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The IPTS REPORT

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

EUROPEAN COMMISSION
Joint Research Centre

ENGLISH VERSION

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C O N T E N T S

very often unilaterally, under pressure to meet strict production deadlines. Apparently even academic journals such as the AER (May 2001, p. vii) have to resort to such unilateral editing, when faced with similar reasons/constraints (i.e. the issue has to be produced and it has to be on time).

From another viewpoint, the excellent DG Research monthly publication "RTD Info" (with a print run of 82000), in its September 2001 issue, p.40, presents a snapshot of itself and its readership, based on a reader survey conducted earlier in 2001. Out of approximately 700 respondents, approximately 47% read the English version, 29% the French one and 24% the German one. Subscribers share their copy with other readers (approximately 4.8 persons see each copy), and although an electronic version is available (**http://europa.eu.int/comm/research/rtdinfo.htm**, the survey found "a very broad consensus in favour of the paper version. This same preference is also confirmed by anecdotal evidence about IPTS Report readers.

The IPTS Report currently has a print run of approximately 7000 copies. We have carried out surveys more or less every two years. The last two (1997-8 and 1999-2000) had an average of approximately 800 respondents. Of our readers about 50% read the English version, 20% the French one, 10% the German one, and another 20% the Spanish one. Interesting information has also emerged from past surveys as to the use readers make of the IPTS REPORT and the aspects of it that are of particular interest to them. A large percentage (38%) uses the IPTS Report on their workprogramme projects, and another 32% in preparing for meetings – very hands-on use; the aspects they value in the Report are almost evenly split across the anticipation of policy needs for Europe, the analysis of technological developments, and the alerting on techno-economic impacts.

The advent of the Internet is no doubt one of the biggest changes to have hit publishing since Gutenberg's days and its ramifications will continue to play themselves out for a long time yet. The IPTS report was one of the early arrivals on the web –being published online since its inception in 1995– and continues to use the web as a key publication venue. As print-based publications have sought to build a web presence there has been no shortage of statistics generated as publishers seek to identify trends. Thus, the leading Spanish newspaper "El Pais" on 1 July 2001 (p.40) published statistics regarding the readership of its electronic version, as well as that of other large Spanish newspapers. El Pais enjoys numbers (more than 800,000 visits per month) which are much higher than those of other Spanish newspapers. Obviously these figures are subject to all sorts of provisos and the number of hits received by a monthly journal cannot be expected to be as high as those of a general circulation daily newspaper, but what is interesting – and something of a pleasant surprise – is that IPTS Report web visits (of the order of 60,000 per month) would place it in the same group as the "El Periodico" and "Expansión" newspapers, which are in the 62,000-89,000 range, and rank sixth and seventh in the web-readership list published by El País.

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Scientific advice for policy-making

It is useful to distinguish between the two different roles to which scientific advice is put in the policy-making process. Firstly, scientific advice may be used to define and manage science policy itself - for example, in relation to the European Union (EU) Framework Programmes (FWP). Secondly, it may be used to define and support other (non-science) policies. Scientific advice for science policy has received much attention in connection with the *implementation* of supranational research and development (R&D) programmes, although strategic long-term scientific prospective -for example, for the scientific discussion of *future* FWPs- is an activity that still needs to be carried out successfully. Indeed, no broadly accepted methodology for the *ex post* evaluation and assessment of R&D programmes has yet been clearly established. In a still earlier stage is the second role –scientific advice for non-science policies– which still lacks a conceptual framework and an operational procedure, although a number of approaches have been recently made, mainly at national level[2].

Very often, the need to use scientific advice to provide a firm scientific foundation for policies in the areas of health and environment has been urged, but seldom has scientific advice to other EC policies received the same degree of support. This is probably rooted in the fact that outside those two areas –and even there only in the recent years – citizens do not tend to perceive that science has any influence on their welfare[3]. This is an unjustifiable limitation, as policies with considerable impact on society, such as those in the fields of education, energy, language etc., require substantial scientific knowledge to clarify the background *against* which political decisions can be made.

When dealing with the use of scientific advice for policy-making, a word of warning is needed. When faced with the threat of some kind of catastrophe public opinion often demands rapid action based on scientific analysis and, frequently, governments respond by creating an *ad hoc* scientific panel to deal with the problem[4]. On many occasions, when the pressure from the public opinion and the media increases, governments might feel inclined to justify their political choices by conveying to the public the feeling that they were following scientific advice. Although it may be politically convenient, this is certainly the wrong attitude as scientists are never supposed to make the choices. Rather, they are expected to provide a clear picture of the scientific and technical aspects of the problem, which illuminate the pros and cons of the different choices. Clarifying the boundaries between scientific advice and political decision-making is essential if citizens are to perceive science as objective.

Time-scales

A considerable body of experience has built up in relation to the use of scientific advice for science policy. Frequent use is made of it in the *ex ante* evaluation of projects submitted to programmes such as the FWP. The normal procedure involves setting up *ad hoc* panels of scientists. While the choice of the so-called experts is not itself exempt from criticism, the general framework of action, and the specific rules of procedure, for this kind of advice at the short-term end of the time-scale, seem to be appropriate to its goals.

A different picture emerges in the analysis and discussion of long-term policy and, even, in the *ex post* evaluation and assessment of past programmes. Although a number of studies have been launched by the European Commission, we still lack clear and widely accepted guidelines for operation. It is not unusual to hear that the successive Framework Programmes of the European Union are too strongly influenced by political concerns. It could hardly be otherwise taking into account the fact that seldom did the earlier proposals of these programmes

As an input to the policy-making process, science advice may be used to define and manage science policy itself, or to define and support other policies

Policies with a powerful socio-economic impact, such as those in the fields of education, energy, language etc, require substantial scientific knowledge to clarify the background against which political decisions can be made

Although a number of studies have been launched by the European Commission, there are still no clear and widely accepted guidelines for the evaluation and assessment of past programmes

'burning' issue, whatever its importance or urgency, cannot be overemphasized.

Secondly, the panel's rules of procedure and its infrastructure need to be discussed. For this type of activity, bureaucracy needs to be kept to a minimum and, whatever working groups are created, they must proceed on the basis of a scientific (not an administrative) approach to the problems. This is particularly the case regarding issues concerning the European Commission (EC) programmes, in which all the administrative procedures are primarily aimed at *control* (be either expenditure or scientific performance). It goes without saying that adequate secretarial support must be provided: one should not forget that the scientists involved in these panels face multiple demands on their time, use of which has therefore to be optimized. Last, but not least, the panels have to be provided with up-to-date and state-of-the-art data. Few people are aware of the number of studies and official statements, sometimes with far-reaching implications, which are carried out on the basis of insufficient or inadequate sets of data.

Thirdly, we need to tackle the thorny issue of independence and transparency. A common area of concern is how to avoid the working groups which review specific subjects being influenced by scientific lobbyists on the subjects of their interest. Past experience shows that all too often members of this type of panel do not perceive clearly what capacity they are acting in and some of them even tend to act as "representatives" of one or another scientific group. Perhaps an obvious point, but never-theless one worth being made explicit from the outset of the panel's work, is that any scientist serving on one of these panel is in no way representing any institution or scientific group but is expected to act solely on the basis of his/her wide scientific and technical capabilities.

It is worth recalling a very practical model for selecting a panel which has been successfully tested in the ESF committees dealing with infrastructure proposals -e.g. proposed new Large Research Facilities- in Europe. The model works as follows: the working panel is split into two groups, the Review Group and the Advisory Group. The Review Group members are recognized scientists of broad expertise with no direct involvement in the subject which is being reviewed, whereas the Advisory Group includes the specialists in the subject. The final report is written and approved by the Review Group *only*, which uses the Advisory Group as a continuous source of ideas and information. It has been observed in practice that this *modus operandi* substantially reduces the influence of lobbying on the final report.

The fourth issue to be examined is the expertise on the panel. Selecting the members of this type of panel is not an easy task. Instead of trying to select the 'best' scientists and/or the 'best' industrialists, one should aim at picking people with sufficient experience and a broad view of intersecting scientific areas and, even, of the whole research and technology system. It may very well happen that in the course of the analysis of a given subject the panel detects that some new piece of study is required, e.g. a scientifically-based prospective study in a given area. The panel should be allowed to freely commission such research. Although this could be done in some of the Institutes that exist in Europe dealing with evaluation, one well qualified candidate would always be the Joint Research Centre (JRC) of the EC. This is in line with the recent quadrennial evaluations of the JRC, in which it was recommended that a substantial part of its resources should be devoted to supporting EC policies. Using the JRC would guarantee independence from specific national interests and bias from specific scientific lobbies could also be kept in check.

Conclusions

The main conclusion of this article is that when considering scientific advice, two limiting time-

Panels need to proceed on a scientific rather than administrative basis and excessive bureaucracy should be avoided

A common area of concern is how to avoid the working groups which review specific subjects being influenced by scientific lobbyists

One approach to selecting panels is to divide them into a review group and an advisory group, where the subject specialists are in the advisory group but it is the more generalist review group that writes the final report

Mobile Phones, Health and the Future of Wireless Technologies

Ioannis Maghiros and Laurent Bontoux, *DG JRC*

Issue: Mobile phones have reached mass market status in just a few years, with a current penetration in EU 15 countries nearing 60% of the population. Yet, simultaneously, public concern about the safety of exposure to Radio Frequency (RF) energy has grown to significant proportions. This raises questions at a time when a variety of new mobile/wireless devices are expected to come on the market soon. The question of the potential health effects of electromagnetic fields (EMF) is very high on the European political agenda, judging, among other things, by the number of parliamentary questions addressed by the European Parliament to the Commission on this topic. At least 4 Directorates General from the European Commission (DG SANCO, DG RTD, DG ENTR and DG INFSO) are now involved in this issue.

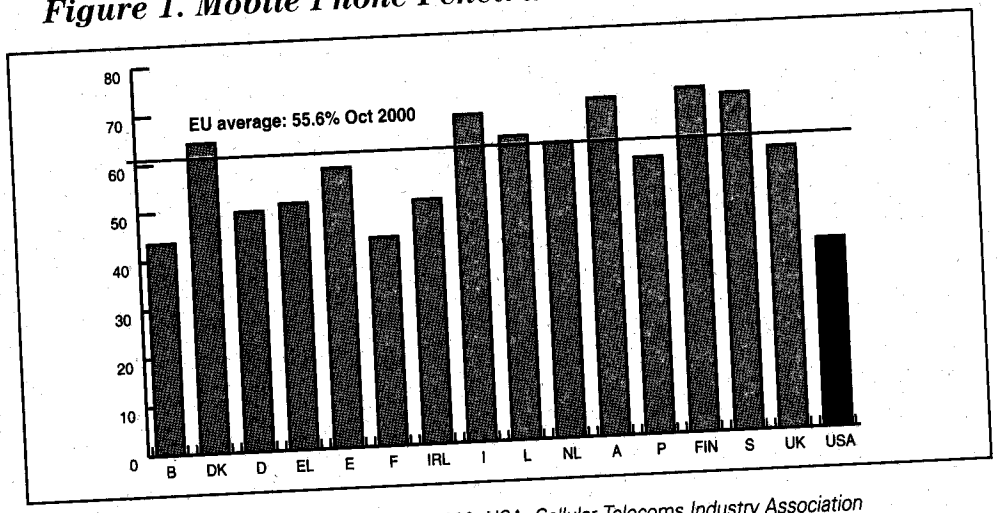
Relevance: Under the Fifth Framework Programme for Research and Development (FP V), dedicated research is being conducted on this issue. While it is still too early for definitive research results on all possible hazard areas to allay fears concerning RF emissions, existing research supports the conclusion that no major health risks should be expected from these technologies. Therefore, better communication from public authorities and industry, in conjunction with greater responsiveness to the wishes of the public would enhance the current acceptability of the mobile phone technology already on the market and are necessary to ensure smooth introduction of the forthcoming mobile/wireless devices. Failure to tackle the issue adequately could have a serious impact on the uptake of wireless technologies.

Introduction

Health concerns about exposure to electromagnetic fields (EMFs) are not new. Radiation emitted by overhead power lines (0-100 Hz, or the ELF range of the electromagnetic spectrum) has been under investigation for more than 20 years[1]. In our everyday lives, we are all exposed to radiation emitted by a number of devices such as ordinary home appliances (e.g. microwave ovens, toasters, hair dryers, electric shavers, PC screens), industrial heating systems and electricity transformer substations, radio and TV transmitters, anti-theft systems, normal electric circuits, remote control devices, and, of course, mobile phones, which are now being subjected to rigorous investigation. The combined radiation from all these sources is

In our everyday lives, we are all exposed to radiation emitted by a number of devices such as ordinary home appliances, e.g. from microwave ovens, toasters, hair dryers, electric shavers and PC screens

Figure 1. Mobile Phone Penetration the EU and the USA



Source: FT Mobile Communications - October 2000. USA: Cellular Telecoms Industry Association

–GPRS– or Universal Mobile Telecommunications System - UMTS). In addition to voice, they will allow fast data transmission (Internet connections) with 'always-on' capabilities.

Today, mobile phones are mainly used for voice transmission and SMS (Short Message Service) messaging a utility much appreciated by younger users. E-mail, mobile video telephony, mobile advertising, transactional m-commerce (m for 'mobile') services, location-based services and financial services are the new applications that are expected to broaden the market, in part by adding new users. Mobile operators hope to be able to take advantage of their comprehensive customer databases and derive revenue from new content and services that they expect will create new demand for mobile devices in general.

Mobile Network Technologies and Operating Frequency Ranges

All existing mobile network technologies operate in the RF section of the electromagnetic spectrum. Car phones and cordless phones, communicating with the fixed network using analogue technology, have been around for over thirty years and operate in the 50 MHz, 900MHz and 2.45GHz range. New digital technologies like GSM have popularized the use of personal mobile phone devices of a fraction of the size and cost of the older analogue models. GSM phones operate in the 900 MHz and the 1800 MHz (1900 in the USA) frequency bands. The new GPRS standard is a packet switched wireless protocol that offers 'always-on' connection capability and transmission speeds of up to 115 Kbits/s compared to 9 kbits/s for GSM. UMTS is the third generation (3G) mobile phone system, which promises to be based on a single network standard (CDMA) and one type of access device throughout the world. It allows connections at speeds of up to 2 Mbits/s. Both GPRS, foreseen to be operational by 2002, and UMTS, expected by 2005, operate in the 1800MHz to 2200MHz range (see Box 1). However, these standards are unlikely to be the last ones and new ones are already emerging (e.g. EDGE – Enhanced Data for GSM Evolution).

All of the above technologies require base repeater stations which receive and transmit signals from the mobile phones. These base stations, through their antenna, reach up to 10 km in rural areas but only about 0.5 km or less in urban areas (greater demand). Maximum power radiated from an antenna for mobile phones is in the order of 80W

Digital technologies like GSM –which operates in the 900 MHz and 1800MHz frequency bands– have popularized the use of personal mobile phone devices of a fraction of the size and cost of the older analogue models

All mobile telephony technologies require base repeater stations to receive and transmit signals from mobile terminals. These base stations can cover a radius of up to 10 km in rural areas but only about 0.5 km or even less in urban areas

biological phenomena involved are not yet fully understood, and new dosimetric and experimental studies need to be performed if clear conclusions are to be drawn.

The evidence on health outcomes other than cancer, compiled from the British Medical Association (BMA-May 2001) and other reports cited above may be summed up as follows:

- **Reproductive system:** "Studies on rodents have not found convincing evidence of risks to the foetus or male fertility".
- **Effects on the eye:** "High level (thermal) exposure to RF radiation may produce adverse effects in the eye, particularly in the retina, iris and cornea, although no definitive conclusions can be reached since the studies have used intensities of pulsed RF fields well above the SAR (Specific Absorption Ratio) specific absorption that could occur in the eye from the use of current mobile phones".
- **Cognitive effects:** "The [UK] NRPB writes that the few studies that have investigated these issues do not suggest the evidence of an obvious health scare". The only effects documented are slight decreases in reaction times and an enhancement of the brain's electrical signals during sleep. RF radiation at typical environmental exposure levels does not increase memory loss or attention deficiency.
- **Children:** No specific health risks have been put in evidence for children. However, "due to their developing nervous systems, greater absorption of energy in the tissues of the head, and their longer lifetime exposure, children may be more vulnerable to the effects of RF radiation". Therefore, more precautions should be taken with them.
- **Subjective disorders:** Today, large numbers of people in certain countries still complain about "electromagnetic hypersensitivity", a poorly defined syndrome that the patients themselves attribute to EMF. However, the BMA report states that "one review [by the Royal Society of Canada (1999)] concluded that existing evidence does not support the [conclusion] that microwave radiation (part of RF radiation) can induce headaches".
- **Driving:** There is strong experimental evidence that those engaging in mobile phone conversation while driving have an impaired ability to react to potentially hazardous situations. A correlation has been found between phone conversation whilst driving and an increase in the risk of involvement in an accident.
- **Effects on the ear:** Mobile phones affect the inner ear in perhaps 5-8% of users causing headache and transient confusion. It has been suggested that hair cells or fluid in the inner ear are affected by direct action of phone radiation or by heat from the phone.

In short, while some minor effects have been observed, no evidence has yet been found of any serious health hazards. The greatest recognized risk lies in phoning while driving. The latest thinking in terms of where could unexpected health effects come from is oriented towards pulsed fields. The rationale for this orientation is the theoretical possibility that resonance could cause energy to concentrate in certain very localized spots and lead to DNA damage. The latest research is addressing this issue.

While some minor effects of exposure to RF EMFs have been observed, there is as yet no evidence of any serious hazard to health

New Research on the Potential Adverse Health Effects of RF

In response to the high level of concern from the public worldwide, a significant amount of new research is being planned and carried out. Our purpose here is to give but a few highlights of these efforts. More detail can be obtained through the WHO "*EMF Project*" (**http://www.who.int/peh-emf/**). Box 2 summarizes the research efforts currently funded by the European Commission. Among these, two projects (PERFORM-A and

INTERPHONE) deserve special attention because of their large scale and scientific quality. Both also benefit from funds provided unconditionally and under independent supervision by Industry. In addition, in mid-2001, the European Commission has launched a third phase of the COST 244 action on the biomedical aspects of EMFs that coordinates a number of national research projects across the EU.

Industry is also funding a project called PERFORM-B mostly aiming at replicating research conducted previously with a view to addressing shortcomings that prevented the scientific community from drawing clear conclusions.

In addition, the UK government has pledged £7 million for research, mostly on non-cancer health effects, with the selection of projects being finalized in the Summer 2001. Half of this money is provided by the mobile phone industry. The US NIEHS (National Institute for Environmental Health Sciences), through its National Toxicology Program (NTP) is planning to launch a $10 million study similar to the PERFORM-A project but adapted to the frequencies most used for mobile telephony in the USA. A common feature of all these state-of-the-art efforts is the emphasis given to the quantification of exposure (dosimetry).

Quantitative Health Risk Assessment and the Regulatory Framework

Scientific uncertainties surrounding the health effects of RFs are making it difficult to make sound policy decisions and therefore quantitative risk assessment is needed. This requires the development of extensive exposure and effects databases for which current knowledge remains too limited. One of the major difficulties inherent to the field of EMFs is the difficulty of measuring exposure. Exposure to EMFs (RFs in particular) is usually quantified by using the Specific Absorption Ratio (SAR – given in W/kg), which is the amount of electromagnetic energy absorbed by a given mass of body tissue. Unfortunately, the physical characteristics of EMFs make this quantity very difficult to measure. Measurement requires the use of 3-dimensional models and readings need to be averaged over a certain volume. Additionally, the SAR may sometimes not be sufficient to understand the effects because radiation itself is described by several variables, each with its own importance (e.g. frequency/wave length, amplitude, pulsation, etc.)

Exposure is also rarely limited to a single frequency, and each frequency has different tissue penetration and energy carrying properties. This causes unpredictable uneven doses (e.g. "hot spots") in 3-dimensional organisms. This complexity explains why it has been so difficult to come up with commonly agreed standards on how to measure SARs. It also explains why the relevance of the results of most older experimental studies on the potential health effects of EMF has so often been put in doubt: in many cases it was impossible to actually know the dose to which the test animals or tissues were exposed. In addition, because of the importance of geometry in the distribution of EMF doses, it is difficult to extrapolate the results obtained in the body of a rat or mouse to that of a human. This explains in part the need for so much new research, especially *in vivo*, in order to establish a reliable effects database for risk assessment. These issues are being seriously addressed in the latest experiments, in particular PERFORM-A and PERFORM-B.

In spite of all these difficulties, SAR measurements remain a useful quantitative tool. On July 26, 2001, the European Commission published CENELEC standard EN 50360:2001 which establishes the SAR values that will guarantee that telephones will not exceed the emission limit authorized for all radio or telecommunications devices set by Council Recommendation 1999/519/EEC. This standard, contributing to the application of Directive 1999/ 5/EC,

One of the major difficulties inherent to the field of EMFs is the difficulty of measuring exposure. Moreover, exposure is also rarely limited to a single frequency, and each frequency has different tissue penetration and energy carrying properties

public authorities to ensure that any possible health risk resulting from them is alleviated. In general, public authorities ought to continue funding and conducting testing procedures, defining and announcing threshold levels – considering known knowledge gaps and the best available scientific advice – in order to prevent unnecessary public fears. Rather than convincing the public that the risk involved is smaller than other risks confronted in everyday life, public authorities should be visibly committed to researching potential adverse health effects and communicating the results in a timely and accurate way. In short a few policy options, as already expressed through various sources (e.g. BMA interim report May 2001, GAO congressional report May 2001), need to be considered:

- Continuing and developing collaboration between industry, the public sector and the health authorities.
- Building industry-wide consensus in order to resolve standardization issues (this has now been achieved in the EU thanks to the new CENELEC standard for measuring SAR presented above).
- Public sector measures to ensure enough people are trained in standard measurement techniques and are available to perform extensive compliance testing.
- Identification by health authorities of the guarantees for public health that need to be in place first and the information needed. Plus a proactive stance by industry to demonstrate up-front with practical results what risks are involved in any new technology about to be deployed.
- Publicly funded research in line with the above mentioned criteria.
- Raising public awareness through regular information updates on the status of research addressing the possible adverse health effects of mobile devices. Providing explanations on the level of risk for individuals and precautions to be taken in the absence of definitive scientific conclusions.

Keywords

health, mobile phones, EMF, radiation exposure, policy needs

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Note

1. After a long period of controversy, a consensus is emerging that there is a link between average exposure to ELF radiation above 4 milligauss and childhood leukaemia (MicroWave News, 2000).

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Innovation and Patent Protection in Pre-Accession Countries

Nikolaus Thumm, *IPTS*

Issue: Although many of the candidate countries for EU membership have shown strong innovative performance in the past, their situation has deteriorated since 1990. In particular, patent application figures suggest that the Czech Republic, Poland and Hungary have all become more dependent on foreign technology with foreign firms now dominating innovative performance in these countries' markets.

Relevance: Fostering local innovation processes is generally acknowledged to be a key factor in stable long-run economic growth. Adequate protection for intellectual property rights is seen as a prerequisite for a thriving innovation system. However, although bolstering patent systems in pre-accession countries is clearly beneficial to foreign companies investing in these countries, the gains reaped by local players so far are less apparent. In the long run, however, the patent system could spur the local innovation process and harmonization with the standards applicable in the European Union is a necessary part of the political integration process.

Introduction

The extent to which economies are able to foster innovation and technological development is clearly an important factor in their competitiveness. Research and development in pre-accession countries (PACs) was traditionally strong compared to their neighbours within the communist bloc. However, with the lifting of the iron curtain their position changed and a significant technological gap opened up between PACs and the European Union countries (see Thumm, 1999). More detailed investigation is needed into the role and importance of local innovation in PACs, and its influence on trade in technology and the technological dependency of PACs on Western European countries.

Local innovation is one of the keys to long-run economic growth. For PACs it is therefore necessary to identify where innovation comes from and in particular how much innovation is local in origin and how much is transferred via foreign direct investment, licensing, imports or imitation. All these means of transfer are beneficial to closing technological gaps and spurring local innovation in the short run. The aim of this article is to examine patterns of innovation in PACs in terms of the quantity, origin and the industrial distribution of innovation in those countries. The objective measure of innovation used comprises patent application data of three types: applications filed at national offices in PACs by domestic and international applicants, and patents granted by the United States Patent and Trademark Office to PAC-based applicants. For the purposes of

Local innovation is one of the keys to long-run economic growth. For pre-accession countries (PACs) it is therefore necessary to identify where innovation comes from and in particular how much innovation is local in origin or transferred via foreign direct investment, licensing, imports or imitation

When a technological gap exists between the industrialized countries and transition economies exporters would naturally like to see their technology and know-how protected when products with a technology component are imported. However, the same is also true of exports from PACs to more industrially advanced trading partners, given the need to develop a domestic culture of innovation. Hence our structural analysis needs to look at both the development of technology transfer in forms of trade and goods to PACs and the diffusion of their technology abroad. The question that arises is therefore the degree to which IPRs are important to trade. Clearly they are an important part of the institutional setting needed to promote international commerce, but what is less clear is whether IPRs can promote the exchange of technology and help narrow technology gaps. More detailed analysis is needed to determine how IPRs affect innovation in the context of particular countries.

Although patents are an important factor in the composition of both imports and exports in pre-accession countries, the data are much more straightforward for exports than imports[5] and show that PACs themselves obtain clear advantages from protection. On the other hand, more research is needed to assess the extent to which IPR protection is able to bring about technology transfer through trade.

Intellectual property rights systems in the PACs

The countries of Central and Eastern Europe are undergoing a dual process of alignment in their intellectual property rights (IPR) systems. Firstly, they have to establish conditions for international agreements such as TRIPs (Trade-Related Aspects of Intellectual-Property Rights) and the Paris Convention. Secondly, they are trying to bring their countries into line with the EU system and standards in order to open the doors to membership of the Union in the near future. Eight central and eastern European countries have applied to join the European Patent Organization and have been granted observer status on the Administrative Council. On 29 January 1999 the Administrative Council of the European patent office invited Bulgaria, the Czech Republic, Estonia, Hungary, Poland, Romania, Slovakia and Slovenia to accede to the European Patent Convention on 1 July 2002.

One aim of the accession agreements is to set the protection of intellectual, industrial and commercial property at a similar level to that applicable in the European Union and to harmonize national legislation with EU regulations and standards. Another option for patent protection is the so called "extension system" with the European Patent Office. This system is applied by Albania, Latvia, Lithuania, Romania and Slovenia and enables patent applications to be directly applicable in the Country of extension so that the patent holder has no need to go through a separate local application procedure.

As regards international agreements, it is worth noting that all the pre-accession countries are already members of the Patent Co-operation Treaty (PCT). Indeed the adhesion of PAC countries to international IPR agreements since the lifting of the iron curtain has been remarkably swift. The EU accession agreements commit all countries to compliance with the Paris Convention, the Madrid Convention and the PCT and a major incentive for assimilation appears to be the rapid achievement of full membership of the European Union.

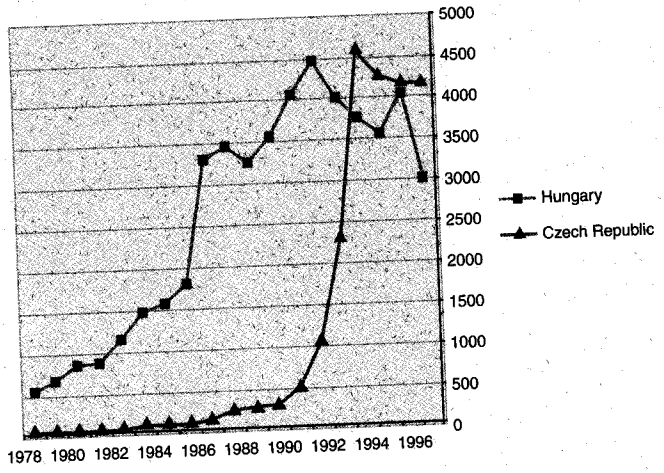
Czech Republic

With the political changes that took place in 1989 a return to the classical system of exclusive legal protection was possible. Until the end of 1990

IPRs are clearly an important part of the institutional setting needed to promote international commerce, but what is less clear is whether they can promote the exchange of technology and help narrow technology gaps

The countries of Central and Eastern Europe are establishing conditions for compliance with international agreements (such as TRIPS and the Paris Convention), while at the same time trying to bring their countries into line with the EU system

Figure 1. Number of patent applications in Hungary and the Czech Republic. Source: author's analysis of data from Derwent World Patents Index.



patent applications as an indication of the attractiveness of the national system of protection.

This becomes particularly clear when looking at the rate of technological dependency (Figure 2). The OECD defines the rate of technological dependency (dependency rate) as the ratio of the number of non-resident patent applications and the number of resident patent applications.

Figure 2 shows the development of the dependency rate for Hungary and Poland, which are the countries for which the most complete data series are available. Technological dependency rose in both countries after 1990. In Poland this trend is relatively moderate in comparison to Hungary, however, it still reached a level of 6 in the year 2000. In Hungary the dependency rate reached a level of 76 with a continuing sharp upward trend in recent years[6].

Hungary seems to be becoming more and more attractive to foreign applicants. In particular there is a relatively small number of local business

Assuming that patent applications can provide information on where and when marketable inventions appear, distinguishing between resident and non-resident patent applications can reveal the degree to which a country is technologically dependent and/or the attractiveness of the local IPR system

Figure 2. Dependency rate, Czech Republic, Hungary and Poland. Source: national offices (data compiled by the author).

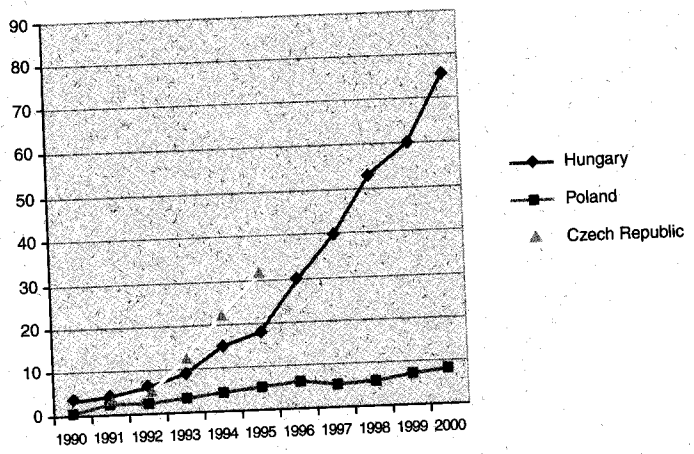
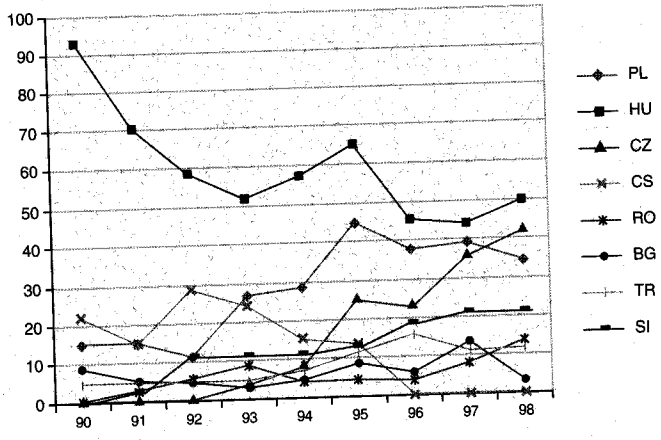


Figure 3. Numbers of patents granted to applicants from PACs at the United States Patent and Trademark Office, search criteria: Inventor Country AND application date (data compiled by the author)[7]



US patent office applications received from applicants outside the US can be used as a measure of the originator country's technological efforts at the world innovation frontier

Local Innovation

US patents capture only part of the technology effort in economies in the process of catching up with developed countries. Irrespective of the size of the country, US patent applications indicate the presence of technology at the world innovation frontier and thus indicate either an underlying imitative technology effort or R&D. Figures 3, 4, and 5 look at patents granted by the USPTO (United States Patent and Trademark Office). Bearing in mind that the patent granting procedure can take up to three years, the numbers available today are only complete up until 1998. Numbers for smaller countries such as Cyprus and Malta have not been considered. In the case of Czechoslovakia (CS) from 1993 on, only the more innovative part of the country, the Czech Republic, is considered. In Hungary the numbers of patents granted decreased sharply over the course of the 90s, slightly recovering in 1998. Slovenia with only 2 million inhabitants shows a remarkable number of patents being granted by the USPTO. Poland and the Czech Republic were able to increase the numbers of important patent applications granted in 1998 so that by then, both economies show a level of 40 to 50 patents in 1998 which is comparable to those from Greece (27). For comparison, the numbers in 1998 from a number of other European Union countries were: Germany (10020), Italy (1711), Belgium (812), Spain (310) and Ireland (169).

The results in figure 3 confirm those in figure 4. Figure 4 shows the inventiveness of PACs defined as the number of USPTO patents granted a year per million inhabitants. Slovenia with a large number of patents per inhabitant performs best, followed by Hungary and the Czech Republic. Poland with 38 million inhabitants shows performance similar to Romania, Turkey and Bulgaria in terms of "US-oriented inventiveness".

Figure 5 shows the breakdown by manufacturing sector of US patents granted in 1997 and 1998 where the inventor is from Hungary, Poland, the Czech Republic or Slovenia. One remarkable feature is the high percentage of consumer goods (e.g. cut stone, drinking glass stem, cup cover etc.)[8] The high percentages of pharmaceutical, organic chemistry and the petrol industry patents are characteristic of the sample and the propensity to seek patent protection is characteristic of these industries. Most of the patent applications filed by

benefiting outside interests more than domestic ones. Insofar as patent application numbers can be used as an indicator of technological performance, increasing technological dependency on Western industrial countries is apparent in the Czech Republic, Hungary and Poland. Therefore, one major conclusion of the analysis is that foreigners are seeking protection under the new legal framework, which is a clear indication of the importance they place on it for investment and the orientation of trade.

Only time will tell to what extent the current situation represents a transitional phase. In the long run, foreign technology will probably help to close technological gaps where they exist and the technology transferred should also help to reinforce local innovation. Moreover, despite the clear signs of technology dependency, PACs also have inventions of their own at the world's leading edge (i.e. filed at the USPTO) although the numbers are still small in comparison with other western countries. Inventive activity in PACs is based on traditional industrial sectors with a focus on consumer goods. Innovative activities in prospective fields like biotechnology and information technologies are still relatively rare.

For stable long-run economic growth it is essential to ensure that local innovation processes are nurtured. It is difficult to evaluate whether the establishment of patent systems in PACs has so far proven to be of direct benefit for local firms and inventors, although it clearly is for multinational companies. However, in the long run the patent system should spur the local innovation process. Moreover, it is in the political interest to search harmonization with western standards of the European Union as part of the accession process.

From the analysis it also follows that a new institutional setting, such as new legislation, regulations and harmonization efforts, are not alone sufficient to stimulate national innovative processes in the PACs, but that they do facilitate the transfer of western technology. To what extent the institution of local innovative systems or the transfer of foreign technology is more important for the process of transition and for long term economic growth of economies in transition cannot be answered here and has to be left to future theoretical and empirical studies.

It would be valuable for future research to investigate the contribution of intellectual property rights to the capacity to innovate in the countries of Central and Eastern Europe and to discover their specific role in the transition process. It would also be interesting to assess in which countries and industries technological gaps exist. The relationship between intellectual property protection and trade has to be analysed carefully.

Much work has to be left for future research, such as the evaluation of the market-power effect and the market-expansion effect from stronger IPRs, the relationship of IPR and foreign direct investment as well as the analysis of the relationship between IPR and technological needs in PACS.

Bringing It All Back Home: Linking National and Regional Foresight

Ian Miles and Michael Keenan, *PREST*

Issue: Foresight has been used at national level to inform policy decisions and actions in the science, technology, and innovation fields. Here, it promises enhanced national competitiveness and dynamism. However, regions have benefited very unevenly from this. Indeed, by being effectively blind to regional inequalities, national innovation and related policies have tended to reinforce such differences.

Relevance: Foresight could contribute to the development and participation of regions in the knowledge economy. To do so, it will be necessary for regions themselves to develop and apply their own knowledge, understandings, networks and communities of action. Practical experience with Foresight offers regions a set of tools and guidelines for these purposes. But a customized approach is required. Regional Foresight activities themselves need to be designed to fit regional circumstances. The way these activities are articulated with national Foresight is also contingent on regional and national features. To forge more effective links between regional and national Foresight, policy makers need to consider which forms of articulation between them suit the objectives and capabilities of the parties involved.

Why Relate the Regional to the National?

Regional actors, seeking to activate regional Foresight, may pursue several different objectives in relating this to national Foresight activities. More than one objective may be pursued at once, even by the same agency - often different actors in the process will have different aims. Among these objectives are:

- At the most reactive extreme, a region may simply be conforming more or less willingly to national requirements to undertake an exercise, or to disseminate the results of a national exercise into the regions. This may be motivated by the provision or withholding of specific resources, so that there are sanctions for non-performance, rewards for good performance.
- A region may seek to utilize information from national Foresight activities. It may see the outputs of Foresight as providing important knowledge about trends that are liable to influence the region. There will be some "translation" of the outputs; more actively, detailed studies may be commissioned to further elaborate the regional dimensions of the trends – and opportunities – they depict. As well as providing intelligence on such affairs, national Foresight

Regional actors, seeking to activate regional Foresight, may pursue several different objectives when they relate regional to national Foresight activities

Some of these are speculative possibilities; some are visible at the regional level; some are visible in other sorts of subnational agency (for example, parts of national government, or semi-autonomous agencies, that suspect that the main Foresight exercise is failing to deal adequately with their domain of interest and expertise). What is abundantly clear is that numerous objectives can be at work when regional and national activities are related: the relationship may even be one of contest rather than co-operation. As noted above, it is possible for more than one approach to be used by different agencies in a region. Additionally, one agency may take different stances with respect to different parts of national Foresight programmes, and an agency's strategies may well change over time – this is practically inevitable, if the Foresight process is institutionalized.

Linking Levels

Given these different objectives, and given the various circumstances that may exist, diverse modes of interrelationship between regional and national Foresight are possible. These range from regional activities that are very heavily contingent on national ones, to those that are effectively independent. **Figure 1** maps out a number of distinctive modes of interaction, relating these to different degrees of activity at national and regional levels. Perhaps the ideal interrelationship between levels is the one we term **Alignment**, in the upper right-hand corner of the chart.

- **Alignment** is perhaps more of a goal then something that has been achieved in practice to date. Here, there are strong national and region-al activities, coexisting largely in harmony. Coordination and autonomy are reconciled in various ways – for example, there may be a separation of the themes to be addressed (e.g. national technology focus, regional cultural focus), or considerable overlapping of membership of working groups.

Since we do not examine the case where there is little activity at either regional or national level, the other modes reflect different balances of activity between the two levels. The range thus extends from top-down approaches (national active, local passive) to bottom-up ones (national passive, local active). Beginning from the top left of the figure, these are, briefly:

- **Passivity.** Here there is very little in the region that can be called a Foresight exercise, or at best Foresight is limited to some very specific areas (typically these will have low S&T content). The national programme makes its results available to regions, but makes little effort to enlist regional participation or provide regional analyses. This state of affairs characterizes many of the national Foresight programmes we have seen, especially those that are in their early stages.
- **Translation.** Here there is an effort to explicate the regional implications of the results derived from a mainly national exercise. National agencies may prepare regionally-specific versions of their material, or more local actors may "translate" the results of the national programme into a local context. This may be very limited - for example just looking at the regional demographics in the light of national expectations - or it may involve effectively new research, such as determining a region's technological or other capabilities in the light of national identification of important areas for future development. In the context of the larger and more influential national exercises, such "translations" have been often prepared within regions, and also by other classes of territorial actor – large firms, Universities, small business associations, etc.
- **Contribution.** This is the situation where a national programme has enlisted substantial regional inputs, and has (or has acquired) the objective of bringing out the regional dimensions of its work. There may be regional workshops on a more or less frequent basis, regional "quotas" for participation in activities, specific

Given these different objectives, and given the various circumstances that may exist, diverse modes of interrelationship between regional and national Foresight are possible

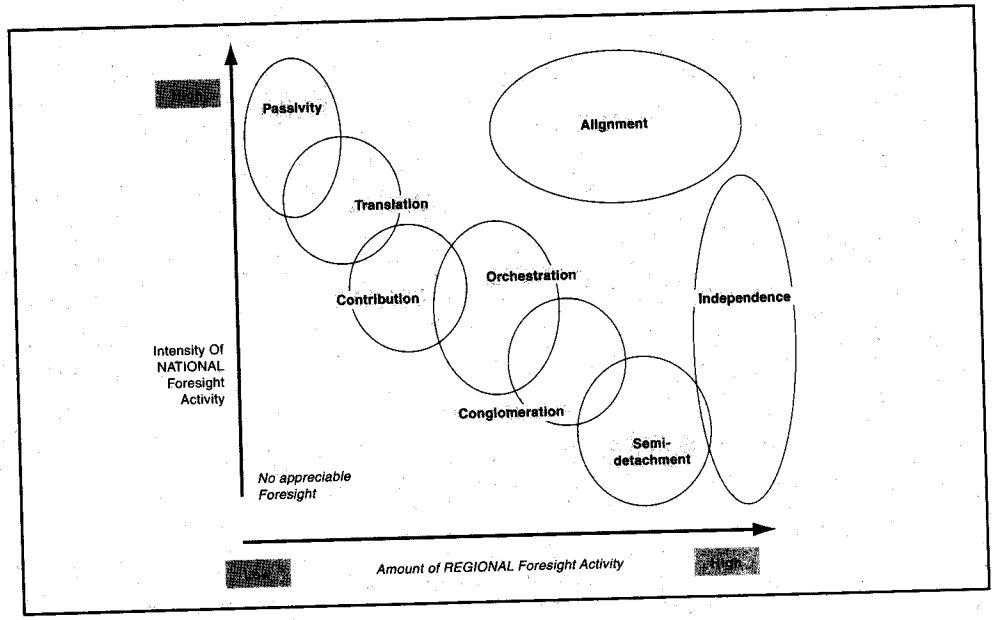
Where there is some sort of interaction between national and regional foresight, this relationship can range from passivity on the part of the region, in which it translates national results to regional level, to a more independent approach

we have seen efforts at **Contribution** from the national level, and also some regional actors taking on a **Translation** role; and it looks likely that there will soon be a move to **Orchestration** as well. Within a country, different regions may adopt different strategies; different policy-makers or agencies may also adopt different approaches. The various objectives for linking regional and national activities also overlap with these categories in a "fuzzy" way: policy-makers should be aware that one set of objectives does not necessarily dictate aiming for one mode of interrelationship.

The type of interrelationship between national and regional exercises will also be in part determined by the substantive foci of the Foresight activities. The topics most frequently considered are liable to vary across different territorial and political scales, in large part (but not solely) because of where the policy levers lie. For example, many Foresight programmes have been dominated by a concern with S&T – and it is common (but not universal) for research and industrial policy to be organized nationally. If there is no regional S&T policy, and little hope of moving beyond a rudimentary one in the foreseeable future, then the region may well be rather "passive" in its reception of national results. (This is not intended to undervalue the contribution that improved awareness of national or global trends in S&T or other matters can make to regional policy-making: only well-resourced regions can afford to be "active" across the board.) In contrast, regions are likely to be much more proactive where more socio-demographic issues are concerned. Even though many key elements of social policy (e.g. benefits systems) are typically a national matter, major aspects of housing, land-use, transport, recreational and educational policy may be shaped by regional or local decision-making. Environmental issues form an area where uneven development may also be expected. Furthermore, there may be quite different time-spans addressed in Foresight activities at different levels (and that this will also vary across agencies and, probably, countries too.) Policy-makers need to be aware of these issues in designing their regional activities, and in relating these to national activities.

The type of interrelationship between national and regional exercises will also be in part determined by the main topics being considered and their perceived relevance to the regions

Figure 1. A "Map" of Regional/National Foresight relations



unstable, poorly designed, or ensnared in a web of competing interests.

The framework discussed here should direct policy-makers to critical considerations that arise when regional Foresight activities are being considered or implemented, and that concern the relationships of these activities to national Foresight. Similar considerations also apply where there are efforts being made by EU-level agencies to stimulate the use of Foresight as a tool for regional development, or to help coordinate such activities in different regions. We may conclude by reiterating the importance of being aware of the type of interrelation that is feasible and desirable between national and regional activities, and of the circumstances that can influence this. Managing these interrelations in an adaptive and flexible way in the light of such considerations is liable to be a crucial factor in the success of regional Foresight. Full alignment may be a distant goal, but well-informed choices can make for productive synergies in the immediate future. That is, indeed, what Foresight is all about.

Keywords

national foresight, regional foresight, product-oriented approaches, process-oriented approaches

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projects, led by German and other European examples (Butzin, 2000), foresight elements have hardly entered policies so far:

- Firstly, conceptual gaps must be made responsible for the omission: Most network-oriented approaches rely on a theoretical base that remains rather 'fuzzy' with respect to crucial practical issues and does not devote enough attention to developmental dynamics and the need to match assumptions about future situations with present activities.
- Secondly, practical implementation difficulties need to be overcome: Even when there is an awareness that new forms of territorial governance should incorporate aspects of foresight, important questions of actual transposition and realization still need to be resolved, and suitable tools developed.

This article discusses both these issues and offers a number of suggestions. First, an overview of recent achievements in regional development policies and procedures is presented – against the backdrop of the neglected topic of future dynamics – and this is followed by a specification of urban area development policies where the application of foresight seems most necessary and promising. Suggestions are then made for planning instruments which could be used to put the idea of time-space sensitive policies into practice. Finally, the wider relevance of that approach with respect to general policy requirements for Europe's urban regions is considered.

New Perspectives of Regional Development Policies

Soon after a whole 'family' of theoretical concepts on the merits – specifically support for industrial innovation – of network-based regional economic development appeared in research publications (*e.g.* industrial districts, creative milieus, learning regions - see the glossary in Box 2), they inspired regional policy-making (Cooke, 1996; Fromhold-Eisebith, 1999). They also substantially widened the scope of measures for regional economic restructuring and development. More emphasis is now given to processes of communication, collaboration and negotiation between relevant actors from different organizations, as well as the categories of mutual acceptance and consensus (Butzin, 2000). This departs significantly from earlier approaches, in particular those assuming that it suffices to build local infrastructure in order to trigger development (Biehl, 1991).

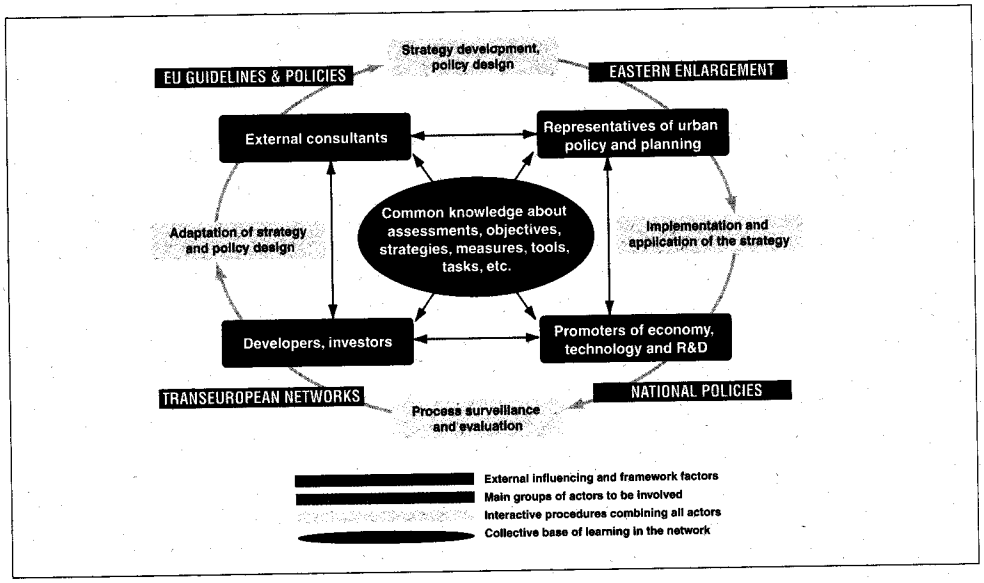
This new approach to regional and urban policies is manifesting itself in planning. Reliance on top-down approaches has largely been replaced by systems of tailored projects or project modules driven from the bottom up. In contrast, large top-down unidirectional programmes have become less important (Butzin, 2000). Correspondingly, the construction of targeted, flexible policy networks is seen as the main organizational model. This notion relates to forms of more equal mediation between public and private actors and to processes of decision making that are driven by neither the market nor the administrative hierarchy (Waarden, 1992; Börzel, 1997).

This shift in regional development policies definitely represents an important step towards more efficient planning. But the transformation has not yet gone far enough. In particular, time-space dynamics and the future outcomes of current actions are insufficiently integrated into planning procedures. This does not mean that policy-makers are not aware of the evolutionary power that their activities today might have on tomorrow's outcomes. Nevertheless, policy approaches have scarcely managed to systematically feed project-specific information from foresight into current negotiation processes of the participative network of local actors. With the

A range of ideas regarding network-based regional economic development are now being discussed in regional policy-making and the scope of measures for regional economic restructuring and development has been widened substantially

This shift in regional development policies definitely represents an important step towards more efficient planning, but time-space dynamics and the future outcomes of current actions are insufficiently integrated into planning procedures

Figure 1. Framework factors, actors and interactive procedures to be regarded in the new approach to urban area development policies



Source: Hesina, Rammer and Czerny, 2001, 1; slightly modified

increase policy efficiency in at least two important ways. Firstly, well-grounded information on expected future coordinates of regional economic development and their implications for the project area, according to its planned functional and structural outlines, can be fed into decision-making processes. This could render the negotiations between actors more purpose-oriented and objective. A common factual basis is provided and the focus is placed on collective learning, around which the interactive planning procedures of the 'learning policy network' can evolve. The depiction of future scenarios may also lead to the formulation of –and commitment to– general guidelines for development objectives (e.g. priority to supporting innovative industries in town). Additionally this can facilitate mediation between actors.

Secondly, by a systematic application of regional foresight, the objectives envisaged for the particular project zone can be evaluated more fully against the overall framework of the expected – rather than actual– structural and functional dynamics of the city. This might prevent detrimental imbalances worsening in the future, for instance, an over-supply of built office space forming in the region. Therefore, aspects of time-space sensitivity and adaptability can possibly act as a catalyst for complementarities between city area restructuring projects. This would support the positive, well-balanced development of the entire future urban system.

Moving on to the third question, the issue of instruments and tools which can possibly help to integrate foresight into the practice of urban development policies needs to be addressed in more detail. However, initially a major caveat must be mentioned that limits opportunities for standardized methodologies. From project to project, from one regional case to the other, the constellation of actors at different hierarchical levels of public and private organizations, of interests, of specific tasks, objectives and problems varies greatly. In principle this leads to a demand

The issue of instruments and tools which can possibly help to integrate foresight into the practice of urban development policies needs to be addressed in more detail

New foresight-based policies should explicitly make use of additional expertise, which could be drawn from university departments, other specialized research organizations or outside professionals

regions may be experimenting with new political concepts and tools which include assessments about future scenarios, the fact that they are at an early stage means the relevant information has not yet been brought to the wider public. Thus, this article cannot refer to – or compare– different practical concepts. Rather, the suggestions made open up a new field. They mainly draw on a methodology which has been developed for practical application and is currently undergoing practical tests (see box text on the ARCS Concept on Prospective Regional Planning).

However, first we need to emphasize that new foresight-based policies should explicitly make use of additional expertise, which could be drawn from university departments, other specialized research organizations or outside professionals. Within the debate on new approaches to planning, special importance is attached to enabling suitable 'context management' (Gualini, 2000, 204f). This refers to guidelines handed down from higher levels of the public administration and also to the contributions of highly qualified specialists to the development of sophisticated planning methods. Their conceptual inputs can considerably advance the quality of foresight-based regional development and should be regarded as an intrinsic characteristic of the new policies.

As regards the ways in which prospective methods may be incorporated into modern approaches to pro-active urban development, three suggestions can be made. Firstly, foresight information can be used as a central frame of reference within the negotiations by actors participating in a planning project. Thus, it might support the emergence of a true 'learning policy network'. New means to assess and visualize the future impacts of certain planning options could substantially enrich the foundations of decision making. With regard to the question of how such information can be collected and presented, new software tools potentially provide solutions (see box 1 on the ARCS Concept). These are able to deal with the complexities and interdependencies of the various determinants of regional development, thus considerably easing scenario generation. In addition, software offers a wide range of options for modifying the basic parameters, thus making it possible to adapt to the various framework conditions present across the EU. Software tools fulfil the requirements both of flexibility and a stable quality standard for scenario generation.

Secondly, the foresight information produced can be used to optimize the process of project implementation as a whole. Based on insights into how the completion of certain project modules is likely to affect wider indicators of the regional situation, the progress of work can either be accelerated, delayed or otherwise modified so as to better fulfil policy objectives. The time-space pattern of project realization can therefore be continuously adjusted to actual and envisaged changes in overall urban dynamics. The strategy helps to prevent or counterbalance time-dependent market imbalances.

Third, prospective surveys that ask relevant actors about the way they would be included to respond to certain policy influences can help ascertain what measures probably serve best to support the specific objectives of the regional project in question. In addition, this preview information contributes to enhancing efficiency because consequently, planning efforts can focus on measures which are expected to be highly responsive to political support.

The insights provided by foresight can be used to optimize the process of project implementation by adapting its pace and content to the policy objectives

Conclusions

While there is a growing recognition in the EU that regional development policies need to take innovative planning methods and elements on

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ABOUT THE IPTS

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

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

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

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

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

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