is one of the five main areas for research and technological development under the "Multimedia Content and Tools - Key Action III" of the Information Society Technolo-

The application of advanced information technology to those areas connected with studying, preserving and exploiting our cultural heritage has grown in recent years

Table 1. Projects included in Action Line III.2.3: Access to scientific and cultural heritage

(Digital Heritage area, 1999 work programme). (http://www.cordis.lu/ist/ka3/digicult/en/projects.html).	
COVAX	The COVAX (Contemporary Culture Virtual Archive in XML) project, in which ENEA is a participant, intends to combine document descriptions and digitized surrogates of documents from libraries, archives and museums, so as to build a global system for search and retrieval, thus using the Internet to enhance the accessibility of primary source documents regardless of their physical location **(http://www.covax.org/)**. COVAX should act as a meta-library, offering access to a network of distributed repositories and databases of contemporary culture: the user will see the network as a single library with book references, search aids, facsimile images, museum items, etc.
CULTIVATE-EU	The CULTIVATE-EU **(http://www.cultivate-eu.org/)** project establishes a European Cultural Heritage Network linking the National Nodes across Europe. It provides a single point of information on the Cultural Heritage research programme. The main purpose is to link European institutions with national administrative bodies and professional organizations and institutions in order to link European activities and directives to citizens.
The MEDICI Framework	The MEDICI Framework (Multimedia for Education and employment through Integrated Cultural Initiatives) **(http://www.medicif.org)** is a framework of cooperation established and supervised by the European Commission, it operates not only in Europe but worldwide. MEDICI promotes advanced training systems, which will exploit knowledge and skills across Europe so as to create new job profiles and opportunities.

ced information technologies have been applied in practice to enable or enhance access to cultural content. The examples presented are: the application of natural language processing techniques to provide solutions for the planning and implementation of a multimedia information technology system; the use of neural networks to recognize works of art; and use of systems able to create user models and filter information to enable intelligent access to document archives.

Example 1: A multimedia system based on Cesare Ripa's Iconologia

One of the most important literary works for understanding images is the treatise *Iconologia* by Cesare Ripa. It is obviously not the only book of its kind, but it certainly one of the richest and best known. The author clearly stated that his book was intended for painters and it supplied them with a reference code for creating images or parts thereof (for instance, combining images or incorporating them in a more complex context). The book fulfilled its aim and was so successful that it is nowadays an essential tool for interpreting a large part of the art that was created between the 17^{th} and 19^{th} centuries.

The planning and implementation of a multimedia information technology system (Bordoni, *et al.*, 1996) based on Cesare Ripa's *Iconologia* (Ripa, 1992) has made it possible to combine iconography and the new multimedia technology. Natural Language Processing is a central problem for

resources held in libraries. Moreover, the end user is no longer a passive consumer of documents, but an active researcher. In order to assist users in these new interaction methods, it is necessary to supply them with much richer and more flexible environments. It is thus necessary to seek efficient methods that would supply a digital library's interaction environment with the appropriate forms of content representation in order to give users the suggestions needed to locate the desired data. Recent research has shown that displaying information in appropriate ways can speed up the process of locating and understanding that information. Electronic library service prototypes are being developed that use machine learning techniques to analyse, classify and understand documents and to classify and model patterns of usage.

These systems are able to create *user models* that allow the system to adapt itself to the characteristics and needs of the specific users of the system. Information filtering systems (Belkin, *et al.*,1992) are interfaces located between the information source and the user and can determine the relevance of a document by comparing it to an explicit model of the user's information interests. These systems base their modelling activities on a dynamic user classification model by means of a series of so-called "stereotypes". Besides acquiring knowledge, the system is also able to infer data to obtain new knowledge from that contained in the model. An information filtering system based on usage modelling means that the user need not read all the documents provided by the source, but only the potentially interesting ones. While reading a document, the user can express an opinion on its relevance, which makes it possible to adapt the model to the topics that the user seems to be most interested in. These filtering systems have been used for a number of experiments and assessments (Bordoni, *et al.*, 1999).

Conclusion

The use of advanced technologies allows the achievement of goals of important cultural value which are beyond the reach of traditional tools. The dissemination and fruition of cultural heritage benefits from the use of these technologies. In particular, personalization and interactivity (which are intrinsic features of multimedia communication techniques) exhibit a good match with the complex and variegated contents typical of cultural heritage. Moreover synergies can be obtained from connecting museums, libraries, and archives; and this will no doubt open up our cultural heritage to new avenues of exploration.

Multimedia or virtual libraries create new ways of managing documents and require efficient methods to enable users to locate and understand information rapidly

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