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# THE IPTS REPORT

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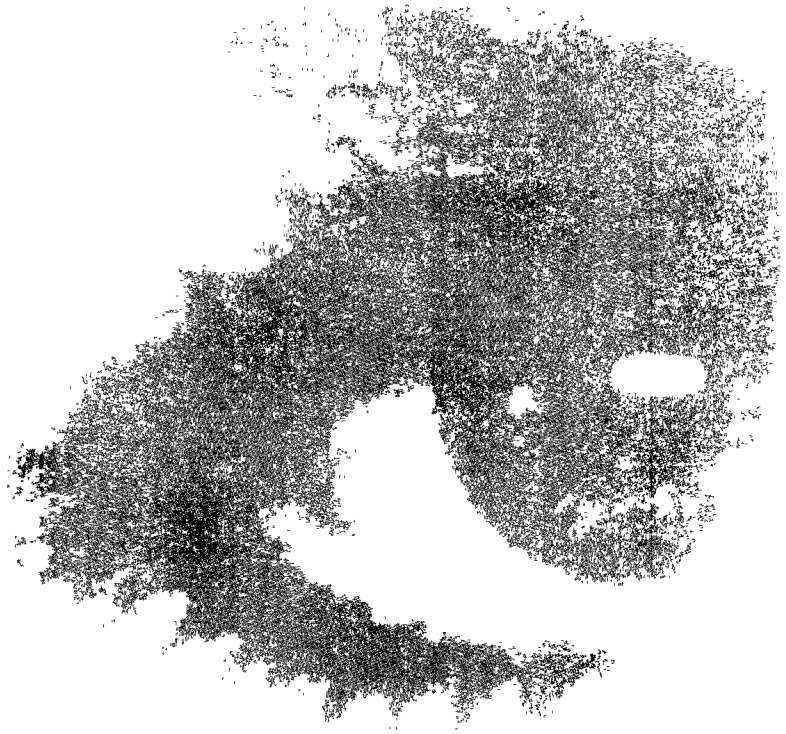

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SEPTEMBER
1996

## Innovation
### Special Issue

- **The Challenges of Innovation**
- **Networks of firms confronting the challenge of globalisation**
- **Electronic commerce and the new forms of industrial organisation**
- **Innovation in services: the example of multimedia**
- **Foresight and innovation: the role of initiatives at European level**

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*he Institute for Prospective Technological Studies carries out and co-ordinates research on techno-economic intelligence in support of the decision-maker. Structured communication is the main task of this objective and it is performed by establishing an active dialogue among all main actors.*

*The IPTS Report is the principal tool for this dialogue focusing on issues of prospective pertinence and selectively signalling the socio-economic impact of scientific and technological developments.*

*IPTS is dedicating its first special thematic issue to a theme which is high on the agenda of policy makers in Europe, namely* ***innovation.*** *The following introduction by the Commissioner for Science, Research and Development, E. Cresson, comes as an affirmation both of the importance of the topic, as well as of the role of the IPTS Report in exploring such crucial issues, at a time when the Commission is rounding off the consultation procedure on the Green Paper on Innovation, and is in the process of preparing the Fifth Framework Programme on RTD.*

# Innovation, Europe's Achilles heel

Although still the world's greatest economic power, the European Union's position on the global economic chess-board is weakening. Whilst keeping up its competitiveness in key sectors its economy is nevertheless ageing, and the consequences of this are serious, particularly for employment.

What is the reason for this?

For many years the difficulties suffered by the European economy have been attributed to high labour costs, but this explanation does not take into account the relative decrease in European labour costs in recent years. Comparison with the United States is particularly illuminating. From 1985 to 1994 the European Union and the United States both experienced similar growth in their GDP, the rates being 26% and 25% respectively. In Europe 78% of this growth was due to improvements in productivity, ie. increasing workers' efficiency, and 22% was due to job creation. On the other side of the Atlantic 40% of growth was due to productivity gains and 60% to growth in employment.

Thus, the United States created 16 million new jobs in ten years. At the same time not only did they get back their impressive economic vitality but they also took up the offensive in traditional branches and strengthened their superiority in high-tech sectors.

The European Union's principal weakness, as brought to light by a series of analyses over recent years, lies in the fact that the economy suffers from an innovation deficit. It has become apparent that what was Europe's great strength in the nineteenth century, namely its capacity to assimilate scientific progress, translate it into technical reality and exploit it commercially, has weakened.

It is not that the standard of European researchers has dropped, or that European scientific excellence is a thing of the past: but the innovation chain, linking ideas to products, has slackened. The number of researchers, and both public and private research budgets, has decreased with the crisis, at the very same time that our competitors are moving in the opposite direction. Obviously, the seriousness of our lag should not be exaggerated, as many examples of success can be found. However, it is time to reverse the trend.

It was out of the attempt to understand this phenomenon that the study, which gave rise to the Green Paper on Innovation, emerged. At the end of this examination process three main blocking factors were identified. The first is the inadequacy and the dispersion of research efforts. European research is above all handicapped by a lack of resources, research efforts are too scattered and the distance between the scientific sphere and the world of business is growing.

*The second adverse factor is the unfavourable legislative and regulatory environment. An excessively rigid administrative structure is handicapping businesses. The third series of hindrances to innovation relates to a closely linked series of problems concerning financing and protection. European capital seems to be shy of technological risk and investment in novel undertakings. One of the reasons is the absence of a stock market for companies that are growing rapidly or could be looking for the capital necessary to finance their expansion. At the same time there is a noticeable tendency to under-use patents and a generally high cost associated with intellectual protection rights.*

*These are, in short, the findings reported in the Green Paper. We have launched a wide-reaching EU-wide debate, and the Green Paper has been conceived of as a means of opening this debate in a tangible way, presenting as it does, 130 action proposals. I personally distinguish six main aims: to orient research more directly towards innovation, to develop the human resources needed for innovation, to improve financial conditions for innovation, to establish a legal and regulatory framework that favours innovation, to develop the modes of action of the public authorities, and finally, to stimulate innovation in SMEs and in the regions.*

*The analyses and proposals presented by the paper are not all new, but it is the first time that they have been submitted to the scrutiny of all the actors in all the countries of the European Union. In addition to those whose views have been included in it, thousands of managers, union leaders, researchers, academics and consultants have read it, discussed it, and have made their contribution to the debate. The synthesis of all the different comments is now underway. In the main, all those who have offered their opinions have tended to support the diagnosis given, and backed the wide-reaching and integrated approach recommended by the Commission.*

*Several themes receive more sustained attention: The financing of innovation, simplifying administration, orienting research towards innovation, supporting innovation in SMEs and at regional level, and the role of training.*

*Suggestions have been put to us emphasising, for example, the role of public spending, the importance of the service sector (including the health and social domains), innovation in organisation, capital risk insurance by a system of public guarantees, the importance of the dissemination of existing technologies among SMEs, and the need to stimulate demand for innovative products.*

*The aim of this consultation process is not to endorse a series of measures already decided upon. We are open to all inputs to the discussion. In the light of these contributions the European Council in Dublin will decide upon a plan of action for the operational measures. This raising of awareness, this mobilisation of energies and ideas concerning an issue which is essential for the prosperity and employment of European citizens, already constitutes, in my eyes, a major success.*

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## Special Issue on Innovation

## Focusing on the innovation process

*Gustavo Fahrenkrog*

By the time this issue of the IPTS report is published the lengthy consultation process on the Green Paper on Innovation will have finished and we will be on the eve of the first round of debates on the 5th Framework Programme It therefore seems to be the right moment to dedicate a thematic issue of the *IPTS Report* to Innovation.

Innovation is defined in the Green Paper as *the successful production, assimilation and exploitation of novelty in the economic and social sphere... Research, development and the use of new technologies are key elements in innovation, but they are not the only ones Incorporating them means that the firm must make an organisational effort by adapting its methods of production, management and distribution*

These processes of change take place in an economic, social and cultural environment where the relationships between the actors in the process (other firms, Science and Technology (S&T) institutions, government) and the rules which they establish may be mutually reinforcing and cumulative (the so called 'systems of innovation').

For this issue of the Report, IPTS has invited a number of authors to contribute their views on the innovation process within the context of a specific innovation system. The articles illustrate the multi-faceted nature of the innovation process. They also demonstrate that there is no simple solution to policy actions in this field. The Green Paper on Innovation already conveyed that sense of complexity and the need to understand how systems of innovation work to be able to design coherent policy actions.

Despite this diversity we can nevertheless identify some themes which recur, albeit occasionally under different names, time and time again.

The first theme is the *systemic nature of the innovation process.* The actions and strategies of some actors affect the development of others. This is clearly the case in den Hertog and Schaffer's article: developments in multimedia affect the structure of the publishing industry and the publishing industry, as 'content' producer, is affecting the development of multimedia. In Mollas-Gallart and Hawkins' paper the systemic nature of the innovation process is illustrated through the developments in Electronic Commerce which is affecting the internal and external organisation of firms. Finally, the systemic nature of innovation and of the innovation system is possibly best illustrated with the article on how Italian industrial districts as networks of SME's are coping with globalization (Farinelli).

Another recurring theme is the importance of *accumulated knowledge as the basis for innovation.* Soete's paper emphasises the role of knowledge accumulation in growth. He identifies and discusses three types of knowledge and their relationship with innovation and growth. Firstly, easily transferable codifiable knowledge. Secondly, non-codifiable knowledge, also known as tacit knowledge (skills), often the basis of the innovative capacity of regions or nations. And thirdly codified knowledge which, through new combinations and techniques, is being used to create new services (ie. the content of the new media). Farinelli's article refers to the role of accumulated skills in innovation in the context of networks of Small and Medium-sized Enterprises (SMEs). It is either produced through education and training or accumulated through 'learning by doing'. Codified knowledge which is creating new services, the so called 'content', is the one which is at the heart of the transformation of the value chain described by den Hertog and

Schaffers for the publishing industry. Finally, the transfer of knowledge through foresight plays a significant role in the paper by Cabello, Scapolo, Sørup and Weber.

A third theme to run through a number of papers is the need for *organisational innovation* within and between firms. Mollas-Gallart and Hawkins address this issue most directly. They describe the way Electronic Commerce is changing the links between firms and how certain firms (SME's) are in danger of being unable to adapt to those changes. Farinelli's paper also focuses on links between firms (in networks) and describes the advantages of these forms of organisation in a globalizing society.

This thematic issue of the IPTS Report is structured as follows. The first article is of a fairly general nature and joins the economic debate on innovation. The following three articles each focus on a different topic of the innovation process. The last article centres on one aspect of innovation policy· the role of foresight and technology intelligence in innovation policy.

Soete's paper, "The Challenges of Innovation" argues that the current debate on the way science, technology and innovation contribute to growth and more generally welfare has increasingly become the subject of some, what he calls "paradoxical features" . In his paper he focuses on two features of the innovation process which might appear "paradoxical": the broad recognition amongst economists and policy makers of the importance of knowledge accumulation for economic growth despite the lack of aggregate empirical evidence supporting such increased recognition; and second the paradoxical way in which new information and communication technologies, through a process of increased 'codification of knowledge', currently erode the incentives for knowledge accumulation itself, particularly in manufacturing.

Farinelli's paper on how industrial districts and networks of firms in Italy are coping with globalization analyses the question on a different level. It describes first how these local systems of small firms, which are not an exclusively Italian phenomenon, have been able to produce a very dynamic economic tissue. Their strength lies in the accumulation of skills in those clusters where small firms operate in 'cooperative competition'. A local base of accumulated skills and 'tacit knowledge' is essential for the success of those clusters. In the past Italian industrial districts tended to specialise in light, labour intensive, mature sectors. Today they are tackling more technologically demanding products in capital intensive sectors. In addition many of those traditionally industrial districts are shifting, as is the rest of the economy, to the service sector. In the author's view this has resulted in a new organisational model in which the key competitive factor is the capability to innovate, to improve design and quality of customised goods, rather than producing large volumes of standardised products. The author observes similar developments in large firms and argues that there is a 'double convergence' whereby both, small and large firms, need the accumulation of local skills to be able to operate effectively in a global context. Policies which support collective infrastructure providing services essential for the continued development of dynamic clusters of SMEs.

Molas-Gallart and Hawkins analyse the effect electronic commerce has on the new forms of industrial organisation. The increasing use of electronic means to transfer commercial and product data is changing the ways in which companies relate to their customers and suppliers. Industrial organisation, the role of small and medium enterprises, and the patterns of inter-firm co-operation are all being affected. In this framework, Information and Communications Technology (ICT) competence is becoming a necessary condition of market access for the smaller suppliers.

They review how Electronic Commerce is changing operational management of firms (lean production, Life-cycle management and Agile enterprises) and the consequences for suppliers. They conclude that although the Green Paper on Innovation identifies organisational innovation as

one of the weaknesses of European innovation systems, the opportunities to use ICTs to support organisational innovation are also fraught with difficulties. The new systems can open up markets to new entrants, but can also impose new barriers to entry. Policy-makers must monitor developments and ensure that market access is not adversely affected by new organisational practices, proprietary standards, and regional discrepancies in access to networked services.

The article by den Hertog and Schaffers argues that compared with innovation in equipment and systems, innovation in services has attracted very little attention until recently. The example of multimedia services shows that the *interaction* between equipment innovation and innovation in services is a major success factor. It is the combined innovation in software - architectures, software production, applications for administration and billing services, embedded software - and advanced service and organisation concepts that currently results in real market development and cost effective solutions. Although innovation in electronic components and systems certainly enables the opening of 'new windows of opportunity', it is innovation in service concepts and software that stimulates the development of new markets. They analyse two elements which are crucial for developing successful multimedia services: The multi-sector character of multimedia services, illustrated by innovation processes in the publishing industry. The stimulation of user involvement as a success factor, illustrated by Amsterdam Digital City and the use of technology platforms. Innovation in multimedia at the industry level should be interpreted as a renewal of chains and networks of value creating activities, causing players to (re)position themselves. At the level of individual multimedia applications, user-involvement is a key success factor.

Finally, Cabello *et al.* report on recent developments in foresight activities in Europe. Different Member States have developed prominent foresight activities and the question is raised if, in view of the approaching debate on the 5th Framework Programme, an initiative for a European Foresight initiative should be launched. The article also reviews the role of foresight at the level of the enterprise and how this instrument might allow a better understanding of existing technological potentials in an increasingly complex economic and social environment.

# The Challenges of Innovation

*Professor Luc Soete*

**Issue:** The current debate on the way science, technology and innovation contribute to growth and welfare in general has increasingly become the subject of some paradoxical features. The Green Paper on Innovation highlighted in particular the so-called "European paradox", the paradoxical feature hitherto mainly popular in the UK, that Europe at least on the basis of the available performance proxies appears relatively strong in science, but relatively weak in technology.

**Relevance:** It is hoped that the current policy debate, initiated by the Green paper on Innovation, will come up with much more informed analyses, and that in the end these will provide more adequate policy responses to the perceived weaknesses of specific elements of the innovation process. However, and as is often the case with respect to particular policies, the cocooning of the innovation policy debate to a set of immediate, specific answers to some of the main policy issues in which Europe appears to lag behind the US or Japan, such as the lack of appropriate financial tools for new high-tech companies (the EASDAQ proposal), intellectual property protection, overregulation or simply business R&D effort, ignores the fact that such policy debate is part of a much wider economic debate on the priority given to science, technology and innovation as engines for European growth and welfare. To understand that debate much more needs to be known about the various institutional arrangements governing the innovation process.

## Analysis

In this short paper I wish to focus on two features of the innovation process which might appear paradoxical: the broad recognition amongst economists and policy makers of the importance of knowledge accumulation for economic growth, despite the lack of aggregate empirical evidence supporting this increased recognition; and secondly the paradoxical way in which new information and communication technologies through a process of increased codification of knowledge are currently eroding incentives for knowledge accumulation, particularly in manufacturing. We shall start the analysis with the growth paradox and in section 2 shall discuss the technology paradox.

## Knowledge accumulation and growth

Depending on the precise definition used [1] there is growing recognition that knowledge, both as an input and output, is central to the process of growth and job creation. As a recent OECD document put it: "Knowledge in all its forms plays today a crucial role in economic processes. Intangible investment is growing much more rapidly than physical investment. Firms with more knowledge are winners on markets. Nations endowed with more knowledge are more competitive. Individuals with more knowledge get better paid jobs. This strategic role is at the root of increasing investments by individuals, firms and nations in all forms of knowledge." (OECD, 1995).

*Knowledge plays a crucial role in economic processes, and it is increasingly important for individuals, firms and nations Most contemporary developed economies have become 'Knowledge-based'*

In short, most contemporary developed economies are, and have increasingly become, knowledge-based.

Growth theory has traditionally recognized the crucial role of knowledge accumulation in the growth process. Without technological change, capital accumulation cannot be sustained — its marginal productivity declines — and the equilibrium growth (per capita) of the economy will inexorably tend towards zero. It is the invention of new machines and intermediate goods which provides opportunities for new investment. Thus, as has been shown in many empirical studies, the efficiency gains following the introduction, diffusion and continuous improvements of new production processes, have been the major factor behind the rise in real wages over the post-war period in the OECD [2] economies [3].

Not only physical but also human capital accumulation depends on technological change.

Whereas the embodiment of technology in physical capital has long been recognised, the increasing importance of the embodiment of technology in people has been recognised much more recently (Schultz, 1964). Yet there is little doubt that the way to use a particular technology is fully part of that technology. Human skills are essential complementary assets, an essential part of implementing, maintaining, adapting and using new physically embodied technologies. As Guellec put it: "Human capital and technology are two faces of the same coin, two inseparable aspects of knowledge accumulation." (Guellec, 1995, p 4) The accumulation of human capital can involve both an increase in the knowledge embodied in skilled workers and an increase in the number of skilled workers.

The recognition of the importance of this much broader notion of knowledge accumulation — including alongside such capital and human embodied technological change, also disembodied technological change — has of course been at the core of the revival of new growth theory (see IPTS Report 05, June 1996, article on "Economic Growth Theory and Technical Change").

## A new growth paradox

As is often the case in economic theory, the academic recognition of the particular importance of knowledge accumulation, as exemplified in the emergence of new growth theory, seems to be somewhat out of step with the empirical evidence.

As David in particular has emphasized, within the broader historical context of US economic growth, large parts of the US economy have been dealing with the creation, distribution and transmission of knowledge for quite some time now. As early as in the 50's, Machlup in his seminal contribution estimated that more than half of the US economy was involved in information and knowledge based activities.

To some extent it might be argued that the new found theoretical wisdom on growth represents little more than a breakthrough in formalisation, enriching the traditional neo-classical growth modelling framework, but failing to include much of the so-called "appreciative" theory, as Nelson (1994) put it, on technology and innovation and in particular the relatively voluminous literature concerning science and technology policy and R&D. As a result new growth theory is coming increasingly under pressure from a revival of Solow-type analyses, pointing to, among other things, the limited role played by technology, as measured in the form of total factor productivity growth, in those countries which have witnessed the most rapid growth: the south-east Asian countries (Young, 1985) or to the importance of the more traditional input variables such as (human) capital in explaining growth (Mankiw, 1985). New growth theory has so far failed to include much of the appreciative theorizing around technology policy and in particular the importance of so-called "national systems of innovation" (Freeman, 1987, Nelson, 1988, 1993, Lundvall, 1993).

The point can be best illustrated by arguing that a paradoxical relationship is emerging between, on the one hand, the new found formal belief in the importance of the increasing returns associated

with research and ideas, identified, for example in terms of rivalry and control or appropriatability (Romer, 1993), and, on the other hand, the empirical evidence about the contribution of R&D — and in particular the public support for R&D — to output and productivity growth.

In the stylized new formalised endogenous growth models (leaving aside the more complex "creative destruction" models such as Aghion and Howitt 1990, and Grossman and Helpman, 1991 [4] the existence of externalities in R&D, leads to the conclusion that the equilibrium growth rate is sub-optimal. In other words if left to the market there will be underinvestment in R&D and thus there is a case for government support (e.g. subsidies to R&D) in order to increase the equilibrium growth rate up to optimal levels. This underinvestment is made most explicit with respect to the basic research or general knowledge part of the innovation process. The latter is generally separated out in the new endogenous growth models in a blueprint part which can be appropriated through monopoly power and which thus brings about a strong incentive to produce innovations and invest in R&D, and a general knowledge part which flows over to other producers of blueprints. It is mainly the latter part which creates the growth externalities and in which underinvestment takes place, pointing again as in the seminal papers of Nelson (1959) and Arrow (1962) to the role for government and public support for basic research.

However, it would be unfortunate, particularly given the quite substantial and rich science and technology policy literature which has emerged over the last thirty years, to reduce the relevant policy issues to a debate about the volume of public financial support to be directed at capturing the elusive knowledge externalities arising from basic research or other general knowledge. As a matter of fact, one could reasonably argue, by making a simple comparison of national differences, that there is no evidence of any relationship, worse still, if anything there appears to be a more of a negative relationship between government support for research and economic growth.

The proportion of total (civilian) research funded by governments is related to some measure of economic growth. That (non-significant) negative relationship appears to be as valid for the group of developed OECD economies as it is for a broader sample (50) of the most research active countries in the world. The approximate evidence is actually supported by more formal econometric evidence which has systematically pointed to the fact that government R&D support did not have a significant impact on the productivity (TFP) growth of enterprises (Griliches, 1986, Lichtenberg and Siegel, 1991), sectors or countries (Lichtenberg, 1992, Soete and Verspagen, 1993) In all these cases the estimated coefficients for government financed investments in R&D were, insignificant in comparison to private financed R&D, and in some cases even negative (Lichtenberg, 1992).

At first sight there appears thus to be **a contradiction between the new formal theoretical growth wisdom and the formal and less formal empirical evidence. It is within this apparent paradox framework that, in my view, the current European innovation policy debate should be framed.** It is also within this framework that the various specific innovation policy proposals discussed in the Green Paper on Innovation take on their particular meaning.

As many scholars of national innovation systems (Freeman, Lundvall, Nelson) or of the history of science and technology institutions — including corporate and public research laboratories, private and public universities, copyright and patent institutions, which have only recently come into being have argued, the aggregate tool box of growth economics provides little insight into the real world of technology policy and on the various underlying processes that lead to effective institutional arrangements.

In this context comparative analyses of science and technology related institutions, of institutional innovations and of institutional rearrangements will provide invaluable insights into this search for institutional learning. As a recent paper by Weder

*Benefits from R&D may not always exclusively accrue to the investor; thus there may be underprovision of R&D in the absence of government support for it*

*It is the "general knowledge" part of the innovation process which creates growth externalities, pointing to a role for government and for public support to "basic" research*

*ICTs provide the infrastructure for the knowledge-based economy, once it is codified knowledge can be transferred or embodied in capital or consumer goods*

and Grubel (1993) illustrates, such a debate might well be framed within Coasean economics terms, in the sense that it might seem to regard the emergence of private institutions internalizing R&D externalities. The particular way public policies might encourage the operation of such efficiency enhancing institutions then also becomes a focal point for analysis. However, before drawing such converging policy conclusions, it seems essential to have available much more factual institutional evidence. Evidence which often will be of a much more appreciative nature than of the traditional econometric type, and which will have to be, by definition, much more country specific.

## New information technologies and their impact on knowledge accumulation

Many features of the knowledge-based economy are based on the increasing use of information and communication technologies. Even if one must not take the Information and Communications Technology (ICT) revolution as synonymous with the advent of the knowledge-based economy, both phenomena appear strongly interrelated [5]

This is not surprising. ICTs are information technologies, the essence of which consist in the increased memorisation and storage, speed, manipulation and interpretation of data and information. With ICTs, the knowledge-based economy gets a new and different technological base which fundamentally changes the conditions for the production and distribution of knowledge as well as its coupling to the production system.

The long term effects of ICTs have to do with the realisation of a new potential for productivity gains in the process of generation, distribution and exploitation of knowledge. It is, at this stage, still only possible to point to a number of knowledge acquisition processes which are likely to be directly or indirectly affected by the accelerated use of ICTs. This evolution can be seen to follow three paths (see Cowan and Foray, 1995, Ergas, 1994, David and Foray, 1995, Foray and Lundvall, 1996):

(1) the increasing speed and decreasing cost of developing tools and instruments for basic research and R&D (prototypes, demonstrators, simulation techniques);
(2) the increasing ease with which new technological options can be generated; and
(3) the extending power of electronic networks as tools for research.

## ICTs and codification

As David and Foray (1995) have defined it:
"the codification of knowledge implies that knowledge is transformed into 'information' which can be easily transmitted through information infrastructures. It is a process of reduction and conversion which renders the transmission, verification, storage and reproduction of knowledge especially easy.

Codified knowledge will be expressed in a format that is compact and standardised to facilitate and reduce the cost of such operations. Codified knowledge can normally be transferred over long distances and across organisational boundaries to low costs. As a consequence it makes such knowledge more accessible than before to all sectors and agents in the economy linked to information networks or with the knowledge how to access such networks.

However, information and codified knowledge, remain difficult to exchange in the market.

The seller normally keeps his access to the information and it is difficult to prevent the buyer from distributing it to other potential customers.

Furthermore, it is not a straightforward matter to reach agreement on the price since the buyers do not know what they buy in advance (if it was fully revealed, they would not be willing to pay for it)".

In contrast with codified knowledge, tacit knowledge refers to knowledge which cannot be easily transferred because it is has not been stated in an explicit form. Skills are one important kind of tacit knowledge. The skilled person follows

rules which are not known as such by the person following them. Another important kind of tacit knowledge has to do with the implicit but shared beliefs and modes of interpretation which make intelligent communication possible.

These distinctive features of knowledge as an economic resource establish the context in which the changes in knowledge generation and use described above are occurring. At the centre of these changes is a transformation in the character of society's knowledge stock involving codification and a change in the techniques for using codified knowledge.

## The relationships between codified and tacit knowledge

ICTs of course play an essential role in this knowledge codification process. More broadly, the latter implies that knowledge is transformed into 'information' which can either be embodied in new material goods (machines, new consumer goods) or be easily transmitted through information infrastructures. The embodiment of codified knowledge in material goods has been typical of the dramatically increased performance of many new capital and consumer goods, incorporating many new electronic information and communication devices. The latter in turn have been at the core of the continuous productivity, investment and growth in consumer demand in Western societies. As emphasized by authors criticising the early post-industrial society literature [6] this process could also be described as a process of industrialisation of services: the continuous replacement of particular service activities by household material goods, embodying at least the codified knowledge part (washing machines, television, dryers, etc.). More recent electronic improvements to these products have further increased their household performance of these products, freeing further household time. While the quality of these new material goods will not always substitute for the service activity they replace (a dishwasher is a good example), the codification process will be to some extent complete. The product might not be particularly user-friendly (the typical example being the video player), but the user is not required to possess, or to understand, the knowledge embodied in the machine.

In the case of services, on the other hand, the codification of knowledge will have made such knowledge more accessible than before to all sectors and agents in the economy linked to information networks, or with knowledge of how to access networks. However, its immaterial nature will imply that the codification will never be complete. The codification process will even only rarely reduce the relative importance of tacit knowledge in the form of skills, competencies and other elements of tacit knowledge, rather the contrary. It is these latter activities which will become the main value of the service activity: ie. the content. While part of this might be based on pure tacitness, such as talent or creativity, the largest part will depend closely on continuous new knowledge accumulation — learning —, which will typically be based on the spiral movement whereby tacit knowledge is transformed into codified knowledge, followed by a movement back where new kinds of tacit knowledge are developed in close interaction with the new piece of codified knowledge. Such a spiral movement is at the very core of individual as well as organisational learning.

The implications for this continuous shift in value from manufactured goods embodying increasing amounts of codifiable knowledge towards service based tacit knowledge activities is typical of the way the value chain is shifting away from the hardware, high tech sectors towards the soft, content part where scarcity is still the dominant variable creating value. It is a true technology paradox: firms and sectors which are investing heavily in the production and manufacture of new high-tech products find themselves confronted with a slipping-away, a leaking of their Schumpeterian innovation incomes to other sectors and consumers, before they even have the time to recover a part of the research investment.

*The value chain is shifting away from the hardware towards the soft, content part*

On the other hand firms at the content end, when confronted with competition in the same way will use copyright protection effectively to guarantee the value of their new content product. In other words the codification process punishes the individual high tech firm; while providing all other sectors and consumers with the benefits of the new innovation.

This technology value paradox also explains the attempts of electronic and computer manufacturing firms to move into information content activities. Within services, it explains the move of carrier operating firms, which are most directly confronted with the codification of knowledge and its distribution, to enter content sectors such as media, education and culture (see IPTS Report issue 01, Feb. 1996, article on Content versus Distribution).

## Conclusions

How should Europe respond to these broad challenges? The Green Paper provides some of the answers, certainly with respect to the growth paradox outlined above. However, and as argued here, it also carries with it the danger of narrowing down the innovation policy debate to a set of too narrow issues of immediate concern to European member countries' policy makers. One should not ignore the fact that the innovation policy debate is part of a much wider economic debate on the priority given to science, technology and innovation as engines for European growth and welfare. And from this perspective and despite the analytical arguments set out above, I would claim that currently the macro-economic policy priority given in the EU member countries to science, technology and innovation is low: worse still, in the period of restrictive monetary policies of the early 90's and current restrictive fiscal policies, it is even hostile. As a result, Europe is not just lagging behind in technological innovation and business competitiveness, it is probably also rapidly losing its proclaimed scientific excellence. Secondly, I would argue that with respect to the process of knowledge codification closely associated with the new ICTs, Europe has clearly so far failed to develop a more appropriate concept of comparative advantage, not based on single market concepts such as economies of scale, the development of common standards and the harmonisation of regulations which undoubtedly have played an important role in the further liberalisation of commodity and information flows, but on new more service content related concepts based on diversity, on the differentiation of needs and market niches, and economies of scope.

**Keywords**
innovation, knowledge accumulation, codification, services, content

**Notes**

- [1] In contrast to some recent contributions on growth (e.g. Young, 1994, Solow, 1995, Mankiw, 1995), which in the old growth tradition separate human capital from technology, the concept of knowledge accumulation used here includes **both** capital and labour embodied technology.

- [2] While in the newly industrialising countries (NICs), the narrowly measured contribution of technology to growth (e.g. the total factor productivity contribution) has remained small, as pointed out by Young, 1984, there is little doubt that here too the international catching up with best-practice production techniques has been a major factor in contributing to their output and employment growth.

- [3] As Paul Romer put it : "The personal computer that I used to write this paper is made from almost exactly the same physical materials as the PC that I bought 10 years ago - about thirty pounds of steel, copper, aluminium, plastic and silicon, with bits of gold, iron oxide and miscellaneous other elements mixed in. In my new PC these materials are arranged in a slightly different way that makes them about fifty times more useful than they were in the original configuration. No amount of savings and investment, no policy of macro-economic fine-tuning, no set of tax and spending incentives can generate sustained economic growth unless it is accompanied by the countless large and small discoveries that are required to create more value from a fixed set of natural resources" (Romer, 1993, p.345).

- [4] In these cases there are also negative externalities to research associated with the so-called business stealing effect; in this case there could also be overinvestment.

- [5] Much has been written on this subject. Recent contributions include Foray and Lundvall, 1996, Howitt, 1996 and OECD, 1996.

- [6] See amongst others Gershuny, 1977 and Gershuny and Miles, 1982.

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# Networks of firms confronting the challenge of globalisation: The Italian experience

*Fulvia Farinelli*

**Issue:** The post-Fordist revolution has brought about profound changes in traditionally Marshallian clusters of firms, particularly from the organisational point of view. In Italy these are now facing a range of adjustment and restructuring problems, whilst trying to respond to the challenges of market globalisation, but nevertheless are tenaciously maintaining a rapid pace of technological change.

**Relevance:** The process of globalisation, or more precisely the process of global-localisation, has profound implications for the design and execution of economic, industrial, and R&D policy. Rather than diminish the need for active government policies, the increasing globalisation of trade and technology seems actually to augment it considerably. Failure to implement coherent policies can lead to a single local system, or indeed a whole region or country, being locked into slow growth due to its inability to compete effectively in an increasingly integrated world economy.

*Thanks to their dynamism and vitality, Italian industrial districts have sustained a high level of performance, even in periods of generalised decline*

Since the beginning of the eighties local systems of small firms, and in particular industrial districts, have been the focus of attention of an increasing number of scholars and policy makers from a range of national backgrounds, as well as from prominent international organisations such as the OECD (Organisation for Economic Cooperation and Development) and the ILO (International Labour Organisation). This upsurge in interest is primarily due to three factors: the successful economic performance of such industrial districts in terms of exports, employment, flexibility and innovation; their role in stimulating endogenous regional development; and their ability to sustain high wage rates and favourable employment conditions despite strong international competition.

The Italian clusters of firms known as industrial districts are probably the best known example of local productive systems based on groups of specialised but flexible small businesses. Thanks to their dynamism and vitality they have sustained their outstanding performance, even in periods of generalised decline. The so-called Third Italy has its heartland in the regions of Tuscany and Emilia Romagna, and similar phenomena can also be found in West Jutland (Denmark), Vallés Oriental (Spain), Baden Württemberg (Germany), Oyannax and Cholet (France), south-west Flanders (Belgium), and even in North America and Japan, although outside Italy however, these experiences are more often at the level of regions than small well-defined areas.

It must be borne in mind, however, that the unit under analysis here is not sharply defined. In general terms a cluster of firms or industrial district is understood to comprise a group of numerous, closely interacting small and medium-sized companies, devoted to one predominant manufacturing activity, located in a relatively confined geographical area, producing for the same end markets (whether directly or indirectly) and with

a specific cultural environment created through shared knowledge and values. According to the traditional Marshallian point of view, a district's strength lies in clustering and cooperative competition, together with the industrial atmosphere created by a mix of competence, skills, entrepreneurial ability, trust and a sense of community, which together open up the possibility of gains in terms of efficiency and flexibility which individual producers can rarely attain working alone.

In Italy about sixty such industrial districts have been identified (this estimate varies considerably depending on chosen parameters). They are mostly located in the Centre and north-east of the country, but a few can also be found in the Southern regions of Abruzzo, Puglia and, to a lesser extent, Campania (Il sole 24 ore, 11 April 1996, "la geografia dei distretti"). Thanks to their thriving performance in the eighties these districts have managed to become the backbone of Italian industry, taking on a much more prominent role than they had in the past. This has brought about a genuine upheaval in industrial employment; between 1981 and 1991 these businesses created almost 178,000 new jobs, and this at a time when the Italian industry as a whole shed 770,000 workers. 76 per cent of these job losses where suffered by large firms, a reflection of the wider crisis felt by companies structured along the lines of the large-scale, vertically-integrated factory model of industrial organisation, which started in the United Stated in the mid seventies (Sforzi, 1995).

## Industrial districts (clusters of firms) shift to services

Traditionally, Italian industrial districts have tended to specialise in light, labour intensive, mature sectors (such as clothing, textiles, shoes and furniture), but they are now increasingly tackling more technologically demanding products and capital intensive sectors (ceramics, plastics, metalworking, industrial automation, mechanical engineering). Thus, for example, Prato has specialised in textiles, Como in silk fabric, Carpi in knitwear, Castelgoffredo in stockings, Poggibonsi and Pesaro in furniture, Montegranaro in footwear, Sassuolo in ceramics, Emilia Romagna in machine tools and agricultural machinery, Belluno in spectacle frames, and so on (Table 1)

In addition to a marked, although unevenly distributed, technological up-grading, the main transformation which has taken place in these clusters of firms has been a gradual shift to the service sector, following the trend set in the rest of the Italian economy (Table 2). From 1981 to 1991 employment in services (including business, consumer and social services) rose by 1,200,000, reaching 35.2 per cent of total national employment (in 1981 it stood at 30 per cent). It is worth mentioning that the increase in jobs in the service sector refers both to small and medium sized businesses as well as to large companies, but the percentage change in employment in business services experienced by local systems of small firms was twice that undergone by local systems of large firms (64.4 per cent compared with 32 per cent).

The birth of new specialised firms, both in the manufacturing and service sectors, reflects the adjustment of many Italian districts to the new competitive challenges of an increasingly globalised economy. The internationalisation of markets, technologies and productive processes, the emergence of competitors from the newly-industrialised countries, and the accelerated spread of microelectronics technologies are the key features of the transition from mass-production (Fordism) to flexible production (post-Fordism). This process has resulted in a new, more service oriented model of manufacturing growth, in which the key competitive factor is the capability for continuous innovation, to improve design and quality and to customise goods, rather than producing large volumes of standardised products.

This model affects industrial organisation in various ways. To use new technologies efficiently and to compete effectively, more flexible and innovative strategies and work patterns and production organisation are required. Globalisation entails

*Italian industrial districts have traditionally specialised in labour-intensive, mature, light industries, but are now tackling more technologically demanding products*

*The key competitive factor is the capability for continuous innovation, rather than producing large volumes of standardised products*

**Table 1**

**Small service companies boom...**

(Employment rate % and variation % per category of local systems of small firms, 1981 -1991)

| Local system of firms | Industry | | | | Services | | | |
|---|---|---|---|---|---|---|---|---|
| | Agriculture | Construction | Mining | Manufacturing | Company | Social | Consumption | Traditional |
| **PERCENTAGE RATE (1991)** | | | | | | | | |
| Small businesses | 16.2 | 14.4 | 10.2 | 21.0 | -12.8 | 11.0 | 12.5 | 11.1 |
| Small-medium sized businesses | 14 0 | 16.4 | 11.3 | 22.3 | 12.8 | 11.3 | 12 5 | 11.1 |
| Large businesses | 12.8 | 18.7 | 22.2 | 26.7 | 26.6 | 18.8 | 19.4 | 19.4 |
| Rest of Italy | 57.0 | 50.5 | 56.3 | 39.0 | 47.8 | 58.9 | 55.5 | 58.4 |
| ITALY | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| **PERCENTAGE RATE (1981)** | | | | | | | | |
| Small businesses | 12.7 | 12.0 | 7.4 | 18.0 | 10.2 | 8.6 | 9.6 | 8.9 |
| Small-medium sized businesses | 13.8 | 15.8 | 11.1 | 19.8 | 12.3 | 10.9 | 11.6 | 10.9 |
| Large businesses | 9.7 | 19.9 | 17.0 | 34.0 | 29.1 | 20.9 | 20.2 | 21.4 |
| Rest of Italy | 83.8 | 52 3 | 64.5 | 30.2 | 48.4 | 59.6 | 58.8 | 58.0 |
| ITALY | 100 0 | 100 0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| **PERCENTAGE VARIATION (1981 - 1991)** | | | | | | | | |
| Small businesses | 18.5 | 34.3 | 169.3 | 17.6 | 80.4 | 45.1 | 50.5 | 31.6 |
| Small-medium sized businesses | -8.0 | 16 0 | -13.8 | 1.2 | 51.0 | 19.4 | 24.3 | 6.0 |
| Large businesses | 23.4 | 5.2 | 10.4 | -29.5 | 32.0 | 3.3 | 10.6 | -5.3 |
| Rest of Italy | 17.1 | 7.9 | -25.4 | -10.6 | 42.4 | 18.2 | 9.2 | 3.9 |
| ITALY | -7.1 | 11.8 | 15.8 | -10.2 | 44.3 | 14.8 | 15.2 | 4.0 |

*Source ISTAT:* data taken from 6th and 7th general census of industry and services, 26 October 1981 and 21 October 1991

**... while the industrial manufacturing giants decline**

| Local system | Industry | | | | Services | | | | Total employment |
|---|---|---|---|---|---|---|---|---|---|
| | Agriculture | Construction | Mining | Manufacturing | Company | Social | Consumption | Traditional | |
| **PERCENTAGE VARIATION (1981 - 1991)** | | | | | | | | | |
| Small-medium sized businesses | 6.7 | 23.9 | -1.7 | 8.5 | 84.4 | 30.7 | 36.2 | 17.4 | 19.7 |
| Large businesses | 23.4 | 5.2 | 10.4 | -29.5 | 32.0 | 3.3 | 10.6 | -5.3 | -9.9 |
| Rest of Italy | -17.1 | 7.9 | -26.4 | -10.6 | 42.4 | 13.2 | .9.2 | 3.9 | 6.4 |
| ITALY | -7.1 | 11.6 | -15.6 | -10.2 | 44.3 | 14.6 | 15.2 | 4.6 | 5.6 |

*Successful clusters of firms take advantage of established tradition and rely on continuous product and process innovation*

greater focusing on core activities, decentralising management structures, distributing responsibility more widely, and increasing the flexibility and skills of the workforce

Successful clusters of firms could thus take advantage of their established tradition and ability to target market niches, to rely on the quality approach and continuous product and process innovation, to use new multi-task production technologies, and to introduce rapid changes in the organisation of production, both at the micro (individual firm) and the macro (cluster or sector) level.

To cite just one example, this is the case in Montebelluna, a true leader district, located in the region of Veneto, which specialises in sports footwear and ski-boots and represents two thirds of total world production (the trade-marks Nordica, Salomon, Lange-Rossignol, Tecnica, Dolomite are all concentrated in the region). In 1995 all economic indicators for the district registered continuous expansion (total turnover +20 per cent, production volume +6.7 per cent, employment +6.4 per cent, creation of new firms +14.4 per cent), especially thanks to the boom in new high-tech roller-blades, a market which it promptly cornered (+106 per cent in terms of turnover).

**Table 2**

| REGION | PROVINCE | CITY | INDUSTRIAL SECTOR |
|---|---|---|---|
| Piedmont | Biella | Biella | Textile |
| Piedmont | Novara | Omegna | Household articles |
| Piedmont | Alessandria | Valenza | Gold |
| Lombardy | Milan | Brianza | Furniture |
| Lombardy | Mantova | Castelgoffredo | Tights |
| Lombardy | Brescia | Odolo | Steel Reinforcing bars |
| Lombardy | Como | Como | Silk |
| Veneto | Vicenza | Vicenza | Gold |
| Veneto | Verona | Bovolone | Furniture |
| Veneto | Vicenza | Arzignano | Tanning - Leather |
| Veneto | Treviso | Montebelluna | Ski Boots |
| Veneto | Belluno | Cadore | Glasses |
| Friuli Venezia Giulia | Pordenone | Alto Livenza | Furniture |
| Friuli Venezia Giulia | Udine | Manzano | Furniture (Chairs) |
| Emilia Romagna | Parma | Parma | Parma Ham |
| Emilia Romagna | Reggio Emilia | Reggio Emilia | Parmesan Cheese |
| Emilia Romagna | Modena | Sassuolo | Tiles |
| Emilia Romagna | Modena | Carpi | Textile |
| Emilia Romagna | Reggio Emilia | Reggio Emilia | Agriculture |
| | | | Machines |
| Tuscany | Massa Carrara | Carrara | Marble |
| Tuscany | Pisa | Santa Croce | Tanning - Leather |
| Tuscany | Firenze | Prato | Textile |
| Marche | Pesaro | Pesaro | Furniture |
| Marche | Ascoli Piceno | Ascoli - Macerata | Shoes |
| Marche | Macerata | Tolentino | Leather |
| Campania | Avellino | Solofra | Tanning- Leather |
| Campania | Salerno | Salerno | Tomatoes |
| Puglia | Lecce | Casarano | Shoes |
| Puglia | Bari | Barletta | Shoes |

Industrial districts, however, represent just one of the possible forms of flexible production organisation. Large companies themselves have been decentralising, devolving and breaking down their operations into looser networks of semi-autonomous subsidiaries, franchisees, subcontractors joint-ventures and strategic alliances. In short, a process of double-convergence of large and small firms structures is taking place. Small firms in these districts are learning to rely upon common services - for instance, in technology, market research, and financial intelligence and assistance tasks - which give them some of the advantages more normally enjoyed by large firms Large firms are in turn seeking to reproduce among their subsidiaries and subcontractors the collaborative relationships and flexibility characteristic of industrial districts (Sabel, 1990).

## Rediscovering the territoriality of production

Rather than witness the eclipse of industrial districts we have seen developments over the last decade which seem to be leading directly to the re-emergence of the role of geographical location of production and networks of traded and untraded interdependencies among firms and social actors where production takes place.

*A process of double-convergence is taking place small firms are learning to rely upon common services giving them some advantages enjoyed by large firms, and large firms are using subsidiaries and contactors to reproduce the flexibility characteristic of clusters of firms*

*Over recent years there has been on renewed emphasis of the role of geographical location and networks of traded and untraded interdependencies among firms and social actors*

According to Sforzi, the newly acquired awareness that the manufacturing system cannot be considered apart from local features and the human factors which contribute to its accomplishment, means the recognition of the integrated productive unit· both the productive system and the labour market are local, insofar as they tend to both share and be rooted in the same geographical area

As Porter (1990) points out:
"all around the world, in country after country, the focus of competitive success is increasingly local".

*The homogenising force of a shrinking world will make it essential for firms to be different from their rivals*

The ability to create a unique concentration of local skills, of local technology, of local infrastructure, of local suppliers in the relevant fields gives the ingredient for competitive success... The homogenising force of a shrinking world, with computer technology available to all, will make it essential for firms to be different from their rivals. Such differences, especially in economic vitality, appear to be established at home.

*Clusters of firms carry with them an element of 'tacit knowledge' technology, skills, products and processes Innovation and technical progress is based on this tacit knowledge*

In the global struggle for competitiveness, then, clusters of firms may be particularly favoured by their distinctiveness and by their uniqueness factor potential (Sweeney, 1987), which is based on local and endogenous capabilities. Patterns of technological change, innovation and diffusion may also be seen as an endogenous category directly related to the social fabric in which it is located, and this has two important implications Firstly, clusters of firms carry with them an element of - often socially codified - tacit knowledge concerning technology, skills, products and processes, often specific to that cluster of enterprises and usually accumulated over a lengthy historical period. Secondly, innovation and technical progress is an evolving and incremental process, based on this tacit knowledge and operating through the dynamics of an interactive and incremental learning-by-doing/learning-by-using process, and this is of mutual benefit to both users and producers (Lundvall, 1992).

On this subject in the 1996 OECD report on Technology, Productivity and Job Creation we read that the key challenge for the future is the capability to boost productivity and growth through increased knowledge-intensive economic activities, while maintaining social cohesion and equity, an issue notably raised by Jacques Delors a few years ago, and recently stressed again in the Green Paper on Innovation published by the European Commission (1996). The Report however warns:
"The situation of unskilled workers has deteriorated in absolute terms, while earnings potential of those capable of fully exploiting the new technologies in a global market has considerably increased. Policies to co-ordinate technological and human resource development and to ensure universal access to the new information infrastructures and services take on particular importance. Special efforts must be devoted to those caught in the poverty trap owing to insufficient skills or poor learning capability" (OECD, 1996)

## The importance of public policy

Within the framework described above, policies addressing infrastructures, human capital and technological diffusion can play a fundamental role in sustaining established districts and even in stimulating the emergence of new ones. As with other forms of industrial organisation, local productive systems based on small firms are not necessarily innovative, flexible, consensual or successful, and the notion of the stages of development of industrial districts, elaborated by Brusco (1990), shows that, after a phase of spontaneous growth, their continued progress requires external intervention and support, without which the district may even become locked into a spiral of decline.

In this regard, the consortia or other collective structures providing real services, which are typical of the Italian model, but are also shared by the German, Danish or Belgian experience, can prove to be a key player in the dynamics of the district A role is seen for them in encouraging entrepreneurs and employees to

work with new technology, to tailor it to their needs and to improve it. They also support the design and implementation of new techniques in such a way that they can be introduced in the most painless way possible, without causing upheavals in the workforce, major shifts in the organisation of labour, or huge changes in company hierarchies (Brusco, 1990). In the future, they may turn out to be even more crucial in ensuring that standards of pay and employment conditions are met, by providing assistance through vocational training, and in acting as interface structures between local actors and global networks - a sort of dual-buffer in the dynamics of change and rapid adjustment, intercepting the codified knowledge made available by new technologies and matching it to the tacit knowledge of deeply rooted cultures.

In the complex process of interweaving and blending emerging technologies with traditional cultures, and of supplying information in a way that is genuinely personalised rather than simply off-the-shelf, the expertise provided by specialised research institutions may show itself to be a particularly valuable support, as the experience of ENEA (Ente per le Nuove Tecnologie, l'Energia e l'Ambiente) in the districts of Prato and Como has demonstrated. Indeed, in many cases technology research centres have made an essential contribution to the phenomenon of industrial rejuvenation based on the blending of new technologies with existing productive sectors, and this has opened up valuable opportunities to Italian industrial districts and other clusters of small firms in Europe, traditionally weak in high-tech sectors. In fact, we can go so far as to say that there are no more obsolete sectors in the globalised economy: industry is now mature, and therefore in danger of decline, particularly when it reveals its incapacity to absorb emerging technologies into its production and marketing processes (Colombo, 1989).

## Conclusions

Global networks require highly sophisticated organisational integration, as well as demanding the ability to adapt to an ever more uncertain and unstable environment. One often finds a certain scepticism or pessimism about clusters of firms, based on the assumption that their capacities and mode of operation will not be sufficient, or may even be inappropriate, for the task of tackling the large amount of increasingly codified knowledge required to reach, and to stay on, the technological frontier, and the managerial (rather than entrepreneurial) skills to exploit such a position successfully.

This article argues instead that the impact of globalisation will probably further emphasize the local dimension, since regional differences will become more and more evident in terms of innovation and economic growth, as well as widening the gap between winners and losers.

Therefore, it is likely that localisation, agglomeration and tacit knowledge will remain essential determinants of the competitiveness and success of local systems to just as great an extent as information and communication technologies, modern infrastructures and training. Industrial districts, adequately fostered by political means which are able to identify them effectively as a target for intervention and as a tool of economic policy, may represent one of the few systems of excellence in the cases where these determinants come together successfully.

*Expertise provided by specialised research institutions may prove to be a valuable support to the process of blending emerging technologies with traditional cultures*

**Keywords**

Italian Industrial Districts, clusters/local systems of small firms, globalisation, post-Fordism, territoriality of production

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# Electronic commerce and the new forms of industrial organisation

*Jordi Molas-Gallart and Richard Hawkins*

**Issue:** The increasing use of electronic means to transfer commercial and product data is altering the ways in which companies relate to their customers and suppliers. Industrial organisation, the role of small and medium enterprises, and the patterns of inter-firm co-operation are all being affected. Assisted by new information and communication technologies (ICTs), supply chains are becoming more integrated, particularly in sectors where large product assemblers deal with hundreds of smaller suppliers. It is common for systems assemblers to be establishing closer working relationships with a reduced number of 'trusted' suppliers. In this framework, ICT competence is becoming a necessary condition of market access for the smaller suppliers.

**Relevance:** This change in the forms of industrial organisation is central to organisational innovation, an area which the Commission Green Paper on Innovation has identified as one of the weaknesses of European innovation systems. Yet, the opportunities to use ICTs to support organisational innovation are also fraught with difficulties. The new systems can open up markets to new entrants, but can also impose new barriers to entry. Policy-makers must monitor developments and ensure that market access is not negatively affected by new organisational practices, proprietary standards, and regional discrepancies in access to networked services. There are also asymmetries in the quality of information on new ICT systems available to different groups of market actors. In particular, awareness campaigns are necessary to alert small and medium enterprises to the nature of Electronic Commerce, the extent of its development, and the problems such development may cause them.

## Introduction: what is Electronic Commerce?

The term electronic commerce is becoming widely used to describe the whole spectrum of electronic business relationships, involving the electronic transfer of commercial or product data in digital formats. Electronic commerce implementations are diffusing throughout the economy in multiple forms, ranging from trade facilitation mechanisms to fully-fledged "electronic markets" that allow for price determination and the completion of transactions, even between anonymous partners. Most existing electronic commerce applications relate to the wholesale and retail distribution of services and commodities, but applications are beginning to develop in the manufacturing industries as well.

Although Electronic Commerce can involve the exchange of business data in relatively unstructured forms, the major technological developments in electronic commerce are oriented towards the exchange of structured data. One of the core electronic commerce applications is Electronic Data Interchange (EDI), a technology

*Electronic Commerce, the conducting of business relationships using Electronic Data Interchange, is spreading from wholesale and retail distribution to the manufacturing industries*

*Many key applications that must be linked in product data exchange mechanisms are proprietary*

*Lean production aims at reducing all necesary human, material and financial inputs to the production process*

for exchanging large amounts of transaction-related documents between computers using standardised message formats (Sawhney and Williams 1994). EDI is mainly transaction-oriented, and facilitates supply management operations during production and/or distribution. At the production stage, other kinds of electronic commerce applications are being employed to transfer 'product' data - technical specifications, design and engineering graphics, and product descriptions.

Of these two data exchange domains, EDI is the best established. EDI is used in both production and distribution contexts, and, in Europe, its applications are growing steadily at about fifteen per cent per year (PFA, 1994). Sophisticated ordering and stock control systems are based on EDI exchanges across networks of hundreds of suppliers. Many of these suppliers are pressed into implementing EDI systems by their larger clients.

The capability to establish EDI links is often a necessary pre-condition to becoming a supplier to car manufacturers, or large supermarket chains, for example. The barriers to implementing EDI are lowered to some extent, however, in that there are relatively well defined frameworks of non-proprietary standards for EDI messaging.

Firms in the manufacturing sectors have data exchange requirements that go beyond EDI, and many have taken an active role in the development of systems to exchange product design and engineering data. In this field, however, the standards frameworks for the representation of product data in digital formats are not well defined. Many of the key applications that must be linked in product data exchange applications - like Computer-Aided-Design (CAD), Computer-Aided Engineering (CAE), and Computer-Aided-Manufacturing (CAM) - are proprietary.

As most EDI applications can be operated efficiently over low speed communication networks, existing telecommunication facilities can be employed at relatively low cost. On the other hand, product data files are often very large, and typically require more expensive high-speed communication networks. As these two environments begin to merge, a number of issues of network access and availability problems will inevitably surface. Systems already exist, for example, that allow the attachment of CAD/CAM data to EDI messages, but their application depends on the availability of high-speed networks.

Whatever its form of technological implementation, however, electronic commerce is primarily a business strategy oriented to the proactive deployment of ICT in order to facilitate changes in the operational management of business processes. Thus, Electronic Commerce requires changes in the way business is conducted, and production is organised. An electronic commerce strategy can support new production management philosophies that result in new ways to organise supply-chain relationships. In this paper, we will outline three main such philosophies: lean production, life-cycle product management, and 'agile' enterprises.

## Electronic Commerce and operational management

### Lean production

Lean production aims at reducing all necessary human, material and financial inputs to the production process (Womack and others 1990).

This approach to product development and manufacturing places the emphasis on tighter, co-operative working relationships between assemblers and suppliers. The lean-production method has been described mostly in relation to the car industry but is also common to other industries, above all in the consumer durables sector.

At the heart of lean production is the Just-In-Time (JIT) philosophy. JIT is a set of operational principles and techniques that attempt to make business processes more sensitive to customer demand. JIT aims at producing and delivering parts and sub-systems only when a customer requires them, thus eliminating production line 'buffers', and preventing the build-up of stocks.

Components and sub-systems may be delivered directly to the assembly line as and when they are needed. The JIT philosophy spans the entire supply chain from component and sub-assembly supply, through final assembly, to customer delivery. As a consequence inventories are reduced up and down the supply chain, and the entire system can respond more flexibly to market changes. JIT systems have proved successful in reducing 'design-to-market' time, and in increasing the variety of products offered to final customers.

Toyota is commonly accepted to be the architect of lean production. Their system was developed in the 1950s and 1960s, and did not make extensive use of ICT. As other car manufacturers began to follow the lean production model, however, sophisticated EDI systems were developed to streamline the planning and the ordering of components and sub-systems, and to establish closer communication links with suppliers and dealers. Thus, the roots of electronic commerce in lean production were as a 'lubricant' for the just-in-time system. As the objectives of lean production become increasingly ambitious, however, electronic commerce is progressing from being an assisting technique to becoming the core of the supply chain management system. For instance, car manufacturers are starting to operate 'made to order' regimes, whereby a customer will choose a configuration in consultation with the dealer, that will be electronically transferred to the car assembler, who in turn will generate the production plan for the car and automatically generate and send the required orders for components and sub-systems. The 'made to order' car should reach the customer in a couple of weeks. This kind of regime would be impossible to sustain unless supported by advanced ICT systems.

The bargain-oriented system in which suppliers would constantly compete, mainly on price, for every new component or sub-assembly contract is not well-suited to lean production (Nishiguchi 1994). Co-ordination can only be achieved in this system through close co-operation within the supply chain. This favours longer term relationships with a smaller pool of selected suppliers. Increasingly these suppliers are put in charge of organising their own supply chains along similar principles. The result is a hierarchical network, in which each supplier in every layer controls its own cluster of suppliers (Nishiguchi, 1994).

As more and more manufacturers move towards the lean production model, it becomes crucial for the survival of 'upstream' firms (especially SMEs) that they become integrated into these supplier clusters. As the structures of these clusters increasingly become electronically mediated, sophisticated ICT capabilities will inevitably become an explicit requirement for market entry.

*Just-In-Time management attempts to make business processes more sensitive to demand, only delivering parts and sub-systems when a customer requires them*

*Life-cycle management aims to orient all business processes to the whole life of a product, from design, manufacturing and maintance, to decommissioning*

### Life-cycle management

Life-cycle management aims to orient all business processes to the whole life of a product, from design, manufacturing and maintenance, to decommissioning. Life-cycle management relies on 'enterprise integration' strategies, by which firms up and down the supply chain work together with the final customer in addressing design, manufacturing and support processes. The ultimate objective is to enable all actors in a supply chain to function as if they were a single entity throughout the life of a product. It is this last aspect that makes life-cycle management distinct from other kinds of electronic commerce initiatives.

Unlike other electronic commerce strategies, life-cycle management places special emphasis on support logistics; that is, the organisation of the supply and delivery of parts for the maintenance of deployed systems. As a consequence, systems and spares procurement no longer appear as a series of discrete operations, but are grounded on the continuing relationship that customers and producers establish throughout the product life-cycle. The life-cycle orientation requires the generation, exchange and updating of large repositories of product data. Product data files include technical specifications, drawings and product descriptions and are much larger than the text files involved in the exchange of transaction information.

*Agile enterprises concentrate on their core competencies and subcontract the remaining functions to other firms*

As a consequence, life-cycle management requires a highly sophisticated ICT infrastructure that goes well beyond the requirements for EDI. Unlike lean production, however, where experience with application is now quite advanced, life-cycle management is a relatively new concept, and its applications are at very early stages. The most important current life-cycle initiative is Continuous Acquisition Life-cycle Support (CALS), a programme begun in the mid-1980s by the US Department of Defense. Subsequently, CALS has been made the cornerstone of the electronic commerce strategy of the US Department of Commerce, and CALS implementations are now being considered in other countries, in both military and non-military contexts.

### Agile enterprises

Agile enterprises have already been addressed in a previous IPTS report (Harvey and Gavigan 1996). Very much like CALS, 'agile manufacturing' was conceived as a result of a US Department of Defense report commissioned from the Iacocca Institute in 1991. But the resulting 'agile enterprise' concept, presents interesting differences with the life-cycle management strategies we have just discussed. 'Agility' aims to respond as rapidly as possible to customer demands, and being able to adjust to a turbulent market environment. To this end, large 'agile enterprises' will concentrate on their core competencies, and subcontract the remaining functions to other firms. The 'core' firms will thus establish project-specific links with a network of subcontractors. These links will be sustained only for the length of an individual project. Once the project is terminated, the team is disbanded and a new one assembled for each new project.

*Business structures in different industrial sectors may call for different approaches to industrial organisation and modes of implementing electronic commerce*

The 'agility' derives from the shifting architecture of project-oriented teams, allowing for faster adaptation to changing market conditions.

Unlike lean production and life-cycle management business strategies, the agile enterprise is based on short-term relationships. The vertical disintegration process at the core of lean production is now compounded by short-term relationships with the supply chain, and, equally important, horizontal disintegration. In this environment, organisations become 'virtual', and anything that it is not a core competency becomes a candidate for outsourcing (Baker 1996). The agile enterprise concept proposes a radical change in the way production is organised. This change requires fast and reliable communications systems linking the many and variable units of the virtual organisation.

## Electronic commerce and industrial organisation: consequences for suppliers

All of the strategies described above herald changes in industrial organisation, underpinned by the application of ICT systems. There is little consensus, however, on the shape these changes will take. In many ways, lean production, and life-cycle management are not compatible with agile manufacturing strategies. The former revolve around the establishment of long-term customer-supplier relationships along the supply chain, while the latter thrives on flexibility and short-term relationships.

Some business analysts see agile manufacturing as a step forward in the evolution towards more flexible means of manufacturing, arguing that it will supersede lean production, which in turn had replaced mass production (Baker 1996; Harvey and Gavigan 1996). However, it is debatable whether all industries will follow such a linear evolution. There is evidence that business structures in different industrial sectors call for different approaches to industrial organisation and modes of implementing electronic commerce strategies. Agile enterprises, lean production and life-cycle management are likely to coexist, with different sectors and industrial groups taking different strategies.

In any case, all three strategies are changing profoundly the way clients, distributors, and producers relate to their suppliers. Common to all these strategies is the requirement that all market actors will have to operate in some kind of electronic commerce environment. This can portend a number

of advantages. Wide spread deployment of electronic commerce may substantially lower transaction costs throughout the supply chain, and the costs of accessing distant markets may be lowered. Electronic commerce may open up new opportunities for firms in less favoured regions by minimising some of the negative effects of geographical separation from the main industrial centres.

Nevertheless, there are a number of serious impediments to realising these opportunities.

Where ICT diffusion lags behind, as in most less-favoured regions of the European Union, firms may find that they are disadvantaged in trying to deal with the technical requirements of electronic commerce. Less favoured regions may also suffer from an inadequate telecommunication infrastructure that is unable to deliver the speed and reliability requirements demanded by advanced electronic commerce implementations.

Even where infrastructure facilities exist, moreover, access charges to these facilities may vary dramatically from country to country. In all regions, firms that lack adequate levels of basic ICT expertise may be pressured under the terms of large contracts to install ICT systems that restrict their future technology choices. Many SMEs have a low awareness of ICT, and of electronic commerce developments taking place further up in the supply chains for their products or services.

In order to profit from the new forms of industrial organisation promoted by electronic commerce, or simply to survive the change, firms must become proficient in the use of electronic commerce technologies. How fast will they have to learn will depend on their industrial sector and on the supply chain clusters ion which they are involved, but hardly any industrial operation will remain untouched.

## Policy implications

Electronic commerce is gradually changing the forms of industrial organisation, and is therefore central to organisational innovation. The success of established and new businesses will become increasingly dependent on the ability to exploit electronic linkages with suppliers and customers.

This dependency will have special implications for SMEs.

Although they represent a large percentage of economic activity, and will certainly become involved in this process, most of them will be technological followers rather than leaders [1].

Basically, there are two main areas for policy action. The first is to ensure equity of access.

*Firms in some regions where ICT diffusion lags behind may find themselves at a disadvantage*

Electronic commerce can open up markets to new entrants, but it can also impose new barriers to entry. The task for public policy-makers is to monitor electronic commerce developments and to ensure that market access is not negatively affected by new organisational practices, proprietary standards, and regional discrepancies in access to networked services, especially their unequal pricing. All are factors that can severely restrict participation in electronic commerce.

The second area for policy action is to address asymmetries in the quality of information on electronic commerce that is available to different classes of potential market participants. In particular, information and awareness campaigns are necessary to alert SMEs to impending changes.

SMEs should be aware of the nature of electronic commerce, the extent of its development world wide and the problems that are likely to emerge when implementing electronic commerce systems.

*The success of established and new businesses will become increasingly dependent on the ability to exploit electronic linkages with suppliers and customers*

Caution must be exercised to stay clear of the hype that has surrounded the diffusion of actual or potential electronic commerce technologies.

Exaggerating the benefits of the technology, or making widely optimistic estimates about the speed of diffusion is likely to backfire in the form of sweeping scepticism. Policy-makers should be less concerned to promote specific approaches to electronic commerce, and more concerned to provide impartial information such that firms can make informed decisions.

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**Keywords**

electronic commerce, lean production, just-in-time philosophy, agile enterprises, life-cycle management

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**Notes**

- [ 1 ] For instance, according to figures from the UK Central Statistics Office, SMEs are responsible for 51.5% of UK manufacturing output.

# Innovation in services: The example of multimedia

*Pim den Hertog and Hans Schaffers*

**Issue:** Multimedia technology is developing at a rapid pace, but it is the creation of innovative multimedia services and concepts that is the driving force behind the multimedia market. Innovation in multimedia at the industry level should be interpreted as a renewal of chains and networks of value creating activities, causing relevant players to (re)position themselves. At the level of individual multimedia applications, user-involvement is a key success factor.

**Relevance:** It is only recently that innovation in services has attracted serious attention. However, its importance for industrial renewal should not be overestimated. The case of multimedia illustrates that multimedia services are causing traditional industries delivering 'multimedia equipment' ('hardware') and 'content' ('software') to converge, compete and cooperate at the same time. Advanced multimedia services will be a major enabler for creating innovative products and services aimed at industries as well as the general public. Policy-makers are looking for opportunities to give meaningful stimulation to the development and use of multimedia services.

## Introduction

Compared with innovation in equipment and systems, innovation in services attracted very little attention until recently. The example of multimedia services shows that the interaction between equipment innovation and innovation in services is a major success factor. It is the combined innovation in software - architectures, software production, applications for administration and billing services, embedded software - and advanced service and organisation concepts that currently results in real market development and cost effective solutions.

Although innovation in electronic components and systems certainly enables the opening of 'new windows of opportunity', it is innovation in service concepts and software that stimulates the development of new markets. We will concentrate here on two elements which we consider as crucial for developing successful multimedia services:

1. the multi-sector character of multimedia services, illustrated by innovation processes in the publishing industry;
2. the stimulation of user involvement as a success factor, illustrated by Amsterdam Digital City and the use of technology platforms.

Finally, we will look at the implications for innovation policy-making.

*Although innovation in hardware opens up new opportunities, it is innovation in service concepts and software that stimulates development at new markets*

## A value system perspective: innovation in publishing

The concept of a value system was originally developed by Michael Porter (1985). A firm is a collection of value-creating activities: primary activities such as logistics, operations, marketing

*Interaction between equipment innovation and innovation in services is a critical ingredient for success*

and sales, after-sales service; and supporting activities such as technology development and procurement. Each of these activities, which are in many ways interlinked, employs information technologies allowing coordination between the processes of logistics, inventory management and financial transactions. Information technologies allow information as well as the physical interlinking of a business with the activities of its suppliers and clients. This system of interlinking is called a 'value system'. New value systems emerge as a result of persistent market forces and the innovative application of IT, causing players to continually change their position in the industry.

Innovating value systems implies the development of new service concepts and far reaching organisational transformation.

As an example we will look into changes in the publishing industry. Most European publishers thus far have proven to be quite hesitant to invest in multimedia and new distribution channels.

*Successful companies in the info-industry are able to re-use stocks of content and to develop formats for specific groups of users. This requires knowledge of the best way to reach potential users*

Although interest in multimedia publishing in Europe is quite high, investment decisions by the major players are emerging only slowly. However, the type of questions which publishers face regarding the use of multimedia can be illustrated by looking at the changed context in which publishers have to operate. Five major drivers of change in this industry and their consequences are:

- Digitisation of information. This implies that information, data or 'content' can be stored in a neutral manner and is not tied to one medium, publishing technology or distribution channel.
- Convergence An increasing number of industries are involved in producing and recycling content. As new (combinations of) media, new distribution channels and new facilitating technologies develop, contributing industries increasingly integrate and new players enter the field of publishing.
- Enormous growth in need for 'content'. As the number of players is on the increase and the ability to reach the user is no longer a scarce item - as for instance is the case in (multi-channel) broadcasting - the need for content is growing rapidly (Steward & Laird, 1994, p. 30).
- Personalised media. Media, including publishing, will increasingly develop from being aimed at general interest, to special interest and finally being aimed more at personal interest.
- Globalisation, re-regulation and liberalisation. Publishers are increasingly being incorporated with integrated communication companies.

Due to these drivers, the publishing industry in a traditional sense no longer exists. Publishers are being confronted with completely new products, new categories of users and new competitors to which they have to respond. Publishing has become part of a much larger and more complex industry with a variety of enabling technologies, players and delivery systems: the info-industry.

Electronic distribution will change the existing modes of exploitation of content. Having these changes in mind, the core competencies of a publisher or company in the info-industry can be defined as:

1. the ability to produce, re-package and market content and
2. to focus on and subsequently deliver content to a specific group of users.

The ability to produce, re-package and market content. Companies active in the info-industry are first and foremost rated on their ability to create and/or distribute original and valuable content. It does not matter whether this content consists of a best selling book, a popular TV-programme, an entertaining game or up-to-date financial data. As most of the products just mentioned are protected by copyright, most of these companies have 'libraries or stocks of content' at their disposal.

Companies that are successful in the info-industry are typically able to use, re-package into new products and market these stocks over and over again.

The ability to focus on and deliver content to a specific group of users. The ability to develop formats for books, magazines, TV-programmes, CD-ROM's, games, computer programmes requires an intimate knowledge of the potential customers at whom the product is targeted, plus a knowledge of the best way to reach these potential customers.

Being able to identify a new niche where there is a need for a new magazine, to understand specific user groups or to run a new magazine aimed at a mass market is an intangible asset on which a publisher depends. An example is electronic publishing which might possibly revolutionise academic scientific publishing as well as other segments of the publishing industry.

## User involvement in service innovation: digital cities

At the micro-level of an innovation process, the establishment of user-relations is a critical factor for success. The creative process of developing new services demands close cooperation between technology provider, service provider and the end-user of electronic services. For this reason, market leaders in the service industry and equipment providers are currently testing new electronic services such as video-on demand, teleshopping and home banking in various kinds of field trials.

However, the mere supply of multimedia does not automatically create a demand for multimedia products and services.

Involving users in multimedia development is a key factor for success. User involvement is needed not only to passively test new products and services but also to allow users to become accustomed to multimedia and invite them to actively help in shaping the multimedia services they need. A first example of an experiment which stresses user involvement is Amsterdam Digital City.

In 1994 a joint initiative was set up to create Amsterdam Digital City, a local electronic platform for cultural and social organisations. The Digital City initiative provides citizens with the opportunity to request information from government organisations, to communicate with each other and to enter parts of the Internet. The graphical user interface is designed in such a way that the images of the city represent various functions of public buildings in the actual city.

The building of the virtual city is an ongoing creative process with the active involvement of the users themselves. Residents and guests of the Digital City are constantly invited to help construct the city and thus help shape the electronic society.

Amsterdam Digital City is proving to be a helpful instrument in lowering entrance barriers for potential users of new applications of information and communication technology. It is a playground where citizens, local business people, community organisations and policy-makers experiment with a new electronic medium and services. For many people the graphical user interface Amsterdam Digital City presents a well know and safe starting point from where they can explore the possibilities of electronic networks and services.

Since the opening of the Digital City in 1994 the experiment has been a great success. The total number of visitors to the city has stabilised at around 4,000 a day. More than 1 million pages are being requested every month. The total number of citizens registered is 31,000. Two thirds of this population can be regarded as active participants in the digital city. Besides their rôle in democratic processes and knowledge transfer the Digital City fulfils a platform function for product development in small and medium-sized enterprises. The Digital City allows small firms to experiment and learn about new technology without the need for large investments.

## Organisation of user involvement: technology platforms

A second example of user involvement is the establishment of technology platforms. Since the end of the 80s an increasing number of technology platforms have been established in the

*User involvement is needed not only to passively test new products and services but also to allow users to become accustomed to multimedia and invite them to actively help in shaping the services they need*

*The successful development of multimedia services requires innovation, human resources, organizational concepts, software, marketing, etc.*

Netherlands to facilitate the introduction of technical systems or address specific societal issues. Some of these platforms were deliberately established/supported by the Dutch government as part of its technology policy. Some of these platforms are related to the development of multimedia products and services like the HDTV-platform, the National Chipcard Platform (NCP) and the Telework Platform.

Platforms as a tool for technology policy-making in general seem to have acquired a place among the other instruments of policy-making such as the scanning of new strategic technologies, foresight activities, awareness and information provision, subsidies for specific demonstration and research projects. Platforms can be used for such different purposes like bringing together the most relevant actors involved, stimulating the awareness of a promising technology, pooling R&D efforts, creating consensus on the most promising applications, preparing the actual introduction or starting a public debate on the impact of a certain technology. Platforms seem to be less suited as a tool to actually implement new technologies or infrastructures since the interests of the participants might differ to too great an extent.

*Technology platforms can be used to bring relevant sectors together*

The HDTV-platform clearly started as a technology and industry-driven mechanism to introduce and push HDTV and, later on, widescreen television (TV-sets, studio-equipment and productions) onto the market. It gradually became apparent that introducing HDTV not only meant the introduction of a new product, but also required a great deal of technological (e.g. from companies transmitting the signals to various kinds of content-providers), organisational and political support from a large number of actors.

Now, the HDTV-platform seems to be developing in the direction of a platform where the focus is on the introduction of new TV systems (including digital television). This change is reflected in the changed name - Dutch TV Platform (for advanced systems and services) - and also in a growing number of elements of the TV-production chain that will participate in the platform. It is expected that commercial broadcasters, TV-production companies, audio-visual production companies and other content-providers, as well as educational institutions, will participate in the revitalised and refocused platform.

The National Chipcard Platform (NCP), established in 1994 for a period of 4 years, plays an important role in introducing chipcards in the Netherlands in a coordinated way. One of the problems encountered is not so much in the card technology itself, but in defining creative applications, (distribution of) cost/benefits of these applications among members of the value chain and balancing their interests. The NCP was set up as a "foundation for coordination, information and reference", it was not established with the aim of implementing projects itself or to set up a national chip card infrastructure. NCP is primarily dominated by potential (intermediary and end-users), who are mainly private and public service companies about to start introducing chipcard applications on a large scale to differentiate and upgrade their service products.

The main design problem for the NCP is how to guarantee inter-operability and a general host mode. The NCP seems to offer the opportunity to better harmonise the interests of the various actors involved in the value chain, including (representatives of) end-users. It is generally acknowledged that in its first two years the NCP has been quite successful in performing the tasks set out for it.

## Implications for policy-making

The successful development of multimedia services requires more than product or service development. It requires innovation in intangibles - human resources, organisational concepts, software, marketing and advertising, distribution and logistics, image, design and brand names, reputation. Given the increasing weight of these intangible components in the innovation process, an important question is whether industrial and technology policy needs adjustment, and if so, to what extent and in what direction. A productive

follow-up might be the focus on the barriers and obstacles to intangible investment as an innovation factor, contributing to competitiveness.

A second point relates to user involvement in the innovation process. The case of digital cities points to a role for policy makers in stimulating user involvement, the actual design of policy instruments, and the transferability of experiments to other technological or geographical areas. With regard to the policy role in stimulating user involvement, a dual government role - sponsor as well as provider of information services - may prove to be fruitful.

Another success factor is a very low entrance barrier for citizens to participate in electronic information exchange. Current discussion in this area relates to the access to and pricing of government information.

Technology platforms can be used - and in many countries are used - for such different purposes as bringing together relevant actors, stimulating the awareness of a promising technology, pooling R&D efforts, creating consensus on standards.

They seem to be less suited as a tool for actually implementing new technologies or infrastructures since the great an extent. Technology platforms seem a useful method if the focus is on a specific technology which requires the involvement of different actors. However, in many cases they require critical mass and the cooperation and even the financial commitment of key persons.

**Keywords**

multimedia, publishing industry, digital cities, national chipcard platform (NCP), HDTV platform

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# Foresight and Innovation: The role of initiatives at European level

*Cecilia Cabello, Fabiana Scapolo, Per Sørup and Matthias Weber*

**Issue:** Foresight studies have been carried out in several countries in order to complement decision-making processes on emerging technologies. They promise to improve the ability to deal strategically with technological innovation and socio-economic change.

**Relevance:** Arguments in favour of a European level Foresight initiative, building on the results of individual national initiatives, have been voiced. The debates on the Commissions Green Paper on Innovation and on the 5th Framework Programme on Research and Technological Development also deal with this topic. In order for Foresight initiatives to play a beneficial role in relation to the planning and implementation of European research and technology policy difficult institutional and cultural issues will have to be addressed.

## The emergence of Foresight in the 90s

In the last five years a variety of exercises and studies have been carried out, figuring under the headline of Technology Foresight (Table 1).

In times of crisis and uncertainty, especially in relation to new technologies and economic recession, it has been regarded as a promising tool for dealing more successfully with innovation and socio-economic change. The value of Foresight is that it provides a structured opportunity to look ahead and consider the role that may be required of science and technology in the future.

It should be made clear that foresight is not about predicting the future, but it can help to overcome the limitations of a static analysis of the present situation. Foresight attempts to capture the dynamics of change by placing todays decisions into a context that includes the likely developments of tomorrow. It is not Foresight's purpose to replace more traditional methods of analysis, nor to define policy; Foresight is rather a process which adds a new dimension to our thinking about the future, and in the process elicits expert opinion and promotes relations between government, science and industry.

Foresight activities have three aims: Firstly, to try to identify events and seek opinions in order to prioritise future events. Secondly, to contribute to the development of a well informed support environment for resource allocation and funding prioritisation. Finally, it aims to promote co-operation and communication between actors from different fields so as to incorporate the viewpoints of a variety of societal interests.

Foresight forces large and important groups in society (individuals and institutions) to deal seriously and systematically with future possibilities. Thus, it prepares a platform on which the optimal interaction necessary for growth and welfare can be created. Foresight points out technological opportunities and societal demands, and at the same time it can identify possibilities to match them. In other

*Foresight provides the opportunity to look ahead and consider the future role of science and technology in a structured way*

**Table 1: Recent foresight exercises**

| COUNTRY | YEAR | INSTITUTION and TOPIC |
|---|---|---|
| Japan | 1988 | MITI - Trends and Future Tasks in Industrial Technology |
| Netherlands | 1988 | Ministry of Economics Affairs - Technology Foresight Experiment |
| Australia | 1990 | CSIRO |
| USA | 1990 | Department of Defence - Critical technologies Plan |
| USA | 1991 | National Critical Technologies Panel |
| Japan | 1992 | STA - Future Technology in Japan |
| New Zealand | 1992 | Public Good Science Fund Priorities |
| Germany | 1993 | ISI-FhG - Delphi based study: 2010-2020 |
| Germany | 1993 | ISI-FhG - Technologies at the Threshold of 21st Century |
| United Kingdom | 1993 | Office of Science and Technology - Technology Foresight Programme |
| France | In progress | Technology Foresight Programme |
| Netherlands | In progress | Dutch Foresight Steering Committee - Foresight Programme |
| Spain | In progress | ANEP - Technology Foresight Programme |
| Ireland | Planned | FORFAS - Technology Foresight Programme |

*Source Adapted from [3]*

words, it goes far beyond a purely technological approach, taking on board a variety of socio-economic factors.

There are a variety of methodologies implemented for Foresight exercises. According to a recent study [3], the methodologies used for Foresight activities can be divided into:

- Qualitative methods:
  (i) Brainstorming;
  (ii) The Delphi method,
  (iii) Scenario writing;
  (iv) Prospective.
- Semi-quantitative or judgmental methods:
  (i) Cross-impact methods;
  (ii) Relevance trees.
- Quantitative methods:
  (i) Substitution theory;
  (ii) Systems dynamic simulation;
  (iii) Econometric models.

Foresight exercises conducted by governments in industrialised countries have usually adopted brainstorming, the Delphi method, and scenario writing

The successful application of the Delphi approach in the Japanese Foresight activities since 1971, has influenced its adoption as one of the key elements of the UK Foresight Programme.

In the case of the British example the aims have been to forge a new working partnership between science and industry to assess emerging market opportunities and technological trends, and to inform decisions on the balance and direction of publicly funded science and technology.

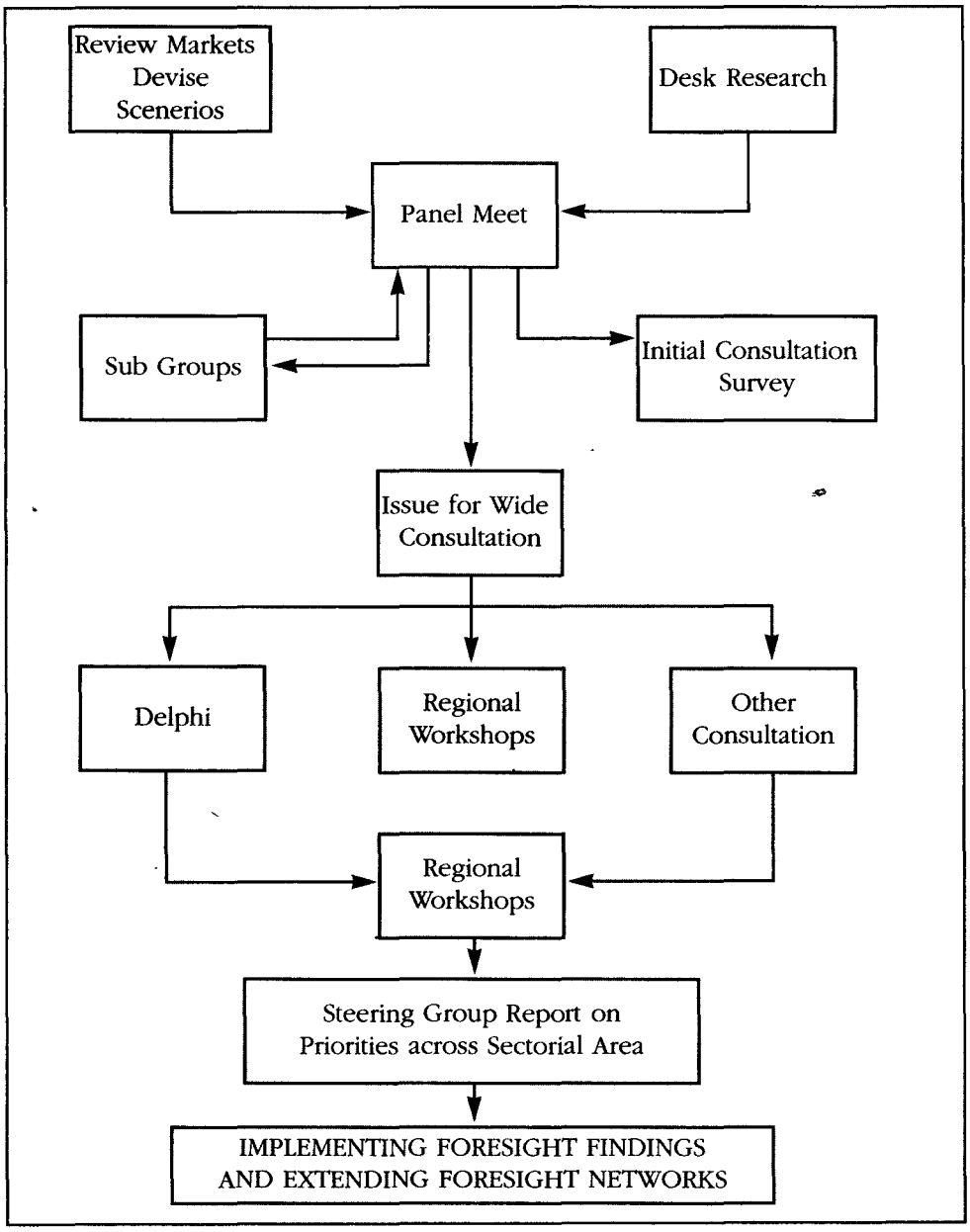
The overall Foresight approach was a complex one. In the preliminary phase, a Steering Group was appointed to oversee the programme, the main elements of the methodology were established, and

the experts for the Foresight panels were identified, while at the same time Government Departments and the Steering group defined the 15 areas. These were covering the full range of markets and technologies of concern to the UK. The main phase, which is described in Figure 1, included construction of scenarios by the Panels on their specific area, wide consultation with the relevant communities, the Delphi inquiries, and at the end the production of a report by each Panel.

## Foresight as a contribution to innovative performance

The initial motivation to start technology Foresight activities lies in the crisis in techno-economic development which affected many Member States, and in particular in the paradox of excelling in research on the one hand and losing ground in successfully translating invention into innovation and industrial production on the other. Japan's

**Figure 1: The structure of the UK Foresight**




*Source [4]*

economic success is characterised by precisely this strength in bringing inventions to the market successfully.

Technological innovation has been recognised as one of the key elements of competitive performance. This means also that the traditional factors of production, capital and labour, lose their predominant role in relation to competitiveness, in favour of factors which were assigned a secondary role in the past: knowledge, organisation/institutions and education/culture.

Foresight has a role to play in relation to all three factors.

First of all, it informs decision-makers about new developments, and about the establishment of common visions of the future, taking the longer-term needs of society into account. The latter is particularly important because the future is not predetermined, but is the result of todays actions.

Sharing a vision thus contributes to the orientation of diverging efforts into a similar direction and to the creation of a common knowledge-base on emerging trends and needs.

*Facilitation of access to dissemination of Foresight results and approaches throughout Europe is crucial*

Moreover, it helps to define criteria for targeted public and private R&D spendings.

Foresight is particularly beneficial when it is established as a permanent activity, because it provides a mechanism to adjust innovative efforts to socio-economic needs. The networks which are established between research, industry and government in the course of the Foresight process provide communication channels through which the different viewpoints on the future can be aggregated. This way, it is easier to achieve agreement on needs and priorities. The exercises performed in the member states have confirmed these beneficial effects [1, 3, 5]

This institutionalisation of networks is a first factor for making Foresight a constituent part of management and government practices. A second element consists of the emergence of a Foresight culture, which needs to be reflected also in education, training and the accumulation of experience from Foresight exercises. The results obtained in the UK have revealed that indeed the exercise has stimulated the incorporation of Foresight principles in the business processes of the participating firms [2].

## The opportunities and drawbacks of a European Foresight programme

Given the difficulties of innovating successfully mentioned above, initiatives are urgently needed to prevent a further decline in economic performance. Reducing the gap between the scientific world and business, both at national and European level, would be a major step in this direction. One action the Commission has taken in order to achieve this has been the setting up of task forces. A further possibility would be to extend to European level the Foresight exercises carried out in a number of Member States. This European Foresight programme could then be followed by concrete actions to promote the priority areas identified in the course of the process.

At the moment, a debate is underway on the possibilities for the implementation of an all-encompassing Foresight action at European level which draws on the international initiatives carried out in the main industrialised countries [3]. Despite the temptation to embark on a comprehensive European Foresight as soon as possible, the opinions on its usefulness differ considerably. Four main points can be identified in favour of an early start-up of a such an exercise:

- As shown by the national studies, Foresight is a useful tool for policy making support. Also at European level, the provision of better communication channels between all relevant stakeholders, and the creation of networks of experts on technology and innovation can be expected to have a positive impact. At the very least, gaps and misunderstandings between industry, research and policy-makers could be reduced.

- European Foresight would provide a long-term view of main expected trends. The availability of this knowledge would allow more targeted and co-ordinated efforts in science, technology and innovation, as well as in the upgrading of R&D infrastructures. This would be an important contribution to increasing European competitiveness.
- The broad socio-economic scope of Foresight means that it promotes the more direct taking into account of the needs of society in European policy. In principle, it could even be a helpful tool for identifying priorities and grid of criteria [6] for future Commission research funding.
- Finally, a shared vision across Europe as a result of an all-encompassing Foresight would help to achieve consensus on the strategic pathways to be taken in the main technological areas and facilitate the co-ordination of activities between member states and the Commission.

On the other hand, a number of important arguments can also be raised against a comprehensive European Foresight programme, at least at the present stage:

- Different national research and policy cultures exist, which will prevent a generally acceptable common approach to Foresight.
- Differences between national systems in terms of industrial and research structures may simply be too big to allow the definition of common European priority areas.
- If Foresight is to be given a more prominent role in feeding into the European research policy planning process, institutional adjustments will be necessary at the European level. Such changes are slow and step-by-step.
- Finally, the principle of subsidiarity is also relevant to Foresight. Despite the advantages of a common approach, many technological fields do not have a particular European dimension. National and regional diversity requires a tailored approach.

Experts seem to agree that it is doubtful whether a major and all-embracing European Foresight initiative would be feasible at the moment. On the other hand, a potentially beneficial role for the European Commission in providing support for sharing national experience and in promoting the Foresight approach throughout Europe has been recognised [5]. The crucial question is how this could be achieved in practice.

## Possibilities for European action to stimulate Foresight

Below the level of a comprehensive European Foresight Programme, a number of more limited possibilities for action can be identified in order to complement already existing activities, e.g. in the context of the European Technology Assessment Network (ETAN) or at the Institute for Prospective Technological Studies (IPTS). These proposals have also been discussed in the context of a consultation exercise as a follow-up of the Green Paper on Innovation [7].

A first possibility for action can be seen in the creation of a European discussion forum for National Foresight activities so that the studies and their results become more accessible to decision makers. The reasoning behind this aims at sharing national experiences, the identification and extension of Foresight practices, understanding the positions and interests in the Member States, and recognising regional, national and cultural differences in approaches to Foresight.

Despite present caution with regard to a general European Foresight, this does not mean that European exercises should not be undertaken at all. A second potential activity should therefore be seen in certain targeted Foresight actions which can most sensibly be carried out by European institutions. They would be of a more focused character than, for example the British Foresight programme. Exercises would be particularly appropriate in selected subject areas with a European dimension, i.e. in areas where Europe has already established an important policy platform as in agriculture, transport or energy.

Although a detailed methodology still needs to be defined, workshops or seminars bringing industry, policy makers and experts together to discuss

*Foresight exercises (Targeted) on key European technology issues could be considered*

specific topics seem to be a promising starting point. Such exercises would result in reference documents that include all relevant perspectives and highlight diverging opinions.

Building on such a shared knowledge-base, the key actors could then be invited to discuss particularly difficult or polemic issues, especially those that need to be treated at a European level.

As pointed out in the Commissions Green Paper on Innovation [7], business management needs a good notion of possible future developments, interdependencies and constraints in order for companies to survive in today's rapidly changing world. Obviously, this will require a solid understanding of the complex innovation process, and a stronger consideration of social and consumer needs, and this implies a departure from a narrow sectoral approach to innovation.

*Stimulating the use and provision of techno-economic intelligence services for business would be welcome*

This is considered to be of particular importance for small- and medium-sized enterprises (SMEs), which usually do not dispose of the competencies to access and apply techno-economic intelligence in the way that large businesses do. In other words, the diffusion of a Foresight culture in business, building on the widespread use of techno-economic intelligence would be an important step towards the improvement of European industry's performance. Consequently, it would be promising to launch a EU-initiative to stimulate the use and provision of techno-economic intelligence services, based on a decentralised bottom-up approach.

Emphasis should also be given to the training and education on techno-economic intelligence, in order to make sure that companies and especially SMEs can actually access, incorporate and exploit it.

## Conclusions

A number of clear potential benefits in terms of political support and industrial strategies can be identified in a Foresight exercise at European level.

In particular, the communication processes created would contribute to the establishment of greater consistency in the approaches to the key technological areas of the future. On the other hand, expectations should not be set too high.

Methodological problems, diverse national cultures and structures, and the difficulties of integrating Foresight institutionally point to the fact that a step-by-step process needs to be followed which balances these limitations and the range of European Foresight activities.

However, this does not preclude the possibility of carrying out European Foresight actions on specific subject areas in order to pave the way for a more a deeper penetration of decision making by foresight culture. They would be easier to handle and implement, and also reflect the higher degree of flexibility envisaged for the Fifth Framework Programme. In addition to this, and reflecting the principle of subsidiarity, a co-ordinating and disseminating function of the EU is recommended in relation to Foresight. In this sense, the Commission can also help to establish Foresight practices and adequate techno-economic intelligence services in business and industry.

These proposals are now on the way to being taken into consideration in Commission policies and programmes over the coming years, thus giving an innovative input to improve decision-making processes in Europe.

**Keywords**

Foresight, innovation, 5th Framework Programme

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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 across EU undertakings, contributing to and co-ordinating the creation of common knowledge bases at the disposal of all stake-holders. Though the work of the IPTS is mainly addressed to the Commission, it also works with decision-makers in the European parliament, and agencies and institutions in the Member States.

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