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The IPTS REPORT

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

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ABOUT THE IPTS REPORT

The IPTS Report is produced on a monthly basis - ten issues a year to be precise, since there are no issues in January and August - by the Institute for Prospective Technological Studies (IPTS) of the Joint Research Centre (JRC) of the European Commission. The IPTS formally collaborates in the production of the IPTS Report with a group of prestigious European institutions, forming with IPTS the European Science and Technology Observatory (ESTO). It also benefits from contributions from other colleagues in the JRC.

The Report is produced simultaneously in four languages (English, French, German and Spanish) by the IPTS. The fact that it is not only available in several languages, but also largely prepared and produced on the Internet's World Wide Web, makes it quite an uncommon undertaking.

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

The first, and possibly most significant indicator, of success is that the Report is being read. The issue 00 (December 1995) had a print run of 2000 copies, in what seemed an optimistic projection at the time. Since then, readership of the paper and electronic versions has far exceeded the 10,000 mark. Feedback, requests for subscriptions, as well as contributions, have come from policymaking (but also academic and private sector) circles not only from various parts of Europe but also from the US, Japan, Australia, Latin America, N. Africa, etc.

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

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EDITORIAL

The Essence of Mobilizing Human Energies in Organizations

Dimitris Kyriakou, *IPTS*

The question that can leave an auditorium-full of executives at a loss for words is: "Why should anyone want to be led by you?" (see Harvard Business Review, September-October 2000, pp. 62-70). Successfully mobilizing human energies in an institution often reflects the answers given to such essence-of-leadership type questions. Such mobilization can be particularly crucial during times of transition, such as shifts in technological or competitive environments.

Mobilizing human energies amounts to modifying the relationship between members (be they employees, co-owners, citizens, etc.) and the institution to which they belong from one of "involvement with" the institution to one of "commitment to" the institution. This is not a minor accomplishment and it may entail a substantial investment by all parties concerned, as it often raises the stakes of institutional undertakings to new heights (e.g. in organizations going through a turnaround experiment, or in states embarking on drastic reform). Unfortunately it is often at times of crisis, allowing little room for manoeuvre that the need to mobilize human energies appears more pressing and indeed when such tasks often undertaken.

Many institutions exist in environments characterized by perennial flux. The long-term success of the institution is largely predicated on its ability to adapt to changing circumstances. As changes in the environment are almost continuous, occurring in small imperceptible steps, and given the power of institutional inertia, institutional adjustment may not be seriously contemplated until the cumulative effect of such changes has reached salient if not alarming proportions. It is exactly at times like these when incremental alterations within the existing game plan may prove insufficient, and a thorough reappraisal and eventual reorientation of institutional practices may be needed – for which a successful mobilization of human energies is a *sine qua non*.

Naturally, the importance of mobilization of human energies is not limited to its role in dealing with crises. It extends to cases of lesser severity, which, however, do foreshadow changes in the institutional modus operandi (e.g. the arrival of a new leader in an organization, or a new government in a state). More generally, rallying human energies is key in handling discontinuities in institutional practices.

The case can be made for the view that the institution can be viewed as a machine that will work properly if its component parts complete their tasks as expected. In order to achieve this goal it would be enough to: i) analyse the system's components and their interconnections; ii) produce a model of its operation and, on the basis of this model, iii) produce and apply a schedule of rewards and punishments to direct human energies towards the completion of their appointed tasks.

This carrot-and-stick approach, though not without support, would fail in the cases in which successful mobilization is most urgent. First, this approach applies only when tasks are largely standard, well defined and unchanging. It does not help when the organization is facing a drastic overhaul of its operation, when the nature of the tasks is changing and the institution is moving into uncharted waters.

Second, the supervisory costs this approach implicitly downplays may actually be too high. In certain industries abnormally high (by competitive standards) wages are paid to prevent shirking by employees in tasks where both shirking and supervising are very costly for the organization (such wages are usually called 'efficiency wages' in the literature).

Third, an approach that treats humans as robots may overestimate their acquiescence in such treatment, and may underestimate their ability to find loopholes allowing shirking.

Fourth, when inputs are of the expected kind, the kind that the system has been programmed to handle, a carrot-and-stick model of the sort suggested above may perhaps work – with all the caveats mentioned - in times of 'normal' operation (where the analogy with Kuhn's 'normal' science is intended). During times of transition however, the behaviour of the system may become chaotic, in the sense that a small perturbation, a tiny mishandling in an initial phase (e.g. due to ill-suited pre-programmed instructions appropriate for a 'normal' period) may lead to catastrophic results down the road. More succinctly, the degree of freedom of the system at such junctures varies tremendously.

Finally, a strict reward-and-punishment system may be effective in accomplishing certain tasks of a repetitive nature but at the cost of putting human brains in straitjackets, constraining their creativity to near-triviality levels, of the one-plus-one-equals-two type. We have found in the last few years that the "brain operates on different kinds of mathematics from the norm. It is a synergetic mathematical organ, device,... an associative machine that with one plus one can generate infinity"[1]. It is this kind of creativity that we sacrifice in mechanistic modes of operation, precisely the kind of creativity which could help us at times when successful mobilization of human energies is of the utmost importance. Due to space limitations we will limit this analysis to criticism and postpone suggestions of alternative strategies for future issues.

Note

1. Tony Buzan's presentation on Creativity in Beyond 1992: 22nd International Management Symposium at the Univ. of St. Gallen, Switzerland, Best Essays, p. 129, 1992.

Mobile Europe: Harnessing Rapid Change to meet European Needs

Matthias Weber and Jean-Claude Burgelman, *IPTS*

Issue: Over the next ten years Europe will be confronted with the full impact of both the single market and the effects of the emerging e-paradigm; the combination of which implies new ways of living, working and producing in Europe. The "Mobile Europe" concept is put forward as a guiding framework that could be helpful in reconciling the drivers of change in the network economy with the values and objectives of an integrated Europe.

Relevance: European policy cannot simply sit back and hope to benefit from the emerging e-paradigm in the single market. There is a risk that social and political tensions will emerge and that economic opportunities will be missed. Policy needs to give direction to the inevitable changes ahead and to create the frameworks necessary to ensure they are exploited to the full.

The Information Society Technologies revolution is emerging as a new paradigm that is set to transform our patterns of living, working and producing

The e-paradigm as a key driver of change

The IST (Information Society Technologies) revolution is emerging as a new paradigm (the so-called "e-paradigm") that is set to transform our patterns of living, working and producing[1] although clearly there will be differences between sectors in terms of the magnitude and timing of this transformation. Production systems are becoming more flexible, global and real time; patterns of work are increasingly shaped by the use of computers; digital devices are entering society at all levels and the emergence of "ambient intelligence" or "ubiquitous computing" could change our daily lives fundamentally.[2] What is unique is not only the scale of the change, but its speed, which is regarded by many as unprecedented in the history of mankind.

Nevertheless, the e-paradigm not only has a technological dimension (e.g. mobile communications, the internet and pervasive computing), but is also rooted in social phenomena, such as the emergence of the mosaic society, economic developments such as electronic business, (the so-called "e-conomy") and political drivers, such as EU enlargement, on the one hand, and increasing regionalism within states on the other.

In the European context in particular, the pressure for change is further augmented by other drivers such as enlargement, the economic integration process, demographic transformations and migration. Some of these forces are an expression of political will, others reflect wider social and economic developments.[3]

In view of these fundamental ongoing transformations, Europe faces (at least) two major challenges. First of all, the e-paradigm could jeopardize a number of the societal goals, values and principles, for which Europe stands. However, at the same time the e-paradigm promises tremendous economic and social opportunities. The balance between the opportunities and risks depends on actions to be taken now and in the near future. For example, social cohesion might be affected by the widespread uptake–or lack of uptake by some groups if the predictions of the digital divide are fulfilled–of ISTs. Indeed, these technologies offer opportunities for connecting less-favoured regions more closely to the main economic centres in Europe. However, ISTs and related service activities offer potential "economies of scope" that tend to favour clustering around the main existing centres. Similarly, major European cities are increasingly integrated in the global business networks, while at the same time the gap between their centres and their peripheries is tending to grow. Another clear trend is that we are moving away from the traditional 9-to-5 society, towards a 24-hour society, at least in the major cities. This can bring many advantages, for instance in terms of access to services around the clock, but at the same time it challenges the institutions and frameworks on which stable working and family life are based.

The second major challenge that these drivers raise concerns many of the traditional spatial and institutional boundaries framing economic and social life. This particularly affects political and legal frameworks, and the organization of (public) services, which still tend to be defined at national or regional level. The level at which framing actions need to take place are shifting increasingly either to the European and global level, or to the local level. Both globalization and localization are facilitated and enabled in many ways by IST. While the efforts to build a European or global institutional framework to match the global and European scale of many of the drivers of social and economic change come up against a number of concerns, there is a desire–as expressed in the Commission's position on modern governance–to bring decision-making closer to the grassroots level.[4] The role of flexible markets in dealing with the challenges of the new economy should also be underlined. In any case, a growing divergence is becoming apparent between the emerging requirements of the new economic and social space on the one hand, and the existing institutional and policy context on the other.

The key future task for Europe is thus how to reconcile the new techno-economic paradigm with the main European values and policy goals. To achieve this, new organizational and institutional principles of governance will be required. What is needed is a guiding framework that can help policy make the necessary choices to mould future developments in a desirable direction.

The notion of a "Mobile Europe" is put forward here as a basis for formulating a roadmap that helps to reconcile these forces for change with the characteristics and goals of the growing European Union and the society it is home to. It stands for a European approach designed to exploit the potential benefits of the e-paradigm in an open market under the current circumstances of rapid change, which at the same time respects Europe's social values.

Mobility, as used here, has a wider scope than just the fields of transport and labour to which the term has traditionally been applied. Rather, we use it here to encompass a wide range of areas of social and economic concern. Obviously, infrastructure

In Europe the pressure for change is further augmented by other drivers such as enlargement, the economic integration process, demographic transformations and migration

The challenge for Europe is how to adapt to the changes wrought by the information revolution in a way that preserves its diversity, welfare and social values

The notion of a "Mobile Europe" is put forward here as a basis for formulating a roadmap that helps to reconcile these forces for change with the characteristics and goals of an expanding European Union

The principles of accountability, visibility, transparency, coherence and effectiveness are the elements of a style of governance compatible with a Mobile Europe

A Mobile Europe needs to guarantee maximum access to European networks so as to allow all its citizens to participate to the full

A Mobile Europe needs to foster compatibility between the different networks and applications of Europe so as to allow seamless interoperability

systems such as transport or telecommunications have an important role to play, as have mobile labour markets. But also less obvious areas can be captured by the concept of Mobile Europe: social security systems that need to enable the easy transfer of social rights, research systems that favour the exchange and mobility of qualified researchers as well as the creation of European research networks[5], flexible production systems and public services, and a culture of tolerance that is open to change. Finally, perhaps the most important elements to be considered are the ways in which Europe's citizens live, especially in the major cities where the pace of change is fastest.

Mobile Europe thus represents an emerging new way of living, working and producing in Europe that acknowledges the challenge of the e-paradigm (in terms of speed and flexibility) and reconciles it with the main principles and goals of European society (i.e. social cohesion, welfare and cultural diversity). From this perspective, a Mobile Europe would be subject to the same principles of modern good governance the EU has set for itself, namely accountability, visibility, transparency, coherence and effectiveness.

Governing Mobile Europe: what is needed?

A Mobile Society conceived of in these terms imposes a number of new requirements that will need to be met by society in the future. These requirements apply not only to social and economic life, but equally to governance in Europe. The principles of accountability, visibility, transparency, coherence and effectiveness just mentioned can indeed be interpreted as elements of governance compatible with Mobile Europe. More specifically, the new requirements created by the mobile society can be summed up in the following five principles:

- **Accessibility of networks**: Mobility means that all citizens, workers and consumers, wherever they are, should be able to tap into the physical or non-physical networks they need for their work and everyday life. For accessibility to be a reality both the social and economic barriers need to be brought down. In the case of communications networks this not only means that cost should not be a barrier, but that the skills required need to be within reach of the average citizen. However, the issue of access is not only applicable to information networks like the Internet, but also to energy and transport networks. A Mobile Europe therefore needs to guarantee maximum access to European networks so as to allow all its citizens to participate to the full.

- **Compatibility and feasibility of transfers**: While accessibility mostly concerns a one-way interaction, the possibility of exchanging work and intangible goods, and the potential for communication between regions and countries, demands that units of exchange are compatible. Products need to comply with specifications and meet certain standards (e.g. for safety or environmental reasons) and services need to fulfil pre-defined quality standards if they are to be widely accepted. Most obviously, electronic exchange needs to rely on a set of well-defined standards to work at all. However, additionally, social rights should be compatible independent of location. A Mobile Europe therefore needs to foster compatibility between the different networks and applications of Europe so as to allow seamless interoperability.

- **Tradability and economic exchange**: Once economic value is assigned to the exchange of goods and services, a Mobile Europe needs to guarantee that these exchanges can be performed smoothly, and under conditions of equal opportunities, so it is possible to work and do business from all points of Europe. A Mobile Europe therefore requires the thresholds for e-commerce to be lowered as far as possible for all locations and business types so as to create a level playing field and foster a thriving and "universal" e-market.

- **Cohesiveness and consistency with culture:** A Mobile Europe can only work if the patterns of working, living and producing are compatible with local and regional cultures. Imposing an elogic alien to the diversity of local cultures in Europe would most likely not be sustainable. Indeed, it would be likely to create protests and social tension, for example of the type recently seen in the movement against globalization. A Mobile Europe therefore needs to operate bottom up, by exploiting the diversity of its cultures rather than seeking to impose a unified approach.

- **Adaptability:** Successful regions, cities, firms and individuals will be characterized by their flexibility and ability to react to changing circumstances. A mobile Europe therefore needs to develop the rights tools and policies to stimulate innovation-mindedness at every level.

Meeting these five requirements will be essential if Europe is to remain globally competitive in the new networked e-conomy. However, they also reflect Europe's social goals. There are different possible ways of addressing the challenge of coping with and shaping the emerging e-paradigm. Technology, and especially ICT (Information and Communications Technology), may underlie much of the eparadigm and also be the source of many of the risks is poses, but technology also has considerable potential to help address these risks. At the same time it can help to create the innovations that are needed to realize Europe's social and policy goals.

Realizing a Mobile Europe on different levels

The challenge of making Mobile Europe a reality can be approached on three different levels. While the Trans-European networks initiative looked at the transport, energy and telecommunications problems in Europe mainly from an *infrastructure* point of view, mobility, as understood here, also addresses two additional dimensions: the *legal and institutional background conditions* and the actual *patterns of living, working and producing.* All three together (infrastructure, context conditions and patterns of living/working/producing) constitute Mobile Europe, and on all three levels there are still many problems to be solved in order to meet the requirements of a Mobile Europe, though these problems vary greatly from area to area.

Regarding the first level, the *creation of flexible infrastructures,* is one of the overarching issues not only for guaranteeing access in a technical sense, but also for ensuring equal access for the entire population. In both transport and telecommunications, the infrastructure part is quite well developed or continuously improving, though most of the highways of Europe seem to have reached their saturation point. Not only are there capacity bottlenecks (such as those in air traffic), but also in many cases the physical traffic-capacity limits seem to have been reached. The constant traffic jams, near-permanent delays etc., in most European countries speak for themselves. In the case of ISTs the issue of accessibility is more one of a deficit in the skills that are required to ensure equal access than deficiencies in the network itself. Competition means Europe is getting wired very quickly, and a potential digital divide is therefore more likely to be due to the lack of net literacy than a shortage of hardware. A typical problem with infrastructures used to be their inflexibility, i.e. once established, they are hard to change. Here too, newly emerging IST infrastructures and devices (e.g. mobile telephony, personal digital assistants etc.), and applications in the field of ambient intelligence offer new solutions.

Enhancing mobile ways of living, working and producing is the second level at which the issue of

A Mobile Europe needs to operate bottom up, by exploiting the diversity of its cultures rather than seeking to impose a unified approach

The challenge of making Mobile Europe a reality can be approached on three different levels: infrastructure, context conditions and patterns of living, working and producing a Mobile Europe needs to be addressed. As we move from a 9 to 5 industrial logic towards a 24-hour economy and society, global production systems remain in operation all day long, by switching key data from Asia to Europe, then from Europe to America, and then back to Asia again, around the clock. A contradiction is emerging between the way of organizing working and living we have inherited from the industrial society and the needs of the competitive 24-hour society.

A contradiction is emerging between the strictly delimited patterns of working and living we have inherited from the industrial society and the needs of the competitive 24-hour society

In particular within the enlarged Europe the creation of such integrated and coordinated production systems is likely to become a crucial issue for competitiveness (See Box 1).

The way life in cities has changed is perhaps the most striking example of Mobility and its implications. The major cities have turned into the hubs of the global production system and operate around the clock. Shops and supermarkets are increasingly open 24 hours a day. What is striking is that the social support systems that have stabilized the industrial logic of producing, working and living have not yet developed new modes of supporting a 24-hour society. The main deficits in this respect

Box 1. Mobile Production and Distribution Systems in Europe

One of the economic opportunities for Europe in the years ahead will be to exploit the potential synergies between the economies of the pre-accession countries and the EU15. One of the opportunities for achieving this is the existence of highly integrated production systems that are coordinated by means of advanced ISTs and logistics.

For such systems to operate smoothly excellent *infrastructures* are required for both high-speed telecommunications and for the physical transportation of goods and intermediate products. The issue of the *legal framework* necessary to make this coordinated production operate smoothly is being addressed by the implementation of the Single Market programme, both within the EU15 and in the pre-accession countries. This will cover issues such as recognition of standards and norms, environmental regulations, etc. The actual setting up and *operation of such highly integrated production systems* is first of all a task for the private sector, even if similarly advanced forms of networking are likely to become imperative for public administrations in the future, too. The automotive industry has been at the forefront of integrated production across Europe. In fact, research and development is also increasingly carried out cooperatively between different sites, with each of them drawing on its specific strengths and competencies. Hungary, for example, has not only attracted major production sites for key components, but has also turned into an important location for automotive R&D.

In many cases, the cooperation in such networks no longer operates within the confines of a single company but is outsourced to a multitude of firms which are interconnected by means of e-business portals. The recent initiatives by car manufacturers to set up B2B (business-to-business) portals for dealing with their suppliers is just the latest element of a longer-term strategy of reorganizing business relationships. Again, this applies not only to standard operations, but also to certain R&D tasks that are carried out jointly with first-tier suppliers or are entirely outsourced to contract research organizations.

Similarly, the relationships with the final customers are changing. Products and services are increasingly available on the web, even if cautious assessments are being given for the potential for selling complex products and services on-line directly to customers. Additionally, the influence of the final customer on design and definition of the final result is changing rapidly. Customization is increasingly required by the end-user, implying either local presence strategies (e.g. in car manufacturing, or many services) or excellent customer service through the Internet (the Dell model). For Europe to gain a competitive advantage from enlargement, it will be necessary to introduce such practices extensively.

can be found in areas such as childcare, education, and access to public services (see Box 2).

Another area in which we are still far from achieving a Mobile Europe is the labour market. Not only are there language and cultural barriers to labour mobility, but also the social security systems (e.g. transfer of pension rights, health insurance) are extremely inflexible. The research systems in the European member states are a prime example of institutional barriers to mobility. In many countries, universities in effect allow very limited access to foreign candidates. This not only has implications for pursuing lifelong learning for mobile workers, it also underlines the urgency of the recent EC initiative on the creation of a European Research Area.

The third level on which a Mobile Europe needs to be addressed is that of *the legal, institutional and contextual conditions* that govern economic and social life. The issue of transferability of pension rights or of unemployment benefits mentioned earlier is a problem of legal frame-

Social security systems and education systems still represent barriers to worker mobility in the European Union

The demands of the 24-hour economy call for a rethink of the educational, child-care and work system

Box 2. Living and working in a post-industrial society

Since World War II, a number of global shifts have occurred in the way life is organized in Western Europe. First, labour has moved completely out of the private and into the public domain, where it has been organized according to standardized and usually highly formal procedures (nine to five, etc.). Freelance and wage work at home, living next to the factory, and so on, have become things of the past. Thanks to the rise of the unions, collectively negotiated labour agreements, etc., labour and related activities also moved into the public domain. Moreover, the twentieth century's increased mobility rendered the link between the place where one works and the place where one lives less important.

New technologies are now reversing this process and bringing work back into the private domain. Part of the appeal of teleworking, for example, can be explained by the need to make labour more personal (as well as allowing people more choice over where they live and the hours they work). But, in the meantime the private sphere has also changed. Many tasks that were once the preserve of the private domain - like education and training - have become public. One driver of this phenomenon is the increase in the number of women in the workforce. This was the result of the demand for more labour in the fifties as well as of a change in female identity brought with the rise of feminism.

In short, two trends have dominated Europe since World War II.

- First. the shift from the industrial organization of work to a post-industrial pattern and the demands for change in the related institutions (labour unions, schooling system and so on).
- Second, the shift from life in the "extended family" a more individual-centred model.

The convergence of both trends, i.e. the individualization of living and working, is underpinning the development of what is being called the "mosaic society" and constitutes the focus for many areas of tension that are likely to emerge in the future.

In the traditional or "industrial" model, working, living, learning, etc were clearly separated in a logical, well delimited (9 to 5) sequential order - school, student, learning, work, kids, etc. The demands of the 24-hour economy, with its requirement for permanent availability and flexibility of services, the labour force etc. has disrupted this pattern. Thus a tension has arisen between the industrial way of organizing life, which still persists in certain areas, and the demands of the 'informational', service based, way of working and living.

works. The barriers to access to the educational systems are institutional in nature and are only beginning to be broken down at university level. At lower levels of education, however, considerable barriers still exist. But mobility also has implications for school hours. Nowadays schools start in many countries at 9 and stop at 4. In the 24 hour e-conomy, work is no longer organized according to this schedule and therefore a rethinking of the educational, child care and work system has to be on the agenda if society is to be made conducive to family life.

In order to create Mobile Europe we need a better diagnosis and analysis of what areas are likely to be most affected by the new paradigm, and also we need a debate about what we want Europe to look like in the future

In other areas, such as electronic commerce, standards are a key part of encouraging uptake. The Single Market regulations, based on the principle of mutual recognition, provide an example of how national regulation standards and the need for free flow of goods within the European market could be reconciled within an overarching framework.

Anticipating and preparing for a Mobile Europe: A key task for policy

The overall challenge outlined is of a magnitude that will require a major joint European effort if it is to be met. In fact, the creation of a Mobile Europe could be understood as the next step, after the creation of the Single Market and the Monetary Union, toward building a competitive Europe and maintaining a high quality of life.

The areas of greatest relevance for the new paradigm include decoupling transport and growth, examining how electronic business networks will affect production patterns, studying the opportunities networking offers for health-care services, and the more general impact of the e-paradigm on living and working

Mobile Europe refers to two sets of ambitions. On the one hand, it refers to the need for people, capital, goods and services to move freely and seamlessly around Europe in order to respond to the economic, social and technological challenges which a unified market, European enlargement and a globalized world impose on the EU. On the other hand, a mobile Europe also refers to the distinctive ambitions of European societies to maintain their identities and qualities of life. Mobile Europe therefore is a Europe-specific paradigm to create a more attractive location in which to produce, and also to create a better place in which to live and work.

In order to develop a strategy for moving towards a Mobile Europe, two important preparatory steps should be made as soon as possible. First, we need a better diagnosis and analysis of what areas are likely to be most affected by the new paradigm. Secondly we need a debate about what Europeans want Europe to look like in the future (i.e. a debate on our vision of the future in the era of the e-paradigm).

Regarding the first requirement, we need to deepen research and refine our understanding of mobility requirements and how a Mobile Europe could be achieved. There are a number of candidate areas that seem to be particularly affected by the changes described. In these areas a better understanding of the emerging changes, opportunities and risks would be a valuable contribution. Moreover, the Europe-wide relevance of these issues means they lend themselves to in-depth consideration in future European research activities:[6]

- *Transport and mobility visions for an enlarged Europe*: In this area it is necessary to look beyond the construction of new infrastructures, and to try to explore new forms of e-mobility and organizational solutions able to satisfy mobility needs with less physical transport. It would encompass the definition of critical paths and the outlining of policies to achieve a decoupling of transport and economic growth by a wider use of ICT-based solutions.

- *B2B-commerce and its impact on production structures*: Investigation in this area should focus on changes in the structure of production systems, and also look at the critical role of payment systems and web-based interfaces to enable and facilitate the introduction of new production and distribution systems in Europe.

- *Community services in the health sector:* This area represents a large item of expenditure for society and one which is set to grow as populations age and new health-care technologies come onto the market. The focus here should be on the impact of new distance services and medical data exchange on economic efficiency and patterns of organization in the European health sector. There is the potential for improving the health sector's efficiency by networking specialized health centres using IST. Making the health sector more mobile would also imply strengthening such patterns of cooperation (but also of competition) across national borders which, at the moment, are still underdeveloped.

- *Mobile media services and patterns of living in future cities*: Research in this area could look at the transformation of space and time in and around cities, as well as between cities and their hinterlands. New "good" practices of how life and work are organized and facilitated by local policies need to be continuously monitored and exchanged, and collaboration fostered through the development of global cities networks.

- *Open labour markets in Europe and cross border communities*: The barriers to an effective single labour market, and the means to overcome them, need to be studied. For example, the lack of mobility of social protection across national borders has been identified as a critical impediment to labour mobility[7]. This research issue also links up with the current debates on future education systems and the creation of European cross-border research networks.

Regarding the second requirement, we need to shape a mobile society that is compatible with Europe's values and goals. At the moment it does not seem to be very clear what Europe wants to look like in ten or twenty years time, or at the very least there seem to be competing visions.[8] A wider societal dialogue about the objectives of a Mobile Europe project would thus be important, along the same lines as the intense debates we saw during the preparation of the Single Market and Monetary Union projects. This would even be a requirement in terms of the principles of governance for which Mobile Europe stands.

As part of this debate, research policy will have to make sure that the implications, consequences and mechanisms underlying Europe's move towards a Mobile society are better understood so as to inform decision-makers about the options and risks at stake, and to give guidance regarding the possible choices. This could perhaps be taken into account in the Sixth Framework Programme, which could use Mobile Europe as a model issue to bridge traditional S&T issues and socio-economic concerns, especially since the European Research Area initiative seems to be very much in line with the notion of a Mobile Europe.

Keywords

mobile economy, 24-hour society, e-conomy, European governance, European values, European Research Area, Sixth Framework Programme

Notes

1. We prefer the term Information Society Technologies over Information and Communication Technologies as it suggests a more citizen-centred approach to technology.
2. Ubiquitous computing and ambient intelligence denote the pervasive and interconnected application of computing power to all kinds of activities. For more details, see *Information and Communication Technologies and the Information Society,* ICT panel report, Futures Report Series 03, EUR 18730, IPTS, Seville.
3. These drivers of change have been analysed in more detail in the IPTS Futures Project. See the various reports at: **http://futures.jrc.es**
4. See Romano Prodi's speech "Shaping the New Europe", European Parliament, Strasbourg, 15 February 2000. Available on the European Commission's website: **http://europa.eu.int**
5. Regarding the research world , the Mobile Europe concept overlaps obviously with the European Research Area Initiative launched by Commissioner Busquin in January, and specified in a recent Communication of the Commission (COM(2000) 612, 4 October 2000).
6. The list of topics suggested for more in-depth study was developed at a workshop organized by the IPTS in Barcelona on 29the June 2000.
7. See the new Social Policy Agenda until 2005 that was adopted by the Commission on 28th June 2000.
8. G. Bertrand, A. Michalski, L. Pench, *Scenarios Europe 2010, Five possible Futures for Europe,* Forward Studies Unit, 1999. Available from: **http://europa.eu.int/comm/cdp/working-paper/senarios_an.pdf**

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Integrated Land Use and Transport Planning: the Way Ahead for Europe

Tomás de la Barra, *Modelistica*

Issue: The integrated land use and transport planning approach allows the creation of a more comprehensive and consistent picture of the effects of a transport project, thus helping decision-makers produce better plans. Such an approach also allows the economic, environmental and social impacts of transport to be taken into account.

Relevance: Land use planning and transport planning are dealt with by separate departments in most urban areas and regions around the world, in spite of overwhelming evidence that both aspects make up a single and highly integrated system with profound consequences on quality of life and the environment.

Introduction

Traditionally transport plans are prepared on the basis of given assumptions about the future location of activities and uses of land. In turn, most land use plans are prepared on the basis of preconceived ideas about how urban areas and regions should develop, and pay little attention to the effects of transport infrastructure and services in shaping our cities, and indeed may even ignore how the real estate market actually works. Given this state of affairs, it is not surprising that investments in transport infrastructure often clash with urban plans, and that the actions of developers are not always in tune with the good intentions of city planners.

The methodologies used for designing trans-port and land use plans also differ considerably. Transport planners tend to be rigorous in their analysis, resorting frequently to computer models that simulate the behaviour of travellers. Such models are calibrated against surveys, traffic counts and other observations of the real system. Urban planners, by contrast, do not base their designs on formal methods, but instead use their experience and knowledge of the area in heuristically. It is common for projections about the future location of activities and the use of land to be decided by panels of experts.

Land use plans frequently pay little attention to how the transport infrastructure can shape our cities

Transport planners tend to make more use of computer models and observations of the real system than urban planners, who often leave decisions to panels of experts

This situation is, however, changing rapidly. On the one hand, theories and models that represent urban areas or regions in an integrated way are increasingly becoming available. The widespread availability of personal computers, databases and geographical information systems facilitates the use of integrated modelling. Moreover, the planning community is recognizing the importance of the integrated approach. This has come about as a result of pressures from the community at large, *More readily available computing power and better models are changing this situation, and planners are increasingly recognizing the importance of the integrated approach*

Transport plans compare models with and without the proposed new infrastructure and analyse the costs and benefits. The problem with this approach is that it does not fully take into account the way the infrastructure may encourage activities to relocate

For example, a new motorway may provide initial benefits in terms of reduced congestion and emissions, but by making outlying land more accessible, commuters will be encouraged to travel further and congestion will again increase

from a growing concern with protecting the environment, and in some cases, through specific legislation. The most notable case is ISTEA (Intermodal Surface Transportation Efficiency Act), a bill passed in the USA in 1991 that makes integrated analysis a requirement there.

This article begins by discussing the importance of the integrated approach in improving urban areas and regions worldwide. The main elements of the urban system are described and the main relationships between activities, developers and the transport system are presented. This is followed by a brief review of the analytical tools that are available to make the integrated method possible. Next, a discussion of the various ways in which such tools may be put into practice is presented. Finally, the benefits to European cities and regions are discussed, and some specific actions that can be taken to promote the integrated approach are put forward.

Why is integrated land use-transport analysis important?

Transport plans, such as new roads, railways and other facilities, are traditionally analysed using transport models. Typically, a set of trip matrices is estimated and assigned to a multimodal network. The model estimates congestion and reallocates traffic to alternative roads until a state of equilibrium is reached. Estimates of the travel matrices are then projected into the future, usually based on the expected location of population and economic activities, as devised by urban planners. Such matrices are also assigned to the network, both in a baseline scenario where the proposals are not included, and another scenario in which they are. The results of the proposal are compared to the baseline case to estimate the economic benefits to users of the transportation system, to the operators of the transport services, and to the environment. The environmental impact is estimated in terms of congestion and emissions responsible for degrading air quality.

The problem with this approach is that the future location of population and economic activities does not necessary consider the proposed transport investments, at least not in a consistent way. In fact, transport planners usually adopt the same matrices for the "with" and "without plan" simulations. However, it is evident that the future location of activities will be affected by the proposed projects in important ways.

A typical example is the proposal of a new motorway to alleviate traffic caused by commuters travelling from the outskirts to the city centre. Following the model described above, results will probably show that travellers will perceive benefits in terms of reduced travel times and costs, operators will benefit from operating cost reductions, and fewer emissions will be generated thanks to the fact that vehicles travel at speeds and spend less time on the road. There may also be additional benefits in terms of reduced accidents, noise, and other externalities. The sum of these benefits is compared to capital costs in a typical cost-benefit analysis.

The above approach ignores the land use effects that may derive from the proposed motorway. In the short term, it is possible that the project will generate the envisaged benefits, but an integrated analysis can give a different picture for the longer term. The new road improves accessibility to peripheral land, thus allowing population and activities to grow, often at the expense of prime agricultural land. In the end, the number of commuters might well increase, and they will travel longer distances, thus consuming more fuel and generating more emissions.

Another possible consequence of the proposed motorway is that population will sprawl, i.e. move away from the centre into lower density housing developments, making it more difficult to run effective public transport and making the population more car-dependent than before. Lower density housing is also less efficient from the point of view of energy use and so also adds to emissions. These effects must be evaluated and added in to the cost-benefit accounts.

Social consequences also need to be taken into account. The new road will drive population, shops and businesses away from the city centre, which could decline as a consequence. These processes can affect each social group differently. Higher income groups are more likely to move out to the suburbs, while lower income groups with lower levels of car ownership and who are unable afford the larger plot sizes will tend to stay in the centre, thus deepening social and spatial segregation.

These are the main arguments in favour of the integrated approach. Any transport project will have effects on land use, and these need to be taken into account in the simulation and evaluation processes. By considering such effects, not only will the results of the traffic assignments and emission estimates be different, but land consumption may also be evaluated, together with a number of social and environmental indicators. In sum, the integrated approach will show a more comprehensive and consistent picture of the effects of a transport project, thus helping decision-makers produce better plans.

What tools do we have to implement the integrated approach?

The last couple of decades have seen important advances in the development of integrated land use and transport models. The theoretical developments, in fact, go back much further, to the first spatial economists of the early 1800s. But it was in the 1960s that a comprehensive theory of urban and regional settlements became available. It then took 20 more years to derive practical models from the theory, and so to make it possible to test hypotheses against the evidence. Nowadays we have a number of practical integrated models that can be used to assess the combined effects of transport and land use policies. Such tools are rapidly becoming the *new* way of looking at urban and regional plans, combining a large number of effects comprehensively. Traditional transport-only models are limited in their analysis compared to this new breed of integrated models.

Figure 1 summarizes the current paradigm on which this new generation of models is based. The urban system definition distinguishes between two main elements: activities and transport. In this scheme activities are located in space and interact in various ways. In order to perform their functions, activities, such as industry, services and households, need land and buildings of various types. In order to satisfy these requirements, they must "consume" buildings and land from a given stock. Because this stock is limited, the system is balanced by land rents. If there is too much demand for space in a given location, land rents will go up. Activities can react by consuming smaller amounts, that is, increasing densities, or changing location.

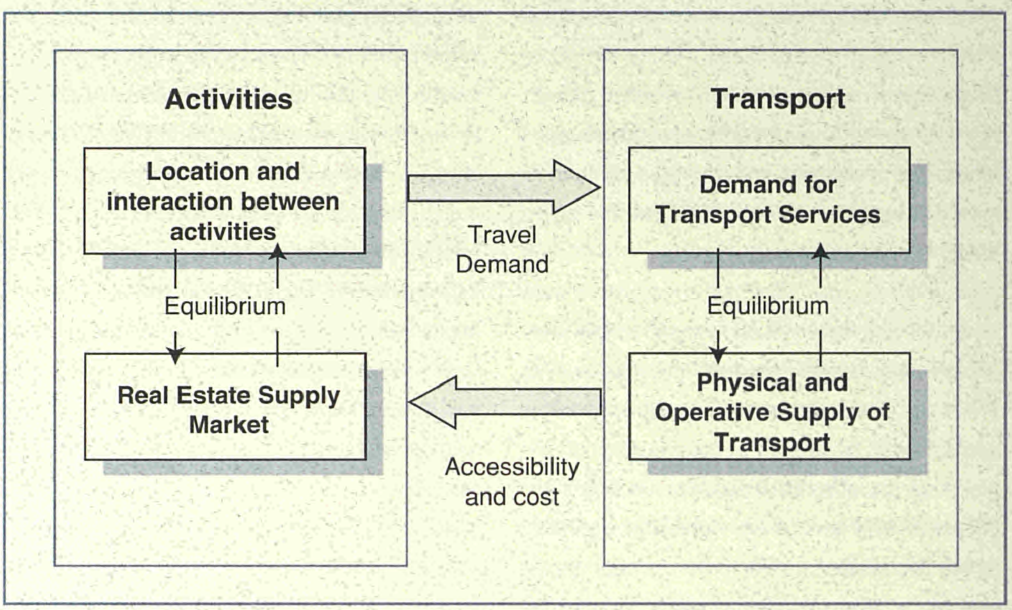
The spatial interaction between activities gives rise to transport demand, in the form of trips to reach work, services, education, recreation, etc. Travel demand interacts with supply, in the form of a given infrastructure (roads, railways, etc.) and services (bus routes, metro lines, cars, truck companies, railway routes, and so on). In this case equilibrium is achieved not only through prices, but also through time, as congestion evens out the differences between supply and demand. The equilibrium solution may lead to high levels of congestion, long commuting times and considerable harm

The integrated approach takes into account the fact that any transport project will have effects on land use that need to be considered in the simulation and evaluation processes

A number of practical integrated models that can be used to assess the combined effects of transport and land use policies are currently available

The spatial interaction between activities gives rise to transport demand, in the form of trips to reach work, services, education, recreation, etc. Travel demand, in turn, interacts with supply, driving changes in infrastructure and services

Figure 1. Interaction between land use and transport



Source: Tomás de la Barra

to the environment. Perceived equilibrium costs are turned into comparative accessibility indices for zones. Accessibility is a very complex variable, but fortunately, there are models with precise definitions to estimate it.

In turn, accessibility patterns affect the location of activities and the interactions between them, and so also indirectly affect the real estate market. This triggers a dynamic process in which activities and the transport system interact. A new transport facility alters land rents, and developers find opportunities to develop new land or transform existing sites. The system is made more complex because of possible preferences that some activities may have for certain types of land and buildings, and because of the presence of constraints, such as the need to preserve historic areas or prime agricultural land.

The scheme shown in Figure 1 forms the conceptual basis for most current integrated land use and transport models. There are several such modelling systems commercially available that can be used in practice to implement integrated planning, and that are able to capture a large proportion of a system complex as that existing at an urban or regional level.

Existing models may be divided into two broad categories: those that include all elements of the system, that is both land use and transport, and those that rely on existing transport-only models. The latter extract measures of accessibility from a given transport model, simulate the location of activities, and provide the inputs for subsequent runs of the transport model. Naturally, the first category is more comprehensive, and the interaction between the land use and transport systems is represented in a more consistent fashion.

MEPLAN[1] and TRANUS[2] are the most widely used fully integrated models. Both systems are able to simulate the location of activities and the use of floor space and land in great detail. They also include a highly detailed representation of the transport system. Because both sub-models have been designed and developed to work in an integrated way, consistency is guaranteed. These models have been applied in a large number of cases, including cities and regions in Europe, the USA, Latin America and Asia. Both models may be applied to the regional as well as the urban scale, and are able to represent a full input-output accounting system.

Belonging to the second class, DRAM/EMPAL[3] has the largest number of applications in the USA. Based on accessibility estimates calculated by a conventional transport model, it simulates the location of jobs and households. These are in turn fed back into the transport model. The problem with this modelling system is that it does not represent land markets, land rents and the behaviour of developers. Recent developments include DELTA[4] and UrbanSim[5]. These systems are more advanced than DRAM/EMPAL in that they enable a more sophisticated representation of the urban system. However, they still rely on conventional transport models to calculate accessibility, which entails the risk of a lack of consistency in the integration process. These are also recent developments, and consequently have not yet acquired a large basis of practical applications compared to MEPLAN and TRANUS.

There are also a number of land use models that are at the research and development stage, mostly in academia. Given the increasing demand for this type of analysis, a wider availability of systems is only a matter of time. Even so, the current breed consists of fully developed and documented systems that are available for use by any city or regional authority.

Potential benefits of integrated planning for Europe

Most cities in Europe are growing only fairly slowly, but in spite of this they are going through profound processes of change and adaptation. In many cases, manufacturing industry is decaying, while the tertiary sector is expanding rapidly. This means that firms are changing location, with new office and retail developments emerging in a variety of places. Even if population is not growing, the number of households is increasing, which explains the rapid growth in housing. At the same time, households are showing changing expectations about the type and location of dwellings, with a strong trend towards suburbanization. This, together with growth in car-ownership, restricts the role of public transport and increases energy use and emissions.

The city of Brussels is a good example. People have been moving away from the city centre, to the point of causing problems for the city's finances. Public transport has seen a reduction in ridership and there is growing demand for car-dependent commuter traffic, increasing congestion and pollution. The metropolitan area was modelled with an integrated model[6] so as to design policies and projects that balance, or at least mitigate, the trend. A wide range of policies were analysed and evaluated, such as land use controls, use of commuter railways, road pricing and other schemes. This is a classic example of how integrated models can be very useful tools for designing a strategy for the future development of metropolitan areas in Europe, and can be used as a tool to promote sustainable development goals.

There are many initiatives that have been taken in Europe to promote the integrated approach. Most notably, there have been research projects that have supported modelling work with applications, such as SPARTACUS[7] and the ongoing PROPOLIS[8] projects. Some European countries have their own initiatives, such as the Sustainable Cities Programme supported by the EPSRC (Engineering and Physical Sciences Research Council) in Britain.[9]

A range of sophisticated integrated land use and transport models are available for use by any city or regional authority and the number on offer is likely to increase

Although most European cities are growing only slowly, the shift from manufacturing to services and the trend towards suburbanization are causing profound changes

However, these are limited to research-oriented initiatives. It is now necessary to move ahead and take full advantage of the integrated modelling technology that is currently available, and that can lead to improved urban plans and an increase in the quality of life and a better environment. The research stage is now behind us and the time is now ripe for concrete actions. Among such actions, the following are suggested:

- Specific legislation at a European level that could require proposed transport projects to comply with specific requirements, such as integrated land use and transport modelling, long-term projections and analysis on a metropolitan scale. Criteria for funding from EC sources could be adapted to reflect the need for compliance with these criteria.

- It is crucial for the integrated approach to be used for the approval of projects financed by member countries. If country-level legislation is in tune with that at European-level, local initiatives will not run counter to community level goals.

- New legislation should include provisions to facilitate the participation of interested groups. The integrated approach lends itself to the participation of such groups in the planning process. These groups provide an excellent means of monitoring and supervision to help ensure that the environmental and social goals are taken into account in proposed plans and projects.

The EU also finances transport investments in countries outside its own territory. This includes development agencies both at European level and Member State level. If projects in developing nations supported by EC funds comply with the integrated land use and transport approach, this will help ensure consistency with the EC's own standards.

About the author

Tomás de la Barra is an architect/planner with a PhD from Cambridge University, UK. In the last two decades he has been active in the development of the theory of land use and transport systems and models to represent them. He is the author of the book Integrated land Use and Transport Modelling, Cambridge University Press, 1989. He is currently a professor at the Central University of Venezuela, and a director of Modelistica, the developers of the TRANUS integrated land use and transport modelling system.

Keywords

transport, land use, integrated approach, modelling

Notes

1. MEPLAN is developed and supported by ME&P. See **http://www.meap.co.uk**
2. TRANUS is developed and supported by Modelistica. See **http://www.modelistica.com**
3. DRAM/EMPAL is developed and supported by S.H. Putman Associates.
4. DELTA is developed and supported by Simmonds Consultancy. See **http://www.davidsimmonds.com**
5. UrbanSim is developed by Paul Waddell of the University of Washington with funding from the Oregon Department of Transportation. See **http://urban.u.washington/urbansim**
6. The consultancy firm STRATEC applied the TRANUS model in this study. See **http://www.stratec.be**
7. See the report *SPARTACUS: System for Planning and Research in Towns and Cities for Urban Sustainability.* Commission of the European Communities – DGXII – 1998.
8. A description of the PROPOLIS project is available at **http://www.ltcon.fi/propolis**
9. Within this programme an implementation of the TRANUS system was carried out for the city of Swindon, showing the advantage of integrated modelling. See **http://www.modelistica.com**

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Ethical Considerations raised by Biotechnology Patents

Nikolaus Thumm, *IPTS*

Issue: According to Article 53 (a) EPC (European Patent Convention) it is prohibited to grant European patents for inventions which are contrary to *"ordre public"* or *morality*. The patentability of biotechnological inventions has been a matter of debate now for more than a decade. But, as ethical values change over time, so does the interpretation of patentability.

Relevance: In June 2000 the French National Committee on Ethics decided that the European directive on the legal protection of biotechnological inventions (98/44/EEC), which legalizes the patentability of human genome sequences in certain cases, is incompatible with French national legislation. At the time of writing it is not clear what the attitude of Member States will be towards this directive. After more than ten years of debate and preparation prior to the approval of a final version of the directive it has become clear that the debate on the ethical issues regarding biotech patents is still far from resolved.

Patents create a necessary incentive for firms by enabling them to recoup their research and development costs in a market where the cost of copying their innovations is small

Introduction

The granting of Patents for biotechnological inventions, such as patents on breeds of animals, plant varieties, the patenting of nucleotide sequences or of material derived from human tissue, has already been a subject of public debate for more than a decade and public sensitivity over the issue is such that the controversy is still ongoing. Patenting of biotechnological material should not be understood as an isolated economic activity but as taking place in a social context, and this context shapes the ethical concerns raised. The importance of biotechnology for the new millennium and the heavy burden of future responsibility borne by biotechnological research, development and economic exploitation, an indication of how high the stakes are.

The aim of the patent system is to create a necessary incentive for firms by enabling them to recoup their research and development costs. This is in particular true for biotechnology firms, whose research costs can be very high and for whom patents play an important role in obtaining venture capital[1]. From the common sense point of view, it may be hard to understand how property rights can be given on animals, plant varieties or tissues derived from human body parts and how these rights can be used for economic ends, thus accusations of "patenting life" became the rallying call of the campaign against patenting biotechnological inventions. From this perspective the whole debate on the patentability of biotechnological material boils down to a conflict between entrepreneurial reasoning on the one hand and social and ethical arguments on the other. One side frequently forgets about the economic rationale and real scope of patents, whereas the other tends not to take ethical arguments into consideration.

The justification for intellectual property rights

According to the English philosopher John Locke, everybody should be entitled to the fruits of their labour and therefore, in Locke's view, property rights are based on natural rights. Intellectual property rights, however, tend to be considered as socially created rights based on a utilitarian justification. They are a necessary provision for science and technology to progress and in the absence of intellectual property rights there would be little incentive to spend large sums on research and development. In an unregulated market others could easily copy intellectual property and the outcome would be little or no original development. This would deprive the public at large of many of the benefits of scientific and technological progress.

This market failure regarding technological knowledge is due to three factors (Geroski, 1995, page 91). The first is the indivisibility of research expenditures and the burden of huge fixed costs for any investor. The second is the general investment risk that goes along with the technological uncertainty and investment for research and development. The third reason is the public good feature of technological knowledge. Producers of knowledge cannot prevent others from using it (non-excludability). Intellectual property can be used and enjoyed jointly by as many as care to make use of it without hindering the others (non-rivalry). In economic terms, the marginal costs of providing intellectual property to an additional user are virtually nil. Under unregulated market conditions these public-good features result in a loss of incentive for investment in activities which provide intellectual property (R&D investments). This provides the rationale for government's role in protecting intellectual property rights.

Ethical concerns

In most cases, the ethical concerns raised about patenting biotechnology target biotechnology as a whole and not biotechnology patents *per se* (cf. Claes, 1996). Biotechnology is criticized because man-made modifications to natural organisms are felt to be contrary to morality. However, the moral issues thrown up by regulations governing biotechnology patents are only a derivative of biotechnology specific problems. Patents as such are no more than rights regulating the ownership of biotechnological inventions. For the correct treatment of the issue it would be helpful, therefore, to treat the morality of biotechnology and the issue of patenting separately.

General ethical arguments against biotechnology are based on the concepts of natural integrity and the natural destiny of living organisms. Man-made modifications of living organisms are believed, in this view, to violate natural integrity and are as such against the fundamental structure of nature. This line of argument assumes that all living organisms exist for some natural destiny, which provides them with an intrinsic value. Any distortion of this value would be a violation of nature itself. Ethical concerns emerge where, for instance, genetic manipulation goes against the natural destiny of a living organism. According to

Intellectual property rights are socially created rights based on a utilitarian justification –namely the encouragement of technical progress

General ethical arguments against biotechnology are based on the concepts of natural integrity and the natural destiny of living organisms this view, changes within living organisms should be left to either biological evolution or divine intervention. Here it becomes clear that this opinion relies heavily on a particular set of beliefs rooted in religious conviction. A difficulty with the concept of natural destiny is its definition. Who defines the destiny and the finality of an organism? Certainly one would have to make a ranking of different forms of living organisms. It becomes clear therefore that the concrete meaning of the concept of natural destiny is very much a matter of interpretation, and that this interpretation takes place within the context of a set of moral values, which may vary over time and between societies. Moreover, evolutionary theory undermines the concept of natural finality. And in general, the whole argumentation runs counter to a contemporary understanding of a secularized world of science and technology.

All legal systems embody the Kantian principle that human beings are a pure end and cannot exist to serve someone else's purposes, such as being their property

The intrinsic value of living organisms should by definition be a value that is independent from any valuing agent, so that living organisms are to be respected because of what they are. Frequently it is said that living organisms must not be reduced to pure objects for human ends or living beings should not be reduced to the status of an invention. This line of argument goes back to the German philosopher Immanuel Kant (Kant pp 50 ff.), who said, that any rational living being exists as an end in itself and that it should never be used as a pure end for another purpose. Kant restricts this argument to rational living beings and hence explicitly excludes material objects, animals and plants. Only the rational natural being is an end in itself. This principle is embodied in all legal systems going back to the Roman law. Consequently, material objects, including animals and plants, can well be the pure ends of human desire and our legal system is full of such regulations, all through ownership regulations in private law. A person is not a material object, hence can never be used as a pure end but has always to be looked upon as having his purpose in himself (cf. Kant p. 52). Human beings or human body parts cannot, therefore, be the property of somebody else. This idea is also reflected in the European Directive on the legal protection of biotechnological inventions in Article 5, 1: "The human body at the various stages of its formation and development, and the simple discovery of one of its elements, including the sequence or partial sequence of a gene, cannot constitute patentable inventions".

In the case of the human protein H2-relaxin the opposition division of the European Patent Office had to decide on a patent on DNA fragments of the protein taken from the tissue of pregnant women. Was this a case of patenting human life or patenting human body parts? The European Patent Office decided that the patenting of a single human gene has nothing to do with the patenting of human life and that there is nothing immoral about the patenting of genes (although it is interesting to note that this decision would seem to be against the wording of Art. 5, of Directive 98/44/EC). In another famous case in the United States, after a patient called John Moore had his spleen removed, his doctor managed to obtain a patent on a cell line retrieved from the spleen cells. After the patent had been licensed, the patient sued the doctor for having taken his property. In this case the California Supreme court decided that Mr. Moore had no property rights over cells that were once taken from his body. If one applies the general ethical rule of not using any human being to the pure end of somebody else, the application focuses very much on the question of what can be considered an essential part of human beings regarding their body. The European Council and Parliament argued in 1995 that "elements obtained by a technical process from the human body in such a way that they are no longer directly linked to a specific individual may not be excluded from patentability because of the human origin of these elements".

The most recent case of a human body part patents was a patent granted to the University of Edinburgh by the European Patent Office in December 1999 (EP 0695 351 B1). This patent was given on a method of preparing a transgenic animal deriving from stem cells, theoretically also comprising the cloning of human beings from human stem cells. Complaints were made, the press kindled public debate, and several objections arrived at the European Patent Office (EPO), claiming a clear infringement of Art. 53 (a) EPC. The EPO reacted and finally changed the patent claim, making explicitly clear in the patent description that human beings are excluded from this cloning method. The furore around this case, however, made it clear that the public opinion is very sensitive whenever the issue of patenting of human body parts arises.

As a consequence, the discussion should clearly differentiate between those arguments against biotechnological methods in general and those referring specifically to patenting. In fact, ethical arguments against biotechnology patents are in many cases only a derivative of the more general discussion on ethics in biotechnology. At the core of the patent system stands private property and its definition, and patents are nothing more than a right to economic exploitation. Thus, it may be argued that the intrinsic value of a living organism could not be violated by a property right (i.e. the patent) if it had not already been violated by the technology itself (on which a patent is being applied for). "Patenting, as such is in itself neither wrong nor right, but could be classed as ethically neutral" (Crespi 1998, page 261). What is possible, however, is the creation of ethical conflicts by patents when one ethical value has to be balanced against another. In the Harvard/-Oncomouse case the EPO Appeal Board had to decide on a patent for a transgenic mouse carrying a special cancer gene and as such being useful in cancer research. The board of appeal had to balance the benefits for mankind of such kind of research against the suffering caused to the animals. The board decided that likely benefit for cancer research outweighed the other factors and granted the patent. Other ethical conflicts can derive from one of the main features of patents: Patents are always a compromise between the development and distribution of a technology on the one hand and the restrictions licensing places on the further development of future technologies on the other. In concrete terms, it is always possible to imagine the case where a patent is essential for the development of an important drug, but at the same time it hinders the development of another, perhaps more important, follow-up vaccine or drug.

Patentability of nucleotide sequences

Patents are always a compromise between the development and distribution of a technology on the one hand and the immediate restrictions licensing places on the further development of technologies on the other

Are nucleotide sequences an invention or a discovery? This issue is no longer a matter of discussion, neither by the US patent office, nor by the European office, since patents on gene sequences are now common practice. However, for the layman it is not easy to understand why a gene sequence that already existed in nature is patentable and is thus not considered to be a discovery.

Gene sequences are treated by patent offices in a similar way to naturally occurring substances. If these are present as components of complex mixtures of natural origin they are in principle patentable once they are isolated, identified and made practically available together with a process to develop them and the implication of a useful purpose (cf. Crespi page 4). Thus, the official position is that a patent cannot be given for a gene in its natural state, but when the gene is isolated and made available for a practical industrial or other purpose, then it is patentable. Hence, the invention lies in its use. The patentability of gene sequences is also justified by the tremendous effort expended in their identification. The industry claims that

The position taken by patent offices is that a gene in nature is not patentable, it is when the gene is isolated and made available for a practical industrial or other purpose that a patent can be obtained

Particularly in biotechnology, the ease or difficulty of obtaining the object of the patent application corresponds to the "inventive step" patenting criterion. Thus in the future, it may be necessary to rethink patentability of gene sequences if improved sequencing machines make them much easier to identify

identifying genes is never a routine, and although the full sequence is present in nature, it has never been in the public domain before. This being the case, it would be hard to exclude gene sequences in general from patentability on the basis of the usual criteria. Better public understanding of the legal reasoning would no doubt help to avoid misunderstandings on this score. Although the question as to whether patent offices should take the significance and the future responsibility of the topic into consideration when making their decisions remains.

From the point of view of patentability criteria, in addition to the issue of the pre-existence of genes in nature just discussed, there is the question of inventive step. After all, is identifying gene sequences not just like reading a book? Patent offices have tended to use the difficulty of uncovering the gene sequence as a measure of inventive step. Nevertheless, given that the work of identifying gene sequences is becoming increasingly automated, it may in the future be necessary to rethink the patentability of gene sequences should the effort of identification be very much reduced by improved sequencing machines. Especially in these cases where the inventive step is defined actually by a very low level of inventiveness, the danger of obstructing further innovation and the creation of legal insecurity for researchers might limit the development of medicines and diagnostic techniques. Politicians have become aware of this problem and consequently in Germany, for example, it was decided to put strict limits on the patenting of human genetic information (cf Atkins, Krägenow). DNA patents should only be allowed with the indication of a detailed function, for example the treatment of a disease.

Is it possible to separate ethical and patentability issues?

The general exception of patents which are contrary to public morality ("ordre public") according to Art 53 a EPC, the special regulations in Art 53 b EPC and the explicit exceptions to patentability in the new European directive 98/44/EC in Article 6, have all come in for criticism.

However, it should be borne in mind that a patent only gives its owner the right to prevent others from exploiting the patented invention, it does not give him the right to exploit it. It is not meaningful to obtain a patent on things that cannot be produced and purchased. As patents themselves do not provide the right to use the invention, prohibition of commercialization for ethical reasons should not be regulated within patent law, but articulated somewhere else (though where this could be done in practice is an open question). Industry would like the patent granting procedure being restricted to the technical questions of novelty, inventive step and industrial applicability. It is not only that ethical issues make the patent granting procedure more complicated, but also that these are questions that should not be dealt with by patent administrations. Critics of this approach claim that handling ethical questions during patent examination places excessive strain on the patent examiners.[2] In addition, certain ethical exceptions could put a further burden on local producers and put them at a disadvantage in comparison with their US competitors, who are already in an advantageous position in certain cases.

Conclusion

The ethical criticism of biotechnology patents should distinguish between arguments against biotechnological treatments, therapies and experiments in general and arguments against biotechnology patents in particular. There are, in fact, few ethical arguments that apply specifically to the particularities of biotechnology patenting. Patenting concerns ownership rights in relation to the economic exploitation of an invention, whereas moral principles tend to be expressed in constitutional law. Much ethical criticism of patents is not actually being aimed as appropriately as perhaps it could. Ethical discussion of biotechnology as a whole could be pursued more effectively if patenting were limited to the more narrow definition of a property right regulation which applies the general criteria of novelty, inventiveness and industrial applicability. It would also be useful in this respect to raise public awareness and to inform public opinion in order to point the arguments in the right direction so as to focus them more effectively.

At the core of the ethical criticism of biotechnology patents stands the patentability of human body parts. It is a widely held belief that human beings should never be the pure end of somebody else's desires or purposes, and this principle should indeed be a guideline for the assessment of all critical cases in this respect. However, cases like those of Relaxin and John More have demonstrated that it is not always easy to determine at the outset whether a particular patent violates this maxim.

Over and above ethical concerns. This involves for instance the interpretation of patenting criteria that fast paced innovation in nucleotide sequences has brought about in recent years. As a general rule, patent law should concentrate more closely on its original intention and its application should be strictly guided by the criteria of novelty, inventiveness and industrial applicability. Europe should also be guided by its own principles when deciding policy and not necessarily seek to follow approaches taken elsewhere.

Generally, patent offices are not the ideal venues for dealing with ethical issues. This does not mean that these should be disregarded altogether, but that they should be addressed elsewhere in a more appropriate way. One approach would be for ethical questions and related value judgements to be placed in the hands of national courts, or other responsible authorities in the individual countries. Another idea would be to establish different monitoring systems outside patent law, meaning that patents conflicting with public morality could be granted according to patent law (under the novelty and inventive step criteria) but its enforcement would be subjected to other controls. Such controls could be in the hands of an ethics committee or state agency responsible for product control or the initiative could be left to any challenger. The legal grounds could either be the constitution or special rights, dealt with, however, in national courts or through the establishment of a competent European patent court.

Keyword

patentability of plant and animal varieties, human body parts, ethical concerns

Notes

1. For the general development and of the European biotechnology industry and a number of further patenting related issues in biotechnology, see Thumm (2000) pp. 73-123.
2. "Are EPO examiners to have courses in moral philosophy or theology? And if so, of what variety?" Grupp (1999) page 258.

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Start-up Support and Company Growth

Martin Meyer, *SPRU*

Issue: Academic start-up companies can often benefit from a number of grants and other support measures. Case studies illustrate how policy measures have influenced the growth pattern of start-up firms in science-based fields of innovation.

Relevance: Badly targeted support mechanisms can have a negative impact on the growth-pattern of science-based SMEs by providing a distorted set of incentives. Although funding can be crucial to the success of high-tech start-ups, there is evidence that attention needs to be paid to management aspects in order to ensure growth. Lessons can be drawn as to how to avoid policy measures having unintended effects with adverse consequences for growth.

Start-ups in a research context

The emergence of a new mode of knowledge production, the formation of a "Triple Helix" of university-industry-government, and the advent of the academic entrepreneur –all these different developments point, in one way or another, to the increased attention that is being paid to the economic utilization of publicly funded research. One way to utilize academic research in a commercial manner is to set up so-called university spin-off companies.

Spinning off a company is a challenging task. Carayannis et al (1998) discuss various definitions of spin-off companies and suggest that the process is much more complex than the conventional notion suggests. The conventional approach commonly denotes a new firm a spin-off company if it is established by individuals who were former employees of a parent organization and if it focuses on a core technology that originated at the parent organization and was transferred to the new company. However, this is in some ways an oversimplified understanding of the nature of a spin-off. A more complete picture needs to take into account the fact that, in addition to the two previous factors, the parent organization might provide venture capital, management advice, office/factory space, and other support.

A French survey of 250 spin-offs from public R&D laboratories showed that the ventures that developed most successfully were those that were best able to utilize a wide range of resources and skills (Mustar 1998). This report suggested that the rate of growth of start-ups is highly dependent on the extent to which new firms and their entrepreneurs are capable of establishing multiple partnerships in a variety of fields. These include financial partnerships, partnerships in the fields of science, technology, and innovation, and also international contacts.

One way to utilize academic research in a commercial manner is to set up so-called university spin-off companies

Actors in innovation policy have tried to further the establishment and growth of academic SMEs with a number of policy measures among which financial support plays a dominant role

Grants are justified as a way of supporting firms that have developed technology up to a point where, although commercial prospects are good, there is still considerable market uncertainty

A common weakness of academic start-ups is a tendency to focus on technical aspects to the detriment of the business side

Actors in innovation policy have tried to further the establishment and growth of academic SMEs by means of a number of policy measures. Financial support seems to play the dominant role in this context, as indicated by the variety of grants available for start-ups. Examples include SBIR (Small Business Innovation Research) and STTR (Small Business Technology Transfer research) awards in the US. The SBIR programmes fund R&D efforts of a high-risk nature that have high commercial potential, while STTR grants support cooperative early-stage R&D efforts of a SME with a university partner[1]. There are a number of similar measures in European countries, for instance, government grants that cover the newly established firm's overheads. In addition to grants of this type, which are available to help companies through the very early phases of commercializing a technological development, there are also grants like the ATP (Advanced Technology Program) awards, which are intended to support companies that have developed technology up to a point where although the market uncertainty is still considerable commercialization prospects are nevertheless good. This type of support mechanism often requires a consortium involving both the developer and potential users. Often these grants are more substantial than the initial awards. Job creation grants are another popular means of start-up support for academic spin-offs and other small firms, even though they were not originally intended for this purpose and are usually not related to a specific phase of development. Thus, public money is made available to potential start-up entrepreneurs in a variety of ways.

However, some authors have warned that funding might have a negative impact on growth and market orientation (Clayton et al. 1999), although research in this area has so far only been done on spin-off from large firms. Given the possibility of policy measures having a negative impact on academic spin-offs too, we have looked at a number of start-up companies in a science-based environment.

In this context, it is important to realize that the driving force behind university spin-offs or equivalent start-ups spun off from other public sector research establishments is often not a classic entrepreneur, but frequently an entrepreneurial academic. For instance, Olofsson and Wahlbin (1984) studied twelve new technology-based companies spun off from Linköping University in Sweden. Nine of the dozen companies studied were set up to exploit research results obtained by their founders. In seven of the firms the founders still continued to work at the University at the time of the interviews.

A common deficiency of science-based start-up firms in particular is a tendency to focus on technical aspects to the detriment of the business side (Otto 1999). This suggests there could be a need for a different set of support measures going beyond financial support alone, which is important to bear in mind when considering whether start-up support could be made more effective.

Case Selection and Data Collection

Our focus in this article is on support mechanisms and the impact they have on the development of start-up companies in a science-based environment. We will look here at four case histories drawn from a more comprehensive effort to explore corporate activities aiming to exploit novel science-based technologies (Meyer 2000). The original study looked at thirty cases of companies in the area of novel nano-scale technologies.[2] Most of the European companies active in this area were either large, multinational firms or established medium-sized firms. Although there were also a number of spin-off companies operating in the field, they were mostly spun off from non-university organizations. The apparent predominance of corporate over academic spin-offs is in line with other studies in the field, for example a Swedish study of 30 entrepreneurial technology-based spin-offs found that just one-sixth of the companies investigated were spun off from universities while two-thirds had originated in the private sector (Lindholm-Dahlstrand 1997).[3] The four cases looked at here were start-ups that originated in a university or public sector research environment. Three of them were from the US and one from Northern Europe. US examples are a useful reference as the US has a well-known set of start-up support mechanisms designed to promote technological development and growth of start-ups during different stages of commercialization, and the US programmes are often cited by European entrepreneurs as an example to emulate.

The findings presented here are mostly based on a number of interviews with industrial researchers and research managers, academic scientists and decision-makers in science and technology policy administrations. These narrative accounts were integrated with other background information such as annual reports, newspaper/journal articles, press releases, public and official announcements and other documents.

Reference Pattern

Comparing case studies necessitates a reference pattern to guide the investigation. The reference pattern should allow us to address three points: (1) We need to discriminate more from less successful companies in terms of our study; (2) we need a framework to relate policy measures to successful growth; (3) we need to be aware of the limitations of the case studies.

First of all, we need to establish a framework within which to evaluate the success of a company. Clayton et al (1998) point to the inappropriateness of financial performance indicators alone to evaluate start-up businesses. They suggest one should also look at how good the new venture has been at attracting partners and external talent. Initial public offerings (IPOs) might be a good indicator of the extent to which a start-up has managed to attract this attention in the business and financial world, although their success may also be affected by external factors affecting stock market confidence. We shall also look at conventional measures, such as staff and turnover. The background of board and supervisory board members can indicate the extent to which firms have been able to exploit non-financial resources, such as access to people and partners.

The network of relationships and the involvement of the founder are factors with a potential impact on the development of start-up firms in a science-based environment. One of the main conclusions of the French study cited earlier was that "regardless of their talents, high-tech entrepreneurs can do precious little on their own". In other words, in order to succeed start-ups need to be integrated into diverse networks of interactive relationships and partnerships.

The personal characteristics and commitment of the founders might have a profound impact on the firm's development. In the late 1980s, Dôutriaux (1987) studied 38 academic new-technology-based firms with roots in universities. Dôutriaux distinguishes between companies with and without direct links to a university, where a direct link is deemed to exist if the company's principal entrepreneur still worked at the university. One of Dôutriaux's findings was that part-time involvement by founders had a negative impact on the growth of the newly established company. In other words, if the founder resigned from his academic position, the company was likely to grow faster.

Secondly we need to have a frame of reference for the various policy mechanisms or phenomena that help us identify and evaluate various influencing factors. The literature suggests that a number of policy measures, such as grants and incubation

The findings presented in this study are mostly based on a number of interviews with industrial researchers and research managers, academic scientists and decision-makers in science and technology policy administrations

The network of relationships, and the involvement of the founder are factors with a potential impact on the development of start-up firms in a science-based environment

Incubators are seen as playing a critical role in science-based innovation. These range from those providing just facilities to those offering mentoring, long–term support and human capital

programmes, are particularly important for start-up ventures in a research environment.

Start-up support most often takes the form of financial assistance. Clayton et al (1999) put forward the view that too much cash can lead to an unnecessary build up of facilities and staff.

Incubators are widely seen as playing a critical role in science-based innovation. For instance, Cooper (1973, 1984) argued that incubator organizations can affect the nature of the new business started, and, at least to some degree, its subsequent pattern of success. Based on an analysis of the development of incubators, from the invention factory "skunkworks" to the contemporary, university-based business incubator, Etzkowitz *et al* (2000) devised a list of elements that characterize an "ideal" incubator. Their work draws our attention to the range of incubators, from mere facilities to networked support mechanisms. They also suggest the requirements a modern incubator should meet, such as mentoring of new ventures, long-term support, a human capital support structure and access to students (as a source of appropriately qualified and relatively inexpensive employees) together with a solid financial base.

Thirdly, we need to be aware of the limitations of the study undertaken resulting from its reliance on case studies. In order to prove the validity of the policy measures/growth relationship, the influence of a number of other factors has to be excluded, such as market characteristics, technological characteristics, characteristics of the main business, or non-policy environmental characteristics. Clearly, this is not entirely possible to achieve. As Table 1 shows, although the companies are in the same broad technological area, they serve different markets in a spread of industries. Thus, this study has to be understood as an exploratory effort highlighting issues of relevance to the policy-maker that deserve further attention.

Chief Findings

The analysis given here is based on four case studies of academic start-up companies. Table 1 provides an overview of key features of the firms

Box 1. Case 1: Alpha

Alpha Corp. is widely recognized as one of the more successful examples of commercializing nanotechnology. Formed in 1993, Alpha has developed technology with broad commercial applications in biomedical research, medical diagnostics, genomics research, genetic testing and drug discovery. Alpha is pursuing collaborations with corporate partners, including 'leading industry players', to develop its technology for a number of applications in areas, such as infectious disease diagnosis, genomics, and drug discovery.

The executive management have a broad academic background and industrial experience. The chairman and CEO, who is one of the company's founders, has extensive management experience and has served on several boards of start-up companies in the field of biotechnology. He also had experience running his own investment and consulting company. The president and COO (Chief Operating Officer) of Alpha has a strong scientific background and management experience in the biotechnology field. She has a strong record of scientific publications and patents, and also served on the board of a division of a large life science corporation. In addition, she has close links with the scientific community. Finally, it should be noted that the other company founder is still active as CTO (Chief Technical Officer). In addition, he has served in leading positions in several other biotech ventures.

Box 2. Case 2: Beta

BETA is a commercial-scale producer of nanostructured materials. The company employs 50-100 staff. It is focused on product development and manufacturing. Less than 10% of its efforts are devoted to R&D. The employees at Beta do not publish in scientific journals. BETA was founded in late November 1989 by an academic –at that time a scientist at a US National Laboratory. The lab's technology transfer centre was very helpful in the start-up phase. Initial funding for BETA was supplied through the lab's venture capital fund, and by State grants for new job creation. The company has also received financial support from a number of sources, among others several SBIR awards. The most useful funding scheme was found to be the Federal Advanced Technology Program (ATP) award. The ATP grant from the Department of Commerce enabled the company to develop their patented process for manufacturing the nano-materials in commercial quantities. Subsequent funding was raised from a consortium of venture capital funds, and later also from high net worth private individuals and groups. The company went public with a successful IPO in late November 1997.

One of the perceived reasons for the successful spin-off from a public research organization is the strict division of academic research and commercial activities. The founder keeps his corporate and academic activities strictly separate. His academic research is focused on 'cutting edge' themes while the company operates in a more established area. Another reason for the success of Beta is perceived to lie in the experience and contacts of the supervisory board members, who are very experienced and distinguished individuals and who enjoy a good reputation in the business world. Other members of the board have served in top executive positions for companies, and were recruited for the company through contacts arranged by an individual whom the academic founder knew previously.

Box 3. Case 3: Gamma

Gamma was founded in 1990, with the assistance of the local biotechnology transfer centre, to develop sensitive reagents and methods for detecting biological molecules. It is a spin-off company from one of the US national laboratories. When the university-based incubator was opened, Gamma was one of the first companies to move in. An important attraction was the incubator's special waste disposal facilities, which lowered costs considerably.

Managerial or other business functions are supported by external organizations, such as the State Biotechnology Association or the biotech transfer centre. Customers can place their orders via the Internet, e-mail, or fax. Gamma started with two full-time employees in 1990 and now has nine full-time staff. Most of the employees, all of whom have a scientific or technical background, are from the National Laboratory. Also, the President and CEO of Gamma has a full time position at the Laboratory.

Researchers based at Gamma also publish papers, which they consider important references for their products. The company also collaborates with professors at the local university, and these collaborations often result in publications. It is reported that there are few 'real collaborative activities' with other companies in the incubator.

Gamma is owned by the President and CEO, who holds 80%, and two other senior researchers. The shareholders put money into the company rather than taking revenues out. Growth has become one of the company's major concerns. One of the scientists employed by Gamma is currently taking an MBA at the local Business School and he will eventually perform analyses that will increase the level of information about potential customers' needs.

Gamma has a very strong focus on R&D activities. R&D makes up around 75% of the company's total budget. Gamma has been very successful at obtaining funding from public sources supporting scientific research. The NIH is a primary source of SBIRs and the Department of Energy and the NSF are also important sources of funds for the company's research activities. The strong focus on R&D is explained by the increased need to expand into new areas over the course of the next 2-3 years. Then it is expected to return to "the normal 40-50%" share of the company's budget being devoted to R&D.

Box 4. Case 4: Delta

Delta is a university spin-off company from an Applied Physics Department of a regional Nordic university. Delta's proprietary technology platform is based on Professor C's work on a novel temperature sensor. In 1994, the manager of the neighbouring science park suggested setting up a company to exploit C's research. Delta was established in 1996, with some start-up support from the government. The start-up help, a 2-year grant from the Ministry of Commerce, covered 50% of the salaries and the travel expenses. The founders and employees had worked in the field previously and knew each other.

Delta relies on a number of suppliers. The electronics of the company's major product has been developed in collaboration with Nanobite, which is a small manufacturer of control instruments. The collaboration between the two companies started originally from academic contacts. Entrepreneur B of Nanobite, who studied with C at the same institution, was impressed by the 'beauty of the physics' and agreed to develop the additional instrumentation for the project.

Spinning-off Delta has led to a challenging management situation because of disagreements about restricting Nanobite's opportunity to freely distribute the component in question. At a relatively late stage in the commercialization process a manager, A, was brought in to take control of the business aspects. He recognized the need for increased volumes, which has ultimately led to the explicit difference of opinion. However, the fact that A made these issues explicit does not imply that this conflict had not existed before. Even before Delta was set up there was a divergence in interests between B and the prospective academic entrepreneurs. Nanobite is not a growth-oriented company. B's major interest is to ensure a certain level of profitability that allows himself and his family to live comfortably. Otherwise his efforts are dedicated to keeping administrative and bureaucratic burdens as low as possible. The Delta entrepreneurs, on the other hand, are growth-oriented. Commercialization is not on hold anymore because A has managed to find another company that produces components which partly substitute the electronic device manufactured by B.

according to the reference pattern we devised in the previous section (see Boxes 1-4 for more detailed summaries).

Our analysis follows the reference pattern. Firstly, we shall discuss the development of the companies in terms of their success in various areas, such as financial terms, human resources, and network integration. Then, we will take a look at the support measures these firms received and discuss their potential impact.

The cases looked at suggest that professional management and commercial advice can have an important influence on success

Successful and less successful cases

In terms of the success criteria we have defined, two of the cases (Alpha and Beta) appear to be reasonably successful. Both companies were established in an incubator environment that also offered commercial advice and consultancy and provided links to business networks. They had good contacts in the financial and business world and were both able to hire professional managers. Alpha's researcher/founder is still on the management board of the company as CTO (Chief Technical Officer), while the managerial co-founder manages the company as CEO (Chief Executive Officer) and President. Most of the other board members appear to have both extensive business and research experience. It is reported that Beta has a number of very experienced former managers on its supervisory board. Both companies have successfully floated through IPOs (Initial Public Offerings).

The two other companies have remained relatively small. One of them (Delta) experienced initial difficulties finding suitable collaborators in certain areas, whereas the other (Gamma) spent almost a decade in an incubator facility and still is heavily R&D focused. Gamma does not have professional management. A senior scientist, who spends two hours a week on company matters, functions as CEO and President. The network links appear to be situated in an academic or research environment, while marketing and other business functions are "outsourced" to trade associations and similar federations. Delta appears to have undergone a certain transformation from originally being embedded in a predominantly academic network environment to a more business-oriented set of connections. This might indicate the influence professional management can exert on a company. The involvement of a professional manager specialized in start-up companies has helped the young firm to overcome its original problems.

The potential impact of support measures

The evidence from the cases studied suggests that the more growth-oriented companies differ from the two other cases in three areas. Firstly, they

Table 1. The cases

	Alpha	Beta	Gamma	Delta
Year of establishment	1993	1989	1990	1992
Area of business	Nano-electronics for complex life-science applications	Nano-materials	Scientific equipment for nano-scale applications	Producer of nano-scale scientific devices
Staff/Turnover	• N/A	• 50-100 staff	• Nine employees	• 5 staff • Turnover EUR 400k
R&D orientation	• strong	• less than 10% of the firm's efforts devoted to R&D	• 75% currently • target 50%	• [low]
IPO	• Yes	• Yes	• No	• No
Growth	• High	• High	• Moderate	• Moderate, now higher
Grants, etc.	• Mostly private venture capital	• Public start-up grants • ATP ($250k twice) • SBIR • Venture capital	• Public start-up grants • SBIR/STTR • Research grants	• Public support • Ministry of Trade and Industry start-up grant
Incubator	• Established incubator programme	• Established technology transfer center	• Incubator facility	• Local science park
Network Environment	• Business contacts in biotech industry	• Academic • Business • Experienced managers on the supervisory board	• Academic networks • Trade associations, State biotech association	• Primarily academic in the beginning • Increasingly business
Involvement of "academic entrepreneur"/ founder	• Involved as CTO	• Involved as board member	• Full-time researcher as President and CEO on a 2-hour -per week	• Shareholder

Source: Based on data in Meyer (2000)

appear to have benefited from different forms of start-up. In addition to grants for research projects, the more successful companies, Alpha and Beta, also benefited from additional support. Beta managed to attract grants, such as ATP, that are more substantial and involve other, more established industrial partners. Alpha was able to take advantage of the biomed cluster that had evolved around a well-established incubation programme. Beta also received help and advice from its well-known regional development corporation (the technology transfer arm of the national laboratory it was spun off from).

It could be argued that these programmes made it easier for the two start-ups to integrate into the business world. Alpha had very business-experienced individuals on its board from the outset, and Beta was able benefit from a number of industrial connections that were established by its academic founder early on.

Gamma and Delta also received financial start-up support and they too were based in incubators. However, the form of support they received from these organizations appears to have been different. Here incubators, or science parks, seem to have had the function of a facility rather than a networking programme. It should be pointed out that, in particular, Gamma has benefited from substantial sums in research grants.

Delta ran into trouble with business partners at an early stage. The partnership was the result of an academic friendship rather than a business decision. It was said that the problem could have easily been detected before the establishment of the spin-off if someone had only looked at the network environment of supplier companies and their interests. This seems to coincide with a lack of timely and comprehensive business advice. Rather late in the commercialization process a professional manager was hired who detected the problem and helped solve it.

It might be difficult to link policy measures and observed performance directly in each of the cases. However, it is possible to point to certain co-occurrences. One can speak in the case of Gamma's operations of an academic trajectory. Gamma relies to a substantial extent on public research funding. Here, the founders have succeeded in developing another research organization outside the 'mother' institution. Here, only low-level involvement of the founder as CEO and President on a 2-hour-per-week basis goes along with a low level of integration in business networks.

The more successful cases seem to be characterized by more supportive and networked incubator facilities. One of the companies was supported by network-building grants. Also these cases had experienced management. In Beta, there was a clear division of competencies between the academic founder and the other board members. He restricted his activities to his distinct area of expertise and left the business and management issues to the professionals who were brought in successively.

Conclusions

The case studies looked at here suggest that in some cases policy measures have promoted and channelled activities in certain growth-averse directions and amplified 'academic' tendencies in the management of the slower growing start-ups. The cases reveal two contrasting scenarios. Firstly, that of a moderate-growth start-up in an incubator facility with little management advice and a small network of business contacts, which basically survives on public research grants. Secondly, that of a high-growth company in a networked incubation programme with experienced board and supervisory board members, a successful IPO and network-facilitating ATP grants. This analysis would suggest that research grants alone are not always an optimal way of supporting this kind of venture. Indeed, one might wonder whether a company that is 75% R&D-oriented, still residing in an incubator facility ten years after its foundation, and occasionally relying on 'love money' infusions from its academic shareholders should finance its major activity –research and development– through public research grants. One might also wonder whether universities and research centres might not be a more appropriate setting in which to pursue research of this type. Our examples suggest that a clear division between business and the academic world is a key factor for success.

Another suggestion that could be drawn from the case studies addresses the sort of start-up and growth support that is commonly administered. Start-up support in science-based technologies should include help with access to and integration in an established business network. The more successful cases involved academics that understood how to establish connections with experienced industrialists, sometimes with the help of an incubation programme. The case of Delta illustrated how the involvement of a manager has changed the orientation of the company towards growth. Even in the case of Gamma, the fact that one of the researches is receiving a business education means market analyses can be performed, which is a sign of a long learning process from a primarily technical orientation towards a more market-based and managerial understanding of the enterprise. This would seem to suggest that start-up advice at an early stage of the commercialization process, ideally before the company was set up, might have got the company off to a better start.

Keywords

SME, networks, incubators, science-based innovation

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Notes

1. See also **http://www.odod.state.oh.us/tech/sbir/What_is_SBIR/what_is_sbir.htm**
2. All in all, companies in nine sectors and five countries have been contacted. The sectors encompass materials, scientific services, instruments, vehicles, telecoms, modelling, electronics, chemicals and pharmaceuticals, biomedical products, and the countries studied include the United States, Germany, the United Kingdom, Sweden, and Finland.
3. However, generally speaking, this pattern is not that surprising, given that the private sector employs many of the people employed in the university or public research sector.

The list includes specifically: (1) a master inventor in residence, who may also serve as a mentor or consultant to other companies in residence; (2) a stable organizational environment, capable of long-term support to the start-up development process; (3) the university offers a human capital support structure for innovation and access to university staff members for consulting and collaboration and to students as inexpensive employees and potential inventors and firm founders; (4) significant financial base to fund enterprises and accelerate the development of firms, if warranted.

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Bridging the Gap between Science and the Public

Patrizia Galeffi and Cristina Cantale, *ENEA*

Issue: Apart from the excitement about their future possibilities, the extraordinary steps forward being made in the life sciences are, more than ever before, forcing researchers to confront the social impact of their work and to take into account the ethical implications of the research process as a whole.

Relevance: The current heated debate about scientific advances and the most recent extraordinary applications of science, particularly in the life sciences, involve the whole of society and have a bearing on policies on the interaction of science and society.

Science and society: a complex relationship

The scientists involved in research areas with a powerful impact on the human community are sometimes seen by many social actors to be creating more problems than they solve. The strides forward in the understanding of nature and the possible benefits that may result are often left in the background, smothered by the projection of possible negative effects, ultimately reflecting a largely pessimistic attitude among sections of the public towards man's capacity to control himself or the forces of nature. Although recently the complicated interactions between science, technology and society have been increasingly debated by the media and interest groups, they have been studied in depth by philosophers and scientists throughout history.

The emerging picture underlines a non-specified anxiety that pervades society and is related to the profound implications embedded in Galileo's "Dialogo sopra i Massimi Sistemi" (Dialogue Concerning the Two Chief World Systems) and its aftermath. From that point on, man stopped being the centre of the universe, with everything going around him, the sole reason for its existence, and he was placed in the background, without the reassurance of believing himself part of a system created completely for him.

This consciousness gave rise to increased faith in human abilities but also to anguish and to a vague sense of discomfort that, in time, led some to put the blame on science, accusing it of suppressing the spiritual, artistic and emotional components of life. Contemporarily, the growing specializations of science and its language/jargon on one hand, and the difficulties for non-scientists to understand such jargon and scientific methodology on the other, resulted in a distancing of science from general culture. The break became sharper and deeper, as stated by Snow in his seminal 1960 lecture on "The Two Cultures" (Snow, 1977).

Although science and technology have given us products that have transformed human life, quite a few people tend to focus only on the negative outcomes of new discoveries and inventions

The complex interaction between science and technology, both of which interact with power structures, has itself been instrumental in fostering sceptical attitudes in society

The media plays a key role in building the public perception of science, which tends to mean this perception is shaped to the media industry's needs

Scientific training should include historical, philosophical and ethical issues on the curriculum

On the other hand, the products of science and technology have transformed and improved certain aspects of human life beyond recognition. Nevertheless, the blame for many disasters is laid at the door of science and technology up to a point where some even go so far as to suggest putting brakes on the pursuit of knowledge. This simplistic idea appears to be more common than one would imagine, even among the cultural elite. Furthermore, there is an impression that scientists lack ethical sensitivity and are indifferent to the consequences of their work. This image, together with a continued growth of esoteric scientific specializations and impenetrable jargon, have brought about the further isolation of scientists and increased the difficulty they have communicating with the rest of the world, a difficulty often exacerbated by attitudes within the scientific community itself.

The complex interaction between science and technology, both of which interact with power structures, has itself been instrumental in fostering sceptical attitudes in society, to the point of affirming the relativity of knowledge, i.e. the view that knowledge does not embody absolute truth, but varies with the times and socio-economic conditions, and not coincidentally, often reflects the predilections of the holders of power. On the other hand, political, religious and ideological powers may themselves also have ambivalent attitudes towards science as they may see it as being intrinsically unpredictable and, in principle, intellectually independent. Nevertheless, science can at times be used to further economic interests and to support political leadership (i.e. by providing scientific authority to sustaining various economic and ideological choices). And it can also be used as a scapegoat when things go wrong. In its role in supporting power, the main way in which it can be manipulated today is through politically motivated funding decisions.

The Public Perception of Science

In today's information society, people's perception of science is mainly built by the media. Unfortunately, some attributes of the media, such as the propensity for sensationalism tend to equate science with new discoveries and gadgets. This does little to broaden understanding of science, and this is exacerbated by the fact that the media seems incapable of analysing scientific issues. This general ignorance of the purpose and methodology of the scientific enterprise in society is also reflected in the make up of political and institutional establishments, which are often staffed by people with a background in the arts and humanities rather than science. It has been reported in several analyses that scientific instruction is dangerously weak, even in the most industrialized countries. The rationality of science is perceived as being too restrictive, exclusive of emotions. Thus the existence of the so-called "the two cultures", and the difficulty scientists have in getting across to the public at large, has greatly conditioned social dialogue on science.

If this divide is to be bridged, there is a need for a broader and deeper scientific education on all levels. Science needs to be made the protagonist of a cultural Renaissance. Education and scientific diffusion need to be given priority. Certainly there is scope for broadening the appeal of science. For instance, attractively written books on science have had success that publishers would never had expected, and this need not necessarily imply simplification or popularization (take for instance the success of Stephen Hawking's "A Brief History of Time"). New television programmes and magazines need to replace a naturalistic-explorative, Victorian image of science with a more realistic and up-to-date one.

In addition, improving the popular understanding and appeal of science needs to go hand in hand with an emphasis on sensitization and training of scientists in the social implications of science, as well as in overcoming the jargon/specialization barriers, in order to communicate with the public. At present, the historical, philosophical and ethical aspects of science are not included on scientists' academic curricula. If the gap between "the two cultures" is to be bridged so science can be brought closer to the public at large then both sides have to take steps towards reducing the distance.

Keywords

biotechnology, science and society, science and culture

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