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The IPTS REPORT

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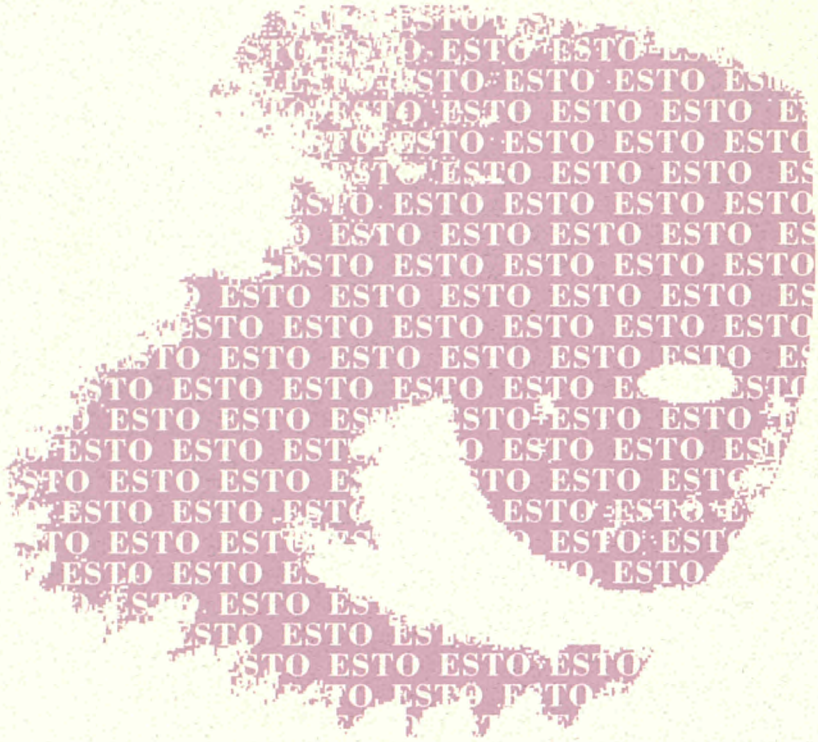

SPECIAL ISSUE: "EUROPE 2010: FUTURES AND SCENARIOS"

EUROPEAN COMMISSION
Joint Research Centre

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 clearest indication of the report's success is that it is being read. An initial print run of 2000 for the first issue (00) in December 1995 looked optimistic at the time, but issue 00 has since turned into a collector's item. Total readership rose to around 10,000 in 1997, with readers continuing to be drawn from a variety of backgrounds and regions world-wide, and in 1998 a shift in emphasis towards the electronic version on the Web has begun.

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 ENEA and 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.

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SPECIAL ISSUE: "EUROPE 2010: FUTURES AND SCENARIOS"

EDITORIAL
An Introduction to the Futures Project

J-M Cadiou, *Director, IPTS*

The Futures Project is a major prospective exercise by the IPTS. It examines the implications of key drivers affecting technology, competitiveness and employment in Europe to 2010. The drivers operate at both European and global level. At the European level there are three major economic and political drivers. The Euro will become the main currency in Europe. The first round of enlargement countries will be complete. The single market and the associated deregulation of markets will continue to consolidate Europe as the wealthiest market in the World. On societal drivers, Europe faces the particular challenge of demographic ageing that will put pressures on the pensions and healthcare and will make the retraining of older workers an imperative.

The project also considers three global drivers. Two are technological: information and communication technologies (ICTs) and the genetic revolution that is transforming the life sciences. The third global driver is the environment, which without doubt will have a significant impact on technology, competitiveness and employment in the next decade.

This special issue of the IPTS Report on "Europe in 2010" provides results from the first phase of the Futures Project. So far, the project has drawn on over 120 experts from industry, academia, the Member States and from the Commission itself. Each of these experts took part in a series of expert panel discussions and in the establishment of a series of reports. The panel reports examine four of the key global and European drivers: Demographic and Social Trends; Information and Communication Technologies; Life Sciences and the Frontiers of Life; and Natural Resources and the Environment. In this special issue some key messages from each of these panels are highlighted. In addition this issue features a paper on enlargement drawn from the complementary "Scenarios Europe 2010" exercise carried out by the Forward Studies Unit. This introduction, meanwhile, provides an overview of the Futures Project. It draws upon key results from the four panel reports and in so doing lays out the main challenges that Europe faces in the next ten years.

Taking first the demographic and societal drivers, a defining feature of Europe in 2010 will be that its population profile will be significantly older than it is today. This will be seen first in the workforce, older workers (55-64 year olds) will start to out number the younger workers (20-29 year olds) from about 2007. But the retired population is on the rise as well. The average retirement age across Europe was until recently falling, which means that, with rising life expectancies, an average male worker today retires with an expectancy of living a further 8 to 11 years, up from around 2 or 3 years in the 1960s.

Europe's ageing will create pressures on the public services, especially healthcare, pensions and education. An older population will mean a rising bill for care and health services especially for those with chronic ailments and for costly end of life treatments. Moreover, with the decline in the flow of young people entering the workforce, there will be a need to substantially reorientate

the education and training systems to meet the rising demand for retraining. This re-engineering will require radical changes in the formal education and training sector, but all the stakeholders will have to play an active part. Employers will have to reinvest in the current workforce to a far greater degree than they do at present and, correspondingly, older workers will have to avail themselves of retraining opportunities to maintain employability.

Up to 2010 it is expected that the working population will be relatively stable across most of Europe, although after then it will decline. This stability depends on workers being able to get jobs all the way through their working lives, which is not always the case nowadays as older workers in many countries have high inactivity rates. It also requires that trends towards rising participation of women in work will continue. In fact, the forecasts assume that most of the new entrants to the labour market will be women.

But a steady rise in female participation cannot be guaranteed, not least because an emerging "Mosaic Society" means that work and living patterns are becoming less predictable for everyone, but especially women. Boundaries between work and life are blurring. Lifetime jobs are a thing of the past. Families are being split by increased mobility, the greater economic independence of women and rising divorce rates. Acting together, these trends mean that the customary roles in family and working life can no longer be assumed to hold. More parents have to juggle responsibilities between work and family. There are more single person households and single parent families. The Mosaic Society will inevitably provoke a profound rethinking of social institutions (pensions, unemployment and welfare, training and health services) that respond to more complex demands from a more varied and changing client base.

Meanwhile, the imperative to reinvest in the current working population will be accentuated by breathtaking technological changes over the next ten years. Technological life cycles are shortening all the time, such that a recent OECD report suggests a half-life of skills of only 3.5 years. To keep up, Europe will have to continually update the skills of its technology specialists and ensure a general dissemination of ICT literacy. The ageing of the workforce compounds this challenge, enlarging the demand for training while simultaneously raising its importance.

But the signs are that Europe is already not "keeping up" with the so-called "digital economy". The recent explosive growth of the Internet has been constructed almost entirely on United States technologies and by US firms such Intel, Microsoft, Netscape, Cisco and Sun. Also, around 80% of electronic-commerce is currently transacted in North America; Europe lags in this area by up to 5 years. With potentially large economic advantages for the first movers, European firms need to identify areas of competitive strength and move fast in order to reap the benefits of this new information revolution.

One potential area of European strength, emphasised in the ICT Panel Report, is the coming wave of "Ubiquitous Computing" – the idea that soon computers will be so cheap and commonplace that they will be found in everything from walls and furniture to clothes. Ubiquitous Computing will be based on the networking of tiny embedded systems. With Moore's Law - which says that circuit complexity doubles every year for the same cost – set to continue to 2010, low cost "systems on a chip" will available for embedding into literally any solid surface. These systems will be networked, so that they can be controlled and maintained remotely. Many will be sensors or actuators, and will provide a psychomotor capability to the

nervous system of the Internet. Interfaces will also change. Keyboards will remain important but many devices will be controlled by voice and pattern recognition instead. These alternative data entry techniques will permit autonomous or hands free applications. Computer power will be available no matter what the activity whether it is driving, walking, running or whatever. The implication is an explosion of new devices, applications and services.

This new wave of ICTs heralds an opportunity for Europe. Europe already has some world class players in relevant industries, such as mobile telecommunications, portable computing, embedded systems integrators in the automotive electronics and consumer electronics. Also, ubiquitous computing may be able to avoid proprietary lock-ins such as "Wintelism" (Windows plus Intel) that dominate standards setting in the PC industry. There may simply be too many players across too many industries for proprietary dominance to take hold. However, to keep the game open requires decisive leadership on the part of industries and complementary policy efforts. Despite the Single Market, there are many incompatible administrative, legal and technical standards. In the internationally connected Information Society, such islands inhibit innovation and investment. For example, there are currently 22 different smart card standards and many different electronic payment systems in Europe. No one knows which will succeed, no one knows who to trust or how their rights will be protected: a recipe for hesitation. It may be time for administrations to take some leadership, by adopting a "Digital Charter" that commits them to doing business on-line, to using common standards and to making sure electronic commerce is a safe place to do business. The weight of public administration in the economy alone could thereby provide a strong stimulus to investors and innovation.

Turning now to the area of life sciences, it is clear even to a casual observer that here too a technological revolution is taking place. In medicine, breakthroughs in human genetics could transform healthcare practices yielding better and more cost-effective treatments. But there will also be escalating expectations. Longer lives will create widespread demands for effective palliatives for chronic conditions, which will undoubtedly be endemic in an ageing population. Once again, the bottom line will be to redesign health care services in order to respond to these changing demands and expectations, with the aim of raising quality while constraining to the extent possible the insistent pressure towards rising costs.

Meanwhile, the application of new biotechnologies in the agrofood sector reveals another critical challenge for Europe. Europeans seem to be more reluctant than are North Americans to accept genetically modified products in foodstuffs. This is understandable given that the long term health and environmental risks have not yet been tested - if indeed such testing is possible. However, in the global economy keeping such products out is virtually impossible, while slow regulatory adaptation may undermine the competitive position of European firms. This begs a major policy issue: how to satisfy European citizens that adequate measures have been taking to protect their well being whilst avoiding a loss of competitive position in a strategic industrial area. One important approach will be to give consumers the choice through clear labelling of genetically modified products, supported of course by better investigation and information about the risks. At the very least, the issue calls for a constructive and open dialogue between all interested parties, industry, biotechnologists, health specialists and people at large.

The European response to global issues also figures prominently in the environmental field.

The example of the Kyoto Protocol on the control of greenhouse gases throws the different policy approaches of Europe and the USA into stark relief. Post-Kyoto, the EU has positioned itself as the champion of climate protection. It aims to show its engagement in the issue by achieving much of its CO_2 emission reduction targets domestically. With a move towards cleaner more efficient technologies there could be a medium term industrial competitive advantage. This advantage, however, will only materialise if other countries follow path towards domestic reductions in CO_2 emissions. But, the emerging US position prefers to meet its obligations through international cooperation and trade. There are substantial cost differences between these different routes. Domestic carbon emission reductions (the EU approach) are definitely more costly than supporting reduction efforts in fast industrialising countries (the US approach). The basis for this difference is that fast industrialising countries such as China and India are expected to increase emissions by over 150% to 2020 (compared to 32% growth in the EU and 38% in the USA). In a high growth market there is always more scope to install lower emission technology, such as new power generating plants to meet the new demands. Probably such plantswill be based on western technology, yielding an extra gain of technology trade. The problem is that unless the USA and Japan also follow the EU emphasis on achieving carbon emission reductions at home, the competitive position of Europe could be harmed by rising costs for producers and higher prices for consumers.

The carbon gas example illustrates a general challenge of globalisation. There will be conflicts of interest, because there are different attitudes between the players. Europe generally adopts a precautionary principle - i.e. if in doubt abstain. The US, and the WTO, position is the reverse - if in doubt proceed. Globalisation, moreover, transforms these bilateral contrasts into multilateral complexities, yielding recurring conflicts and deadlock. But such is globalisation, and Europe has to fully engage itself into the process in order to take a strong part in shaping the future.

European enlargement will reinforce Europe's role as a key shaper of the global economy. Certainly, acceptance into the first round of enlargement seems to have attracted foreign direct investment in Eastern Europe. But these flows will continue only if the infrastructures are brought up to standard and a stable and predictable investment environment is maintained. The challenge of enlargement is huge but it is fundamental to Europe's future. With the end of the cold war the EU is the lead player in a much larger "neighbourhood". This brings responsibilities to help stabilise the region, as the recent war in the ex-Yugoslavia indicates. It also brings advantages. Europe stands to become by far the largest bloc of advanced democratic economies.

The different trends, challenges and opportunities identified in the Futures Project are unlikely to come separately or at a sedate pace. The rising costs of maintaining the core social systems (pensions, health and unemployment support) will have to be met just at the time when the number of social security contributors in the active population ceases to grow and then starts to fall. Tremendous pressures will have built up to force a shake out in Europe's overly rigid education and training systems. And if Europe aims to stay in the vanguard of technological innovation and competitiveness it will have to re-engineer this sector. Elsewhere, European industry will be facing a large bill to mitigate CO_2 emissions. Meanwhile, the initial costs of enlargement will fall due - even if in the long-term the prospect is greater wealth and influence for Europe as a whole.

There is a further demon in the box. Faced with all these pressures on the social systems, Europeans may decide to defer consumption in favour of saving, for fear of future gaps in social provision. If many of them start to hold large liquid reserves to cover pensions, illnesses or periods of unemployment, there may be a danger that a lack of demand could tip Europe into recession. A less extreme consequence of low consumer confidence could be to reduce spending on consumer electronics and media thus stifling or delaying the next wave of the Information Revolution.

Some of these drivers, particularly demographic ageing, will hit the EU much harder than the USA. All the more reason, then, in a world of global competition, for Europe to move quickly and surely if it aims to stay at the heart of the action. In the global game, dynamic and innovative players tend to win out. Europe will have to overcome its natural cautiousness, if we are not to miss the boat in areas such as embedded systems when first movers stand to take the lion's share of the winnings.

On the other hand, we cannot afford to throw away all the special features that distinguish Europe from its competitors - the cultural diversity, the commitment to socially balanced growth, the tradition of progress by consensus. Fast and loose could become fast and lose. Structural and institutional reforms are needed, especially in areas such as education, health and pensions. But the solutions should also be effective and long lasting. They should capitalise on emerging growth areas by building on Europe's existing strengths such as Europe's technological excellence, its cultural richness and its social cohesion. The window of opportunity is open. Action has to be fast, but with the long view of building institutions and solutions for the next century.

About the author

Jean-Marie Cadiou is Director of the IPTS. He holds degrees from École Polytechnique (Paris), École des Mines (Paris) and a doctorate in Computer Science from Stanford University (California). He has been Scientific Director of INRIA and a senior executive in IBM. He joined the European Commission in 1981 and was the first Director of the ESPRIT Programme. From 1992 to 1997 he was Assistant Secretary General in charge of Scientific and Environmental Affairs at NATO.

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The Learning Imperative for Europe's Ageing Workforce

James P. Gavigan, *IPTS*

Issue: Europe's ageing workforce is characterized by high rates of age-biased skills and knowledge deficits, with concomitantly high inactivity and unemployment rates. As the proportion of the older working-age cohorts rises (there will be more 55-64 year-olds than 15-24 year-olds after 2007), maximizing their employment rates and productivity will be vital to ensure a sustainable functioning of the economy.

Relevance: A system which continues to be dominated by front-end education and training - pending the advent of true 'lifelong learning' - will be incapable of guaranteeing the continued employability and rising productivity of an ageing workforce. Recent trends encouraging earlier retirement have delayed recognition of this issue. EU-wide shock-therapy is needed, joining public and private efforts, to involve the middle to upper age cohorts in appropriate continuous learning up-skilling while there is still some time.

The Main Story Line

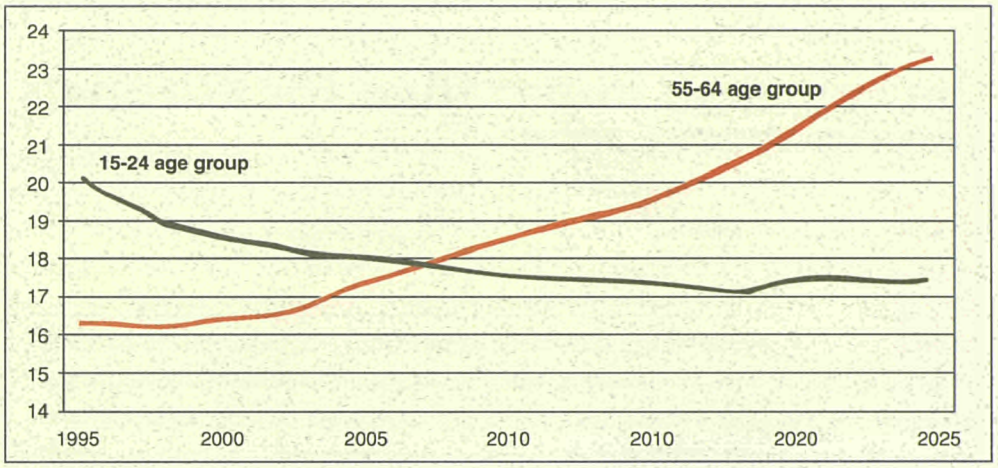
Leaving aside important national and regional differences, Europe's population is ageing considerably due to the well-documented decline in fertility in the second half of the twentieth century. One key component of this with immediate short-term policy implications is the ageing of the working-age population - i.e. the 16 to 64 age cohort.

The imminent inversion of the age pyramid shown in Figure 1 raises several questions regarding the adequacy of the knowledge and skills profile, as well as learning competence, of a work force which traditionally has been strongly biased in favour of youth. Previously, renewal of the knowledge and skills pool was provided by a growing swell of incoming young workers with up-to-date knowledge and training, and overall macro-economic conditions which made it possible and affordable to encourage early retirement for older workers whose skills were apparently no longer useful. However, this is no longer sustainable for a number of reasons:

1. Demographic ageing combined with a static or low population growth places strains on the active population to support a growing cohort of retired citizens. To ease the growing dependency rates, workers should defer retirement and underused labour reserves, especially women should be activated.
2. Rapid obsolescence of skills, the 3.5-year half-life of most work place skills[1], calls for almost continuous retraining.

In the past an ample supply of young workers made it possible for firms to update skills by simply replacing older workers with more recently trained younger ones. Demographic ageing will make this unsustainable

Figure 1. Age groups 15-24 and 55-64 as % of age group 15-64 - EUR 15 - 1995-2025



Source: Eurostat 1997 Demographic Projections (baseline scenario); G. Coomans, Europe's Changing Demography - Constraints & Bottlenecks, IPTS Futures Report Series No.8,1999.

Early retirement of older workers whose skills were considered outmoded has often resulted in a loss of tacit knowledge by their former employers

3. For the youth cohorts, the school-to-work transition is increasingly problematic, with a lack of relevance of formal education to demanded work skills. There is an increased gap between skills demanded in the labour market and revisions in the curricula.

4. Against the misconception of older workers as a drag on productivity, research results point to the value of the experience and tacit knowledge embodied in older workers. Retaining experienced workers and better knowledge transfer can yield gains. Early retirement can result in the loss of knowledge assets that took years to accumulate.

The short-term imperative is to up-skill and retrain all, especially older, workers, noting that this is just one, albeit essential, dimension to managing an ageing workforce[2].

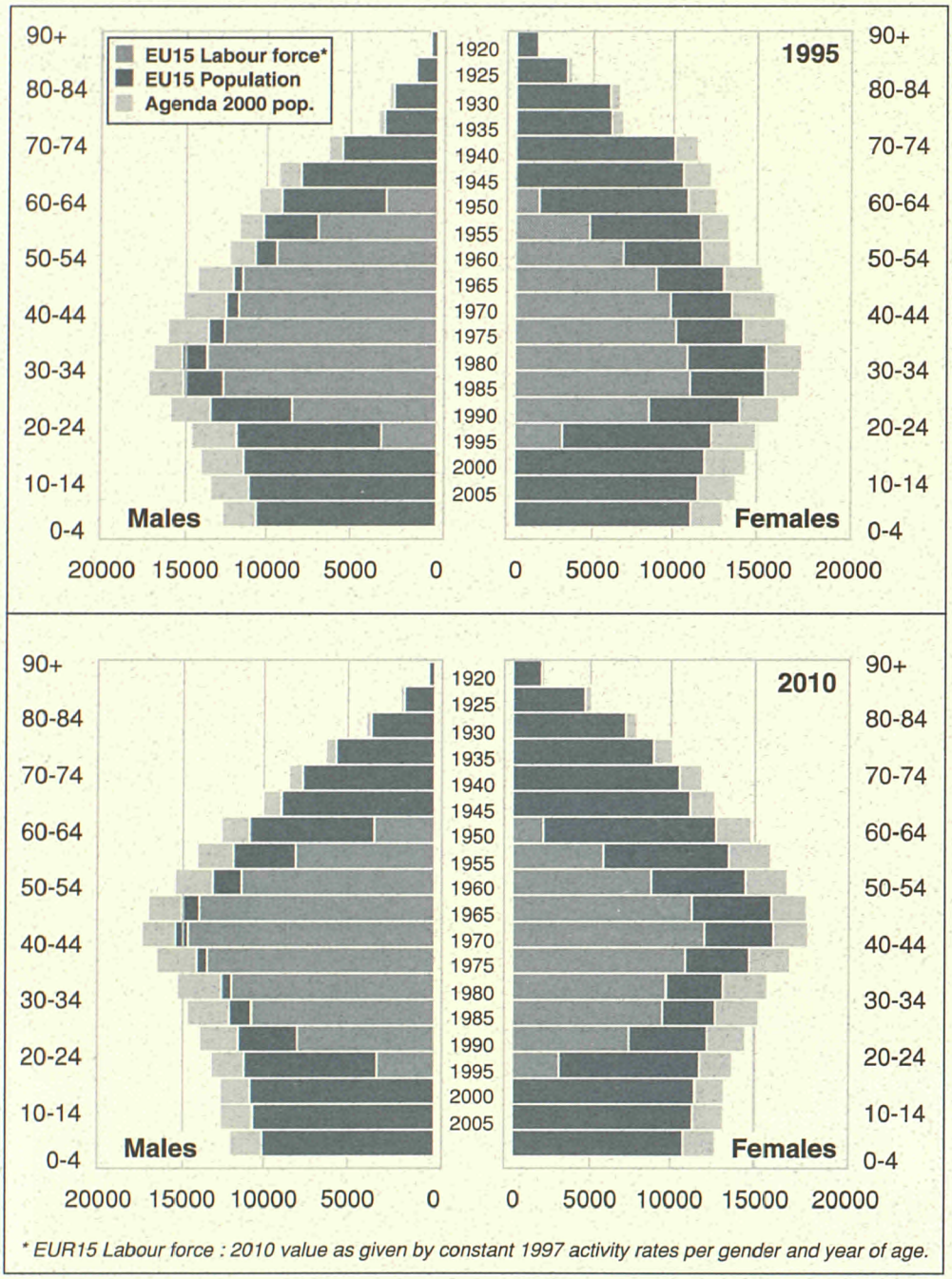
In the medium-to-long term, the challenge is a complete overhaul of the education and training culture, institutions and mechanisms. Continuous learning from the cradle to the grave should be reflected in all economic and social institutions - from private, public, cooperative to community levels. Such a desirable situation can be termed *Lifelong AND Life-wide Learning*.

The challenge is to engineer a complete overhaul of the education and training culture, institutions and mechanisms so as to ensure that continuous learning becomes an integral part of people's lives

Box 1. Adult Skills and Literacy Predicament

The half-life of most worker skills is 3.5 years
(OECD, 1998)
80 % of all technology will be replaced in the coming decade
(DG V, 1998)
One third to half of 25-64 year olds have less than adequate literacy levels for today's work and living requirements
(OECD - Human Capital Investment, 1998)
We become technologically obsolete every 5 years and need retraining
(S. Rush - IBM's Global Education Industry general manager, 1999)

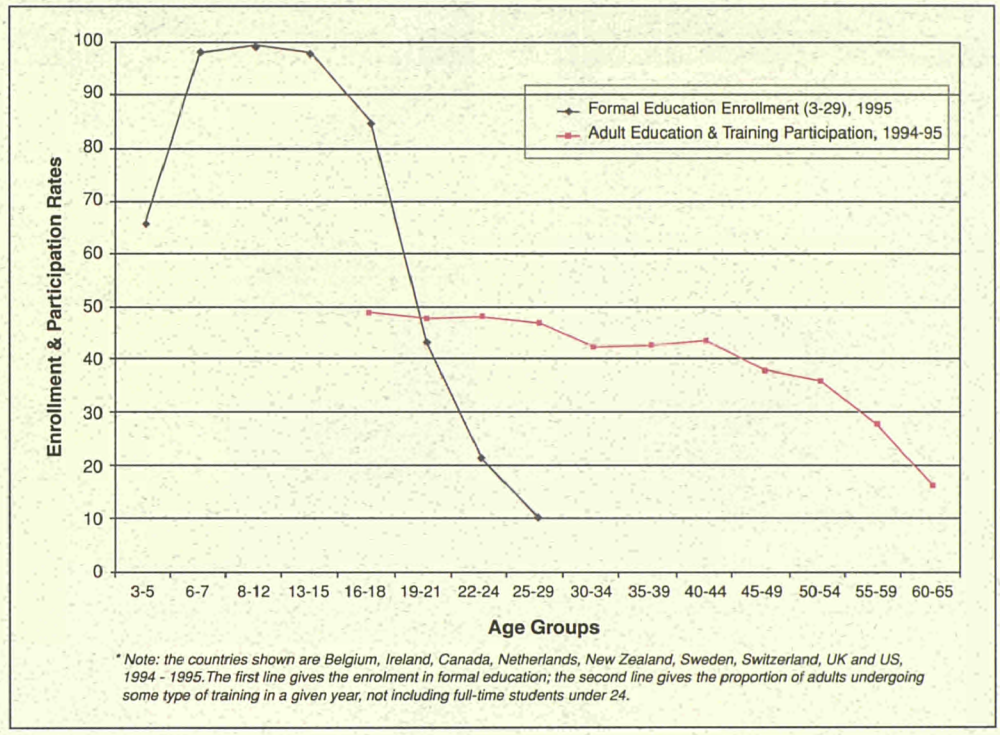
Figure 2. Age pyramid - EU15 and Agenda 2000 countries - 1995-2010



** EUR15 Labour force : 2010 value as given by constant 1997 activity rates per gender and year of age.*

Source: Eurostat 1997 Demographic projections (Baseline scen.) - UNO 1996 Revision World Population (Medium var.); G. Coomans, Europe's Changing Demography - Constraints & Bottlenecks, IPTS Futures Report Series No.8,1999.

Figure 3. Participation in education and training over the life-span - unweighted mean for nine countries



** Note: the countries shown are Belgium, Ireland, Canada, Netherlands, New Zealand, Sweden, Switzerland, UK and US, 1994 - 1995. The first line gives the enrolment in formal education; the second line gives the proportion of adults undergoing some type of training in a given year, not including full-time students under 24.*

Source: OECD 1998, Education Policy Analysis.

A significant proportion of workers probably rarely receive any organized training, and participation is biased toward those with higher levels of initial educational attainment

We are far from this at present, even simply in terms of measurable participation rates (let alone some measure of quality and relevance) in some form of organized learning activities over the different age groups (see Figure 3). Worse still, the International Adult Literacy Survey (IALS) results, which take a complex measure of adult literacy, suggest that very large segments of the adult population are under-equipped in very basic 'instrumental' numeracy and literacy skills - see Table I.

Furthermore, as older workers are generally less likely to participate in job-related training, they would have higher barriers to overcome should they be confronted late in their career with the need to engage in instructor-led structured learning or training. This makes the short-term challenge even more daunting.

What can be done?

Resource-wise, one can conjecture how it might be possible to increase worker-participation in job-related training up to an adequate level, and who would pay for the direct and opportunity costs incurred.

Figure 3 shows that more than two-thirds of the population do not participate in organized learning each year. Of course, if informal learning is included, the non-participation rate would be lower. Nonetheless, a significant proportion of workers seem to receive barely any organised training over their working lives, especially those with lower educational attainment.

Furthermore, little or no information is available on the quality and effectiveness of on-the-job training offered by firms or public labour

Table 1. Percentage adults (age 16-65) performing below an adequate threshold of literacy[3], 1994-95

Poland	Ireland	New Zealand	United Kingdom	United States	Switzer-land	Australia	Canada	Germany	Belgium	Nether-lands	Sweden
76.1	57	50.6	50.4	49.6	46	44.9	42.9	41.7	39.6	35.9	25.1

market programmes. It's almost certainly the case that a significant proportion of job-related training could be more cost efficient. Also other areas of human resource or employment spending could be reorientated to give a greater training or learning mission.

In public policy terms this could entail a detailed appraisal and overhaul of all training actions in Active Labour Market policies to raise effectiveness. Other active labour market policy instruments (job-creation, job subsidies to employers, public service job-brokerage) could be designed to include an obligatory individualized training dimension. Going still further into the other areas of labour market policy including taxation and income support benefits, perhaps these could also function as further instruments and incentives for individuals to engage in learning activities and for employers to offer more and better training[4]. Versions of ***'workfare'*** whereby benefit recipients are remunerated in exchange working in firms, the community or taking training, are operational in Canada, Switzerland, Norway, the UK and the US. Perhaps the take up of workfare could be widened and given a new twist by accentuating the training dimension - i.e. ***'trainfare'*** or ***'learn-and-earn'***.

In the private domain, the emergence of a knowledge economy founded on intangible rather than tangible assets is leading to a reappraisal of the value of human capital over fixed capital and technological artefacts. It is important that business investment patterns reflect this new reality, and that entrepreneurs, private business strategists and employers in general invest more in people[5]. This in essence means the development of employee skills and competencies. Clearly this requires a new sort of outlook within businesses, which means that there is a prerequisite on these stakeholders themselves to make a learning transition towards understanding the new economic 'rules of the game'. Obviously, public policy can facilitate this by providing favourable legislative and regulatory framework conditions for it to come about.

Scandinavia takes the lead?

As in many areas, the training situation is not homogeneous across Europe. However, amidst all the variation, the Scandinavian countries stand out on a number of counts. Firstly, in different labour force surveys, the recorded rates of participation in job-related training are consistently higher than elsewhere in Europe[6]. Sweden, in particular is anomalous with regard to the *age-dependence* of the training-participation rate, with a relatively even spread over different age brackets, compared to a steady decline of participation rates with age for the EU as a whole. In fact, the highest job-related training participation rate (20 %) in Sweden is for 40-49 year-olds, while over 59 year-olds at 10 % is over five times the EU15 average! Furthermore, activity rates for over 55 age-cohorts are around twice or more the EU15 average, with correspondingly lower unemployment rates.

A number of countries are experimenting with so-called "workfare" schemes which include training on the list of activities for which benefit recipients can be remunerated

Job-related training participation is higher in Scandinavia than elsewhere in Europe and training is spread more evenly between age groups, although this may be related to the fact they are facing demographic changes earlier than the rest of Europe

Table 2. Activity and Unemployment Rates for 55-59 year olds compared for EU15 and Sweden

	Activity Rate 55-59 years		Unemployment Rate 55-59 years	
	EU15	Sweden	EU15	Sweden
Males+Females	55.2	80.4	10.8	7.5
Males	68.6	84.4	10.5	9.3
Females	42.0	76.4	11.4	5.5

Source: Labour Force Survey Results 1997, Eurostat 1998.

Table 3. Total (public & private) and public spending on formal (initial) education and training (1994), and public spending on labour market training programmes LMT 1995 not including measures for youth and the disabled, as percentage of GDP

	Sweden	Den-mark	Fin-land	Nor-way	France	Hun-gary	Spain	Ireland	Ger-many	Nether-lands	Por-tugal	Czech Rep.	Austria	Bel-gium	UK.	Italy	Greece
Total	9	8.4	8	-	6.7	6.5	6.4	6	6	6	5.7	-	5.6	-	-	4.8	-
Public	6.6	6.6	6.6	6.8	5.6	5.7	4.8	5.2	4.5	4.7	5.3	5.7	5.4	5.5	4.9	4.7	3.1
LMT	0.7	1.47	0.58	0.61	0.5	0.13	0.41	0.43	0.56	0.22	0.39	0.02	0.16	0.32	0.1	0.3	0.09

The figures for expenditure on both formal and labour-market-driven education and training in different countries, also show consistently higher levels for Scandinavia (see Table 3), suggesting some systemic reasons for the above statistics.

All of this does not necessarily mean that Sweden constitutes a best- practice benchmark that should be imitated in other parts of the EU. There is undoubted value in taking a close look at the "hows and whys" of the systemic differences and relative successes across the EU, but it should not be done blindly.

Firstly, with a relatively old working-age population Sweden and Finland had to grapple the ageing workforce problem earlier than others. Secondly, the sustainability of some Active Labour Market policies can be questioned, for example a Danish educational leave scheme was so popular that it led to labour shortages and required stricter eligibility criteria and a reduction in scope[7].

Furthermore, strong national path-dependent cultural and institutional idiosyncrasies often mean that attempts to transfer 'best practices' are doomed to failure. However, 'means' should be distinguished from 'ends'. Outcomes can often be achieved by different, but 'functionally equivalent', policies and actions.

Broadening the Perspective

The main story line underscores the urgency of maximizing the participation and skills level of the working-age population over their full active life on the basis of straightforward but potent demographic and other quantifiable facts. To interpret this from a realistic policy-making perspective, the message needs to be complemented with some other considerations that are inextricably linked to the main labour-force training message.

Although some individuals may welcome the opportunity to continue earning and contributing to society, raising the retirement age may be viewed by many as taking away a sacrosanct and well-earned right

Unemployment

Firstly, to call for urgent policy to counter a forthcoming short-fall in adequate labour supply at a time of **unemployment,** may seem strange. However, labour scarcity does not exclude unemployment, because market- and competition-driven business cycles operate on a different time scale to demographic processes. Policy can play intelligently with these different time scales. For example, the baby boomer generation could still rapidly adapt to continuous-learning, which would better prepare and also favourably dispose them to seeing out their full working life. By contrast focusing on the top age cohort might be difficult - too little, too late!

Immigration

Relaxing immigration controls may be a necessary way to proceed in the future, but is unlikely to be a solution in the short-term. The average skills-levels are rising, and key labour-shortages are mainly for high-skilled workers. For this reason, the US is already following a selective immigration policy[8]. For the EU such measures might be counter-productive in the long run. Europe and its neighbours may gain if skilled people stay at home to participate in developing their own economies, rather than depriving them of the critical assets of knowledge and skills.

Extended working life vs. retirement

What **psychological effects** result from an extension of working life beyond the expected retirement age? For some workers the prospects of retirement can be a traumatic experience when the follow-on is a void. For others, the retirement may signal a fall in income and living standards[9]. However, for many, a comfortable and economically autonomous retirement from 60 to 64 is sacrosanct and to interfere with it amounts to betrayal of the social contract between individuals and the institutional framework. Nonetheless, the macro-economic realities call for a re-evaluation of social need and social responsibility across the generations. This may be hard to achieve given the increasing political voice of an ageing population.

The authors of change

The **baby boomer** generation at the centre of the demographic time bomb is renowned for rewriting the rules as it progresses through life - from the counter culture of the 1960s-70s to the institutional reforms of the 1980s-90s. With the need to find a new balance of social responsibility and cost-coverage this generation may in turn reinvent old age and retirement, building on ideas such as semi-retirement and work arrangements, in flexible formats which accommodate individual choice and preferences. Much innovation in public policy, business, civil society and people's mind sets is needed, but the baby boomers might be the right generation to bring it about.

Work, Employment and Welfare

It is possible that the collective responses to the learning/ageing-labour-market predicament might spell a break with the present centrality of 'market work' as the main source of economic and social well-being. As the cohort of nominally 'old' people increases, so too does distribution of wealth in society. Redistribution issues are critical. For example, poverty is less associated now with old-age and more with new disadvantaged groups such as single (teenage) parents, unemployed youths, low educational achievers.

Meanwhile, older people constitute emerging markets in housing, amenities, health, personal care and leisure Much of the growth will be in the so-called "social economy". The continuing

Although it may seem strange to call for policy action to address a future shortage of suitably trained labour at a time when unemployment is high, it is justified by the differing time-constants of the anderling processes

Selective immigration from countries around the EU may exacerbate existing skills shortages in the countries concerned and so limit their growth potential

Many commentators advance the idea of the need for more generalized flexible semi-retirement/work arrangements, together with changes in working patterns to allow greater access to training

decline of jobs requiring physical strength and motor skills may suit an ageing workforce. Perhaps also jobs where experience counts such as certain caring roles could be reserved for older workers, so as to allow a move out of the economy into the 'social' economy of mentoring, caring, community service, public service, teaching or childminding.

Conclusion

The broader mix of short, medium and longer-term issues just considered, if anything, reinforce the main message. Public and private decision-makers must take steps towards active upskilling of the ageing workforce, in the interests of ensuring viable well-being for all in the medium to long term.

Tomorrow's relatively affluent old-people will drive growth in the so-called 'social economy', and perhaps also participate by working in it

Keywords

demographic ageing, skills, learning, labour market policy

Notes

1- OECD Working Papers 1998, Vol. VI, No. 21 *Policy Implications of Ageing Societies.*

2- For a broader discussion of good practice in managing an ageing workforce see the published results of the research project *Combating Age Barriers in Employment* by the European Foundation for the Improvement of Living and Working Conditions (**http://www.eurofound.ie/**)

3- Literacy skills were identified to cover demands in the home, at work and in the community. Three domains were used - Prose Literacy (understand and use information from newspapers, fiction and expository text); Document literacy (knowledge and skills to locate and use information in official forms, timetables, maps and charts); Quantitative literacy (knowledge and skills to apply mathematical operations in printed materials) - with five levels of difficulty for each literacy domain. The threshold level of adequate literacy was deemed to be level three on the five point scale. Scores of two and one were considered to be below threshold.

4- A November 1998 DG V Report *Managing Change* by the Gyllenhammar High Level Group on Economic and Social Implications of Industrial Change, in relation to employability, lifelong education and training recommended that **labour market policy and education policy be more closely co-ordinated and, if possible, be implemented 'from one source'.**

5- A recent American Society for Training & Development survey found a high correlation between high spending on training per employee and company performance measured in net sales and gross profits per employee. Leading edge firms spend more than three times what average firms spend on employee training ($2000 vs. $650 per annum), the rate of increase in spending is also twice as high + $300 vs. +$150 from 1996 to '97 (**http://www.astd.org/CMS/templates/index.html?template_id=1&articleid=20940**)

6- E.g. the 1996 Eurostat Labour Force Survey found an EU15 average of 3.6 % of over 30 year-olds took part in a training course in the four weeks prior to the survey date while the figures for Denmark, Finland and Sweden were 11.8 %, 10.7 % and 11.7 %. The OECD-CERI's *Human Capital Investment* 1998 report generally concurs with this.

7- When paid-leave schemes (including parental, educational and sabbatical leave) were expanded in 1994 they became so oversubscribed that labour shortages resulted in some sectors. After peaking at 80,000 persons in 1995, access was brought down to about 40,000 in 1998. See Jens Lind **http://www.socsci.auc.dk/~jlind/tekster/oslo.htm** and OECD's Economic Survey of Denmark 1999.

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8- See *Legal Immigration, Fiscal Year 1997,* US Department of Justice, Immigration and Naturalization Service, January 1999 (**http://www.ins.usdoj.gov/stats/index.html**)

9- 40 % of early retirees regard their labour market exit as primarily involuntary, European Commission COM(1999)221.

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Ubiquitous Computing: the New Industrial Challenge

Ken Ducatel, *IPTS*

Issue: A new transition in the information revolution seems imminent in which computers will move from being pervasive to 'ubiquitous'. All sorts of everyday devices - such as walls, doors, consumer appliances and clothing - are expected to be computerized, networked and made intelligent. Ubiquitous computing implies a new infrastructure for living and the emergence of new industries.

Relevance: Ubiquitous computing signals changes in business models in both technology (ICT and consumer electronics) industries and traditional industries. Innovation and industrial policies can respond by raising awareness, focusing on technological bottlenecks and keeping application protocols open.

The fast-growing markets for 'small footprint' non-PC systems include personal digital assistants, mobile phones, smart cards, embedded networks in vehicles and even chips embedded in pharmaceuticals

The transition to ubiquitous computing

Moore's Law[1], the most famous of computer industry axioms, is widely expected to hold at least until 2010, with a strong expectation that the cost of manufacturing a "system on a chip" computers (including input and output controllers) will fall to a few cents. Chips are expected to be cheap enough for them to be considered as "disposable". The low cost and almost invisible nature of these chips will permit chips to be embedded in all sorts of artefacts and devices that today are not computerized (clothes and furniture, for example). Indeed, the embedding of chips into the backdrop of daily life is expected to usher in the era of "ubiquitous computing".

Although computers, those most conspicuous of computer devices still drive the semiconductor business (see Table 1), we can already see strong signals of the trend towards ubiquitous computing. The current fast growth markets for 'small footprint' non-PC systems include personal digital assistants, mobile phones, smart cards, embedded networks in cars and even chips embedded in pharmaceuticals. In the near future non-PC devices are expected to include set-top TVs, interactive, 'magic glasses' for portable information display, and computers embedded in clothing particularly for special purposes, such as monitoring the physical condition of sports people or out-patients, tracking workers in hazardous occupations or environments and battlefield information systems for soldiers.

Actually, invisible computer chips already surround us. A few years ago Andy Grove, current Chairman of Intel, could already claim that the average American encounters 70 microprocessors

Box 1. The intuitive interface

- **Inputs:**
  Keyboards will be around for a long time to come, but speech and handwriting recognition systems for data entry will grow in importance. Direct input based from image analysis and environmental sensors that detect and analyse ambient information from electronic tags, bar codes, biosensors, visual information or smell will be grow in importance. Key advances will be algorithms for image and speech analysis and compression By 2010wide availability is expected of speech activated computing in all sorts of devices; cheap transcription devices; and the widespread replacement of human operators for speech activated devices.
- **Displays:**
  Cathode Ray Tubes (CRT) will provide higher definition and remain a major technology for desktop displays and televisions, but Liquid Crystal Displays (LCD) will grow very fast especially in mobile/portable applications. For example Active Matrix LCDs in vehicles and for personal digital assistants and wearable computers or 'Magic Glasses' using ferro-electric liquid crystal Spatial Light Modulators. Other technologies include: mirror displays (arrays of thousands of tiny mirrors reflecting red, green or blue light; flexible light emitting displays, rear projection of images).

Source: Ducatel, K., Burgelman, J-C, Howells, J., Ottisch, M. and Bohlin, E. (1999). Information and Communication and Information Society, Futures Project Report 03, IPTS, Seville.

each day before lunch. These chips are mainly in the home, in domestic appliances and consumer electronics; in the fixtures and fittings of public spaces, such as elevators and security systems; and especially in vehicles and traffic control systems.

However, ubiquitous computing is likely to be built using devices that offer more than today's embedded chips:

- Ubiquity - integrated circuits are likely to be found in a wide variety of products and will affect virtually all industrial sectors. (Will wearable computers be products of the computer industry, consumer electronics or fashion clothing?)
- These devices will 'think' - the complexity will be on the inside not (like today's PCs) in the user's (inter)face.[2] This implies the need for very good design engineering skills (a possible European competitive strength - see the article on "Competitive Complex Systems" in issue 19 of *The IPTS Report*) and for robust systems that we can trust (unlike today's cumbersome desktop PCs).
- These devices will talk to each other - today's hardwired embedded chips are increasingly operating in local networks and already there are trends towards linking them to external network control for updating, maintenance and control.

The Industrial Challenge of Ubiquitous Computing

Ubiquitous computing raises important technological and competitiveness challenges for Europe. On the technological front, there are many emerging areas of development that will still be avant-garde, even in 2010, especially in areas such as pattern recognition, tactile interfaces (not just the look but the feel of shaking hands in a video meeting) and artificial intelligence techniques (see Box 1). Keeping abreast of the very rapid technological advances in these areas will call for major on-going investments in new technologies. However, one of the key features of Ubiquitous Computing will be the way that it will call for the capacity to integrate different technological trajectories, i.e. different types of

Ubiquitous computing is likely to be built on embedded systems which are robust, user-friendly and readily linked into networks

New microsystems and systems integration industries will emerge, embedding these chips into consumer electronics and all sorts of new devices and products

Table 1. Forecasted of Growth Rates for Selected Electronics Productions

	Market			Production	
Product area	Value (Meuro)	Growth (average annual growth)		Value (Meuro)	Growth (average annual growth)
	1997	1997-99	1997-01	1997	1997-99
Complete computer systems	31470	4.38	3.48	27539	5.02
IC's and semiconductors	21800	-0.92	4.40	10876	-1.00
Control and instrumentation	21586	1.72	1.69	24885	2.17
Consumer electronics	17995	3.27	2.45	12820	0.95
Telecommunications	21867	0.64	-0.48	25536	1.96
Auto electronics	4484	7.30	5.89	No data	No data
Medical equipment	3814	5.23	4.55	5044	5.08
Industrial equipment	3479	2.67	1.84	3216	2.31

Source: Reed Electronics Research: Yearbook of Electronics Data 1999.

The automobile industry has been among the first to take up ubiquitous computing. It has now already begun to move from independent electronic control systems to a networked approach, turning the car into an information and media hub

hardware (ICs, displays, sensors, sound and vision systems) and software systems (controllers, decision systems, software agents).

The effect will be to create new microsystems and systems integration industries devoted to embedding these chips into consumer and automotive electronics and all sorts of new devices and products.[3] We can see these developments very clearly in the area of automobiles, which is probably the area in which ubiquitous computing has had the greatest impact. As Table 1 showed, in the automotive sector there is an expectation of very fast growth in the application of electronics of around 7% per annum over the next four years. Annual growth rates will be even higher in certain product areas such as suspension control (49%), steering (37%), multiplexing (33%) and transmissions (27%)[4]. Until now the evolution of automotive electronics has followed the trend for electronics to substitute for mechanical, electromechanical, hydraulic and manual control in sub-systems such as braking, power train, engine, suspension, gearing and climate control. The high growth of multiplexing reflects a probable trend away from separate and isolated control systems (which has lead to a proliferation of computer systems) towards a single optical fibre network which handles these control systems and the increasing demand that the car operate as an information and media hub. Automotive markets are dominated by a relatively small number of large systems integrators in which the European firms Bosch and Valeo are well placed alongside US (Delphi and Visteon) and Japanese (Denso) firms.

The automotive electronics example clearly shows the importance of the systems integration role in integrating different technologies into a reliable and coherent system. However, automotive electronics is also a special case. A car is relatively "high ticket" consumer purchase with a reasonably large margin for experimentation and a pathway towards economies of scale as electronic equipment trickles down to cheaper models. Development relations are relatively direct: systems integrators work directly with a single final assembler in designing and implementing systems. Safety critical technologies (e.g. braking) have isolated car electronics from the mainstream computer industry, but this is changing with the sharing of platforms for driver information systems , and vehicle control systems.

Although the dynamics of the home automation market are not as favourable as those of the automotive industry, there are an increasing number of networks in homes and more integration is likely in the future

As with cars, the evolution of the smart home has taken the form of a series of stand-alone

appliances or specialized networks (such as heating or security systems). But, so far no effective system integrators have emerged. Instead there is considerable competition from different quarters to define the appropriate standards. This is not for want of potential standards, each industry sector and major world market seems to have its own approach. For example, European actors have recently agreed to achieve convergence between the installer industry standards (EIB and BATIBUS) and that of the Consumer Electronics Sector (EHS), however there remain significant practical interoperability problems and it seems that the computer industry standard LONWorks might actually emerge as the de facto standard - and this just at European level[5].

Home system integration is neither as strong nor as effective as in the car. There is a lack of consumer demand for networked appliances - people are happy with single function standalone appliances and do not need or want integrated or on-line control functions. The lack of current usage points to a lack of usability and functionality in the interface designs, rather than fundamental lack of demand. Most homes do have increasing numbers of networks and there may be gains from integrating them. Also, home web cameras and small-scale sensors and actuators, all of which require networks, are also likely to proliferate in the household in the coming years.

There is also a cost and hassle barrier. Homes have much longer investment cycles than cars, thus the issue of retrofitting is more salient. The cost and mess of rewiring a house is prohibitive. There are technical proposals to resolve the retrofitting problem: wireless home networks or piggy backing on the existing power circuits. Here again, though, there is the problem of competing and incompatible solutions.

By contrast to home automation, portable intelligence is a runaway successes - especially mobile phones, hand held computers and personal digital assistants. Here albeit at a micro-scale, system integration is fundamental. Each device combines a complex range of fast evolving technologies: liquid crystal displays, lightweight batteries, communication capacities as well as software, processing and storage. Furthermore with wearable computers there will be demands for voice recognition and activation for hands-free operation.

New industrial horizons

A stock taking exercise of ubiquitous computing is sorely needed to provide the basis for awareness raising and innovation support to help European industry prepare for Ubiquitous Computing. Areas of emphasis could include prospects for:

- Emerging systems integration industries, especially in existing areas of strength such as specialized circuit design, middleware, knowledge representation and mobile and personal digital devices.

- Design and engineering of 'intuitive interfaces' using flat displays, speech and natural language recognition, vision systems and ergonomics. Growing demand for software engineering will provide many opportunities for European producers.

- The consequences for traditional industrial fields (from mechanical engineering, through construction to textiles), which could also experience new added value creation as a result of embedded computing.

The main policy aim the stocktaking exercise would be awareness raising of the industrial opportunities and challenges of Ubiquitous

Portable intelligence is a runaway success - especially mobile phones, hand held computers and personal digital assistants. Here too, there is considerable system integration

Restructuring along similar lines to the automotive components industry can be expected in many industries in the wake of ubiquitous computing's widespread uptake

The concern for Europe is that the US market for ubiquitous computing is growing faster, implying the possibility that the dominant proprietary standards could be defined there

Computing. There are potentially very large new markets in these sectors for European firms, notably as systems integration and in consumer electronics and telecommunications.

Anticipating industrial structure changes will also be important. For example, the automotive components industry has already seen a massive rationalization due to re-engineering and downsizing, and the replacement of sub-assembly components by semiconductors. Policy leadership might also aid firms in traditional branches to act upon opportunities to add value through ubiquitous computing applications thus improving competitiveness.

Open or Proprietary Models?

A second concern about Ubiquitous Computing relates to the possible emergence of dominant proprietary systems. With rising interoperability, current embedded chip systems will move from custom towards standardized operating systems. This will yield economies of scale, increase access to plug-in software, ease the training of developers and operators and allow remote monitoring of embedded systems.

The automotive industry in Europe seems to be quite well placed. With "smart homes", the high penetration of computers and the Internet in the US households implies amore rapid growth of non-PC network devices (IDC projects that 12 million US homes (12%) will have home networks by 2002)[6]. European producers will have to compete with resulting first mover advantages for the US home systems integrators and protocol setting firms. Contending as the industry standard of small footprint operating systems for home and mobile devices are Windows CE (not yet small and agile enough but offering Internet access and a familiar interface), Sun's Java language and EPOC (from the Symbian consortium of Psion, Nokia, Ericsson and Motorola).

It is not by chance that Java is included in the recent prototype "Network Vehicle" showcased by Delphi Automotive, IBM, Sun Microsystems and Netscape. It has many advantages. It is platform independent and can be written and sent over the Internet (making remote control and maintenance easier). In other words it implies that ubiquitous computing could develop to be independent of the physical platform and of the operating system. However, it may also be that *de facto* proprietary standards are established. The obvious parallel is the case of the desktop PC industry, where a few firms have captured the design and development paradigms, and so dictate the pace of and direction of change.[7]

An alternative to allowing proprietary standards to dominate the way they have in the case of PCs would be to agree memorandums of agreement, such as that on GSM, which was a contributor to European leadership in digital mobile telephony

There are alternatives to proprietary dominance, one is to agree memorandums of agreement, such as that on digital mobile telephony . Another approach is open source standards (such as Linux) which permits an open professional developer community to evolve new systems rapidly and relatively robustly.

There are a number of contenders for the small-footprint operating system for ubiquitous computing devices, including players on both sides of the Atlantic

Ubiquitous computing will introduce new interests into the computing industry, from consumer appliance to building control system manufacturers (such as heating, lighting, lifts or security systems). These firms will offer products and 'content' in the form of new telematic services, such as remote monitoring and maintenance of Internet appliances. The sheer variety of actors, applications and services implies that no one firm will be able to dominate in all areas. But that will not necessarily prevent attempts to control certain key interfaces. The policy implication is that standards and protocols should be kept open, transparent and reliable to permit new entrants to offer products and services on the market.

Conclusion

Ubiquitous Computing signals a new phase of the digital economy. It will create new markets for ICT products and services. Unlike some ICT markets, such as PC systems, Internet infrastructure and e-commerce where US firms are relatively dominant, European firms are in a strong position to contest these markets. Also, the gains from this new avenue are open to traditional industries as well as the high technology sectors.

But there are many unresolved questions. It seems that Ubiquitous Computing will move ahead quickly in areas where there are effective system integrators, such as in portable systems and automobiles. But in the potentially very large markets for consumer appliances and home automation the progress is likely to be slower and difficult. No system integrators have so far emerged, and this raises uncertainty for information appliance suppliers and consumers. The policy issue is to analyse and raise awareness about the industrial opportunities and challenges. There may also be a need for anticipatory measures to support innovation in traditional sectors gain through innovative leadership.

It seems likely that interoperability will emerge through the adoption of standard "small footprint" operating systems which are being tried out in portable devices, mobile phones and consumer electronics. Given the variety of applications and players one system is unlikely to dominate, but certain critical interfaces may be subject to proprietary standards. The very variety of applications and the current fragmentation of markets makes it hard to monitor emergent dominant positions. Although common standards are needed, given that ubiquitous computing will continue to evolve, an early move towards fixed standards risks a sub-optimal technological lock-in. Timing is all. At least some key interfaces should be kept open to allow the free development of technology, markets and industry.

The sheer variety of actors, applications and services involved implies that no one firm will be able to dominate in all areas. But that will not necessarily prevent attempts to control certain key interfaces

Keywords

information and communication technologies, ubiquitous computing, competitiveness, open standards

Notes/References

1- Moore's law states that the complexity of a circuit on a chip doubles every 12-18 months for the price.

2- This is a reference to the MIT Media Lab project *Things that Think* whose leader, Mike Hawley, argues that all sorts of everyday devices will have intelligence designed into them, **http://www.media.mit.edu/ttt/**

3- See: Bell, G., and Gray, J., (1997) *The Revolution Yet to Happen*, in Denning, P., and Metcalfe, R., (eds) Beyond Calculation, Copernicus, New York.

4- Reed Electronics, 1999.

5- See Barlow, J., and Gann, D., (1998) *A Changing Sense of Place: Are Integrated IT Systems Reshaping the Home?* SPRU Electronic Working Paper Series, Paper No. 18, SPRU, University of Sussex.

6- IDC (1999) To Connect or Not to Connect: Home Network Market Review and Forecast. 1998-2002 (IDC No. W18220).

7- See: Zysman, J., and Borrus, M., (1997) *Globalisation with Borders: The Rise of Wintelism as the Future of Global Capitalism*, Industry and Innovation, 4(2): 141-166. The fear of a repeat at a larger scale of this kind of design dominance must surely be a motivation for the recent court dispute between Sun and Microsoft over adaptations to the Java language.

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Pharmacogenomics: Personalized Drugs and Personalized Medicine

Thomas Münker, *IPTS*

Issue: Pharmacogenomics, the combination of genetic testing and drug development, promises new approaches to illness prevention and drug design that will enable health-care providers to pre-check whether a patient will respond well to a drug or will suffer from side effects. Pharmaceutical companies will be able to sharpen the profile of their drugs – drugs may become more personalized.

Relevance: As with other technologies where individual genetic data are handled, for example genetic testing for inheritable diseases, the privacy of such data needs to be assured. The goal of tailoring therapies to the genetic make up of certain groups or even of individuals should not lead to the exclusion of others. The risk is that drugs are adapted to the most common genetic profile creating classes of patient that are 'genetically right' or wrong. On the other hand, the precision of genomics and the possibility of identifying populations of good responders may make the approval of drugs for rare diseases easier.

Pharmacogenomics aims to explore how patients will respond to new drugs, thus bridging the gap between gene discovery and drug development

Introduction

Modern drug development is a complex process. The first step is the identification of a promising molecular target for drug action. This requires screening of the innumerable possibilities suggested by gene sequencing efforts, for example by the Human Genome Project. Validation aims to test the link between a target sequence and specific diseases. Then there is the need to clarify how the activity of the target sequence is regulated, its physiological relevance and the interaction of the products for which it codes. Advances in genomics (the systematic analysis of an entire genome) will eventually enable the identification of the genetic principles of most pathological and non-pathological phenotypes[1]. It will also redefine the understanding and traditional definitions of diseases.

As the tools for identifying and understanding diseases become more sophisticated and precise, more specific treatments will clearly also have to be offered. Drugs that are precise enough to address a single gene within a gene-family need to be developed, otherwise 'sledgehammers are created instead of the lasers that are needed' (Cooke, 1998).

Pharmacogenomics aims to explore whether patients will respond to new drugs, and how. It

aims to bridge the gap between gene discovery and drug development, and it is immediately applicable to clinical studies of existing drugs. The rapid growth in information and technology are stimulating enormous progress in this field (Lin, 1996). One important outcome of research in this area is the development of diagnostic tests that help identify the appropriate drug for a given individual.

The benefits of such tests are obvious: Patients avoid risky, painful and often extended investigative procedures to find the optimal treatment methods. A rapid test helps avoid harmful side effects. The systematic discovery and analysis of genetic variety in drug response should also lead to more cost effective drug development. Given that 80% of the compounds fail in clinical trials and industry spends $500-700 million for each new drug approval, considerable benefits may be reaped (Housman, 1998). Prescription based on a precise and rapid instrument for disease identification could also reduce treatment costs. "With this advancement in molecular technology and the financial implications of the results obtained, genotyping of patients before prescribing certain drug therapies is likely to become routine" (Prows, 1998).

The American National Institute for Health has already launched a $36-million programme to detect single nucleotide polymorphisms, so-called SNPs[2], which can be used in characterizing drug responses, disease susceptibilities, and to study population genetics (Stix, 1998).

New Therapeutic Approaches

Most therapeutic drugs undergo a biotransformation process that takes place, for example, in the liver. Typically, in a one or two-phase process, enzymes transform the lipophilic drug molecules to a more water-soluble metabolite, which usually represents the active form of the drug. These metabolites are then further metabolized and eliminated from the body.

This idealized pathway, as it depends on the activity of biocatalysts, is determined by genetic parameters. Small differences or mutations in the genetic make-up, so-called polymorphisms, can cause modifications in the enzymes they encode. These modifications can subsequently be responsible for altered enzyme activity; the genotype determines the phenotype.

Three different drug-response phenotypes have been described (Johansson, 1993).

- Extensive metabolators, which represent the 'normal' population,
- Slow metabolators, which show little or no ability to metabolize a drug, and
- Ultra-extensive metabolators, which metabolize a drug far quicker than the 'normal' population.

Both slow metabolators and ultra-extensive metabolators show abnormal concentrations of drugs and their metabolites in their blood plasma. Those who are not able to metabolize these can accumulate high, possibly toxic, doses. The ultra-extensive metabolators usually show no clinical response at all because of their tendency to eliminate drugs from body before they can take effect.

Biochemical tests can examine the patient's phenotype. But these tests, which determine the metabolization ratio of a test drug, are complicated and often they do not exclude the risk of an adverse drug reaction (Prows, 1998). External conditions, such as interacting drugs or the overall disease process, can influence and distort the test.

Genetic tests can circumvent these problems. They do not try to detect the symptoms that are caused by a genetic alteration, they aim to detect

Most drugs are eliminated from the body by the liver where enzymes convert them into excretable metabolites. Differences in the genetic make-up can introduce variations into these enzymes, and thus the way the individual's metabolism handles the drug

Genetic tests do not try to detect the symptoms of a genetic alteration, they aim to detect the genetic alteration itself so conclusions about phenotype can be extrapolated from it

the genetic alteration itself. In a subsequent process, this information can be used to draw conclusions about the phenotype.

A New Way for a Personalized Medicine

For the time being genotyping is only used in research. However, many companies are developing genetic tests for pharmacological purposes. In his review of the clinical implications of drugs based on genetic differences David Prows from the University of Cincinnati estimates that genotyping will become an accepted tool within the next five years (Prows, 1998).

So-called 'personalized medicine' will involve developing more highly targeted drugs and accompanying genetic test kits to permit selective prescription

The possibility of genotyping patients in order to estimate the risk of adverse drug reactions could pave the way for a more patient-centred health care model. Methods and tests developed by pharmacogenomics will make it possible to identify groups of patients that will react positively to drugs prescribed to them. Disease-relevant drug-targets will be identified and used "to develop extremely efficacious, broadly tolerated drugs that can be prescribed to the largest possible population. New pharmaceutical products could be marketed alongside a corresponding diagnostic test kit, so as to permit the selective prescription of the drug" (Housman, 1998).

Miniaturization and micro-fabrication technologies will make new types of biosensor available for monitoring risk patients and understanding the role of tiny differences in the human genome

Together with new developments in protein analysis, where simultaneous assays of thousands of analytes will be possible, new integrated approaches in diagnostics can be foreseen. New fabrication technologies and progress in automation will support developments in diagnostics. Miniaturization and micro-fabrication technologies will make this new type of biosensor suitable for automation or even for implantation into the human body. The latter will enable on-line monitoring of high-risk patients. In order to detect the tiny differences in the human genome, which are responsible for diseases or variability in drug response, micro-chips, so-called SNP-chips will soon be on the market. They will definitely "mark the beginning of a personalized medicine" (Schmidt, 1998).

It is estimated that between 1.6 and 4.2 billion dollars are spent each year in the United States for additional treatments to deal with adverse reactions (Classen, 1997), and that they may have caused over 100,000 deaths during 1994 (Lazarou, 1998). Genetic tests would enable the physician to avoid some of these risks and so treat patients more effectively. Tests of this kind can also ensure patients have more information available to help them to make decisions affecting their health. Such technologies and procedures will circumvent long-term trial-and-error measures and may reduce costs and risks tremendously. Patients could be checked before or even while a new drug is being administered. It may therefore strengthen the role of primary care, as more accurate diagnosis may reduce the need to consult experts.

In the US such targeted healthcare models have been predicted for 2008, (Poste, 1998), these include:

- genetic and pharmacogenomic profiling, to identify people at risk of developing serious illnesses because of their genetic predisposition
- diagnostics, to complement and support genetic tests
- smart cards for storage of patient information
- database applications for research, development, and clinical care,
- counselling in clinical genetics
- pro-active disease management protocols for prophylactic therapy, lifestyle modification, and monitoring.

Although this model seems to be closely tailored to the US health market, some parts may also apply to some European health-care

systems. Biotechnology, micro- and nano-technology, and information technology will drive new developments in diagnosis and treatment of disease.

However, despite the promising beneficial trends forecasted for the area of pharmacogenomics and the ability to personalize treatments and drugs, some concerns have been raised. Too sharply focused drugs and therapies may detract from the goal of medicine and pharmacy to find treatments for as many people as possible: pharmacogenomics should not be used to pinpoint the people who are 'genetically right' for the drugs pharmaceutical companies want to sell (Schmidt, 1998).

Such a trend would be worrying. It could be a source of new "rare" diseases,[3] and possibly lead to "therapeutic discrimination" against patients with diseases and genotypes that are expensive to treat.

Other experts, however, argue that these fears are unfounded. They reply that both human genomes and diseases are polymorphic enough to make such a development unlikely to happen. The development of niche products for these markets could be an interesting and challenging market for SMEs given an appropriate intellectual property rights framework.

In the USA, patient pressure resulted in the Orphan Drug Act in 1983, to stimulate the development of orphan drugs, which cannot be developed economically by industry without incentives. In 1999, the European Parliament approved, at the first reading, the proposed European Regulation on Orphan Medicinal Products, which might be implemented by mid 2000 in the EU Member States. Because of the emphasis on rare diseases, a larger number of orphan drugs will result, but in addition the genetic origin of a number of more common diseases will be better understood.

Ethical, Legal and Social Implications

The information produced by pharmacogenomic tests, while potentially valuable for medical treatment, may also be used out of context in ways that are contrary to the interests of the patient. The interests of health-care providers, which – with best intentions - want to produce personalized and evidence based medicine, may be counter to those of the insurance companies, which want to reduce their risks. The risk is a genetic discrimination against people who, while currently healthy, may be genetically predisposed to various diseases. For example, Paul Seymur, of the Faculty and Institute of Actuaries in Great Britain, is concerned that a successful test for Alzheimer's disease could create an "uninsurable underclass" (Financial Times, 1997).

The ability to screen the genetic profile and the predisposition of humans to certain diseases caused by environmental or work related pollutants, for instance, raises the question of the confidentiality of these data and of the possible duty to disclose it to life insurance companies or other third parties. The two examples given below show that the communication even of initially harmless information may ultimately have far-reaching consequences:

- Some people are known to be "slow acetylators". Slow acetylators show an adverse drug reaction towards certain anaesthetics used in surgery. The adverse reactions can be severe or even fatal. For patients and physicians a genetic test determining the risk of an adverse reaction therefore is a very helpful and potentially life-saving tool. But at the same time insurance companies may be interested in the test results. "Slow acetylator"-women are known to have – under certain conditions - an increased risk of developing breast cancer (Schmidt, 1998).

Pharmacogenomics should not be used to pinpoint the people who are 'genetically right' for the drugs pharmaceutical companies want to sell

The information produced by pharmacogenomic tests, while potentially valuable for medical treatment, may also be used out of context in ways that are contrary to the interests of the patient

- Genotyping for the "apoE-gene" gives another example of this kind of cross-implication. The "apoE-gene" encodes a protein that is involved in the metabolism of cholesterol. The uptake and the adequate metabolism of cholesterol is directly related to risks of cardiovascular diseases. Testing for apoE genotypes therefore has diagnostic significance for their detection, particularly in the risk assessment of coronary artery disease. However, there is also some evidence that carriers of a certain apoE allele have a higher risk of developing Alzheimer's Disease.

To know or not to know

The two examples show the kinds of conflicts that may emerge in the near future. Pharmacogenomics will definitely help us to sharpen our medical and pharmaceutical tools. Drugs will become more precise and efficient, the risk of toxic side effects will be reduced. But at the same time increasing amounts of information will be collected which may be put to a variety of uses. As shown above some 'disorders' which seem to have nothing in common on the phenotype level are strongly interwoven on the genetic level. It is therefore possible for patients to become aware inadvertently that they harbour a gene which may have future consequences for their health. This is compounded by the fact that the information will not only affect patients' own lives, but also those of their relatives. Thus the person affected may be forced to decide whether they should be told. Patients may wish to keep the test information secret, even if it is important information for relatives. Some people may find it hard to cope with this situation and may need properly-trained professional help.

As genetic information is inherited the person affected will have to decide whether relatives should share the information or not

Education and Training

The rapid pace of developments in this area is making it hard for education and training of health-care professionals in genomics to keep pace. Lack of experience and competence in understanding the clinical implications of genomics may pose serious threats to the successful introduction of these new technologies (Poste, 1998).

Educating health-care professionals about the implications and the potential impact of (pharmaco-)genetic testing is of tremendous importance in order to ensure the proper evaluation of the data retrieved and to avoid malpractice and misuse. Taking for granted that genetic testing for diseases and physiological characteristics will increase, the need for more specialized doctors and genetic counsellors, is obvious. But, the role of genetic counsellors needs to be defined. Their task could be to examine the value of a test in a particular case and advise whether it makes sense and what information it may provide. They could then further analyse and evaluate the test results together with the experts from the testing laboratory or company (Euroscreen, 1998). The genetic counsellor could give advice and support to both physicians and patients. It could also be their function to prevent malpractice in both the application of tests and the handling of data.

The education of healthcare-professionals about the implications and the potential impact of (pharmaco-) genetic testing is of tremendous importance in order to ensure the proper evaluation of the patient data and to avoid malpractice and misuse

The latter is of tremendous importance for the acceptance of genetically based therapy. Trust and confidence in the new technology is crucial, as the emotionally-charged debates surrounding genetically modified organisms in agriculture and food production have shown. The subjective perception of risks and threats associated with a certain technology can be decisive.

Trust and confidence in the new technology is crucial, as the emotionally-charged debates surrounding genetically modified organisms in agriculture and food production have shown

In order to avoid a backlash, protective measures and standards will be required to control the misuse of personal data and malpractice in testing procedures. Also, it will probably be prudent if patient profiling tools are

not commercialized prematurely and without rigorous validation[4] (Poste, 1998).

Conclusion

Progress in genomics will lead to the development of various genetic tests applicable in medical practice. They will expanding the range of tools available to physicians and complement diagnostic methods. Pharmacogenomics will help to avoid the prescription of potentially toxic drugs, lead to more rapid diagnoses and enable the identification of more effective therapies.

For policy makers, though, there are a number of crucial issues at stake in these developments:

- *Genetic privacy and confidentiality*
  To safeguard the potential benefits of new genetic testing and to enable its optimal use by society, more education and information is not just helpful but essential. A broad social dialogue will be needed on how to implement these new developments acceptably, covering discussions about privacy and confidentiality issues. Clear policies and guidelines are needed to avoid the enormous potential of human genetics being squandered.
- *Education and training*
  In contrast to most laboratory tests performed in clinical laboratories on blood or other body fluids or tissues, genetic tests may require extensive counselling before and/or after the test. With the growing availability of tests, the need for well-trained genetic counsellors will increase.
- *Insurance and the disclosure of information*
  The disclosure of genetic information needs to be regulated. A further major concern is the problem that in the future more, as yet unknown, conclusions may be drawn from today's test results.
- *Equal access to genetic testing*
  The availability of genetic tests for a variety of purposes will affect health-care costs. The new methods clearly imply additional costs for the funding system. The question whether the clinical utility of the information retrieved will be sufficient to justify additional payment needs to be addressed. Policy measures should ensure that the positive trend towards a personalized medicine for many does not lead to the social exclusion of others.

Keywords
pharmacogenomics, genetic testing, privacy, orphan drugs

Notes

1- A **Phenotype** is defined as the outward characteristics resulting from the interactions between genes and environment. The **Genotype** is defined as the actual DNA characteristics that make up each attribute. (genotype + environment u phenotype).

2- Single nucleotide polymorphisms (SNPs) are single base pair mutations having a frequency of >1% in the human population. In the human genome between 6 million and 30 million SNPs at which variation can occur are estimated.

3- Rare diseases have a very low frequency among population groups. Very often for economical reasons, no or almost no treatment is available. The majority of so-called rare diseases are genetic in origin, and many are caused by mutation of a single gene which, at this time, may or may not yet be

known. Of the remainder, it is becoming increasingly apparent that many of those eventually becoming ill do so as a result of a genetic predisposition. Over 5000 different rare disorders have been identified worldwide, and Europe, with its great variety of population groups, is home to a large number of them.
4- The ultimate need for technical validation of genetic tests has already been subject of an article in the *IPTS Report* (*IPTS Report* 1999, Issue 35) Kristoffersson, U., Rosen, K-E., and Sorup, P., (1999) Promoting Equal Accessibility of Genetic Testing Services of High Quality in the EU Through the Development of European Standards, *IPTS Report,* 35: 23-28.

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Technology Options for the Kyoto Carbon Emission Targets and European Competitiveness

Antonio Soria, *IPTS*

Issue: Under the terms of the Kyoto Protocol, the EU is committed to significantly reducing its greenhouse gas emissions by 2010 with respect to 1990 levels. Cost efficient ways of fulfilling this target would involve the deployment of advanced energy technologies, whose costs are likely to be far from negligible.

Relevance: The cost-benefit trade-off for the European economy heavily depends on the policies undertaken by other global actors. Under the appropriate circumstances, an overall climate-protection policy may be neutral vis-à-vis the EU comparative advantage situation, whereas, if improperly implemented, the EU carbon emission mitigation policy may lead to a severe deterioration in European competitiveness.

Introduction

Environmental concerns have progressively gained a prevailing role as a determinant of energy policy. Whereas in the past decades the main focus was placed on security of supply issues, the collapse of oil prices experienced in the 80s and the diversification of the primary energy mix of advanced economies have contributed to mitigating that problem. Back in the 80s, the energy sector started concentrating increasingly on the negative environmental effects of energy transformation and use. The first issue to massively involve the industry was the problem of acid rain, induced by imperfect combustion and impurities in fuels. Technology was, however, relatively quick to cope with the problem, at reasonable and fully affordable costs. The environmental threat that the energy sector has been facing since the early 90s, i.e. the global warming issue, is likely to prove far more difficult to solve.

The problem of global climate change due to carbon dioxide emissions coming from fossil fuel burning represents indeed a clear disruption in environmental policies. First of all, global climate change is the first environmental problem that mankind has to face in a really worldwide context. Domestic policy measures (either command-and-control or market-based) were effective in the past at coping with local pollution problems. However, the characteristics of the climate change issue make it necessary to devise collaborative solutions involving all the countries of the world, via a (possibly) complex negotiation process in which the corporate interests of many actors will come into play, and

Global climate change is the first environmental problem that mankind has had to face in a really worldwide context. What is also new is that it is not amenable to end-of-pipe approaches

Table 1. Sectoral disaggregation of EU energy-related carbon emissions 1985-1996

CO_2 EU Emissions (1000 t. of CO_2)	1985	1996
Bunkers	**88594**	**116598**
Conventional Thermal Power	**893443**	**931495**
Central Heating	**32768**	**16660**
Energy Branch	**127130**	**149305**
Industry, of which	**625798**	**534605**
Iron and steel industry	202470	171990
Non-ferrous metal industry	15682	13818
Chemical industry	100700	85976
Glass, pottery & building mat. industry	104444	83669
Transports, of which	**585283**	**825401**
Road transport	499650	693975
Air transport	61481	101863
Household, Commerce, etc., of which	**733906**	**691586**
Households	520714	432829
Agriculture	39606	53591
TOTAL (1000 t. of CO_2)	**3086923**	**3265650**

Source: EUROSTAT Sirène Database.

Implementing strategies against global warming will undoubtedly place a greater burden on some actors than others. Reaching consensus is complicated by the absence of a supranational moderator

whose outcome is far from being predictable. Second, given the very nature of the problem, which is not associated with by-products or impurities of production processes, but rather with the massive use of a given class of natural resources (fossil fuels that are the result of million years of carbon fossilization), technology can not provide end-of-pipe solutions. The (ultimate) engineering solution relies on a complete technology substitution process, which has to take place over a transition period, the duration of which will largely determine the magnitude of overall costs. Third, the time scale involved is so long and the natural processes involved are so little understood that an attempt at even the most approximate quantification of the damages (as well as mitigation costs) becomes a formidable task. The planet has certainly experienced climate change in the past as evidenced by geology and palaeontology, but never at the rate that seems likely to pertain in the case of man made greenhouse effects and therefore both impacts and possible mitigation options remain highly uncertain. Indeed it is the uncertainty itself which lies at the heart of the problem and gives a sense of urgency to the quest for a solution.

The key sectors

Benefits from climate change mitigation are likely to spread around most of the regions of the globe, positively affecting to some extent almost all economic sectors. The economic burden of carbon emission reduction would also reach all actors, but it is likely that the first shock would be concentrated on a few agents who would experience strong negative impacts before they are able to (partially) transfer it to other actors. Despite the fact that this situation is quite frequent in environmental economics, actors and sectors are in this case national governments (both from advanced and developing countries), energy multinationals, capital equipment manufacturing companies, and there is no supranational authority to moderate the consensus-building process. Under these conditions, the agreement on a coordinated policy to achieve an efficient and

equitable climate protection strategy is plagued with undesirable, suboptimal bifurcation paths.

A cursory glance at table 1 indicates that road transport and conventional thermal power are the two sectors experiencing the fastest growth. This trend can be extrapolated to the rest of the world zones, albeit with reservations. Electricity demand is expected to increase by around 60% between 1992 and 2010 worldwide. The baseline projection foresees an annualized rate of growth of 1.5% in the period 1992-2000, and of 3.4% for the period 2000-2010. Within the developed economies, these rates of growth are lower: for the European group of OECD nations, the corresponding figures are 0.5% and 1.8%. The transportation sector is the second largest chapter in the carbon emission budget at global scale. As regards energy demand by the transport sector, it appears that advanced economies are reaching demand saturation. On the other hand, the growth in some emerging economies, such as China, the South/South East Asia and Latin America exceeds GDP growth.

Looking at the global warming issue requires therefore a closer look to these two sectors, that together account for more than 50% of overall carbon emissions and whose aggregated weight in the global carbon balance is expected to increase.

Technologies

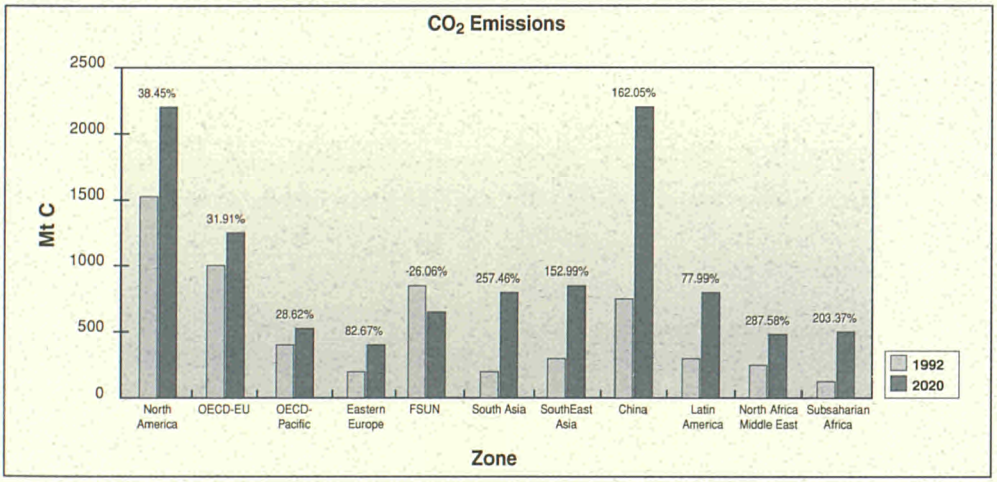
A baseline projection, including business-as-usual hypotheses on technology improvements and efficiency gains and no carbon mitigation policies, as obtained from the world energy prospecting tool POLES indicates that world carbon emissions will increase from 6000 MtC in 1992 to 8200 MtC by 2010. Beyond this date, growth is expected to accelerate, reaching around 13000 MtC by 2030. Two facts must be noted here: first, the decline in carbon emissions induced by economic crisis in the Former URSS is expected to stop in the next decade. Second, the significant increase of carbon emissions from the Asian economies, noticeable even during the 90s.

Full exploitation of technologies available today would permit the EU to go well beyond its Kyoto targets. These technologies include not only carbon-free (or less intensive) energy

Road transport and conventional thermal power already account for 50% of total carbon emission and are the two sectors experiencing the fastest growth, particularly in emerging economies

Full exploitation of technologies available today would permit the EU to go well beyond its Kyoto targets. However, accelerated technology substitution is likely to be too costly for the available time frame

Figure 1. CO_2 emissions worldwide



Source: POLES baseline projection IPTS/IEPE.

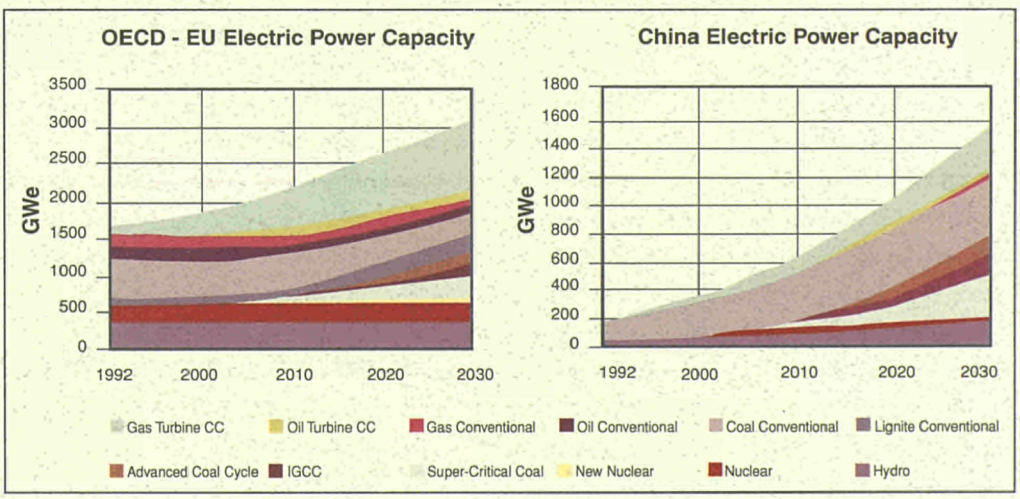
conversion devices, such as renewables (wind, solar thermal, photovoltaics), nuclear, high-efficiency gas-based technologies (combined cycle, fuel cells), but also in efficiency improving devices in the demand side (double glazing, heat accumulators, industrial cogeneration, etc.). However, the dimension of the infrastructures to be replaced and the magnitude of the costs incurred in the case of accelerated technology substitution make this a highly improbable response within the available time frame. Indeed, climate change mitigation costs heavily depend on the time frame adopted to reach a given target, since an early motion towards a less carbon-intensive technology portfolio significantly reduces the overall costs. Two main caveats have to be considered when analysing the role of technology in climate protection, though. On the one hand, enhanced (cleaner and cheaper) energy technologies do not ensure *per se* lower carbon emissions, since they could imply lower energy prices and therefore may induce an expansion in demand, with uncertain results in terms of total carbon emissions. An appropriate set of economic accompanying measures has to be set up to obtain the full results from an accelerated technology substitution policy. On the other hand, the same technology has different efficacy under different circumstances and in different places.

Taking the lead in climate protection may provide some comparative advantage over competitors in terms of accelerated adoption of cleaner and more efficient production modes, provided that the rest of the world follows suit

The analysis of several energy technology scenarios developed within the JOULE programme indicates, for instance, that an accelerated progress for clean coal technologies[1] (in terms of capital cost decline and increased energy conversion efficiency) could indeed induce larger carbon emissions from most of the countries in the world (with the singular exception of emerging Asian economies).

The European Union has engaged itself as the champion of climate protection in the Kyoto and post-Kyoto forums. The market for energy technologies (and, in particular, for power generation technologies) is really huge. Demand for electricity is expected to grow world-wide at an annual rate of 2.3% over the next 20 years. This is equivalent to building a new 250 MW power plant every 3 days during this period, not accounting for replacement of existing power capacity. Taking the lead may provide some

Figure 2. Power Generation Capacity in the EU and China



comparative advantage with respect to the main commercial competitors (i.e. the USA and Japan) in terms of accelerated adoption of cleaner and more efficient production modes, provided that the rest of the economies (first the advanced ones, then the whole world) also eventually embark on this climate protection path. However, it is also quite likely that pursuing an aggressive carbon emission mitigation policy without similar steps being followed by the USA and Japan in the short-term (say within the Kyoto time frame) and global coordination in the mid-long term (2030 and beyond) may represent significant costs for the European economy, the deterioration of its competitiveness and, in addition, induce little climate protection.

Carbon emission reduction costs

Estimates of the overall carbon emission reduction costs are, in general, difficult to obtain. There are a number of hypotheses behind every analysis, and there are caveats that have to be taken into account when considering the figures. Of course, the longer the time horizon, the more unreliable these estimates become. In addition, even for the relatively short-term horizon (typically for the Kyoto target at 2010), the modalities of implementation of carbon mitigation measures imply significant differences in the estimates. Achieving the Kyoto target through an effort which is evenly distributed over time seems to be definitely cheaper than attempting to reach the same objective via a heavily back-loaded effort, due to the intensification of the economic effort which is required to overcome the inertia of economic systems to rapid structural change. In the first case, the cost of Kyoto for the EU-15 may reasonably lie confined below 0.2% of the EU GDP, whereas in the second, the burden of fulfilling the agreement may represent as much as 1%-1.5% of GDP by 2010.

A standard way of measuring carbon emission reduction costs is to estimate the carbon tax that, maintained constant over the committing period, would induce the desired carbon reduction at the target time horizon. This equivalent carbon tax implicitly measures the flexibility of a given economy to shift towards not only a less carbon-intensive energy mix but also to a lower absolute energy consumption. Notice that this assumes early commitment to hit the environment-protection target. Within a sector analysis restricted to energy markets (even if on a cross-territorial basis) it is clear that reaching any carbon emission reduction will imply a net cost (possibly properly captured by the proxy "carbon tax"). No additional assumption is made regarding the use of the income levied via this hypothetical carbon tax. Estimates obtained with the world energy model POLES seem to indicate that the cost of fulfilling the Kyoto protocol on a purely domestic basis would be around 100-150 US$/tC (1990 prices) for the EU and the USA (possibly higher for the latter), and above 200 US$/tC for Japan. These differences are of course due to the different consumption patterns, infrastructure endowment and primary energy mix.

Needless to say, the heaviest burden will be sustained by sectors that are particularly energy-intensive, notably power generation and transport. However, some of the price paid (mainly by the energy-related sectors) may be recycled via tax reform drawing from sectors which are likely to expand as a result of the CO_2 abatement efforts (such sectors would typically be more labour-intensive). Furthermore if any revenues generated (from possible tax receipts or emission permit sales) could be used to address other prevalent distortions in the economy, the overall cost across the whole economic system could be markedly lower (the so-called double dividend of environmental protection policies). Table 2 shows the results obtained by Capros et al.

Achieving the Kyoto target through an effort which is evenly distributed over time seems to be definitely cheaper than attempting to reach the same objective via an escalating economic effort

(1998) using the multi-sectoral energy-economic model GEM-E3 in comparing the economic effect of a progressively increasing carbon tax designed to achieve the desired target by 2010 (-20% of carbon emissions over the baseline) for two cases. In the first one, the resources levied via the carbon tax are not recycled, whereas in the second case, they are employed to alleviate the labour taxes supported by the workforce (therefore inducing higher labour demand).

Energy-intensive sectors such as power generation and transport are likely to bear the heaviest burden. Nevertheless, the revenues generated from taxes or permits could be used to address other distortions in the economy

There is, however, the possibility of achieving the carbon emission reduction abroad, in emerging economies where the same reductions would cost much less, either via Joint Implementation/Clean Development Mechanisms or via global carbon emissions trade. In both cases, the crucial mechanism involves an accelerated technology transfer from OECD countries to emerging economies experiencing a rapid electrification process. Assuming an Annex 2 carbon emission bubble, i.e. allowing for complete and unrestricted joint carbon mitigation efforts within the group of countries subscribing the Kyoto protocol, results from modelling exercises indicate that the (joint) carbon emission mitigation could lie around 60-70 US$/tC (1990 prices). Extending the carbon emission bubble to the entire world could pull the total Kyoto costs down below 20 US$/tC. These numbers, approximate as they are, give nevertheless an idea of the potential benefits from international collaboration, based only on direct energy-related costs, and, therefore somehow disregarding the potential gains that an adequate tax-recycling policy may create across the other economic sectors. The official position of the EU has been so far to conduct the bulk of the carbon emissions reduction domestically, in contrast to the USA position, favouring international trade and cooperation to achieve cost reductions. After an intense debate within the EU, an agreement has been recently reached so that at least 50% of the total European carbon emission mitigation effort shall be conducted within the Union, leaving room for flexible mechanisms for the remaining 50%.

Carbon emission reduction will be achieved more economically abroad, via Joint Implementation/ Clean Development Mechanisms or via global carbon emissions trade

Conclusion

One way or another, and as alluded to above, achieving Kyoto would necessarily imply higher energy costs, and this may harm the relative competitiveness position of European energy intensive and transport-intensive goods and services, unless similar measures are adopted by

Table 2. Emission-constrained case: Kyoto target with no recycling and labour recycling (compared to the baseline) for the EU-14 aggregate

	NO TAX RECYCLING			LABOUR -TAX RECYCLING		
	2001	2005	2010	2001	2005	2010
GDP	-0.03%	-0.38%	-1.10%	-0.0%	-0.18%	-0.65%
Employment (*)	-17	-217	-531	60	645	1460
Exports (in volume)	0.01%	0.03%	0.08%	-0.16%	-2.09%	-4.9%
Imports (in volume)	-0.24%	-2.73%	-6.08%	-0.08%	-1.00%	-2.18%
Intra-trade EU14	0.02%	0.14%	0.33%	-0.17%	-2.13%	-4.99%
Energy consumption (volume)	-0.55%	-6.46%	-14.24%	-0.54%	-6.49%	-14.55%
CO_2 Emissions	-1.0%	-10%	-20%	-1.0%	-10%	-20%

(*) thousand jobs

Source: Capros et al (1998).

the USA and Japan — the EU's main competitors. Free-rider behaviour on the part of the USA and Japan, or an operating mode in which they obtain their carbon reductions credits via (definitively cheaper) international co-operation/trade, whereas the Europeans attain their carbon emission reduction share via (expensive) domestic policies and measures could be highly damaging to many European energy-intensive sectors. This negative impact could be more serious if the domestic implementation of carbon emission abatement is not properly implemented, bypassing the possible gains from a double-dividend cross-sectoral policy.

The Kyoto protocol, however, is far from guaranteeing climate stabilization. This ultimate goal would require a sustained, coordinated world-wide policy during a long time span aiming at eventual sharp reductions of global emissions if greenhouse gas concentrations are to stabilize. The costs of achieving this would definitely be much higher than those corresponding to the Kyoto agreement (a first step towards the final goal), and are of course much more difficult to assess. They depend again, on the time frame adopted to achieve the objective: a continuous carbon mitigation effort, fully exploiting the complementarities between different countries and implementing careful energy planning for countries experiencing a rapid expansion in energy demand would yield lower overall costs. On the other hand, delayed action may induce the adoption of quasi-irreversible carbon-intensive electrification patterns in many cases, therefore hindering the stabilization of carbon emissions within a reasonable time frame, and accelerating the climate change dynamics.

A situation in which Europe's competitors achieve a larger share of their emissions reduction quota through joint implementation and clean development could be damaging to the competitiveness of European firms

Keywords
carbon emissions, energy technologies, environmental-protection negotiations, technology transfer

Note
1- Such as IGCC, Supercritical Rankine Cycle or PFBC.

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EU Enlargement: Some lessons from the "Scenarios Europe 2010" Project

Anna Michalski and Gilles Bertrand, *FSU*

Issue: Enlargement of the European Union (EU) to include the Central and Eastern European Countries (CEECs) will not simply be a matter of new members having to converge on any existing 'European model'.

Relevance: Concerted action will be needed on measures both related to the requirements of applying the Union's body of law and to softer, but equally important, issues, such as social values, frameworks of governance, security and harmonious socio-economic development.

Enlargement of the European Union (EU) to include the Central and Eastern European Countries (CEECs) is one of the biggest policy challenges for the coming decade

Introduction

Enlargement of the European Union (EU) to include the Central and Eastern European Countries (CEECs) is one of the biggest policy challenges for the coming decade. Moreover, it will be taking place in a context of ever faster-paced technology-driven change. This process, as indicated by the findings of 'Scenarios Europe 2010', a major prospective exercise undertaken by the Forward Studies Unit of the European Commission (see box 1), would need to include some 'softer' factors on the political agenda for EU enlargement, such as values, inequalities, governance and regional stability in addition to the more conventional 'hard' factors such as the legal transposition of the Union's body of legislation. These soft factors reflect both the specific political and historical experiences of the CEECs and their traditions, perceptions and symbols. Such legacies affect social values and expectations about the consequences of integration into the EU. Moreover, the CEECs are in a process of political and economic transition, taking them away from a system of centralized command economy and a

Box 1. The "Scenarios Europe 2010" project: Reference of Study

The aim of the "Scenarios Europe 2010" was to prepare five consistent and plausible pictures of the future of Europe. The scenarios were constructed based on a collective exercise involving more than 60 officials, representing 15 different directorates-general of the European Commission. Many dimensions were taken into account, as shown by the diversity of the themes covered by the five initial working groups: governance and institutions, social cohesion, economic adaptability, EU enlargement and the international context. The aim of the scenarios is to stimulate debate on the future of the EU. The Forward Studies Unit of the European Commission intends to publish the results of its "Scenarios Europe 2010" project shortly.

Box 2. The Five Scenarios and their Implications on EU Enlargement

- In *Triumphant Markets,* Europe is evolving towards a liberal market model following the US example by a drastic downsizing of the welfare state, in particular the social protection systems and social services. The EU focuses on the economic aspects of integration, in particular the Single Market, and reduces its most costly policies, CAP and the structural funds. In this scenario, the Union is in a position to enlarge very rapidly because national sovereignty is no longer threatened by political integration and only limited financial transfer is on offer for poorer candidate countries.
- In *The Hundred Flowers,* a major crisis of governance occurs in several member states (especially the largest). Faced with rapidly changing societies, national bureaucracies are unable to adapt and lose contact with day-to-day realities. The citizens show a mounting mistrust towards political and administrative elites and revert to local and community level, adding to a growing political and economic fragmentation of Europe. Due to the political crisis, the enlargement process is interrupted after a first wave of accessions. The enlarged Union is unable to develop a coherent foreign and security policy. Incapable of exporting its stability abroad, the Union is put under pressure by new non-military threats, such as international crime, pollution of the environment, illegal immigration, and smuggling.
- In *Shared Responsibilities,* the European governments decide to push through wide-reaching reform of the public sector at all levels (local, regional, national and European) in order to calibrate administrations according to principles, such as transparency, responsibility, decentralization and subsidiarity. In 2010, the Union has been enlarged to include the CEECs, Cyprus, Malta and two EFTA countries. The EU is equipped with an efficient foreign and security policy, and is able to establish solid political partnerships with its neighbours on subjects of common interest (for instance, in the case of Russia, the fight against organized crime, economic stabilization and environmental degradation).
- After massive demonstrations of public discontent, in *Creative Societies,* a new red/green elite comes to power in Western Europe. It undertakes a radical reform of accounting, pension and tax systems, in order to take account to environmental and social concerns. The CEECs are perplexed by the social and environmental standards being imposed by the Union, which leads to political tensions — and slows down the enlargement process. The Union's preoccupation with internal problems leads it to underestimate foreign policy issues. Excessive concentration on short-term concerns may engender in the long run a failure of Europe's *green and social* experiment (if only because of the demographic imbalance with the rest of the world).
- *Turbulent Neighbourhoods* envisages an unstable regional context: the European Union faces a military conflict in its vicinity and has to equip itself rapidly with a common defence capability. Foreign policy and internal security absorb most of the political attention, and the Union (dominated by its big member states) plays a more "unilateral" and dominant role in the relations with its neighbours. The situation of severe regional instability drives a clear demarcation line between the most advanced CEECs which become members of the EU, and those candidate countries which are left outside which are caught in a spiral of negative socio-economic development and rising insecurity. In adopting a strictly defensive attitude, the EU delays internal socio-economic and governance reforms and fails to remodel the continent on new, more co-operative basis.

single party monopoly of the state apparatus towards more flexible and responsive policy frameworks based on elected government, able to manage the process of national consensus building. They also have to meet more diverse security threats including the spread of organized crime networks, ethnic tensions and aggressive nationalism as well as managing the effects of globalization, rapid advancement of modern technologies on their societies.

Changing values

As the CEECs are now evolving into modern democratic market economies, they are shaping distinctive collective values systems based on their own historical and social experience and the needs and aspirations of their societies. In the context of economic and democratic development, it would be wrong to assume that the CEECs will simply follow -with a time lag- the same trajectory as the Western European societies from the 50s onwards.

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Each scenario covered by the exercise highlights different aspects that will have an impact on the process of integration of the CEECs, indicating that a successful enlargement is not just about economic development but is a process of value shift and change

Western Europe is marked by a diversity of values and patterns of social behaviour and the CEECs will add with their own experience and perceptions to this. And in some cases this will differ from what already exists in the present EU member states.

The consequences of the divergences in the value shaping roots of social change were illustrated in the different scenarios constructed for the "Scenarios Europe 2010" (see Box 2). In the *Creative Societies* scenario the inability of established structures to respond to changing values and new perceived needs sparks off strong popular discontent and revolutionary reform of established structures and policies across Europe. To the CEECs, this red/green revolution seems an incomprehensible luxury. Sustainable growth and the abolition of social exclusion contrast with the drivers towards economic growth, personal gain and consumerism in the transition economies. While Western Europe begins to shed 'mass consumerism' in favour of 'mass customization' for many citizens of the CEECs the standardized products of mass consumerism are still an aspiration, because conspicuous consumption and display of brands remains a symbol of relative wealth.

Similarly, the social solidarity and shared values that lead to a deep reform of governance in the *Shared Responsibilities* scenario stand in opposition to the currently lower degree of trust in fellow citizens and state authorities found in many CEECs. Shared values may also seem suspiciously reminiscent of the utopian dreams of the early 20th Century that were later usurped by repressive Communist regimes. The aspect of social security offered by the state in this scenario, however, is likely to respond to the concerns of those parts of the societies that most regret the disappearance of the institutionalized security and the ideology-based prestige of the Communist past.

By contrast, the personal gain and consumerism of the *Triumphant Markets* scenario have risen in the CEECs during the transition period and are likely to remain strong motivations for some time to come, with all the tensions such models contain. Similarly, the fragmentation in *The Hundred Flowers* scenario, accompanied by a strong distrust of 'the system' (administration and politicians) with a preference for community self-help, are features that can be observed in the CEECs. The scenario sees a reinforcement of regional identities and the simultaneous erosion of the traditional nation-state, both trends that may find supporters among the many ethnic and cultural minorities in the CEECs. But another face of a trend towards greater localism could be social fragmentation in the direction of public intolerance of "deviant" behaviour or "ethnic impurity". A development of public connivance with repressive security policies or institutionalized intolerance points towards the *Turbulent Neighbourhoods* scenario, in which the internal and external security situation is unstable for the whole of Europe.

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The uncertainty of governance

It is in the area of institutional capacity and governance of the enlarged Union that one of the major challenges of enlargement appears – a challenge of a broader importance since many EU member states themselves are experiencing a crisis of governance. The building of systems of good governance for the enlarged EU is dependent on a concerted approach to reform Europe's bureaucracies (at different levels) to new circumstances.

In the CEECs' context, the main challenge is to establish effective governance systems at all levels. All candidate countries have undergone decentralizing reform in recent years, but these efforts have had to go against a strong centralist tradition — and have sometimes been seen as running against the process of rebuilding statehood. As the scenarios indicate, a crisis of confidence could develop in a number of different ways throughout Europe. In *The Hundred Flowers* scenario, for instance there is an erosion of political legitimacy in a number of EU15 states, with low vote turnouts, public distrust of political processes and a lack of capacity to engineer reform.

In *The Hundred Flowers* scenario (and also *Triumphant Markets* and *Creative Societies* scenarios to some extent), the state loses its capacity to maintain the rule of law (both in present EU members and applicant countries). This paves the way to growing regional instability and the faster spread of soft security threats: environmental disasters, trafficking and smuggling of weapons, drugs, and people. By 2010, international crime could well exercise political leadership (either directly or indirectly) over several regions or states in the Union and its immediate neighbourhood. By contrast, *Shared Responsibilities,* the scenario where a successful reform of governance takes place, indicates how dynamic economic growth might be triggered by international coordination of industrial and training policy to release the full potential of ICTs. In an increasingly globalized context, the search for new international governance models assumes greater prominence. Various issues can only be tackled at this level, for instance, the environment, privacy and security on the Internet, the control of genetically modified organisms, regional stability and increasing inequalities. But, as international co-operation rises in importance, it cannot rely on weakened institutions at the European or national levels. In order to allow the international projects to go ahead, it is necessary to negotiate with robust and stable political systems and to avoid the spill-over conflicts that are inherent in unbalanced growth regimes. For these reasons, institutional capacity building in the transitional economies is a concern of all of Europe in order to ensure that they are able to apply effectively the EU legislation as well as new regulatory regimes that may be taken on the international level and that these measures are accepted by the public at large.

Soft security: export stability or import instability

The end of the Cold War dramatically changed the strategic landscape of Europe, and with it the nature and origin of security threats. The threat of organized war between states is now largely replaced by intra-state power struggles, often along ethnic lines.

Meanwhile, organized crime is a rising stability threat across Europe, from smuggling of goods (drugs, cigarettes, harmful substances such as nuclear waste, arms etc.) to human beings and some forms of terrorism. Global phenomena like the increasing use of the Internet, international finance, freer communication and travelling and access to sophisticated technology, may permit organized crime networks to operate relatively undisturbed. The rapidly changing economic and political environment and the still relatively fragile institutional situation implies that some CEECs may be at substantially higher risks from threats ranging from terrorism, drugs abuse, information warfare and piracy, to abuse of intellectual property rights (such as bootlegging, illegal datamining and so on) and dubious portfolio investment in privatized state assets.

In the *Triumphant Markets* scenario, the economic integration of a great number of

Old threats to security from outside have been replaced by internal problems such as ethnic strife, smuggling, organized crime, terrorism, etc

countries in the region and the prospects of a free market between the enlarged Union and Russia have been conducive to peaceful relations throughout Europe. However, a lack of political will and the absence of a strong policy framework result in looming soft security threats around 2010. In the *Shared Responsibilities* scenario, political will and foresight offer greater stability. Here, the EU sets up 'partnerships' with neighbouring countries to the enlarged Union to address soft security issues. In *The Hundred Flowers* scenario, fragmentation and the erosion of the nation-state lead to diffuse and widespread instability in which heightened regional identities lead to occasional, often ethnically inspired, outbreaks of violence. In the *Creative Societies* scenario, the EU, inward-looking and absorbed by revolutionary zeal, fails to mount stable political and economic co-operation with the countries in the neighbourhood. In the *Turbulent Neighbourhoods* scenario, because of the failure of the EU to stem the rising tide of instability and tension, it has subsequently to resort to military action to restore peace.

The policy implications point to a need for structural co-operation to enhance regional stability between the current EU, the pre-accession countries and third countries, like the pact on organized crime with the CEECs or the EU common strategy on Russia. Cross-border initiatives between regions (the EuroRegions) to improve economic prospects, social interaction and cooperation are also important to achieve stability, as are specific bilateral agreements (e.g. between customs, border police and home offices).

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The risks of a 'technical' approach to enlargement

Since 1997, the process of integrating the current candidate countries into the EU is driven by their obligation to take over the "acquis" (the Union's body of law, procedures, political commitments and fundamental objectives). This approach, whilst necessary, omits important complementary dimensions to enlargement. It seems important to develop areas that are today characterized by a weak, diffuse or evolving *acquis*. For instance, where populations have already been hit hard by the transition from a state economy to the market economy, there may be a loss of confidence in the ability and commitment of the state to improving social conditions, and thus a disillusionment with democratic development. This is the downside of a "fast and loose" enlargement, such as in the *Triumphant Markets* scenario. The trend already apparent in the CEECs towards rising regional and socio-economic inequalities may increase fragmentation along the lines of *The Hundred Flowers* scenario. Whilst, instability as illustrated in the *Turbulent Neighbourhoods* scenario might be the price of neglecting the geo-political dimension of enlargement, in particular for regions at the new southern and eastern frontier of the enlarged EU On enlargement, the Union as the strongest player in a wide triangle of the globe stretching from North Cape to the Sahara and from the Atlantic to the Urals will have to support this "neighbourhood's" transition into a strong bloc of democratic market economies.

How to escape the 'in/out' dilemma

Perhaps the most fundamental question for the EU is where enlargement should stop. The pressure for membership is not necessarily positive. Accepting members are not ready to take on, or do not fully understand the requirements of joining the EU (including the necessity to share a number of political, social or environmental values) could create tensions. Perhaps, instead some countries in the EU's neighbourhood could be satisfied with specific cooperation rather than the rights and duties of full membership.

The pressure for expanding membership is not necessarily positive. Specific cooperation agreements might be more appropriate for some countries in the EU's neighbourhood than the rights and duties of full membership

A "neighbourhood policy" that is more consistent, comprehensive and well endowed than at present could be an alternative route forward. The *Creative Societies* scenario features a continent-wide policy platform 'from Russia to North Africa' to include an area of free trade and related policies, ranging from science and technology to transport, energy, exchange programmes. Such a pan-European partnership could be a way to resolve the in/out dilemma', especially by providing a graduated boundary to the EU, rather than an abrupt demarcation.

Conclusion

The arguments outlined in this article, based on the work on the project 'Scenarios Europe 2010', are provisional, and much work remains to be done to deepen the reflections on the future of the enlarged Union to firm up the ideas. Moreover, the express aim of the scenarios is not to provide firm conclusions and recommendations, but to act as a stimulus for extensive discussions both in and outside the Commission.

Overall, though, insights do build up in the process of constructing scenarios. Also, enlargement cannot be isolated from broader developments. West and East are subjected to the same trends: globalization, demographic ageing, environmental pressures, rapid technological change, changing values, and the spread of organized crime. Enlargement processes are also affected by these trends and the consequences will alter the shape and nature of whole of Europe.

For example, the scenarios warn that that technological change could be an important amplifier of underlying social and political processes. Especially, in the cases where there is a breakdown of traditional modes of governance, people will find alternative ways to express their opinions or to exit from national politics by engaging in local and interest based activities. These sorts of developments are clearly aided by the growing use of the Internet as a tool for political organization. But ICT networks can contribute to social and political disintegration, undermining the transparency and accessibility of public life or even becoming conduits for organized crime.

The role of new technology as a broker of change, therefore, reinforces the point that successful enlargement and a stable and prosperous European neighbourhood calls for policy attention to "soft factors" alongside the technical and economic requirements for enlargement.

On the other hand, value systems in particular will play an important part in the acceptance of the requirements of EU membership by CEEC citizens. There is a need to accommodate and recognize the legitimacy of the alternative values, albeit within a general framework of basic liberal rights and freedoms, democracy, the rule of law and tolerance and respect for other countries and peoples. Sensitivity is essential, enlargement agendas driven too much by economic considerations would risk overlooking important dimensions of earlier enlargements (e.g. the provisions of the welfare state, the rule of law, accountable and efficient administrations). This is all the more important, since the needs and aspirations (women's emancipation, active participation in the political process, non-traditional social behaviour or multiculturalism) in these countries' may not be met by implicit EU policy frameworks.

The scenarios warn that that technological change could be an important amplifier of underlying social and political processes. Especially, in the cases where there is a breakdown of traditional modes of governance

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Keywords
enlargement, future scenarios, values, governance

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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.

The Institute's main activities, defined in close cooperation with the decision-maker are:

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

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.

3. Support for policy-making. The IPTS also undertakes work to supports both Commission services and other EU institutions in response to specific requests, usually as a direct contribution to decision-making and/or policy implementation. These tasks are fully integrated with, and take full advantage of on-going Technology Watch activities.

As well as collaborating directly with policy-makers in order to obtain first-hand understanding of their concerns, the IPTS draws upon sector actors' knowledge and promotes dialogue between them, whilst working in close co-operation with the scientific community so as to ensure technical accuracy. In addition to its flagship IPTS Report, the work of the IPTS is also presented in occasional prospective notes, a series of dossiers, synthesis reports and working papers.

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

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