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The IPTS REPORT

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CE

ENGLISH VERSION

ABOUT THE IPTS REPORT

The IPTS Report was launched in December 1995, on the request and under the auspices of Commissioner Cresson. What seemed like a daunting challenge in late 1995, now appears in retrospect as a crucial galvaniser of the IPTS' energies and skills.

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

The first, and possibly most significant indicator of success is that the Report is being read. Issue 00 (December 1995) had a print run of 2000 copies, in what seemed an optimistic projection at the time. Since then, circulation has been boosted to 7000 copies. Requests for subscriptions have come not only from various parts of Europe but also from the US, Japan, Australia, Latin America, N. Africa, etc.

The laurels the publication is reaping are rendering it attractive for authors from outside the Commission. We have already published contributions by authors from such renowned institutions as the Dutch TNO, the German VDI, the Italian ENEAand the US Council of Strategic and International Studies.

Moreover, the IPTS formally collaborates on the production of the IPTS Report with a group of prestigious European institutions, with whom the IPTS has formed the European Science and Technology Observatory (ESTO), an important part of the remit of the IPTS. The IPTS Report is the most visible manifestation of this collaboration.

The Report is produced simultaneously in four languages (English, French, German and Spanish) by the 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 World Wide Web, makes it quite an uncommon undertaking.

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

Preface

For several years now the European Union has been contributing to the financing of international research activities with Third Countries in the spirit of mutually shared interests. In a world in which the economy, problems and stakes are increasingly global, international cooperation has become an important dimension for the European Union's research policy.

In this direction, the forthcoming Fifth Framework Programme will seek selectively to extend scientific and technological cooperation beyond the EU's borders whilst keeping community interests in mind. There are several reasons for this: access to skills which are not available within the Union; assert the presence of the EU within external markets; participation in the international standardization process; dealing with problems of international scope which the Union cannot solve alone; supporting external policy on trade, security, and development, and paving the way for the future expansion of the Union. In other words, this programme should make a significant contribution to the Union's foreign policy, key parts of which are policy regarding those countries of central and eastern Europe which are candidates for membership, and reinforcing Europe's role in the International Scene.

These international scientific and technological cooperation activities will be carried out, depending on the existence of cooperation agreements and their content, by the intermediation of the specific "international cooperation"

action and will take into account the international research dimension in other Framework Programme actions. On the one hand, it means facilitating and coordinating activities managed within the framework of other programmes; on the other, it means supporting oriented additional research activities according to the characteristics of specific groups of countries. Within these two major categories different formulae for cooperation will be put in place, distinguished by the countries concerned, the types of activities performed and the sources of financing.

Finally, I would also like to underline the strengthening of links between the COST and EUREKA frameworks for European cooperation and European research programmes. These two cooperation frameworks have shown their worth, thanks to their flexibility and the principle of launching actions on the initiative of the interested parties within both the non-competitive and market related domains.

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EDITORIAL

Warranted Optimism

Dimitris Kyriakou

The article projecting telecommunications infrastructure developments in this issue of The IPTS Report, serves also as a reminder of not only the challenge but also the opportunity new infotelecoms technologies present, especially for less favoured regions (LFRs). These technologies bring the producer closer to the consumer, bypassing various layers of intermediaries; they reduce the cost of setting up shop and facilitate market entry for smaller firms, even in the face of competition by business Goliaths. Nascent electronic cash further undermines the debilitating role of distance. The continuing trend towards outsourcing (often long distance outsourcing), is not only changing the architecture of firms but also enhancing income, employment and technology transfer to LFRs. The above developments may be vindicating, a quarter century later, Schumacher, though with a twist: Small is beautiful as long as it is interconnected.

The gradually emerging eclipse of intermediate filters opens up possibilities for content producers, symbolic analysts and human capital providers who may claim, and get, a larger piece of the pie. This can only be good news for many LFRs with high numbers of well-educated scientists, often living abroad.

As distance stops being a prohibiting factor, the area in which people live, produce and that which they enrich - as taxpayers and local consumers - will depend less on distance from work or the market, and more on other factors (e.g. climate, safety, environment, culture, etc.). Moreover, as human capital becomes increasingly more crucial in production the competition for attracting (monetary) capital will be increasingly outpaced by that of attracting human capital. It is here that the strictly-speaking economic efficiency rationale for insisting on building attractive societies lies, together with the reason for being optimistic about Europe and about LFRs in particular.

I cannot emphasize this point strongly enough: S/T programmes can foster hope for convergence, allowing less-favoured regions to catch up. Such programmes can focus on innovation, explore the dynamic character of comparative advantage, in order both to exploit effectively and to possibly overcome the confines of the prima facie specializations of less-favoured regions. If it

is too late for them to meet richer partners at a capital intensive stage of development, maybe they can reach them, at an S/T, human-capital intensive one.

The silent scepticism that meets such admonitions reverberates across auditoria and laboratories with an ear-piercing echo. However, those who lament the dire predicament of less favoured regions or states and believe such optimistic transformations to be impossible, should pause to take notice of the reference in the World Bank's 1991 World Development volume (p.14), to a 1947 prime-ministerial report from a developing country. That prime-ministerial report claimed that in that country workers' productivity had fallen, that productive jobs were shunned, that wages were too high, that the country's enterprises were inefficient and heavily subsidized. The country, the authoritative report stated, had priced itself out of the world markets and was facing acute competition. It would be the last opportunity, concluded the prime minister, to see if the country could stand on its own two feet or be a burden for the rest of the world. That country was Japan...

6 Information and Communication Technologies

Infrastructure Options for Interactive Multimedia Services

Françoise Charbit, *CEA*

Issue: The development of the information society is linked to the increasing availability of interactive multimedia services for home, corporate or public service users. These new services will require an interactive broadband access infrastructure which does not yet exist. Current infrastructure relies on either the telephone network (which is not broadband), or the broadcasting television network (which is not interactive).

Relevance: In the current context of a new liberalized environment, a long term vision of technology options for broadband infrastructure is needed in order to develop an adequate European regulatory framework. Understanding the strategic impacts of these options will help policy makers and industrial operators to deal with the issues related to broadband infrastructure for the information society.

Introduction

Forecasts of developments in interactive multimedia are made difficult by the rapidity with which the economic and technical environment can change

The digitalization of audio-visual and telecommunication networks is providing access to more sophisticated services (including greater interactivity and multimedia).

The physical access infrastructure for home or corporate users is not completely adapted to interactive broadband multimedia services. The transport infrastructure (national and European backbone) needs to be extended by a broadband access network allowing a high information data rate for real time transmission of images.

This paper describes a possible vision of the situation over the next ten years: interactive multimedia services anticipated and one scenario out of many possible scenarios of the future broadband access infrastructure.

This kind of forecast is made difficult by the fact that economic and technical environments change very quickly. Our intention is to illustrate a possible scenario, based on defined hypotheses and technical and strategic forecasts of what could happen in the next 10 years. We hope that this vision will help the reader to understand the consequences of European technical strategies, both for industry and policy makers.

Although there are some highly visible European actions such as the Bangemann proposal for an international charter and common proposals in the negotiations at the World Radiocommunications Conference 97, Europe may need strategies to promote European industry and services in future global competition, especially in the light of efforts by participants in the World Radio Conference in 1995 to gain a first-mover advantage for Low-Earth-Orbit satellite projects. We will try to see how policy makers, via an adequate regulatory framework, can

speed up or slow down the development of such broadband infrastructure, through the example of this scenario.

What interactive multimedia services?

Digitalization has allowed text, still images, audio and video signals to be transmitted via the same media. This implies high volumes of information and so requires a high transmission data rate if real time access is to be made available.

The technical specification of broadband infrastructure is initially defined by the possible "pipe flow", i.e. transmission data rate.

Two kinds of service are possible, depending on the interactivity required:

- Symmetric services: the downlink data rate to the subscriber is similar to the uplink data rate to the service provider, e.g. video telephony.
- Asymmetric services: the downlink data rate to the subscriber is much higher than the uplink rate e.g. web browsing, where file downloading requires the movement of much larger amounts of information to than from the user.

Table 1 gives downlink data rates required for the most probable services anticipated over the next 10 years, after currently used MPEG2 standard compression. MPEG[1] may allow data volumes to be an order of magnitude smaller. For example, a video movie with 25 images per second with a normal TV definition, corresponds to an uncompressed data rate of 166 Mbps, and a compressed data rate of 6 Mbps. In the case of asymmetric services, uplink data rates are generally less than 1 Mbps.

Digitalization makes it possible to transmit images, sound and video via the same media, entailing the need for high transmission data rates

Table 1. Future multimedia services and corresponding data rates

Asymmetric services			Symmetric services	
Entertainment	interactive TV and video *(video on demand, near video on demand, pay per view)*	6 Mbps	network video games	1-6 Mbps
On-line services	Internet all on-line services electronic commerce teleservices	1 - 4 Mbps		
Communication	telecommuting	6-10 Mbps	professional videoconferencing (broadcast quality) videoconferencing on PC video telephony on PC	6-10 Mbps 1-2 Mbps 300 kbps
Education	tele-education	6-10 Mbps		

Multimedia services may be categorized as symmetric or asymmetric, depending on whether the user sends and receives similar quantities of data or not

Table 2. Technologies for broadband access infrastructure and dates of availability in Europe

	Technologies	Description	Availability (earliest)
Based on existing infrastructure	Copper telephone network + ADSL (Asynchronous Digital Subscriber Line)	Two ADSL modems at each end of the telephone line (switching node, subscriber): utilizing the entire copper line bandwidth, restricted to voice, by means of a specific digital coding method.	1998
	Cable television network	Data are transmitted over the cable TV network, received and decoded via a cable modem at the subscriber.	1997
	Direct TV broadcasting satellite	Data are downloaded from the satellite network to the PC via the traditional satellite dish and a decoding card. The return channel is provided by telephone line.	1997
Using new infraestructure	Hybrid network: optical fibre + ADSL/VDSL	Fibre from the switching node up to the kerb or building, final access to home provided by telephone copper line associated with ADSL or VDSL modems (Asynchronous or Very high data rate Digital Subscriber Line).	2000-2002
	Fully optical fibre network	Fibre from the switching node up to the home.	2006
	Fixed broadband terrestrial radio	MMDS (Multipoint Multichannel Distribution System): terrestrial TV broadcasting technology with local cover also called "wireless cable", not interactive (return channel provided via telephone line).	2001
		LMDS (Local Multipoint Distribution System): terrestrial broadband interactive technology, with local cover.	2003
	Mobile broadband terrestrial radio	Evolution to broadband of current mobile communication systems (UMTS[2] and future systems)	2001-2004
	Broadband multimedia satellite	Constellations of LEO (Low Earth Orbit) satellites associated or not with geostationary satellites.	2002

All services are supposed to promote the use of broadband at home: it is not the purpose of this paper to describe how policy actions could stimulate demand for such services. Nor will assumptions made concerning the development of these services be discussed.

The development of broadband services is currently generating a strong debate and forecasts range from the very pessimistic to the very optimistic, predicting that electronic commerce and interactive services will take off quickly. This paper takes the line that these services will develop and so will give rise to the need for broadband infrastructure. Our purpose is to assess the technologies that can meet this demand.

Technologies for broadband access infrastructure

Access infrastructure represents the very last part of a communication network: distances of 100 metres to a few kilometres between the last switching or distribution node and the subscriber. The possible technologies for this infrastructure are shown in table 2. We have not included electric power distribution grid (recently experimented with in the UK), since its broadband performance has not yet been proven.

The possible date for availability is given in order to set up the scenario that follows. Obviously the actual date depends upon developments still to take place, as well as on regulatory constraints, especially for wireless technologies, as we explain below.

A scenario for broadband development over the next 10 years

With such a proliferation of technologies, which solutions will take the lead in satisfying future multimedia service needs? Our scenario can be divided into three parts and it is based on three important working assumptions:

1/ Most of the technical solutions will coexist for at least two reasons:

a/ they are complementary in terms of topography and performance, depending on the zones (densely populated urban versus rural areas) and needs.

b/ numerous technologies will be encouraged by the telecommunications and broadcasting markets opening to competition.

2/ The rate of development for these solutions will be defined by data rate needs, i.e. the services required

3/ Nevertheless all these technologies still need technical or marketing developments and will not be available at the same time.

A variety of technically feasible options are likely to coexist and compete over the next ten years

It is important to point out that all these infrastructure technologies, except multimedia Low Earth Orbit satellites, have demonstrated their technical feasibility. Thus, the scenario is fairly reasonable: the main underlying assumption is that broadband will be introduced slowly and that services demanding very high symmetric data rates will be postponed to a later date.

Today

The telephone network is the only form of access home users have to the Internet and on-line services in Europe. Performance is limited: even the ISDN[3] (up to 64 kbps[4]) or the latest phone modems (up to 56 kbps) do not provide comfortable access.

Although high-data-rate Internet access is now available in the US via cable, users in Europe still have to rely solely on telephone lines

High data rate Internet access is available in the United States (between 500 kbps and 1 Mbps) via cable, direct broadcasting satellite or wireless cable (i.e. terrestrial TV-broadcasting technology).

First period: 1998 - 2000

The Internet boom and the development of images and small video and audio sequences on the

The demand for on-line services and Internet favours existing infrastructures: the telephone network associated with ADSL, cable networks and direct broadcasting satellite

Net correspond to a data rate demand of at least 1 Mbps from home users to guarantee comfortable access. The conditions for the on-going development of the Internet, on-line services, electronic trading and tele-activities (all of which are asymmetric services) are:

- Continuous improvement of the optical backbone network and increased server capabilities (often responsible for the Internet access bottleneck)
- A high downlink data rate for the user.

In the next few years both telecoms operators and broadcasters could offer multimedia services, but each with its own limitations

Telecoms operators could then sell or rent ADSL modems to their subscribers, allowing a 5 to 6 Mbps data rate over 3 or 4 kilometres. ADSL data rates are asymmetric and therefore ideal for on-line services. Broadcasting operators also provide high data rate access to Internet via cable or direct broadcasting satellite.

The cable network, which is currently being digitalized, provides broad bandwidth, but has two disadvantages:

- It is not interactive, as a result of its initial function as a means of TV broadcast
- It is not switched and data rates are therefore shared between users.

The cable operators who have penetrated this market have made heavy investments to adapt the current network to new needs in two main ways

- By building a real return channel on their networks (by allocation of a part of the spectrum)
- By guaranteeing a minimal data rate to the user, thanks to a specific price policy and good network management.

Two terrestrial wireless technologies, MMDS and 2MDS are gaining ground in the US

Direct-broadcast satellite is another possible mode of access. More and more satellite operators and TV grouped digital programme providers are offering Internet access in Europe. The user only needs a satellite dish and a PC decoding card. The return signal is directed to the control centre of the service provider via a telephone modem. In the United States the same access channels are developing, with cable and satellite taking a comfortable lead in 1997. However two other technologies are available in America: wireless cable, also known as MMDS (Multipoint Multichannel Distribution System), and LMDS (Local Multipoint Distribution System). MMDS is a terrestrial TV broadcasting technology with local cover, and which, by switching to digitalization provides a direct competitor for satellite. LMDS is also a terrestrial wireless technology, with local cover but allowing real interactivity and higher data rates. In the US the FCC[5] has recently auctioned licenses for LMDS services in the 28-31 GHz band in order to open the multimedia service markets to competition, in particular for Internet access. Some eligibility restrictions favour small business operators, in order to compete with telecoms operators and cable providers.

During this period, the actors will choose their positions in a new open market context. Telecoms operators in Europe are usually the first national cable operators and therefore often faced with internal technological competition which will be difficult to solve. Investment is heavy for newcomers to the market: between 1998 and 2000, the current operators of the existing infrastructure will be the leaders.

Second period: 2001 - 2004

The era of technological competition and "Eldoradio"

In 2001 demand for services begins a second phase, marked by increased use of PC-based videoconferencing and more sophisticated on-line services, including greater use of images, especially video and 3D images. The data rate required for these services is around 4 to 6 Mbps and symmetry is necessary for videoconferencing.

This will not prevent 1-2 Mbps uses to continue to spread. The telephone network, even boosted by ADSL, will be limited for distances of more than a kilometre. Certain telephone operators will then start to install optical fibre lines, at least to the kerbside or to the building in densely populated zones where the demand for multimedia services is high. Then the existing telephone lines, associated with ADSL will provide the final home connections. In this configuration, ADSL is at its best. As early as 1997 a break-though was made with a technique called VDSL[6], offering high performance over very short distances (10 - 15 Mbps over 500m). This technique will certainly be used in this hybrid configuration.

This period is also logically that of the advent of mobile radiotelephony, which will have experienced incredible growth rates between 1996 and 2000. At this stage, the mobile networks have begun to develop towards multimedia, initially for data rates under 2 Mbps. This is the objective of the UMTS system (Universal Mobile Telecommunications System) in Europe, which enables mobile access to interactive services, such as on-line services or 'tele-activities'.

The opening of the telecommunications market to the competition has favoured the development of fixed telephone radio local loops in most European countries as early as 1998, which can evolve to broadband under 2 Mbps. If certain countries follow the example of American MMDS technology (such as Ireland), or LMDS, fixed broadband terrestrial radio technology will also appear. These systems will find a place in the competitive field as they only require minimal and gradual investment and will therefore be accessible to operators not yet present on the market.

Finally, current Low-Earth orbit and geostationary satellite projects will materialize during this period, supplying fixed or mobile multimedia services. There are many such projects that are credible in spite of their technical complexity. All require enormous investments for launch and operation, which is planned for 2002:

- Low-Earth orbit: Teledesic (Teledesic - 288 satellites), Skybridge (Alcatel - 64 satellites), Mstar (Motorola - 72 satellites)
- Geostationary: WEST - Wideband European Satellite Communications (Matra Marconi space), Millenum (Motorola), Cyberstar (Loral)

Thanks to these "information highways in the sky" broadband access will become available from almost anywhere on the planet.

Even if it is likely that there will have been some mergers for economic reasons before reaching this stage, these networks and their operators will represent a serious threat to the positions of telecoms operators. In fact, these positions will be threatened on all sides: by mobile or fixed terrestrial radio, broadcasting satellite, cable... Under these conditions, telecoms operators will have to (within the limits of the means available) generalize the use of optical fibre to the kerb in order to provide a competitive alternative to other service providers.

In this scenario, developments will depend mainly on the choices made by the national regulation authorities who allocate frequencies and licences. This optimistic scenario is therefore subject to a very powerful brake: the lack of harmonization in Europe concerning radio frequencies and licence allocation procedures.

Third period: 2005 - 2009

The Information Society: the Route Towards Fibre?

At this stage, there will be many uses based on digital networks. Videoconferencing services will be standard practice for most professions.

As videoconferencing starts to take off after 2001 telephone operators will need to start installing optical-fibre connections right through to end-users

Mobile networks will also begin to evolve towards multimedia early next century

Low-Earth orbit and geostationary satellites will be used to create 'information highways in the sky'

After 2005 videoconferencing will be standard practice and telecoms operators will need to replace existing telephone lines with fibre-optic cables in order to meet demand

Mobile networks could move to millimetre wavelengths and picocellular architectures

The high costs of new infrastructure may result in reorganization within the industry in this period

The role of cable networks in the liberalization of telecommunications infrastructure was identified some time ago, but there is still a long way to go in terms of regulatory policy

Telecommuting, network video games, etc. Telecoms operators now offer video on demand services or real time pay-per-view to compete with broadcasters. Broadband infrastructure has to develop to data rates in excess of 6 Mbps or even 10 Mbps for high definition images. Several solutions are possible.

The all-optical fibre access network involves totally replacing the current telephone access network. This solution is by far the best, providing almost unlimited capacity and perfect interactivity. To justify the operator's investments, demand must be equal to that described above. Fibre to the home has been technically feasible since 1997. The only limit is economic, i.e. the fact that replacing copper with fibre is expensive, and that privatized operators reduce their long term investments.

Fixed broadband radio networks will have, at this stage, evolved to high frequency cellular systems (27 or 40 GHz in Europe), following the example of LMDS in the USA, providing services of a few Mbps. In order to do this major technical problems will have to be solved, in particular understanding millimetric wave propagation modes, and agreement will have to be reached in Europe on the frequency bands which are available and may be used.

Finally, and this represents real uncertainty, it is also possible that mobile radio networks will have developed to broadband in excess of 2 Mbps. This assumes that the systems will have moved onto MBS concepts (Mobile Broadband System) in Europe, of a completely different nature to the current networks: millimetric waves and high frequencies (40 or 60 GHz), picocellular network architecture. The obstacles involved will be the same as those relating to fixed networks. Operators will probably have to invest heavily in the development of such networks.

With multimedia satellite networks the two terrestrial radio solutions (fixed and mobile) may merge into one single system, enabled by relatively close bands. There may be an interconnection of these radio and satellite networks, in order to optimize frequency resources.

If demand really is as great as anticipated, logically this period will see a concentration of operators and industrial actors prior to the structuring of the broadband service market.

Policy Impact

Given this long term vision, what impact could European regulatory actions have on the development of broadband access infrastructures?

The role of cable networks on the liberalization of infrastructures was identified a long time ago (see the Green Paper on the liberalization of telecommunication infrastructure and cable TV networks - 25/01/95). It is now obvious that cable TV networks are a possible way of opening access networks to competition, especially for Internet access. Here the national regulation authorities play a key role in establishing the technical and financial conditions for this competition. The global opening of voice telephony markets, with consequences on local communications pricing, will also favour ADSL development, if telecoms operators make the necessary investments.

For the mid- or long-term future there are some outstanding questions concerning new infrastructures:

- Regulatory policy will play a major role in the development of wireless technologies, but in Europe there is still a lot of work to be done: the FCC auctions for LMDS (as well as Canadian auctions for the same services) should be seen as warning messages for Europe. Although the European Radiocommunications Committee

(ERC) has specified recommendations for using the 40,5-42,5 GHz band for multimedia interactive video services in Europe, it seems very far removed from the involvement and actions of the FCC concerning LMDS, which are not restricted to video.

- Regarding multimedia broadband satellites, it is now obvious that the USA has acquired a "first-mover advantage", which could be also considered as a warning for European operators. The US seems to be promoting terrestrial radio (micro- and millimetre wave frequencies), and thereby its industry, in the telecommunications global competition. In the Commission the ESPRIT programme has recently launched a call for proposals, in order to improve Europe's role as a supplier of global satellite communication systems, services and applications(see also the ACTS and ESA Artes3 programmes). Although R&D is needed, the regulatory framework to promote these systems is still lacking.
- Finally, the fully optical fibre network cannot be dismissed: first because wireless and cable technologies will never be completely symmetrical infrastructures, secondly, because national telecoms operators will try to upgrade their networks in order to remain competitive with cable and wireless. The regulatory issue is "Is it possible to open these future upgraded access networks to competition?" Who will pay for it? How will this investment will be shared between service providers and infrastructure operators?

Demand for interactive multimedia services will grow as a result of an interactive building process based on needs and technology availability. The ability of public policy makers to speed up or slow down this process is real, thanks to regulatory actions encouraging competition between services and technologies for infrastructures, which can be exploited for the benefit of consumers and citizens.

About the author

Françoise Charbit holds an Engineering degree in Materials Science and a PhD in technology management from the Ecole Polytechnique, F. After working as an engineer for optoelectronic components, she worked as a consultant in technological strategy for high technology companies. She joined the research center CEA (Atomic Energy Commission, F.) in 1994, where she is in charge of prospective technological surveys, in the fields of information technologies and materials.

Keywords

broadband access, multimedia, information society, telecommunications, prospective

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- European ACTS projects: **www.cordis.lu**
- regulation authorities: **www.fcc.gov** for the US, **www.ero.dk** for radio in Europe.
- a good site to begin with Low-Earth orbit satellite constellations: **www.ee.surrey.ac.uk/personal/L.Wood/constellations**

Notes

1- Moving Pictures Expert Group.

2- UMTS Universal Mobile Telecommunication System.

3- Integrated Services Digital Network.

4- kilobits per second.

5- Federal Communications Commission.

6- Very high data rate Digital Subscriber Line.

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Natural Gas: Safeguarding Europe's Energy Supply

Irving Spiewak and Antonio Soria, *IPTS*

Issue: The consideration being given to greater deregulation and integration of the EU natural gas industry increases the likelihood of accelerated growth in demand for gas. At the same time, substitution of gas for coal and oil is one of the important responses to global warming, another issue under urgent consideration. New gas-fuelled technologies may also accelerate the growth of demand.

Relevance: The European Union is a net importer of natural gas, with large commitments to a few countries. A continuing assessment of appropriate strategy is needed to safeguard energy supplies in the context of the political risks from increased reliance on natural gas, and technological solutions able to mitigate the problem need to be examined.

Background, Natural Gas Consumption and Supply

Natural gas provided 22% of the primary energy consumption of the European Union in 1996. Business-as-usual projections indicate this may grow to 26% by 2010. Environmental policy decisions and/or new technologies may further increase the demands on the gas supply. Considering that the increased supply must come primarily from imports and that the EU as a whole is served by an integrated pipeline system, the problems of supply security should be considered at the Community level. An additional argument in favour of a EU-wide approach to natural gas supply management comes from the different vulnerability patterns of the Member States with respect to exogenous supply shocks. A more integrated European focus would reinforce existing National efforts to diversify their individual supply sources and to address problems of security of supply.

EU consumption increased 40% from 257 billion cubic metres (bcm) in 1990 to 360 bcm in 1996 (Eurostat). Table 1 shows a breakdown of the major users and their individual rates of growth.

The reported 5.8% annual growth in gas consumption was recorded during a period when the EU growth of gross domestic product was only 1.4% per year. Gas industry (Eurogas, 1997) estimates of the EU 15 demand for natural gas in 2010 range from 467 to 490 bcm, implying growth of 1.9 to 2.2 % per year. This would represent a considerable slow-down from recent growth. We believe that market, environmental and technological pressures may well cause faster growth than the current projections.

Of the 1996 supply of natural gas to the EU, 61% was produced by member states, chiefly the Netherlands and the UK. The latter was consumed internally, but substantial UK exports

Current trends suggest that EU consumption of natural gas could grow by 26% by 2010, and much of this will need to come from outside the community

Market, environmental and technological pressures may well cause faster growth than the current projections

Table 1. Major consumers of Natural Gas in the European Union

Country	1996 Gas consumption bcm	Growth (1990-1996) % per year
Belgium	14	6.3
France	38	4.1
Germany	91	7.8
Italy	55	2.9
Netherlands	44	3.1
Spain	10	9.7
United Kingdom	88	7.7
European Union 15	360	5.8

to the Continent are imminent. Imports are dominated by Russia, Algeria and Norway (Table 2). The gas resources within the EU are being depleted at a much higher rate than those of the external suppliers. The ratio of EU proven reserves to annual production in 1996 indicates a 15 year supply of gas at current use. In contrast, the 3 external suppliers have 60 to 100 years of proven reserves/annual production (Table 2).

The indicated resources, including unproven volumes in known gas fields and expected new discoveries, in all cases are much higher than the proven reserves.

The question is where future increases in supply will come from. The European gas industry believes that production within the EU is approaching a plateau; therefore the major pipeline companies are negotiating long-term supply contracts with external suppliers. Gazprom, the Russian gas production-pipeline monopoly, is developing a major new field in the Yamal Peninsula, in north-west Siberia. This is estimated to be a $40 billion project that would be able to deliver 70 bcm/year to Belorus, Poland and the EU. Sales contracts for this gas are being negotiated. Supplies from existing Russian fields can be expanded, in addition, for total Russian exports of 150-200

Table 2. Major Sources of Natural Gas Supply to the European Union

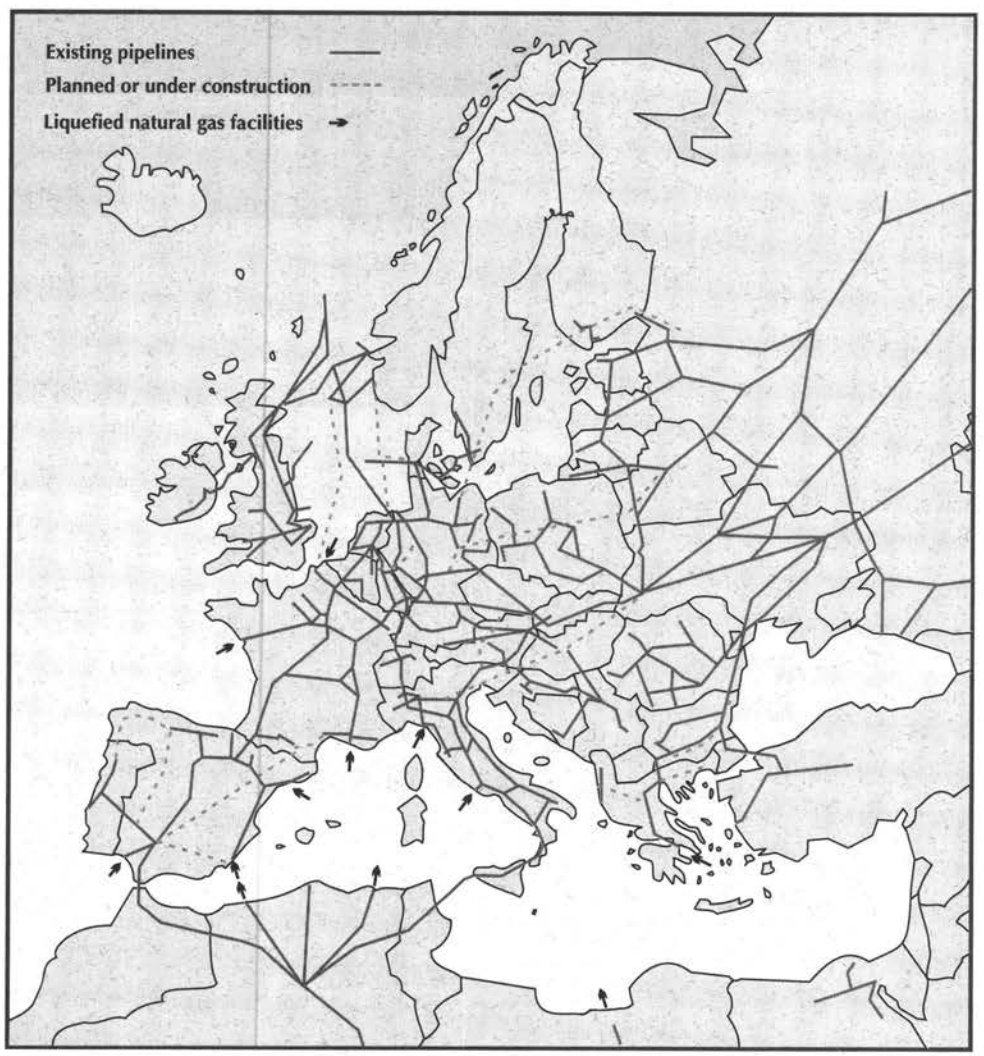
Country	1996 Supply, bcm	Reserves/Annual Production
EU 15 including	221	17
Netherlands	81	30
United Kingdom	88	7
Italy	19	15
Germany	19	20
Norway (estimate)	30	80
Russia (estimate)	70	100
Algeria	32	60
Other (estimate)	7	-
TOTAL	360	-

bcm to Europe in 2010. Norway and Algeria have announced plans for more than doubling exports, as well, and in the former case long-term contracts for everything offered appear to have been negotiated. Potential new suppliers, with pipelines comparable in length to existing lines from Siberia, include the southern former Soviet republics and the Middle East. Many potential suppliers of liquefied natural gas exist, including Algeria (already a major supplier), Qatar and Nigeria.

The Role of Technology

Technology has had a crucial impact on both supply and end-use of natural gas. On the supply side, the cost of finding gas and oil has come down by about an order of magnitude in the last 15 years. This included a reduction from $16 per barrel in 1982 to $4 per barrel in 1994 (Stevens, 1997; Baddour, 1997). These authors indicate that technology was responsible for the recent diffusion of petroleum market share away from the Persian

Figure 1. Map of Europe, North Africa, Russia, etc. showing the integrated system of gas pipelines



The Netherlands and the UK are Europe's main internal suppliers. Imports to the EU are dominated by Norway, Russia and Algeria

Improved technology for both the location and extraction of reserves has pushed gas prices down and made off-shore reserves more attractive

Improvements in gas-transportation technologies have made massive, cheap and safe transport possible

The use of gas as an industrial energy source, for power generation and for transport offers environmental and cost benefits over other fuels

The developing international market in liquefied gas and the entry of both new suppliers and consumers is likely to result in the structuring of the market in a similar way to that for oil

The European gas industry safeguards supply by a range of measures including long-term contracts, underground storage, flexible production, etc.

Gulf that led to the loss of OPEC control over the oil market. The same technology, applied to gas production in the USA, created the 'gas bubble' of the late 1980s that has depressed gas prices to this day; the US gas industry has been operating at a reserves to production ratio of about 9 for many years. The technology includes seismic surveys of the geological formations that define the precise location of potential oil or gas pools in 3 dimensions, horizontal or angled drilling of production wells that can improve accessibility and methods of operation in deep off-shore water. The deep-water technology has been particularly important in the North Sea and in revitalizing the Gulf of Mexico. Exxon reports continued reductions in their oil/gas finding costs to below $1 per barrel in 1995-1996 (Exxon, 1997).

Another technology that was developed in the USA in response to the perceived gas shortage of the 'energy crisis' was coal-bed methane (CBM) technology. This activity was stimulated by US Government tax benefits ending in 1992, by which time production had reached 20 bcm/year. This industry is continuing to expand in a free market with producer prices of about $2/GJ. By 2000 it is expected to supply 6% of US consumption (37 bcm out of 550 bcm). The estimated economically recoverable CBM is 2800 bcm, which supplements the conventional US reserves of 4680 bcm. CBM resources in the EU and eastern Europe are believed to be of comparable magnitude (Preusse, 1994).

Significant improvements have also been achieved in gas-transportation technologies. Modern gasoducts and LNG (Liquefied Natural Gas) facilities allow today for massive, cheap and safe transport of the commodity. The expansion of the gasoduct network across the European continent has been quite important and has also reduced average transportation costs through learning effects.

End-use technology developments have been very important for expanding industrial and electric-utility interest in gas. Specifically, the gas turbine has revolutionized the electric power industry, capturing the bulk of both base load and peaking applications where natural gas is available, because of high efficiencies (approaching 60% in new combined cycle plants), very low capital costs, the possibility of modularized plants and short construction times. Equally dominant are gas turbine-cogeneration or combined heat and power (CHP) plants serving industrial or district heating customers. The role of natural gas in power generation will probably be reinforced by the liberalization processes that are affecting most of the European electricity and gas markets. No economically competing technology is in sight as long as gas prices stay at current or projected levels. Natural gas would also be the most economical fuel for fuel cells or for solar-fossil hybrid plants which may enter the market-place by 2010.

Finally, compressed natural gas is expected to be a suitable fuel for heavy vehicles such as trucks, buses or trains. It would have environmental advantages over petroleum-based fuels in exhaust air quality and reduced CO_2 emissions. If suitable gas-turbine engines and/or electric fuel cell cars were developed, further reductions in CO_2 could result.

Anticipated international agreements limiting greenhouse gas emissions may substantially increase the market for natural gas- consuming technologies by constraining coal and oil burning. The Helsinki sulphur protocol, signed in 1994 by most European countries, calls for large reductions in SO_2 emissions that create additional opportunities for natural gas. Fortunately, the necessary gas resources are present and the technologies for exploiting these resources are constantly being improved.

Gas Prices

Gas prices are constrained by production costs, the high costs of transport relative to oil and the costs of competing fuels. There is also intra-gas competition from various suppliers using the same or competing pipeline systems.

The prices announced for the new supplies of gas are comparable to existing price ranges. Snam (Italy) has announced prices of $2.08/GJ for Yamal gas and $2.39/GJ for Norwegian gas, all delivered to Italy under long-term contracts. Dutch gas is exported for about $2.35/GJ. The selling price (1996) to large industrial users, without taxes, was $3.2 to $4.7/GJ on the Continent and $2.3/GJ in the UK. The latter price fell from the general EU range within the last 2 years, presumably the result of industry deregulation. The prices for new LNG may be expected to be in the range of $3/GJ with an estimated $0.5/GJ needed for regasification.

Based either on present market conditions or on the anticipated liberalized European gas market, gas prices should continue to be competitive in the EU for the next 15-25 years and probably much longer. There is a developing international market in LNG which is driven by demand in South and East Asia, with major new supplies in the Persian Gulf and offshore Southeast Asia. This market is likely to grow to resemble the competitive oil market. In the long-term, an international spot market in LNG could provide a cap on natural gas prices, provided the necessary investments were made in LNG production at remote sites and regasification facilities in the user countries.

Vulnerabilities and Opportunities for EU Initiatives

The European gas industry has provided a high level of security of supply to its gas customers. The security of supply for the EU as a whole is ensured by a mix of measures including the use of long-term contracts for gas imports, the use of interruptible contracts with utility and industrial customers, underground gas storage, flexible indigenous production, and cross-border commercial mutual assistance agreements. However, there are rapidly growing demands for gas in some of the outlying member states such as Spain, Portugal and Greece, and the EU is considering the admission of new states that will substantially increase the overall import dependence of the Community. There is therefore a need for continued vigilance on the part of the Commission, taking into account new developments and the diversity of the supply situation in the Member States (countries with a higher import dependence place more importance on relations with their gas suppliers, giving preference to long-term supply contracts).

The European Parliament and the Council are on record as favouring common rules among the Member States in the internal natural gas market and a greater degree of competition within the gas industry to improve overall European competitiveness (General Secretariat of the Council, 1997). At this time, though, the security of supply is primarily the responsibility of the Member States and the industry. There are, nevertheless, important steps the EC can take to supplement the actions of Member States and existing commercial agreements, in order to improve security of supply. Some of these steps are summarized below:

- In the long-term, the greatest risk is that of supply interruption in a major pipeline from outside the EU. This could result from political instability in the producer country or in a country that is transited by the pipeline. A European Commission (1995) study has indicated that the Community dimension of emergency planning in co-operation with the Member States could have added value when dealing with major

The EU has a role to play in planning measures to mitigate the risk of shortages due to exogenous shocks, particularly in the context of an expansion which will bring more gas-dependent nations into the union

The EU could also look at measures, such as R&D in alternative sources, to ensure safer gas extraction and a more secure supply

supply shortfalls. Appropriate ways to co-ordinate national and EU emergency planning should be studied, similar to the co-ordination provided by the International Energy Agency for petroleum emergencies.

- The EU could continue to support the planning of projects of common interest for Trans-European Energy Networks (DG XVII, 1995). This covers mainly missing links and strengthened inter-connections with external gas suppliers, including pipelines and other facilities outside the EU. Limited financial support for construction may be available in some cases but such capital-intensive projects must be commercially justified.
- Similar support can be given to LNG facilities that hedge the long-term risks of shortages from the pipeline systems or unwarranted price rises by a combination of large suppliers of pipeline gas.

Besides these interventions to mitigate the risk of shortages due to an exogenous shock, several accompanying measures may be foreseen to facilitate safer and sounder gas exploitation:

- The EU should have a role in formulating a common approach to sound political and commercial relations with external gas-producing states and with pipeline-transiting states. This internationally-oriented line of action should be complemented by complementary efforts of the Member States.
- The EU could reinforce potential R&D lines aiming at developing alternative sources of natural gas. Particular attention should be given to the extraction of gas from unconventional sources such as coal seams.
- The EU should continue to promote the improvement of gas use efficiency in end-use appliances, both in the domestic and industrial sectors, as for example in the SAVE and THERMIE programs.

Conclusions

There are grounds for optimism regarding the expanded future use of natural gas in Europe. Current gas industry projections of future growth may be too low. The resources are in place for many decades of consumption, but since a large part of the fuel will have to be imported, it is desirable to consider actions at the EU level that may enhance co-operation among the Member States in dealing with supply interruptions. Other actions, such as liberalizing the internal gas market and especially promoting diversity of gas importing options, could increase the likelihood of limiting long-term price increases, though at the same time it may complicate maintaining long term relations with specific suppliers.

Keywords

natural gas resources, European gas market, energy policy, energy security

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Extreme Ultraviolet Technologies: The European Experience

G. Bachmann, J.W. Otto, *VDI-TZ*

Issue: Extreme Ultraviolet (XUV) Technologies are based on an extension of the use of light as a tool towards shorter wavelengths. The basic science, technological applications, market and employment potential are well understood. Being the first to develop marketable laboratory-based XUV technologies will be crucial to taking the lead in manufacturing integrated circuits with higher densities.

Relevance: The stakes in the global competition for XUV technologies are high in terms of costs, potential profits and employment potential. Skills and knowledge in this field are distributed over Europe. In order to compete effectively, a concerted European effort is needed.

Introduction

The use of light as a tool rests on the ability to manufacture sources, optics for manipulating the light and detectors each tailored to a specific application. For light in the UV to infrared range (wavelengths from about 100 nm to 100 nm, including the visible range), this ability has resulted in numerous applications such as:

- analysis and diagnosis; for example, microscopes in medicine and production (quality control)
- material modification including medical therapy and photolithography (with lasers)
- communication (data transmission, optical data storage, printers)
- measurement.

While Europe has traditionally been strong in optics, the recent history of this industry provides several case studies for ways in which leadership can either be lost, not achieved or even be (re)gained through to European efforts. The case of the microscope and camera industry, for example, illustrates how competitiveness in mature products was lost because of a lack of product innovation and efforts at mass commercialization. European and national programmes (e.g. EUROLASER) have been a key to achieving the lead or competitiveness in selected fields of laser technology. The European microelectronics industry has been revived and the technological gap with its main competitors has been narrowed thanks to the 3.8 billion ECU 6-year JESSI programme (Joint European Submicron Silicon Initiative). A substantial part of the costs went into developing the photolithographic techniques necessary for producing chips with submicron structures. With the support of the JESSI project, ASM-Lithography (of the Netherlands) in collaboration with Carl Zeiss (Germany) has increased its market share in lithography equipment from 7% to almost 20% becoming the world's number three supplier. The success of this

While Europe has traditionally been strong in optics, the recent history of this industry provides several case studies for ways in which leadership can either be lost, not achieved or even be (re)gained through to European efforts

programme rested substantially on both horizontal (pre-market research between companies from the same sector) and vertical cooperation (between companies along the production chain).

XUV technologies and their application

There are strong market forces driving the tool of light towards shorter wavelengths, into the extreme ultraviolet (XUV or soft X-ray) range. This range extends from about 0.5 to 20 nm. The key advantages of this wavelength range are: the improved resolution possible; the enhanced penetration depth with respect to light in the UV to visible range; the possibility of exciting the fluorescence of many elements; and the absorption by and contrast between biologically important elements (C,N,O) (Michette and Buckley, and Röntgen Centenary) The main advantages with respect to electron-based techniques (for example, scanning electron microscopy with which a better resolution is possible) are the relaxed requirements on sample preparation and vacuum conditions and the reduction in damage to the object to be investigated. With electron microscopy, the sample preparation techniques (requiring thinning by mechanical or chemical means or by ion beams; dry or shock frozen samples) may modify or even destroy the structures of interest. This may make it difficult or impossible to investigate the relation between form and function in biological and medical specimens, for example. Both the enhanced lateral resolution of about 100 nm and the increased penetration depth will allow imaging of finer structures in thicker samples with X-ray microscopes. In contrast to techniques based on electron beams, materials analysis with X-rays is essentially non-destructive and can be carried out in-situ (for example, it is possible to image the magnetic domains of a crystals in an applied magnetic field). Applications include process and quality control (for example, the imaging of defects in wafers for the semiconductor industry). Together with the weak absorption by water in the wavelength range 2.4-4.4 nm (the water window) and the X-ray contrast between C, N and O, live samples (such as cell interiors) can be investigated. This has great potential in biology and medicine. The contrast due to different absorptivities of chemical elements can be used to obtain three-dimensional high-resolution images of interior structures (such as bones or tissue). Applications in preventive medicine (to recognize early signs of osteoporosis, for example) may have important cost-saving effects. Large-area imaging is required for security checks of luggage at airports. Chemical analysis by excitation of fluorescence (for example, in total reflection geometry, TRFA) is a technique with broad applicability. In mining/environmental and process control, the quantity and distribution of ores/contaminants can be determined. In the arts and archaeology, analysis of pigments in paintings can help in dating objects and in determining their origin. This can assist in distinguishing fakes from originals, for example.

In materials processing, XUV radiation has advantages compared to light in the UV to infrared range because of its improved resolution and reduced thermal load. The photochemical effects can be used for the cleaning, selective etching and polishing or roughening of surfaces. Lithographic techniques are potentially the most important application of photochemical effects. Various techniques (direct illumination through a mask; projection of a mask with or without demagnification) can be used to chemically alter a resist for subsequent dissolution and filling in of the remaining structures with metals. The structures obtained in this way may be used to build micro-engines or micro-reactors, for example, structures with high aspect ratios (as in technique known as LIGA, which uses a combination of lithography, electroplating and moulding). In order to manufacture integrated circuits, silicon wafers are coated with the resists.

A substantial part of the costs of the 3.8 billion ECU JESSI project went into developing the photolithographic techniques necessary for producing chips with submicron structures

There are strong market forces driving the tool of light towards shorter wavelengths, into the extreme ultraviolet (XUV or soft X-ray) range: applications include non-destructive microscopy, medical analysis and security checking

XUV radiation has the advantage compared with light in the UV to infrared range of improved resolution and reduced thermal load. Photochemical effects can be used for cleaning, etching and polishing

In order for XUV technologies to achieve their full market potential sources, optics and detectors are required

The storage capacity of chips is a function of the density (and hence of the linewidth) of the structures that can be achieved. Current integrated circuits (the 64 Mb chips) with linewidths of about 0.35 nm can be manufactured using lasers in the ultraviolet range. Future generations of chips with high-speed logic circuits and storage capacities greater than 16 Gb (expected from about 2007) require linewidths of 0.1 nm and below which are expected to be achievable only with particle beams or X-rays (with wavelengths less than 15 nm).

Technical requirements, state of the art and necessary developments

A deep market penetration of XUV technologies requires the availability of three factors:

- Laboratory scale sources,
- Optics to be able to manipulate the X-rays just as one manipulates visible light (the short wavelengths of X-rays require near parallel incidence for point imaging with ordinary crystal optics), and
- Detectors.

Each of these components needs to be tailored to specific applications.

Laboratory-scale sources

Plasma X-ray sources have been demonstrated at a laboratory scale and have the potential to be commercially viable

Use of XUV technologies in environmental and quality control (e.g., checking the welds in aircraft) will require portable X-ray sources while the demands on the intensity and size of the source are not so severe. Imaging by holographic techniques with the highest resolution and contrast, for example for specialized applications in biology, requires a coherent source (X-ray laser).

The available laboratory sources for X-rays (based on electron impact on solid targets) emit most of their radiation at wavelengths shorter than the XUV range and hence are not suitable. X-rays with the desired characteristics are produced at electron storage rings (synchrotrons) which are too large and costly for widespread use (it should be noted, however, that the potential significance of X-ray lithographic techniques is considered high enough that small synchrotrons are available commercially and have been constructed mainly for this purpose; experience and knowledge gained with synchrotrons has been crucial for developing optical elements and for judging and playing with possible applications). Laser-generated and pinch plasma sources provide radiation in the desired range with high peak intensities. A high time-averaged intensity of laser-based plasma sources requires the availability of high repetition-rate UV lasers. Plasma X-ray sources (including the X-ray laser) have been demonstrated on a laboratory scale and are potentially commercially viable.

Precision optics

The necessary optical components such as Fresnel lenses, multi-layer mirrors, and glass capillaries are currently being manufactured for scientific applications

High intensities delivered into well-defined small areas are crucial for applications in medicine (in order to reduce the X-ray dose on the surroundings of the object to be irradiated, e.g. a tumour) and in quality control (the increasing density of integrated circuits requires cleaner surfaces and hence increased sensitivity of the analytical tools). For these applications, capillary optics to guide the radiation directly to the object of interest are needed. X-ray lenses and mirrors are required for microscopes and telescopes. Due to the small wavelengths involved, sub-nm accuracies in manufacturing and testing of optical components are needed.

Optical components (Fresnel lenses, multi-layer mirrors, glass capillaries) are being manufactured for scientific applications. Glass capillaries and multi-layer mirrors have recently been incorporated into commercial conventional laboratory-based X-ray systems.

Detectors

The requirements on detectors are as varied as the applications. As an example, the good time resolution needed in the control of high-speed production processes may be mentioned. This may extend down into the picosecond regime to match the emission characteristics of pulsed XUV sources. Detectors for light in the XUV range are commercially available, but special developments are required (such as an improvement in the time resolution).

The developments needed in XUV technologies can briefly be summarized as follows:

- table-top X-ray sources in the XUV (including X-ray lasers) with appropriate emission characteristics
- compact cheap pulsed UV lasers for generating X-ray plasmas
- process control in manufacturing for mass-production of top-quality optical components
- detectors and electronics for special applications

Policy aspects

XUV technologies have applications as broad as those of light in the (near) visible range (consider lasers, for example). This suggests that the market and employment potential are significant. Global sales in laboratory-based X-ray systems top 1 billion ECUs (not counting the effects in secondary markets) (Fraunhofer). In Europe, over 8 million jobs depend on advanced microelectronics; the long-term growth rate in the semiconductor industry is 14%. The costs for the development and production of dynamic RAM chips are very high: for the 1Mb chip, they were around 400 million ECU; for the 256 Mb chip, they were 1.7 billion ECU. It should be noted, however, that currently X-ray, ion and electron beam lithography are competing techniques for future chip generations, with the winner not being obvious at present.

European programmes (CORDIS). Past and present European programmes are aimed mostly or exclusively at the lithography aspect of XUV technologies. In the current 1.6 million ECU EUROLASER-EXULT programme, a UV laser source for generating a plasma X-ray source and special optical elements are being developed (or adapted) in a collaboration between ASML, FOM, Carl Zeiss and Sopra. The manufacturing aspect of the 2 billion ECU MEDEA programme (the successor to JESSI) is strictly aimed at lithography.

International competitors. The US has a head-start in the development of table-top X-ray sources and optics due to the research carried out under various military programmes (such as the Strategic Defense Initiative in which X-ray lasers for shooting down satellites were to be developed). This expertise at national laboratories (Advanced Light Source, Lawrence Livermore, Sandia) is being used by a consortium headed by Intel in a $250-million collaboration to develop lithography with 13.5 nm radiation. IBM has a programme in X-ray lithography with 1 nm radiation while Lucent's research is based on electron beams (Macilwain). Japanese companies currently control almost 80% of the lithography equipment market. The "Association of Super-advanced Electronics Technologies" (ASET), supported by the Japanese Government's "New Energy and Industrial Development Organization", has spent about 85 million ECU on lithographic techniques in 1995-1997, and will concentrate mostly on X-ray lithography in 1998-2000 (Ishitani).

XUV technology has significant market and employment potentials, particularly given its relationship with microelectronics, an industry upon which 8 million jobs depend in Europe

Military programmes have given the US a head start in the development of table-top X-ray sources

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Conclusions

The market potential, benefits to citizens (in terms of health care and employment, for example) high costs, strong global competition and the fact that expertise is scattered across Europe would suggest a role for appropriate European action (complemented by national programmes). Since this technology is very pervasive (extending beyond lithography) and demands an integrated technological solution (from source via optics to the detector), a potential programme should unite these aspects. Russian scientific institutes have a lot of expertise in optics and sources for the soft X-ray range (Russia also had a military X-ray laser programme) and may be valuable sources of information. Some institutes have already collaborated in programmes on lithography (PECO/COPERNICUS, INTAS). Small and medium scale companies would benefit from any programme as component manufacturers, for example. The success of the JESSI programme in promoting European competitiveness in lithography (for example) suggests that a European programme in XUV technologies may prevent the loss of a potential market (in X-ray microscopes, among others) and help not to repeat the mistakes of the past (the case in point being the market for optical and electron microscopes). Finally, it should be mentioned that until appropriate laboratory sources for XUV radiation become available, the existing large-scale facilities (synchrotrons) will be indispensable for testing and experimentation.

Keywords

XUV Technologies, lithography, policy aspects

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Recent Experience with Teleworking: Effects on Transport

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Issue: Teleworking has raised many expectations, ranging from energy savings and reduction of congestion to the diversification of employment in peripheral and rural areas. In fact, very little is known about its actual and potential risks and benefits. Recent findings about first experiences with teleworking can help us to get a better idea of its limitations and potential benefits.

Relevance: One of the main reasons for interest in teleworking is the beneficial impact it might have on transportation patterns. Drawing from this body of evidence appropriate measures to stimulate and guide the uptake of teleworking could be developed. The Benefits and Drawbacks of Teleworking

Teleworking has been the subject of public debate for a few years now, but the high expectations have not yet been realized. Nevertheless, it is predicted to have a major impact on various fields of society, both directly and indirectly. These impacts are highly complex, difficult to disentangle and cover a wide range of areas. Given space limitations we will concentrate here on the impact of home teleworking on transport.

Home teleworking, which is important, but not the only form of teleworking, could be defined as the use of telecommunications to partially or completely replace daily commuting to and from work. The most important impacts of teleworking are hence expected on traffic, and this issue will be dealt with in more detail in this article. A number of other important social issues, however, also come into play. While teleworkers may be able to benefit from commuting cost and time savings, the changes which teleworking implies for their lifestyles may actually be far more important. Work and leisure time would not be clearly separated any more, representing the risk of permanent stress for the individual. However, teleworking may be a 'relaxing' experience if one does not need to adjust to a rigid working environment. On the other hand, isolation and a lack of social contacts are potentially negative side effects. In economic terms, the impacts of teleworking are not clear, either. While it may increase productivity of the individual worker and generate new job opportunities, the flexibility of hiring teleworkers anywhere in the world may also lead to a shift of employment to lower-wage countries.

Teleworking has raised high hopes, especially that it might be able to alleviate traffic congestion problems. However, its actual impact is complex and difficult to disentangle

Teleworking may imply lifestyle changes for the individual. For instance, work and leisure time would not be clearly separated any more, representing the risk of permanent work-related stress

Comparative Situation of Teleworking in Europe

In general, data on teleworking need to be treated with a great deal of care because the definitions used are often inconsistent and disguise rather than clarify the real situation.

Figures on the number of teleworkers in Europe vary greatly. Partly because the definitions of teleworking are often inconsistent

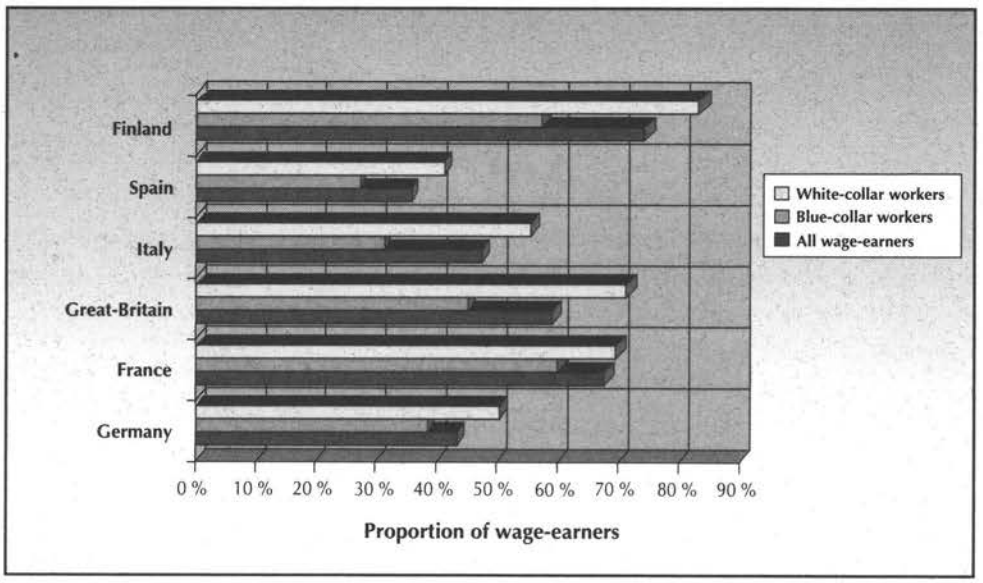
According to an estimate there are currently 1.25 million teleworkers in Europe. However, in another estimate the corresponding figure was three times higher (Handy & Mokhtarian 1996). Variations in the estimates on current levels of teleworking are explained on the one hand by the difficulties and differences in defining teleworking, and on the other hand, by the use of small and non-representative samples. For example, in France the official number of teleworkers for the year 1993 was as low as 16 000 due to a very strict definition of teleworking. For the year 1994 another estimate listed 215 000 French teleworkers. The United Kingdom has 600 000 teleworkers, which is the highest number in absolute figures in Europe. (Korte & Wynne 1996).

Owing to its high standards and penetration in telecommunications, Finland has one of the most 'teleworking intensive' labour markets in Europe. At the moment, there are 150,000 Finnish teleworkers, a little over 8 % of all Finnish employees. . The 325,000 Swedish teleworkers, who work at home at least for one day a week, also represent some 8 % of the working population. Within a European context, these figures can be regarded as high. In Italy the teleworking population represents 0.2 % and in the United Kingdom and Ireland 1.21 % of the labour force.

However, the data about employment moves from non-teleworking to teleworking is subject to major uncertainties. The rising number of self-employed and part-time teleworkers makes interpreting the data difficult, especially because they do not necessarily figure in the teleworking statistics.

Further differences among European countries can be observed with regard to the awareness of teleworking among individuals. Knowledge about teleworking is a sine qua non condition for individuals to form opinions on this mode of

Figure 1. Knowledge about teleworking among wage-earners in some European countries in 1994 (Luukinen 1995)



Source: the Finnish Experience with Telework project, University of Turku/the Finnish Ministry of Labour.

employment. According to the EU's TELDET study, knowledge among the population about teleworking varies significantly in different European countries, ranging from 23% in Spain to 59% in France. (Korte & Wynne 1996). The findings of the Finnish Experience on Teleworking Project (FET) showed that three out of four Finnish wage-earners know about teleworking through information acquired from newspapers, radio, TV or various events.

Interest in teleworking varied less across the countries. The results of the surveys within the EU TELDET project indicate that interest in teleworking from home as a permanent mode of working ranged from Germany's slightly less than 30% to Spain's 42% of the employed labour force. Correspondingly, 36% of German and 45% of Spanish employees show interest in teleworking at least one day a week. 54 % of Finnish interviewees in the FET project reported that they would consider working outside their normal workplace at least one day a week. The high interest figures need to be interpreted cautiously, because interest in teleworking does not mean that it would necessarily be adopted in practice.

Interest in teleworking shown by the public tends to be similar in most European countries

The Potential Teleworking Population

These figures provide a first impression of the future potential of teleworking, but the rate of growth of teleworking is far from clear, mainly as a result of the difficulty of establishing even how many workers currently telecommute, but the results of the surveys of the TELDET project suggest that the development potential for teleworking in Europe is around one fifth of the labour force. This estimate indicates that the target of the European Commission to create 10 million teleworking jobs by the year 2000 is not unrealistic. A new type of analysis of the teleworking potential will be carried out in Finland in a forecasting project funded by the European Social Fund and the Finnish Ministry of Labour. This new method combines data on commuting behaviour and information on the jobs suited for teleworking. It reflects the fact that teleworking is an option only for certain parts of the population.

Basically, the future of telecommuting depends on whether employers provide the opportunity to telecommute and whether workers take advantage of this opportunity. Government policies can encourage both, and their perceived impact will help determine the support for teleworking by employees, employers and policy-makers. An important reason for the hesitant take-up of teleworking lies in the uncertainty of its impacts for the individual, for employers as well as for society as a whole.

Other obstacles to teleworking are based on prejudices such as problems expected to arise from the lack of supervision, or simply ignorance on the part of management. The price of information technology does not, however, seem to hinder teleworking in the same way as it did in the past.

Government policy can encourage or discourage teleworking, but employers have final control over whether it is taken up or not

New evidence of the Impact of Teleworking on Transportation Patterns

As indicated above, knowledge about the actual impact of teleworking is very limited. At least with regard to transportation patterns, the findings of a number of recent research studies provide new insights into the different mechanisms in play.

Optimistic views expect that teleworkers will help ease up traffic congestion, which in some major European cities has grown to uncontrollable and unhealthy proportions. By reducing commuting, teleworkers indirectly reduce the need to spend large sums of money on

Telecommuting's most important single benefit is hoped to be in saving fuel, thus reducing many of the related pollution and waste problems

the construction and maintenance of roads and parking space, traffic control and car-related waste disposal. Telecommuting's most important single benefit is saving fuel, thus reducing many of the related pollution and waste problems. According to estimates by the US Environmental Protection Agency, approximately 10 million American workers drive an average of 75 miles round trip to work in cars that get an average of 25 miles per gallon. As teleworkers, they could save 30 million gallons of fuel every workday while keeping 350 tons of carbon dioxide (C02) out of the atmosphere (Anzovin 1994).

With these potential benefits in mind, transportation planners see telecommuting as a promising way to combat increasing congestion, increasing energy use, and declining air quality. Urban and inter-urban traffic congestion is now one of the major costs affecting business and public administrations in Europe. More than 50 billion ECU are lost every year through delays and accidents. Teleworking can substitute for at least some journeys (Teleworking 94).

Government policies designed to reduce congestion and improve air quality, such as charging tolls on road use, may themselves stimulate teleworking

Other researchers have argued that congestion will not worsen in the future anyway, given structural shifts in the demographics of automobile ownership and use. The growth rate of automobile use should equal the growth rate of population, since nearly every potential driver now has access to an automobile. (Handy & Mokhtarian 1996). If congestion does not thus increase dramatically in the future, or at least commuting times do not increase, then the role of congestion per se as a motivation for telecommuting may remain roughly at its current level of importance. However, government policies designed to reduce congestion and improve air quality may themselves stimulate teleworking. Information and communication technologies together with some other measures such as radical increases in vehicle prices or driving costs might mean that commuting traffic will be reduced through increasing teleworking. As an example, the decision to introduce road tolls in Stockholm from 1999 may become a factor which further stimulates teleworking.

Teleworking facilities make it easier to maintain long-distance contacts, which may be followed up by face-to-face meeting, thus actually increasing certain types of travelling

However, these optimistic perspectives take into account only the positive impacts of teleworking on travel behaviour and ignore several negative and indirect/secondary effects which may counterbalance the positive ones.

From a more critical stance, the interactions between teleworking and physical transportation are regarded as less simple to disentangle. The widespread application of advanced information and telecommunication technology (ICT) for teleworking may generate new types of transportation as well as reduce the need for physical transport. Teleworking facilities provide increasing possibilities to make contacts beyond geographic boundaries between both organizations and individuals. Even though the majority of such new contacts can be maintained electronically, they may gradually result in face-to-face meetings over a long distance. While certain types of trips are being replaced, some new trips will be generated. There has been some scepticism about how large net savings from reducing travel by teleworking might be. Some forecasters argue that people often combine work trips with other trips and that leisure travel will be extended. This argument is in line with the long-term observation that the daily travel time budget has remained fairly constant over the past decades - in spite of substantial technological transformations. If these arguments hold, then the reduction would be minimal.

The situation becomes even more complicated when looking at a number of secondary effects. While personal vehicle use has the largest impact on emissions, the impact from

the mode of travel is also worth a closer analysis. Car pools may dissolve if teleworkers drop out, and transit operators may lose revenue in the near term. However, in case of teleworking centres, trips made closer to home may shift to non-motorized modes such as cycling and walking. The Puget Sound Telecommuting Demonstration Project conducted in early 1990s by the Washington State Energy Office provides travel diary data on 104 teleworkers, both home-based and centre-based. Home-based teleworking was found to reduce travel and emissions by means primarily of the elimination of commuting. The reductions in vehicle kilometres and in the number of daily trips in the home-based group were 66.5 % and 31.9 %, respectively. In the centre-based group the vehicle kilometres were significantly reduced, while the number of trips and cold starts were not. (Henderson & Mokhtarian 1996, 44).

When a person turns to teleworking one day per week, the number of commuting trips to and from work will diminish by 20 %. Accordingly, this requires that a teleworking day is a full day and not two half days. Correspondingly, two teleworking days per week give a reduction of 40 % in the number of work trips. On the other hand, changing time budgets of teleworkers can also increase their leisure travel. One important issue for the future of teleworking and its possible impact on transportation arises therefore, and more specifically, from the frequency of telecommuting, that is, whether workers will do it occasionally, all the time, or something in between. (Handy & Mokhtarian 1996). A related aspect is the duration of teleworking for a given individual: is teleworking sustained over a period of several months or years; is it an on-and-off alternative? The distribution of teleworkers, by virtue of their telecommuting, will have important implications for the transportation and environmental impacts of telecommuting.

According to another critical view other travellers will take the road space vacated by teleworkers. Family members who normally resort to the bike, the bus etc. may start to use the car instead of the home working member of the family.

In the long term, the temporal and geographical flexibility of teleworkers may also change the housing pattern. If you are not so tied physically to the workplace as earlier, it is easier to move to a more attractive living environment, for example to less polluted rural areas. Consequently, long-distance commuting only a few days per week becomes more common, resulting in fewer but longer trips.

Teleworking 'Best Practice' in Europe

The Consensus Group within the DIPLOMAT project has produced guidelines to support various actions on teleworking. One target is the reduction of traffic in Europe. According to this by 2002 the traffic reduction due to teleworking will be 450 million trips per year, equivalent to ten billion fewer kilometres commuted each year, with a corresponding reduction in energy and exhaust emissions.

Europe could promote teleworking projects as manifestations of sustainable mobility. In order to avoid undesirable impacts of generating trips which are not work-related, the awareness of teleworkers should be focused on environmental benefits. Organizations are key actors and facilitators of teleworking. By adopting teleworking and telebusiness they can change their travel patterns within business operation, but the personnel's commuting frequencies as well. Teleworking could be practised as a tool for 'commuting management' while promoting the image of ecological thinking in an enterprise. The diffusion of

Teleworking only reduces travelling if workers stay away from the office whole days at a time - but not if they shift to part-time working

Commuting less often may encourage people to live further from the office, thus making fewer, but longer, trips

If properly managed, teleworking can be used as a tool for "commuting management"

In order for teleworking schemes to be successful awareness first needs to be raised. Moreover, the shortage of data remains a hindrance

teleworking could thus be seen as an expression of the willingness to reduce commuter traffic and as an indicator of a sustainable information society.

The best practice of teleworking realizes that the issue of teleworking cannot be taken simply as a black and white choice of working mode, but as a rich variety of applications simultaneously enhancing the quality of life and the quality of the environment. A broader vision of teleworking should be adopted comprising, besides home-based teleworking, telecentres, telecottages, relocated back offices and mobile work.

Good teleworking practice involves careful planning of each teleworking scheme in organizations. Adequate technical support must be provided for teleworkers in order to avoid loss of efficiency at work. It should be borne in mind that social implications always underpin the successful implementation of teleworking. Teleworking should always be adopted on a voluntary basis. Teleworkers also have to be given the chance to return to their 'normal' working place if they wish. Job security and social benefits need to remain the same as those offered to colleagues working at the office in similar jobs. Managers and colleagues should be well informed on teleworking experiments. Teleworking should not be implemented as a separate case of work arrangements, but included in organization's strategies.

Policy Implications and Needs

The promotion of teleworking cannot merely be based on the high level of awareness or on all the positive attention teleworking has been given. If concrete results are to be achieved, systematic development work is necessary. The gap between the interest and practice needs to be bridged. Thus far, experience has shown that in order to successfully promote the idea of teleworking, well-thought-out actions are needed firstly to enhance the level of knowledge concerning teleworking, and, secondly, to affect the attitudes and technical facilities in organizations, so as to facilitate their decision-making concerning teleworking experiments. In spite of the new findings on the impact of teleworking on transportation, the paucity of data remains a problem. More research and experimentation projects should be launched to gather quantitative data on travel patterns in teleworking.

At national level, various campaigns could be launched to encourage business employers to experiment with teleworking and to monitor its impact on employees' commuting. As an example of how to disseminate best practice in teleworking, nominations of the best performing teleworking organizations could be awarded, for example, during the fourth European Teleworking Week to be held in autumn 1998. In addition, a greater willingness on the part of public institutions and authorities, especially at European level, to use telecommunication facilities for their meetings and workshops would send an important signal for a strategy for the promotion of teleworking.

In general terms, a dual approach of 'carrot and stick' could be applied in Europe. Besides regulatory measures (e.g. on working conditions), various incentives such as tax reductions could be introduced for employers enabling and employees practising teleworking. Finally, local urban development policies could adopt teleworking as a tool for reducing daily commuting journeys.

Keywords

teleworking, transportation, best practice, impact assessment

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Industrial and Technical Assistance in Latin America: Lessons from the Field

Fulvia Farinelli and Stefano Kluzer, *ENEA*

Issue: In order to foster industrial development in emerging economies, it is important to take fully into account the local conditions concerning institutional, socio-economic and industrial structures as well as regional planning policies. Positive results have been obtained in Latin America by projects inspired to the so-called 'Emilian model' of industrial development, essentially based on the participatory (private/public) development of real services targeted on clusters of SMEs.

Relevance: Industrial development promotion in Latin America, through science and technology cooperation and technical assistance projects, is an EU policy objective backed by substantial funding. The lessons learnt by experiences so far may help refining and making more effective the tools and support measures currently adopted. Ex-post evaluation may be useful for practitioners and field operators, as well as for policy makers and development planners.

A number of EC-funded bilateral projects have been carried out in Latin America focusing on building competitive advantage through the transfer of technological, managerial and organizational know-how

Enhancing Latin American Regional Integration Process

Since the creation of MERCOSUR, the European Commission (EC) has consistently supported the process of regional integration in South America. MERCOSUR (Mercado Comun del Sur) is the common market initiative officially launched in 1991 with the Asunciòn Treaty by Argentina, Brazil, Uruguay and Paraguay. It now extends also to Bolivia and Chile (Peru should follow soon). In 1995, EC-backed programmes in this region amounted to 500 million ECUs, with about 700 projects ranging from humanitarian aid, scientific cooperation and academic exchanges, to economic and business cooperation, and technical assistance projects.

We refer here to a number of bilateral projects agreed by the EC (Directorate General Ib) with Uruguay and Paraguay, focused on the transfer of technological, managerial and organizational know-how to the local manufacturing industry, so as to help in building competitive advantage through innovation, specialization and enhanced expertise, rather than merely through production costs reduction. Ultimately, this kind of cooperation is also expected to increase business relationships between the EU and Mercosur, in terms both of trade and investment.

The desire to target SMEs - i.e. the weakest, albeit numerically dominant, local economic actors - is inevitably linked to the issue of employment and income generation, and led to look at European best practices that might be transferred/adapted, in the

realm of industrial promotion of local production systems characterized by the geographical clustering and sectoral specialization of firms. Thus, both in Uruguay and Paraguay, against a background of crisis due to increased competitive pressure originated by regionalization and globalization processes, the 'industrial district model' (of which Europe hosts many dynamic examples) was identified as an efficient form of economic organization for the growth of manufacturing industries, often referred to as 'traditional', but nevertheless potentially capable of incorporating new technology and facing the challenges of global markets and other forms of industrial organizations (the so called 'Fordist' model).

Reference to the industrial districts led to assign the execution of the technical assistance projects being assigned to Italian agencies, and other qualified European institutions (in particular, the Spanish Technological Furniture Industry - AIDIMA - and the Catalonia Consortium for Commercial Promotion - COPCA) with knowledge and experience in these areas. In particular, ENEA, the Italian Research Agency for New Technologies, Energy and Environment, coordinated the projects, on the basis of its long-standing experience in technology blending and industrial rejuvenation initiatives carried out during the 1980s in several Italian industrial districts (Prato, Sassuolo, Como, Biella and Carpi). In addition, ERVET, the Emilia-Romagna agency for economic development, was concerned with the regional planning aspects, as well as with the coordination of project activities carried out by its own sectoral service centres (some of which had previously benefited from the ENEA initiatives mentioned above).

The 'Emilian Model' and its relevance for Developing Countries

In the 'Emilian model' industrial growth has resulted not simply from spontaneous, self-organizing economic processes, but also from institutional initiatives aimed at establishing a positive environment for the development of firms. In the mid-1970s, the newly established Regional Government 'creatively' interpreted the limited powers transferred to it by central government (in areas such as vocational training, agriculture and handicraft-based production) and designed its own industrial policy.

ERVET was thus established to experiment, jointly with entrepreneurial associations and local administrations, with new initiatives to support an economy based almost entirely on small and micro enterprises. Initially, these involved the creation of industrial sites with common infrastructures and services, credit guarantee co-operatives for small entrepreneurs, and human resource qualification actions. In the 1980s, sectoral service centres were established for the local knitwear, shoe, agricultural machinery, machine tools, metal working, ceramics and construction industries.

SMEs were targeted on account of their importance in the economies of these countries and the competitive pressures placed upon them by globalization and regionalization

Three key aspects of the experiment which strongly influenced the design of the projects with Latin America should be underlined:

- The unit of intervention. The target is not a single enterprise, but a network of enterprises. Services are thus designed to increase the level of knowledge and to introduce new skills within the whole local production fabric, while at the same time strengthening cooperation and networking processes.
- The nature of the measures. Clear priority is given to the direct provision of innovative services rather than financial incentives. Besides (regional) budgetary constraints, this also stemmed from the experience that small firms are unlikely to fully pay (whether because they are unable or unwilling) for services which address needs which are still latent and where the pay-off is in the medium term.

Drawing upon the experience of the Italian Industrial Districts the projects were designed to target networks rather than individual enterprises

The attempt to transfer the industrial districts model to Latin America was based on the assumption that matching actions to local contexts is more likely to be successful than imposing specific paradigms from above

- The actors involved in the policy. Initiatives are defined and implemented with the bottom-up involvement of (possibly all) the main local interest groups, both public and private.

Why has this experience been attracting so much interest and raising so many hopes in developing countries, including among these South American partners of the DGIb projects? We can hint at the following explanations.

- The visible success of the model. Emilia-Romagna currently ranks eleventh among EU regions in terms of per capita income and its unemployment rate (5% on average, around 2-3% in the most industrialized provinces) is one of the lowest in Europe. There are also a high degree of social and economic cohesion, a high level of education and training, an efficient local public administration, and a widespread entrepreneurial spirit.
- The reliance of all this on about 300,000 firms (operating within a total regional population of 4 million), 95% of which have fewer than 50 employees - overwhelmingly the typical size of businesses in developing countries.
- The capacity to be competitive at the global level even in traditional sectors (in which developing countries are generally thought to have a comparative advantage).
- The industrial space that is covered by public policy and organizations (with limited budgets), without restricting free-market operation and private entrepreneurship, and in fact even boosting them. This is important at a time when liberalization and globalization are challenging the technical and financial capacity of public authorities to undertake pro-active policies.

Implementing Technical Assistance Projects

The attempt to 'transfer' the Emilian model to South American clusters of SMEs was actually based on the assumption that local contexts have to orient local actions and that top-down interventions aimed at reproducing specific paradigms (such as industrial estates, incubators, technology or scientific parks, etc.) can easily fail. The model was thus mainly used as a conceptual guideline, matched by a 'tool-kit', to be adapted continuously based on initial local conditions and the reactions of the counterparts concerned.

The projects in Uruguay and Paraguay started in 1992 and 1993 respectively and developed through two 18-month phases, with a budget of 800-900 thousand ECU each. They aimed at upgrading four traditional industrial sectors, where micro and small firms were mostly present (5-20 employees): furniture, textile and clothing, leather goods, and ornamental stones (Uruguay only). The local interlocutor in Uruguay was Comisec, a public body established, with the aim, among other things, of identifying the industrial restructuring needs prompted by MERCOSUR and to devise and carry out initiatives to ease this process. In Paraguay, the interlocutor was the Ministry of Industry and Trade, and specifically its newly established Industrial Extension Service (today the Paraguayan Support Centre for Enterprises). This had the task of supporting manufacturing industry's development in the new context of MERCOSUR (rather than its restructuring as in Uruguay), given its embryonic state.

The local interlocutors in both countries were new organizations, highly dependent on foreign assistance for funding their activities and facing a rapidly changing economic and business environment. The institution building/support component of the projects thus turned out to be more important than initially envisaged and took the shape of an original project management arrangement (also made necessary by budget constraints). No permanent expatriate was assigned to the counterparts, but rather an intense

(almost day-by-day) communication and coordination effort took place between the local project teams of indigenous experts and the European project managing institution, with frequent missions for face-to-face coordination and technical assistance activities.

After the first initiatives at grass-roots level (desk investigations, business check-ups, public discussions), it became apparent that the obstacles to generating a significant process of rejuvenation and upgrading in these industries were not so much technical as political, social and cultural. While it was relatively easy for experts to identify technical problems and the possible solutions to them within individual firms, it was much more difficult to handle the problems entailed in changing attitudes, functions and the distribution of power in and among industrial enterprises and the (often numerous and fragmented) trade associations which represent them. These acted mostly as antagonists to the local government, rather than as 'strategists' and service providers for their associates.

Therefore, parallel to efforts that focused on the transfer of single 'technology items' (a machine, a processing method, a piece of technical information), which proved very useful in gaining deeper knowledge of the local production system and the confidence of the business counterparts, effort was also made to initiate complex dynamics in the local productive systems. The aim was to stimulate inter-firm dialogue capable of initiating new industrial networks/clusters, dialogue with local technical institutions as well as foreign experts so that the enterprises would start asking for (and sometimes also generating) innovations themselves, instead of trying to force innovations on them. Once appropriate solutions suitable for voluntary testing by local entrepreneurs were found, the intention was to generate strong demonstration effects.

This is why, following an established practice in Italy, the sequence of actions undertaken started with the organization (jointly with local business associations) of awareness workshops on the shortcomings of current processes and products in terms of quality, flexibility, efficiency. Afterwards, networking among companies, and of companies with universities, public research centres, local technological laboratories, and with foreign firms participating in the initiative was attempted. Finally, the technology or service initiatives themselves were started. This actually happened during or towards the end of phase 2 of the projects.

As a consequence, some key activities and results of the projects are related more to the suggested changes in organizational dynamics than to the technical event itself. These can be summarized as follows:

- Carrying out institution building activity and training civil servants (especially those directly involved in the projects, starting with the directors of the service centres);
- Fostering dialogue among local actors and promoting 'neutral' negotiating sessions involving government, trade unions, representatives of industrial associations;
- Enhancing a process of clustering and networking, through competitive/cooperative behaviour, and an active involvement of the local productive fabric (from the outset, by means of activities related to the evaluation of technological needs);
- Stimulating new interest and parallel autonomous activities on innovative subjects introduced or 'hot' matters emerged (e.g. environmental impact, or safety at work).

In particular, in Uruguay, a consortium of SMEs was established in the furniture industry in order to jointly manage export activities and the importing of critical production items (enabling sharing of large foreign contracts and also leading to a more

It soon became apparent that the obstacles to rejuvenation and upgrading were not so much technical as political, social and cultural

The sequence of actions began by raising awareness of the shortcomings of current processes and products in terms of quality, flexibility and efficiency

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A number of lessons can be learned about the implementation of firm-cluster development projects in countries undergoing industrialization

efficient local division of labour. In the textile and clothing industries, a common strategic vision of the industrial restructuring needed to face the new challenges was agreed among the main trade associations, and jointly submitted to the government. In the civil construction industry, working groups were established with business, trade union, technical and government representatives, which elaborated both policy measures and a sector service centre proposal, focused on three main issues of common concern: quality and ISO 9000 standards; specialization as a way of reacting to the internal market crisis and competition from Brazilian and Argentinean firms; labour qualification and security issues.

In Paraguay, among the small and micro furniture producers of Caaguazu, a new process of clustering and competitive cooperation was initiated through the establishment of a local service centre (Centro para la Tecnologia Industrial del Mueble y Madera), where local entrepreneurs could test and train their workers on the use of modern wood-working machinery. In Carapeguà, the establishment of an industrial site with a water-treatment system for leather processes pollutants (the first one in the country for small producers) was initiated through the joint effort of the local business associations, the city council and the Ministry of Industry. In the garments industry (in Asuncion), the establishment of a joint technical service based on a CAD system and plotter for models design and cutting was relatively successful, while a parallel service for fashion designers, based on a (too) sophisticated workstation developed in the industrial district of Carpi (Emilia-Romagna), eventually proved unsustainable, despite much initial enthusiasm.

Policy-makers face a resource-allocation dilemma: although they want to strengthen the weakest sections, they know their chances of results are better if the back the strongest

Lessons to be learned

Assuming that small firm clustering may be considered a valuable approach to industrialization in developing countries, several lessons may be drawn from the implementation of the above projects:

1. Industrial policy-makers always face a resources allocation dilemma: although they want to strengthen the weakest sections and actors in a given sector they know that the chances of better and quicker results are higher if they support the strongest ones. This dilemma is further reinforced and complicated in the context of international technical assistance by a number of factors pulling in opposite directions. Firstly, cooperation itself is usually legitimized to some extent by equity concerns and social goals. Secondly, short-term results are normally expected and are crucial for project evaluation. Thirdly, it is inherently more difficult for foreign agencies to know who stands in a weaker or stronger position. Fourthly, this knowledge is inevitably filtered by the local interlocutors, whose political agenda and affiliations cannot, in any case, be disregarded.

In terms of cooperation programmes design and management, these observations lead us to recommend:

a) An explicit and realistic preliminary balance (and political agreement on it), between the (social) equity and (economic) efficiency goals that projects must aim at, within the given time frame;

b) Flexible arrangements (in the projects' terms of reference) to allow for the agreement on priority target sub-sectors and beneficiaries to be consensually reached through consultation with the whole (or a broad) range of stakeholders;

c) A clear distinction (in terms of schedules and resources) between a demonstration phase, centred on the pilot project's demonstrative potential and aimed at testing, verifying and modifying (if necessary) the actions implemented in relation to the needs that emerged, and the normal operational phase, which needs to benefit from external subsidies as well, but to a possibly lesser and extent and in a different way.

2. Partly also as a consequence of the above, long-term assistance commitment and inter-institutional cooperation are necessary if self-sustaining change processes of a 'systemic' kind are to be achieved, i.e. if some sort of development of a region or country is aimed at, rather than the simple growth of single economic or even institutional agents. Direct assistance programmes for SMEs and special support agencies have been in existence since the 1970s in many Latin American countries, often with the expert advice of international aid organizations. However, evaluations of this type of assistance show that it frequently turns into isolated intervention and it is mostly characterized by the constraints of administrative centralism and legal formalism. SME development policies should instead be a means of channelling a macro-policy environment conducive to private sector development, and mainly aimed at stimulating economic recovery through decentralized and participatory development.

3. In most developing countries the main problem of small firms is their isolation and powerlessness, particularly in a socio-political setting which is geared to large enterprises. In addition, due to their limited resources and lack of bargaining power, small entrepreneurs often end up in strict subcontracting relationships, with a degree of economic dependency that resembles 'wage labour'. Stimulating clustering and inter-firm specialization is therefore crucial, since only collective efficiency can overcome the resource deficit of SMEs and improve their political standing by integrating them into a larger network of inter-firm cooperation. Business service centres, either related to specific industrial sectors or cutting across sectors according to functional themes, can play an important instrumental role in this, and have proved to exert a strong appeal to all those involved.

4. SME development policies, including the provision of services for technology transfer and innovation, should essentially be based on building consensus and on concertation processes, involving workers and employers either directly or through their associations and organizations. Furthermore, they should:

a) Be decentralized, i.e. carried out at local level;

b) Seek to attain wide participation not only in the design and strategic planning phase but also during the action implementation phase;

c) Be based on some strategic vision and alliances;

d) Address all aspects relating to human resources, information, finance, and infrastructure, since isolated support measures (such as training, credit, or technological assistance) are no longer regarded as being sufficient to foster development of small firms;

e) Be realized by mutual agreement and the efforts of public and private actors.

5. Despite an often strong tendency for local authorities and leading firms to be in favour of the most advanced technical solutions, it is better to address intermediate technologies to avoid the risk of establishing monopolistic groups of companies, especially if social and equity concerns are at play, as well as to make their appropriation more rapid. For small firms in developing countries access to technology is often difficult, either because it is foreign and/or because the initial investment required is very high. In order to guarantee the feasibility of the technologies to be transferred, the existence of a local structure (at least at the national or regional level) which supplies new and second-hand technology as well as a repair service is essential, while a strong interaction of small firms with university or technological laboratories should be stimulated right from initial phase of technological needs evaluation.

Projects should be flexible and a clear distinction should be made between the demonstration phase and the operational phase

Stimulating clustering and inter-firm specialization is crucial, since only collective efficiency can overcome the resource deficit of SMEs and improve their political standing by integrating them into a larger network of inter-firm cooperation

Intermediate technologies may prove more effective than the most advanced solutions as they are more likely to be practically and economically viable in the context of an emerging economy

The process of agreeing upon and designing a service centre, i.e. an entity built to cater for common needs and purposes, has proved highly effective in managing information flows and creating a collective 'vision'

6. Regional integration and globalization processes enhance opportunities (and threats) of all kinds, as well as the feeling of being lost and unable to manage the flow of information relating to them. Making sense of it all is crucial, and this largely stems from a collective, social process of 'vision' generation. The process of agreeing upon and designing a service centre, i.e. an entity built to cater for common needs and purposes, has proved highly effective in this respect. Once operational, a service centres can contribute to filtering and pre-digesting the information overflow, and to turning 'noise' into information. In addition, they can also contribute to the process of inter-firm cooperation by attracting foreign firms to enter into alliances with local universities and firms. In the end this may help broaden the economy's knowledge base and stimulate processes of enterprise (and employment) creation.

Conclusions

This article has argued that the institutional environment is crucial for the success of local development policies, particularly those aimed at SMEs. This environment is made of a variety of public and private support institutions such as regional authorities, entrepreneurial associations, banks, local authorities, universities, service centres, and training institutions. While recognizing that it is not easy, as if using a magic recipe, to replicate the same successful combination (the 'Emilian model') a general conclusion may be drawn: in an increasingly global market, each small entrepreneur finds it more and more difficult to build up its own capacity to compete world wide and to gather information about technologies, markets, products, standards, and so on. Therefore, also with regard to the European policy maker, it may become necessary to intervene by stimulating local forces to create their own networks of supporting institutions. As it has been said, 'clusters of firms do not appear or evolve, by accident or by chance'. While conceiving technical assistance projects directed at SMEs, it should be taken into account that the key to success seems to be the setting up of a creative regional policy, strongly related to local needs and cultural roots, with the direct participation of prominent institutions, scholars, researchers and training organizations for the establishment of a new economic and social environment.

Keywords

local system of small firms, industrial development, international cooperation

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BRIEF NOTE

Kari Ebeling
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Biotechnology in Pulp and Paper Industry does not need any BAT boosting

Chris Tils and Per Sørup published a fairly long article entitled 'Biotechnology as a Cleaner Production Technology in Pulp and Paper' in the July issue of *The IPTS Report* (No. 16, July 1997). Perhaps one motive for writing the article has been the disappointment of these biotechnologists - and maybe even of the enzyme industry - for not succeeding in introducing new, economically viable biotechnologies into the Pulp and Paper Industry. However, there were some shortcomings and mistakes in the article. And the overall conclusion of using the BAT concept of the IPPC directive as a political instrument to activate new technology adaptation to the European Pulp and Paper Industry is questionable.

Firstly, the article did not mention at all that besides chemical pulping there is also a mechanical method to produce papermaking f1bres. The mechanical pulp fibres make up roughly 50 % of the fibres used in the communication paper sector. Much biotechnology research is presently carried out in order to decrease the expenditure of electrical energy in mechanical pulping. This should have been mentioned in the article. Besides, the basic nature of the mechanical pulp fibre in the communication paper structure is based on the presence of certain amount of lignin in the cell wall of the fibre. Thus, high-quality mechanical pulp fibre could not be made from such a genetically modified tree, which would not have lignin.

In connection with the discussion of genetically engineered trees of tomorrow, it should have been stated that genetic engineering so far has been applicable to such forest ownership structures, where companies or governments own huge areas of forest. It would not easily be applicable to Europe, where the local farmers with relatively small woodland areas are the dominant owners of the forests. In addition, in the case of softwood utilization in pulp and paper industry, much of the raw material consists of by-products from the sawn goods and plywood industry. In these products lignin is the main source of rigidity and therefore cannot genetically be engineered away.

The communication paper sector represents about 1/3 of the global consumption of paper and board. It is in these paper grades and in the hygienic papers and products, where the bleached chemical pulp fibres are mainly used. The majority of packaging papers and boards are made from unbleached fibres (fresh or recycled). Thus the statement of the authors: Bleaching is conceived as the process with the most environmental problem is not compatible with the real situation of today. It is just a perceived opinion of the public in the industrialized western societies.

The authors criticize the pulp and paper industry for not being an innovative industry. This is true, but only partially. The authors apparently forget completely the capital intensiveness of the pulp and paper industry. An investment of 3 to 5 ECU is required for each ECU of annual sales in the case of a completely new integrated pulp and

paper mill. There are very few other industries that are so capital intensive and that would be open to free international trade like the pulp and paper industry. The capital intensiveness has increased the mill size and made the investments into new mills gigantic, i.e. up to 500 MECU. Due to this capital intensiveness huge cyclic variations of price and market demand and low long term profitability it is quite natural that the industry is not capable of large scale innovativeness. Once the equipment of the manufacturing process has been selected one, needs to use it for a many years in order to generate the cash flow for pay back.

One should also keep in mind that the time span from an idea and its successful bench scale verification to a fully tested 1000 tons per day new process is long i.e. 7 to 10 years even under very favourable business and R&D conditions. Please keep in mind how the realization of the fusion technology as an inexpensive energy source has been running further and further away during the last 50 years.

The authors state as their conclusion that in accordance with the IPPC directive the boosting of The bleaching, of chemical pulp could in principle be supported by including it in the BAT standards. Based on my comments above and on the fact that UPM-Kyrnmene was one of the companies in the Finnish consortium that sponsored the original research and development of the 'enzyme bleaching technology'. I strongly oppose the conclusion reached by the authors. In my opinion the Best Available Technologies (BAT) and the IPPC directive should not be used to increase the innovativeness of the European Pulp and Paper Industry towards the clean manufacturing technologies. For instance in the case of enzyme boosted bleaching UPM-Kymmene is continuously testing new enzymes but the economic benefits of enzyme boosted bleaching have not always found in industrial conditions.

By setting excessively optimistic, but unfounded BAT targets for the European Pulp and Paper Industry we Europeans can only help the non-European competition based on low cost wood and on relaxed environmental standards. In order to increase the innovativeness of the European Pulp and Paper Industry we should make it possible for the industry to get support in the Fifth Framework Programme to test new processes or sub-processes on large pilot scale operations once the potential of a new process (subprocess) has been verified successfully in the laboratory and on small pilot scale. This way we could shorten the long distance (time and money) from an innovative idea and its successful laboratory verification to a fully tested and commercially ready new process.

BRIEF NOTE

Chris Tils & Per Sørup, *IPTS*

Mr. Ebeling has kindly sent a number of interesting comments on the relations between innovation and (environmental) regulation in the pulp and paper industry in response to our Article in The IPTS Report 16 of July 1997. We would like to add a few words to Mr. Ebeling's reflections to take our discussion a little further.

Mr. Ebeling claims that we highlighted the IPPC directive and the BAT procedures as the instrument to promote innovation. This is indeed not the case. Our main conclusion was that the IPPC/BAT instrument - which very easily (although not necessarily) centres on setting technology targets and not environmental performance targets - should avoid risks creating a lock-in situation that in the medium to long term could hinder not only innovation, but also environmental improvements.

Our view is in fact, that the 'integration concept' the leading idea in EU environmental policy making - should be deepened so that environmentalists concerned themselves more with the problem of technological innovation to obtain maximum benefits for the environment in the longer run.

When Mr. Ebeling concludes that Framework Programme support to the pulp and paper industry is the way forward we would agree only if we are talking about a Framework Programme that integrates environmental and innovative aspects to an extent that still remains to be seen.

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ABOUT THE IPTS

The **IPTS** is one of the seven institutes of the Joint Research Centre of the EU Commission. 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 IPTS enjoys a dual advantage: being a part of the Commission 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 betwen 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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2. Technology, employment & competitiveness. Given the significance of these issues for Europe and the EU institutions, the technology-employment-competitiveness relationship is the driving force behind all IPTS activities, focusing analysis on the potential of promising technologies for job creation, economic growth and social welfare. Such analyses may be linked to specific technologies, technological sectors, or cross-sectoral issues and themes.

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

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