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THE IMPORTANCE OF INNOVATION AND THE CONDITIONS UNDER WHICH PROCESSES OF INNOVATION OCCUR

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The presentatión will focus on three main questions: What do we mean by innovation? Is It more than the technology? How can we undertstand the process of innovation in its social context? What conditions lead to innovation in regions and how can territorial competitiveness be enhanced? The second section of the papel will move on to explore hoy the process of innovation may be described as involving the interaction between a wide range of factors and organisations beyond the innovating firm. Finally, the papes tries to bring this perspective to bear on the regional policy environment in which regional institutions attempt to manipulate the resources that underpin the formation of lhese actor-networks and the skills of the firms at managing such innovation processes.

Aurkezpena hirugaldera nagusiren inguruan burutuko da: Zer esan nahi du berrikuntza hitzak? Teknologia baino zerbait gehiago? Nola uler dezakegu berrikuntza prozesua dagokion gizarte ingurunean? Zein baldintzek bideratzen dute berrikuntza lurraldeetan eta nola hobe daiteke lurralde-lehiakortasuna? Dokumentuaren bigarren atalean berrikuntza prozesua deskribatzen den modua azaltzen da: enpresa berritzailearen at diren faktore eta erakunde sail anitzen elkarrekintza gisa. Azkenik, ikuspuntu hori lurralde-polikaren ingurunean sartzen da dokumentua ingurune horietan jardunbide sareen sorreraz eta berrikuntza prozesuak kudeatzen enpresek duten gaitasunaz baliatzen saiatzen baitira lurralde horietako erakundeak.

La presentación se centrará en tres preguntas principales:¿Qué significa la palabra innovación?¿Algo más que la tecnología? ¿Cómo podemos entender el proceso de innovación en su contexto social?¿Qué condiciones conducen a la innovación en las regiones y cómo puede mejorarse la competitividad territorial? En la segunda sección del documento se explicará el modo en el que se describe el proceso de innovación como una interacción entre una amplia gama de factores y de organizaciones situaciones situados más de la empresa innovadora. Finalmente, el documento trata de introducir este punto de vista en el entorno de la politica regional, donde las instituciones regionales tratan de manipular los recursos que sustentan la formación de estas redes de actuación y las aptitudes de las empresas para gestionar dichos procesos de innovación

INTRODUCTION

This presentation will focus on three main questions:

- What do we mean by innovation? Is it more than the technology?
- How can we understand the process of innovation in its social context?
- What conditions lead to innovation in regions and how can territorial competitiveness be enhanced?

Each of these topies will be subject of a section of the paper.

UNDERSTANDING INNOVATION

Current research into the process of innovation suggests that the linear model of innovation is dead. Some may argue alternatively that the linear model was never an accurate analogy for innovation except for perhaps the odd special case such as the "Manhattan" nuclear weapons project. Nevertheless the debate raised by the need to overturn policymakers' perceptions of innovation as a one-way street from basic science to commercial success has yielded a useful body of literature and a wide array of different models and concepts.

One complicating factor is that there are many conceptions of innovation. I will discuss three specific forms of innovation later, but innovation may be seen differently depending on the scope of the viewer. Thus taking a narrow focused lens, innovation can be examined from the point of view of the innovating firm, as a mechanical process within a formal organisational structure. Taking a wider perspective however the complex inter-relationships between firmlevel organisational constructs and a broader corpus of technological and scientific knowledge moves into focus. Wider still, and innovation cannot be separated from its social context, and scientific knowledge itself can be viewed as socia-Ily constructed and reconstructed in an ongoing dynamic. As I want to explore the conditions under which Innovation takes place, I will therefore examine innovation at these different levels moving outwards to explore the wider social and environmental context.

First I want to stress the nature of innovation as a process of information generation and exchange. The nature of R&D as an information process is often overlooked by the conventional wisdom that technology generation involves physical artifacts; the creation of machines. Macdonald (1983) points out the lack of attention given to tertiary sector activities in which technical information is created and processed «because it does so without also creating machines».

«Yet technology is the totality of information which allows things to be done, and total information is unlikely to arrive in a crystallised package from the conventional research and development process. All that can reasonably be expected to emerge from that process is information which must be supplemented by other information...» (Macdonald, 1983, 29).

The difficulty of adequately conceptualizing the information aspects of R&D, the free flows of knowledge, the transactions of information as a good with legal restrictions on its applications by buyer and seller, contributes to a relative neglect of the subject especially by economists.

As Arrow (1962) explains, the appropriability of information even by a monopolist depends upon legal protection, but no legal barriers can adequately protect disembodied information. Knowledge of the properties of a metal could be used in determining applications for the metal, but also in the search for alternative materials having those properties. It may be possible to control and receive royalties on the application of physically embodied knowledge, but it is not possible to control the wider flow of information on the performance possibilities of that invention, and hence the inputs to other inventive projects.

R&D requires the assembly, use and generation of many types of information, The inputs will include both technical and non-technical information, The obvious inputs are the acquired knowledge and experience of the research workers -including basic scientific and engineering principles, To this can be added new technical information from other laboratories, government technical standards, interfaces and regulations as well as commercial market awareness, aesthetic or styling inputs and strategic information on components, manufacturing systems, etc. that relate to the firms ability to Implement a new product design. New information must then be generated in the form of designs and test results from those designs, or in a more basic research mode, experimental hypotheses and results.

Dosi also places an emphasis on information in innovation and defines innovation as "the search for, and the discovery, experimentation, development, imitation and adoption of new products, new production processes and new organisational set-ups". As such then he suggests that innovation has a number of key characteristics:

- Innovation Involves uncertainty of outcomes
- Innovation increasingly relies upon advances in scientific knowledge
- There is an increasing formalisation of innovation within manufacturing firms
- Much innovation is in learning by doing or using
- There is a cumulative process of innovation building upon existing developments within technological paradigms.

Building on these foundations we have the concept of innovation as a dynamic force, involving the incremental enlargement of the technology and knowledge base of the firm. Although firms may seek to formalise and Institutionalise that advance, it remains subject to a high degree of uncertainty, not least because much of the learning process is informal through learning by doing. The technological paradigm or guidepost idea is also an important lesson, whereby incremental innovation will tend to follow a pre-determined route according to a framework of limitations set by previous rounds of investment, with radical changes arising from major shifts in the knowledge base, often overturning the loglc of the previous directionality. Thus for example major scientific advances in semiconductor physics and electronic design completely replaced a previous pattern of enhancement of valve technology In the 1950s and 1960s setting out new silicon-based paradigms with effects we are still experiencing today.

It is this dynamic and disequilibium nature of innovation as a combination of Incremental efficiency improvement inter-cut with radical transformations that ensures the importance of innovation for students of economic progress Schumpeter for example used the phrase "a perennial gale of creative destruction" to describe the effect of innovation on the economy, and whilst he later recognised that large firms could protect, nurture and fund radical innovations, many new developments required new combinations that were not already found in the economy. As he put it "it is not the owner of stage-coaches who builds railways" (Schumpeter, 1934, 66).

At the heart of the question of innovation is the issue of product and process development within the firm. Here in a sense the linear model has held sway, at least in that there is an implicit directionality from R&D labs through engineering and pilot production on to full production. The organisation of the product development process within the firm often echoes the linear model in the relations between longer term research activities and the final engineering stages, There may even be a spatial differentiation between these activities with an implicit assumption of a more reflective nature of conceptional work requiring distance from production, as opposed to the integration of pilot operations and final testing at the production plant. Yet we see modern practice deviating from this model in a number of aspects: in the move to concurrent engineering and multidisciplinary teamworking; Rothwell (1994) for example suggests that the parallel and integrated innovation processes introduced by Japanese firms in the 1980s represent a step beyond the traditional sequential process. Furthermore, Rothwell aslo suggests that there are signs of a more enhanced version of the integrated model in which networking both internally and externally, supported by state-of-the-art information and communications technology, is a primary feature.

It is important however to separate the organisational "technology" of innovation from the underlying social process. Here I am not so sure that we can be sure of a linear progression from a technology push model, through Rosenberg's chain linked model with its feedback loops to a networked concurrent engineering approach. As Rosenberg has shown, and underlying his chain linked model (see figura 1) the interaction between industrial innovation and the wider engineering and basic science knowledge bases has always been complex and interactive. Science depends on engineered machines for its further development, and products are created using phenomena that are not explained by science, only observed. Consequently, explanations are needed that recognise innovation to be a social process of Information networking.

FIGURE N.1: An Interactive Model of the Innovation Process The Chain-linked Model



Individual firms and productive sectors at a more aggregate level

Symbols used on arrows in lower boxes:

C=central-chain-of-innovation

f = feedback loops F= patilcularly Important feedback

r= patilcularly important leeuba

Vertical links:

- K-R: Links through knowlede to research and return paths. If problem solved at node K, link 3 to R not activated. Return from research (link 4) is problematic - therefore dashed line.
- D: Direct link to and from research from problems in invention and design.
 D: Contribution of manufacturing sector to scientific research by instruundersearch and a sector to scientific research by instru-
- ments, machine tools, and procedures of technology. S: Financial support of research by firms in sciences underlying product
- area to gain information directly and by monitoring outside work. The information obtained may apply anywhere along the chain

Source: Adapted with minor changes from Kline and Rosenberg, (1986)

INNOVATION AS NETWORKS

Whilst we have noted that innovation employs inputs from many sources and the combination of different forms of information and technical resources, we need to understand the mechanisms by which this happens in order to determine the role played by territorial systems. Such a process is essentially a social process of collaboration between individuals and organisations, and therefore we turn to sociological accounts of the innovation process as a source of frameworks and concepts.

A considerable literature has developed around the sociology of scientific knowledge (SSK), with a considerable variety in epistemologies and methods. SSK emerged in the 1970s from foundations laid by Merton, Kuhn and Polanyi, with the aim of developing "an empirically informed view of the social nature of scientific knowledge" (Edge 1994). I would argue that lessons from this can be applied of other forms of knowledge production, including that of technological and organisational knowledge which we may term innovation.

The initial focus of SSK was to understand the social processes within which scientists carried out their research and produced scientific knowledge, a topic that led naturally to an ethnographic approach to the act of "doing science".

One approach which has emerged is actor-network theory, as typified in the work of Latour, Callon, Law and others. Although alternative formulations are used by others such as sociotechnical constituencies, or technological configurations, and even Callon also uses the term Techno Economic Networks (TENs) similar principles apply.

"The actor network-approach" describes sociotechnical ensembles as heterogeneous networks of human and non-human actors (Bijker, 1994) It emerges from a methodological approach that is ethnographic in nature whereby in order to understand what goes on in the process of science or innovation, we are requested to follow the actors (or scientists) and see what they do, to observe, putting aside our preconceptions of what they are doing. What Latour observed in such studies was that scientists sought to construct networks constituted by other scientists, texts, machines, or materials in support of their experiments. The objective was to move those actors to different positions, to change their characteristics or opinons, by what a Latour termed translation. Power was therefore the ability to enact such translation through moving and controlling networks.

In a case study of innovative sybway systems, Latour examines the VAL, system of Lille. Here local planners, inhabitants and developers of Villenueve d'Ascq sought to create a new form of cheap public transport. This "network" then approached the Urban Community of Lille to interest and enrol them in the project, but the concept of the VAL had to be translated to encompass their interests and so became part of a regional subway system. Further translations interested central government funding organisations, designers and engineers, the local university whose technology was used, and the company Matra seeking to move into transport systems. By following such projects we can see how territorial interests in the form of local physical needs, local interest groups, and the nature of political funding over territory all became part of the translation network, to the extent that the final product in the working system is a product of a particular locality. A similar example of a proposed new automatic system in Paris failed due to the inability of the various actors to develop a coherent network, each actor essentially retaining a unique view of the project, and failing to enrol others to that view. No one organisation was able to impose their view or translate the views of others into a consensus. Thus we must undertake research that helps us to understand the relationship between innovation and its external environment, not as a simple process of environment influencing the propensity to innovate, or of innovation only ocurring in specific places and bringing benefits, but where the nature of the environment shapes the actual form of the innovation.

Currently I am involved in a research network supported by the EU Human Capital and Mobility programme, The European Network on Industry, Innovation and Territory. The network is undertaking a project which places successful innovation at the heart of regional competitiveness, but also shaped by regional networks, and therefore conceptualises innovation as being composed of three principal forms: technological innovation (RTD), organisational innovation and institutional innovations in the form in which enterprises and territories are linked. These themes are being examined along value added chains and their inter-relations in a European context, and through the comparison of different territorial case studies.

In this specific project the *technological innovation* theme is examined in terms of the generation, transfer and implementation of business process technologies in a regional context. There is a need to separate out factors relating to the internal generation of such technologies from questions of accessibility to the results of RTD elsewhere, and the means by which firms acquire knowledge of global competitive requirements. The network is examining how regions could better use their unique attributes across a range of industries and services, drawing upon RTD to achieve international competitiveness - a focus on excellent companies as much as on novel industries. The key issue is therefore the process whereby innovation influences both the performance of the company and of its wider regional-environment.

The second major theme concerns organisational innovation, and here two main areas of concern can be identified. One is the changing nature of the relations between firms, both at the local scale within regions, and also on a global basis. Such dynamics are being affected by telematic based innovations such as EDI and logistics system developments. The second dimension is the changing internal organisation of the multi-regional firm, and the possibilities for a new spatial division of tasks such as R&D, production and marketing at a European scale. In both cases the potential for new and more flexible forms of organisation arises from the increasingly sophisticated use of information and communication technologies. Thus internal computer networks create new flexibilities for organising the functions of the firm to take advantage of differentiated labour and other factor markets, whilst external networks such as electronic data interchange (EDI) are combining with innovations in logistics to create a new geography of production and exchange in Europe.

The third and final theme concerns *institutional innovation*, and relates to the changing responses at the regional level to the challenges of technological and organisational change, for example in the adaptation of regional institutions to support inter-firm networks. The economic performance of the regions in a new European economic system will depend in part on the ability of the institutions in those regions to adapt to a changing economic, technological and industrial environment.

Regional institutions are also adapting to pressures towards the provision through the market of public services, by the establishment of new partnerships between the public and private sectors, - in growth coalitions and business leadership initiatives, and through private provision of business services with public subsidy. A common problem in many member states however is the political fragmentation of these efforts between different tiers of administration and overlapping assistance embracing different forms of ownership.

INNOVATION, INSTITUTIONS AND REGIONS

A prime focus for the rest of my discussion is the interrelationship between local governance structures, global processes of restructuring and processes of local economic development. Emblematic of all three is innovation: whether in the proliferation of new policy initiatives, the emergence of new forms of organisation, or the rising focus on innovation as a key to the rejuvenation of local competitiveness. Technology based policies to underpin local economic innovation and development are placed at the centre of both theoretical and empirical analyses of the "new localism" in economic development (Camagni, 1991), yet they are bedevilled by conflicts. These comprise different policy fields and organisations, disparate interest groups and many different spatial levels and arenas for action and interaction.

The enormous shift in the nature of international competition has had major implications for economic development strategies. The stability of production systems, product markets and national corporatist relations have been undermined by the rate of technological change, especially in the widespread effects of generic technologies such as information technology (IT). Technological innovation and access to resources for innovation (skills, knowledge, information) have therefore become central to the competitive strategy of firms, which have developed new flexible structures to better utilise and capture such advantages on a global scale (Howells and Wood, 1993). Consequently states have recognised the need to maintain a position on the leading edge of technology if they are to generate employment and growth, and hence there is an increasing attention to policies to support and promote R&D, innovation and technology transfer (Jessop, 1992).

However, the globalisation of finance and of the organisation of production allied to innovations in reformation and communication technologies (ICTS) that permit the geographical mobility of investment and resources, has weakened the bargaining power of the nation state (Sasson, 1991). In addition, the alleged "hollowing out" of the nation state is removing powers upwards to supranational institutions (e.g. the European Commission), downwards to local and regional governments and outwards to trans-regional alliances (Jessop, 1991). As a result, supra-national institutions and regulation has allowed greater freedom of flow for goods and information such that it is the nature of the production locality rather than the national market characteristics that determines the character and location of investment decisions. Hence not only has a regional or a local intervention become more important to economic success, but there has been a qualitative shift in the form of local policy towards endogenous entrepreneurship and innovation, and to providing a more sophisticated environment for mobile capital so as to maximise the value added gained from R&D activities, high skilled jobs, competitive success and growing firms (Bennett and Krebs, 1991; Mayer, 1993).

The importance of locality has persisted despite the alleged pervasiveness of globalisation. Indeed, the reemergence of the "region" as a strategic site for innovation policy intervention and the building of the foundations of competitiveness has become widespread. Commentators highlight the renewed rationale of localised production networks founded upon agglomeration economies, dynamic Small and Medium-sized Enterprises (SMEs) and dense networks of interaction (e.g. Scott, 1988). Krugman (1991) too notes the importance of labour market pooling, externalities built on the provision of a variety of lower cost non-traded inputs and, through the greater interaction of information arising from proximity, technological spillovers to the process of industrial localisation. Storper (1992) even interprets the current global economy as a mozaic of localized production districts. Common to each approach is the development of competitive advantage at the regional level through establishing "clusters" of specialised assets (both physical, organizational and human), joined by vertical and horizontal linkages, and thriving on their shared vitality and proximity. Not only is it innovation that is central to the sustainability of such linkages but it is innovation in particular places. Whether these be nations (Kay, 1994; Porter, 1992) or regions, the particular attributes of places -or the role of the "local milieu" (Maillat, 1991) - are integral to the creation of competitive advantage. Proximity, shared histories, cultures and experiences all come into play in the building of competitiveness.

However, as the process of geographic industrialisation (Storper and Walker, 1989), and the assembly of tacit technical knowledge within a region depends on the ability of the region to retain and even supplement the existing skilled labour resource, then strong regional technical networking depends also on high labour mobility within a region, but low outward movement. Yet high levels of mobility between a region and the rest of the world may also contribute to stronger global integration as more extended information networks are formed. Tensions such as these are not yet well understood but are subject constantly to external developments such as EC policy on collaboration, and by developments in communication technologies.

Underpinning the economic rationale for more localised production are a whole host of other institutions working at the regional level. Together, both market and nonmarket institutions, linked through policy initiatives, are alleged to contribute to regional competitiveness. Cooke and Morgan (1991), for instance, refer to the emergence of "intelligent regions", such as Emilia-Romagna, which are able to respond, innovate and adapt to external challenges by upgrading their competitiveness. Amin and Thrift (1 994) also point to the importance at the regional level of "institutional thickness" constructed from a differentiated institutional presence, interaction, collective representation and mutual awareness. Here, the issue is not just having the institutions to be able to enhance the competitiveness of firms in the region but constantly to renovate and not allow the formalisation of the structures that provide such dynamism to become constraints. The conjunction of localised production, institutions and policy networks at the regional level are, however, highly geographically differentiated processes of innovation. There remain relatively few empirical examples and, where they exist, differences occur in the degree to which local firms are integrated into the global economy and the importance of local linkages to regional firms (Todtling, 1994).

REGIONAL INNOVATION POLICY

A key implication of globalisation, innovation and regional competitiveness is the application of technological information to productive activities at the local level. During the 1980s this has been a rapidly growing area of local economic development policy, perhaps more so in countries other than the UK (e.g. Germany, see Esser, 1989), but nonetheless there has been a high profile for science parks, technology transfer etc, certainly when compared with traditional local employment measures. This can be seen as an important element of the emergence of the entrepreneurial region, and of the role of business elites in the policy shaping process (see, for example, Peck and Tickell, 1994). Technology initiatives are more attractive to business than social measures. This local policy has also been matched by national and EU initiatives which have provided funding for locally based initiatives out of regional policy, technology policy and training policy.

The main arguments for the need for (industrial) policy to be conducted at as local a level as possible: have been summarised by Geroski (1989) as being that i) good policy needs detailed information in its design and implementation, especially if sectorally targetted, and local policy making units working close to such sectors are therefore best placed to design, tailor and implement appropriate policy, ii) the complexities of policies rise more than proportionately with the number of parties involved and costs rise exponentially also whereas more modest policies applied in situations where existing networks and communication channels are supplemented are far easier to manage and stand a better chance of succeeding, and iii) local level application of policies can be tailored to suit local preferences and choices can be made in a (potentially) more democratic fashion.

Regional innovation policy is however a complex set of policies which operate through a variety of different institutional models, even in a relatively centralised country such as the UK. The problem has several dimensions. First there are a variety of organisations and sponsors involved, from the universities and the science vote, to DTI national and local programmes, to local authority agencies and specific bodies such as Scottish Enterprise. Secondly there are the different scales of action from local to regional to national. Coordination may be driven by funding agencies or may be developed from the bottom up. Different elements of the system may conflict, such as for example the universities international and local missions (Goddard et al 1994). Also there are interesting tensions between areas with strong intervention powers and funds but poor RTD infrastructure, and those areas with a strong resource base but no coordination. Key to this is the role of the EU regional funding, and Institutional structures in the peripheral regions of the UK. Northern Ireland is especially interesting in this sense with the most independent capability for science policy and considerable regional funding devoted to technology support, However underpinning all of the different dimensions of regional innovation policy is the degree to which the regional actors have been able to learn from their experiences and those of others, and forge close local partnerships to implement initiatives.

Such capabilities also arise from the roles that regions play in hosting firms and parts of firms. The demands on institutional thickness, and indeed its very nature, will be dependent on the types of functions and activities of firms that are based in the region. As such, therefore, there is an interlocking of local governance and the structures of governance in the firm. The relationship becomes circular in that the governance structures of the firm limit the scope for action at the local level, and thereby influence both the demands on local institutions, and the direct influence that the firms exert through their participation on boards and in public private partnerships. Processes of restructuring within

firms appear to be "flattening" hierarchies and increasing the responsibility of local managers as well as broadening the functional basis of the local plant, however, enhanced autonomy may not be a corollory of this and if the scope of local units to change their role is unchanged then sectoral interests will remain high, Indeed, the new forms of competition emerging within the firm may lead local managers to seek further support from the locality to defend their current position in the corporation, thereby increasing the extent to which managers seek to redirect public resources to their own ends. As representatives of the firms direct policy towards their own requirements, they create an inertia whereby the region seeks to sustain the conditions to attract further investments of the same nature. Rarely are such organisations able to challenge the existing role of the region in the international division of labour, or present alternative models of corporate governance that might, if implemented, offer alternative development paths for the region and its constituent establishments. This reflexivity between firms and institutions fossilises social structures of production, and appears to be a contradiction to policies aimed at improving innovation, dynamic change and upgrading to competitiveness.

CONCLUDING POINTS

The increasing pace of innovation in economic and institutional structures, coupled with a heightened mobility of capital and labour in Europe, have been reshaping territorial structure. Matching the shift in urban economic structures,

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the governance of territory has seen reformulation as an entrepreneurial style of urban management, where the local state enters into a multiplicity of collaborative arrangements with other public and private sector organisations. Such strategies to compete for resources and roles in multimodal production and distribution systems sharpen the disparities both within and between regions, as success in one activity is matched by disinvestment and disinterest in others.

The industrial structure of a region is a key element in this relationship, and processes may differ depending on the scale and dynamism of the small firm sector, and even more importantly of the large more mobile firms. The whole thrust of Community regulation of the Single European Market appears to privilege the large firms in the restructuring process, whilst neglecting their importance in terms of regional policy (Amin, Charles and Howells, 1992). However new evidence on organisational developments in the large firms, and especially in the process of technical change within that sector is possibly re-affirming the candidature of such firms as an agent in sustainable regional economic growth. Greater integration of R&D and production, the pursuit of quality, decentralisation of decision-making, subcontracting and close supplier relations provide means for further fixing in place what were previously seen as highly mobile investments. These firms then both act as an asset to their local environment, both in relations with other firms and crucially through labour market developments, but place important demands on that region in terms of human capital requirements and the industrial and service infrastructure.

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