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Fundamentos de la Gestión Tecnológica

Redes de conocimiento y políticas de conectividad

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Conocimiento: cuatro perspectivas

- Conocimiento y la perspectiva económica
- Conocimiento y la perspectiva de sistemas regionales de innovación
- Conocimiento y la perspectiva de producción social
- Conocimiento y la perspectiva de relaciones sociales de conocimiento

Conocimiento y redes

- La producción, distribución y uso de conocimiento constituye un único sistema de relaciones
- Las redes de concimiento son heterogéneas y estan socialmente distribuidas
- Las relaciones de conocimiento son asimétricas (no hay Agora)
- Existen diferentes modos de producción de conocimiento (de acuerdo a diferentes campos disciplinarios)

Conocimiento y redes (cont.)

- Las “redes de relaciones” no constituyen “sistemas y subsistemas” sino que vinculan diversos agentes sociales (o nodos) de una manera “flojamente acoplada”;
- estas “redes de relaciones” funcionan como “estructuras laxas” en las que coexisten lazos fuertes y lazos débiles entre los nodos

Conocimiento y redes (cont.)

- el carácter de "estructura laxa" de las redes de relaciones favorece el papel de la "agencia individual", por tanto, no hay "determinaciones estructurales fuertes".
- en la dinámica de las redes las percepciones y las actitudes hacia el conocimiento juegan un papel de apoyo o freno a la articulación de relaciones basadas en el conocimiento .

Las políticas de Europeas de CyT enfatizan la conectividad

Las políticas europeas promueven la conectividad basadas en el “benchmarking”, “Sistemas regionales de innovación”, “redes de excelencia” (6to. Programa Marco), etc.

Cabe anotar que estas políticas promueven la conectividad sin haber incorporado suficientemente un enfoque relacional para el diseño de sus diagnósticos

Desde nuestra perspectiva: diagnósticos relacionales y políticas de conectividad

Para la elaboración de políticas de conectividad es necesario contar con "diagnósticos relacionales"

Los diagnósticos relacionales enfatizan las interacciones entre los nodos o agentes sociales antes que en sus atributos …

Algunas guías para el análisis de redes regionales de conocimiento

1. **Marco institucional: analizar las redes de políticas es decir, las relaciones e interacciones entres los objetivos de políticas y los objetivos de las organizaciones sociales.**
2. **Morfología de redes: analizar la posición de los nodos, al grado y dirección de la relaciones, las relaciones entre las subredes.**
3. **Contenidos de las redes: analizar qué tipos de intercambios se producen de información, de conocimeinto, de tecnologías, de ideas, etc.**
4. **Resultados de la redes: analizar qué resultados han obtenido las redes en términos de innovación y en terminos de aprendijzaje coelctivo...**

Redes de conocimiento y políticas de conectividad

Philippe Larédo and Philippe Mustar

PUBLIC SECTOR RESEARCH:
A GROWING ROLE IN INNOVATION SYSTEMS

This article highlights three converging trends that 'public sector research' has experienced over the last decade. Looking especially at France, the discussion draws attention to the growing centrality of universities, the blurring of relationships between types of research institutions and types of research activities, and the development of 'research collectives' as a central organisational feature now emerging throughout Europe.

1- INTRODUCTION

Universities and government laboratories today face a paradoxical situation. On the one hand, proponents of the new mode of knowledge production proclaim the end of the university's leadership, if not monopoly,[1] in Research, as even fundamental research becomes driven by 'problem solving'. On the other hand, those who advocate national systems of innovation insist on a central role for higher education in the new knowledge economy.[2] Government laboratories similarly face the same apparent contradiction: privatisation has been on the political agenda in many countries,[3] whilst public debates focus on how best to ensure public safety in relation to the environment, health, and food. In a recent analysis of research and innovation policies,[4] we have highlighted the importance of changes that have taken place in the last decade. Most, if not all, the trajectories we observed converge upon the growing role and importance attached to 'public-sector research'.[5] During the last decade, universities have grown in importance, and the troubled times of government laboratories have ended. Both types

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[1] Michael Gibbons et al., The New Production of Knowledge (London: Sage, 1994)

[2] Richard Nelson (ed.), National Innovation Systems (Oxford: Oxford University Press, 1993); Bengt-Åke Lundvall (ed.), National Innovation Systems: Towards a Theory of Innovation and Interactive Learning, (London: Pinter Publishers, 1992), Charles Edquist (ed.), Systems of Innovation: Technologies, Institutions and Organizations (London: Pinter Publishers, 1997).

[3] Deborah Cox, Philip Gummett and Kate Barker (eds), Government Laboratories, Transition and Transformation (Amsterdam: IOS Press, 2001).

[4] Philippe Larédo and Philippe Mustar (eds), 2001, Research and Innovation Policies in the New Global Economy. An International Comparative Analysis (Cheltenham: Edward Elgar, 2001).

[5] Jacqueline Senker J., 'Introduction to a Special Issue on Changing Organisation and Structure of European Public-Sector Research Systems', Science and Public Policy, 27 (6), (2000), 394-396.

of institutions have become critical, both to firms (as evidenced by the exponential growth of collaborative agreements) and to public authorities, whether national, 'regional' or European. Why is this so?

This article argues that the new interest in public-sector research – in Europe and the United States – is explained by two factors. First we are seing a progressive but radical repositioning of science and technology policies away from the direct support of large firms, and towards small and medium enterprises (SMEs). Second, we are finding that public authorities rely more and more upon public-sector research for the implementation of new policy objectives. Public sector research has continued, but not in traditional forms: both universities and government laboratories have undergone significant transformations. In this article we have chosen to show how this process has taken place in one country – France, in the last fifteen years. Even if this supplies only a single case, it does highlight the questions that such developments pose to policy-making more generally, particularly in relations to the changing role of universities, the convergence between universities and government laboratories, and the emergence of new 'research collectives'. In questioning the classical assimilation made between types of institutions and types of research – i.e. universities and fundamental research, and government laboratories and applied research – we argue that Europe is witnessing a progressive decentralised, bottom-up, transformation which is introducing a unique diversity in the practice of research.

2- Four transformations in the European ST&I landscape

In recent years, OECD has reported a shrinking role of public expenditure on R&D in most OECD countries. Even in France, which is known for its large public expenditure,[6] private expenditure has become more important than public spending on research. Part of the explanation for this movement involves the reduction of Defence research and the quasi-disappearance of large programmes, alongside an increasing focus on SMEs and collaborative programmes, with the emergence of new public authorities and 'territorial' specialisations, and new interest in research on public issues.

2.1- Revisiting the role of military R&D and of large programmes

The argument most commonly advanced to explain this 'budgetary squeeze' on R&D lies in the widespread determination to reduce levels of public expenditure. However, this argument -- which may apply in some national situations (such as the UK) -- is insufficient to explain the more general movements that are now being observed. This change was seen first in western countries that traditionally had large military R&D expenditures. In the 1990's, these saw a large decrease.[7] This means that a large fall in public R&D can occur alongside a significant

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[6] cf. François Chesnais, 'The French National System of Innovation', in Richard Nelson (ed.), op. cit.

[7] In the US, this decrease did not touch the research part of this effort, and the diminution observed has only brought back the level of public expenditure to what it was at the beginning of the 1980's (Barry Bozeman and James Dietz, 'Trends in the United States: Civilian Technology Programs, Defence Technology and the

increase in public, non-military R&D expenditure. Furthermore Japan, where private R&D represents three-fourth of total expenditure, has entered, since the passage of a new Basic Law in 1995, a reverse cycle, and aims at doubling its public research expenditure and thus at rapidly increasing the public share of its knowledge base.

A second explanation for this changing pattern deals with civil 'large' programmes, dedicated to the development of complex systems at the frontiers of technological knowledge. These programmes were dedicated to energy (especially nuclear energy), telecommunications, the computer and microelectronics industry, aeronautics, and space. The ideology of large programmes – and their public-private arrangements – was particularly developed in France, where they were successful in making a number of 'national champions' into firms that compete at a world level. Framatome and COGEMA in nuclear energy, Aerospatiale (now part of EADS) in aeronautics, ST Microelectronics in electronics, France Telecom and Alcatel in telecommunications, and Ariane Espace in space are among the best known. Such a list highlights the importance of movements that have taken place. All these firms, which were once nationalised, have now been privatised. Quite a few have developed their present positions through the insertion of national programmes into European wide agreements – Such as Jessi (within the frame of EUREKA) for ST Microelectronics, Airbus, and the European Space Agency. Furthermore, most of these firms entered into European alliances and mergers which have greatly reshaped both their identities and the relationships they entertain with 'their' national governments. This movement has been paralleled by a rapid decrease of public funding (space excluded). This is, at least in France, a second major element in the relative decrease of public expenditure.[8] Such movements also developed in Japan where large programmes have lost ground.[9]

We thus believe that the decline in military R&D expenditure and large programmes explains most of the 'budgetary squeeze'. In most countries, other public R&D expenditure has increased. What, then, are the areas into which public investment is being redirected, and how is this being achieved?

Deployment of National Laboratories', in Philippe Larédo and Philippe Mustar (eds), op. cit.). The increase witnessed following the 2001 events does not change the overall trend, only its relative importance.

[8] Just as an example, the orders of magnitude of the role of both components in France are the following. In the mid-1980's, military expenditures represented around 30% of total public R&D expenditure, and within civil expenditure, large programmes represented around half the total. Today military expenditures are under 20% and large programmes (or the public institutions that remain, like CEA, the nuclear energy institution) represent around 25% of total civil expenditure (out of which two-thirds are internal expenses, i.e. the usual functioning of public research institutions). Still the public civil expenditure has remained on a plateau in constant Euros for the whole decade.

[9] Cf. Scott Callon, Divided Sun (Stanford: Stanford University Press, 1995).

2.2- THREE MAIN FOCI FOR PUBLIC INTERVENTION

Many have asked whether the decrease of large programmes is linked to government disengagement from industry. The answer is not straightforward. We face three simultaneous movements. Elsewhere, we have emphasized the rise of a new policy instrument, which we have called the 'technological programme'.[10] Dedicated to the technological competitiveness of existing industries, such programmes aim at mobilizing different actors to develop collectively new competences and capabilities identified as critical for the future. The Alvey programme in Britain was such a programme, which was followed in almost all EU countries. The European Commission became a major player in this direction, with programmes such as Esprit, Race or Brite.[11] These in turn pushed the Bush and Clinton administrations to create and develop the ATP ('Advanced Technologies Program') in the United States. Collaborative research is at the heart of such activities, both for so-called 'pre-competitive' research between competing companies, and for fostering vertical cooperation between firms and their suppliers or potential customers. They also actively promoted collaboration between private firms and public research.[12]

However, in many European countries, such programmes lost ground in the 1990's. This outcome was explained by the changing nature of large firms, and was linked to arguments concerning globalisation. In France, surveys revealed how specifically national characteristics of large firms have declined, and highlighted the rapid internationalisation of research and innovation.[13] These evolutions led to a questioning of traditional relationships between large firms and national policies and to a new policy focus on the innovation capabilities of SMEs.[14]

In most countries, new simple, quasi-automatic procedures for supporting innovation activities have been implemented – such as R&D tax credits in the US and France, assistance in recruiting researchers and engineers in Germany, fiscal support for investment in Italy, and the mechanism of Aide à l'innovation, a interest-free loan repayable only in the event of commercial success, initiated in France and now present in more than ten countries. This new policy

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[10] Michel Callon, Philippe Larédo and Philippe Mustar (eds), The Strategic Management of Research and Technology (Paris: Economic International, 1997).

[11] These dealt with information technology, communication technology and production technology (such as mecatronics).

[12] For a better appraisal of their role see among others the national impact surveys made on the effects of EU programmes in different countries, and especially in the UK, Germany and France: Luke Georghiou et al., The Impact of EC Policies for RTD upon Science and Technology in the UK (London: HMSO, 1993); Guido Reger et al., European Technology Policy in Germany (Karlsruhe: ISI, 1993). Philippe Larédo, 'Structural Effects of EC RT&D Programmes', Scientometrics 34 (3), (1995), 473-487; Philippe Laredo, 'The Networks Promoted by the Framework Programme and the Questions they Raise about its Formulation and Implementation', Research Policy, 27, 589-598.

[13] For a review of changes witnessed between 1995 and 1999, see Philippe Larédo and Philippe Mustar, 'La recherche, le développement et l'innovation dans les grandes entreprises françaises: dynamiques et partenariats', Education et Formations, 59, (2001), 21-39.

[14] See for France, Bernard Majoie, Recherche et innovation: la France dans la compétition mondiale (Paris: La Documentation Française, 2000).

approach underlines the increasing reliance on frameworks other than those traditionally associated with science and technology policy. In this way, fiscal policy, intellectual property rights, and procurement policies (such as the Small Business Act in the US) have played new roles in fostering a favourable environment. Even more important has been the creation of mechanisms to help SMEs access and use existing public facilities, such as the Manufacturing Extension Program in the US and the numerous Technology Resource Centres in most European countries.

These developments suggest how important public-sector research has become to national political agendas. What was at first, for government laboratories, a question of rationalisation -- and even, in the UK, of privatisation -- has turned in many countries into a rethinking of their role, often entailing massive reorganisation (as in Finland). As Crow and Bozeman point out, government laboratories have shown a capacity to overcome initial difficulties and remain in the public sphere.[15] At the same time, higher education has grown in importance to public research. Even in France, where the balance was strongly in favour of research within numerous government laboratories (and especially, within the CNRS), there has been a dramatic change in less than two decades. There are now twice as many full-time equivalent researchers in French universities than in the CNRS (30,000 against 14,000), which means that, in personnel terms, the ratio is now four to one. For new positions, the ratio for the last five years (1997-2001) has been over 10 to 1!

The growing importance of public-sector research is also visible in most new initiatives for fostering economic growth. Many countries have developed policies to link universities to industry (such as the British LINK programme). For instance, in France, 'national programmes' have been replaced by 'national networks' where public support is limited to assisting public-sector research participation in réseaux nationaux de recherche technologique. Everywhere start-ups and incubators (which typically originate from, and are linked to, public-sector research) have been high on the agenda.[16]

2.3- Towards 'territorial' specialisation

This triple focus – on technological programmes, support for SME's, and public-sector research – is not, however, equally evident in all European Countries. This is explained we believe, by territorial differences and specialisation between regions, national governments, and the European Union. For example, the EU is playing a central role in 'technological programmes'. This role was debated at length in the 1980's. Such is no longer the case. No member country has as important an 'Information and Communication Technnology' programme as has the EU. The 'Industrial and Materials Technologies' programme has by far superseded the sum of

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[15] Michael Crow and Barry Bozeman, Limited by Design: R&D Laboratories in the US National Innovation System (New York: Columbia University Press, 1998).

[16] Philippe Mustar, How French Academics create High-Tech Companies: Conditions of Success and Failure of this Form of Relation between Science and Market, Science and Public Policy, 24, (1997), 37-43.

national programmes on similar issues.[17] Moreover, The recent introduction at the EU level of research in transport technologies (a stronghold of national programmes), in aeronautics, and in the Galileo space programme are clear markers of a progressive transfer of national responsibilities to the European Union. This tendency has been reinforced by the fact that national programmes are increasingly framed within European agreements - such as the European Space Agency, Airbus and Eurocopter. There is now a tradition of European consortia being successfully entrusted with large research facilities (CERN AND ESF being examples). Current debates about direct EU funding of such facilities is another indicator of this new moving partition of responsibilities.

At the same time, National policies have been undermined by progressive developments at the sub-national level – that is by regions in France, Italy and Spain, where elected regional authorities have brought about a redefinition of the institutional landscape. Even the UK is witnessing a similar phenomenon, with its processes of devolution. Currently, we lack studies of the policies this movement has produced, and of the ways in which regions have responded. However, we have pointed to the experience of France in moving from a territorial extension of national policies to regional policies which regional councils discuss on an equal footing with central government. [18] In Spain, Emilio Munoz has shown how 'autonomous regions', such as the Basque region, have developed policies for local industry.[19] Munoz also highlights the institutional transfer of universities to regions that is now underway. These elements highlight two main features of regional policies: their focus upon the higher education landscape,[20] and their assistance to SME innovation through the building of networks and structures (such as technology resource centres). More and more countries now face a situation similar to that of Germany, where higher education and research are responsibilities shared between the Federal Government and the Länder.[21]
This double 'squeeze' of traditional national policy prerogatives has been reinforced by direct links between the EU and regions via so-called Structural Funds. Although these involve only about half the regions, it is estimated that Structural Funds dedicated to higher education, research and innovation infrastructure will far exceed the total amount of the Fifth Framework

[17] This movement is further demonstrated by empirical findings in France. The above-mentioned survey on large firms shows a systematic presence in EU programmes, while national ones are less and less often mentioned. Nearly all high-tech established SMEs participate in EU programmes. Finally even in public research, 'mixed research units' between CNRS and Universities find more external resources at EU than at national level.

[18] Philippe Mustar and Philippe Larédo, 'Innovation and Research Policy in France (1980-2000) or the Disappearance of the Colbertist State', Research Policy, 31, 1, (2002), 55-72.

[19] Emilio Munoz, 'The Spanish System of Research', in Philippe Larédo and Philippe Mustar (eds), op. cit.

[20] The geographical partition of universities on the territory makes them 'proximity' public-research capabilities as opposed to government laboratories or national research institutions which are far from being equally spread on the national territory.

[21] It should be noted that a similar movement is being observed in the US. The amount that states spend on technology policy (excluding university support) is rapidly growing and was in 1998, for the first time, more important than the expenditure of the NSF.

Programme. In Portugal, these funds, have had a central effect, in renewing the institutional landscape (bringing over 100 new institutions, many in a bridging role) and in very rapidly increasing the stock of qualified engineers and scientists (providing nearly 6000 new Ph.D. fellowships over a decade).[22]

These movements bring us to speak of 'territorial specialisation'. This specialisation is not a question of exclusive responsibility, since previous developments have shown that all aspects are dealt with at all levels. However, the mix of priorities differs at each level and enables us to identify specific 'foci'. This leaves open the well-known and poorly addressed question of co-ordination. Co-ordination, however, requires that each level recognise its own goals, as well as others', and stops considering others at 'arm's length'. It also requires us to rethink the appropriate nature of future policy, and the corresponding instruments relevant to each level of government.

2.4- RESEARCH IN THE PUBLIC INTEREST

The question then becomes - what role is left to national S&T policies? The recent developments just presented point not to shrinking public intervention, but to a split in what was previously the sole responsibility of national governments. The answer also entails a redefinition of national public intervention which, at least in France, has *de facto* taken place, even though the views expressed by policy-makers have hardly changed. The focus is now on two inter-connected responses: the shaping of public-sector research, and the development of research in the public interest.

It is rather paradoxical to stress such an issue. State involvement in research activities is an old story, if only for military reasons. In the nineteenth century, the building of railways and bridges and the need to ensure travelers' health and safety drove to the development of specific scientific services. Hygiene in cities was also such a field where policies were developed alongside the work done by scientists. Even, in agriculture, extension services played a major role long before the Second World War.

The 1970's and 1980's, obsessed with industrial competitiveness, revealed a kind of policy blindness towards such issues.[23] It required a number of crises in public health -- AIDS, Ebola fever, contaminated blood, and the mad cow disease – and in the environment -- nuclear safety and the handling of nuclear wastes, nitrates and drinking water, tanker wrecks and oil pollution, and numerous scandals around the dumping of industrial wastes – to bring about a shift in policy priorities. In the EU, research policy has responded with the adoption of a 'problem solving' approach for most of the 'Key Actions' of the Fifth Framework Programme. The issue is no longer that of technological competitiveness per se, but rather that of finding global

[22] Luisa Henriques, National S&T Policy in the Globalisation Era, Portugal as a Research Laboratory, (Lisbon/Paris: CSI, mimeo, 2000).

[23] The war against cancer lost by Nixon (as well as the failed alternative energy programmes) might have played a significant role since, even with an ever increasing budget allocated to the NIH through the 1980's, the idea that this could provide an alternative rationale to the Cold War one was rejected by most US policy analysts.

answers to recognised problems. The priority is no longer one of developing 'precompetitive' activities, but rather of proposing 'demonstrations' which render visible to citizens and their representatives, solutions to identified problems.
This change in perspective has much in common with the development of a 'Mode II' approach to research and development, as it involves very ealry on in the process, stakeholders, users, and public authorities.[24] Most of the time this also requires *ad hoc* tailoring of the space in which such options are experimented.[25] For this, the traditional models of sectoral research no longer apply. That is, it is no longer a question of a 'customer–contractor' relationship -- as proposed by Lord Rothschild in his famous report -- nor is it a question of delgating tasks to mission–oriented government laboratories, whose job it is to apply research to the problem at hand. In France, heated public debates have driven to the adoption of new structures. The response to nuclear waste and AIDS has proven exemplary of this change. Crisis after crisis have produced *ad hoc* solutions, at a distance from both central administration and well-established research institutions.[26]

3- PUBLIC-SECTOR RESEARCH: CONVERGING TRENDS

These four trends – questioning the role of military research and large programmes, focusing public support to industry on SME innovation capabilities, developing a territorial specialisation in public intervention and reestablishing research in the public interest as a major priority – highlight both the changing focus and priorities of research and innovation policies. National studies have traced the massive transformations that most countries have experienced during the 1990's. These transformations are institutional in most European countries, if only because of the emergence of the European Union, and in Japan which is witnessing reforms as significant as those introduced by the Meiji restoration in the 1870's and by those that followed the second World War.[27] In the US, Mowery argues that similar transformations (with the exception of military R&D) have taken place in a stable institutional environment.[28] These transformations mean that a more central role is being assigned to public-sector research. Centrality is not only

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[24] Michael Gibbons et al., op. cit.

[25] Bruno Latour has proposed the wording 'collective experiments' to qualify these processes in which the shaping of new products and services is not confined to industry design offices (even surrounded by a few heterogeneous spokes–persons) but requires effective participation of numerous actors who collectively explore and progressively co-shape the feasibility of a want-to-be innovation.

[26] AIDS gave rise to a specific non-profit organisation, ANRS, supported by most research institutions and in charge of elaborating, piloting and funding the national research action, including clinical trials. On the contrary nuclear waste research has been the object of a law which defines three parallel options to be developed independently by three institutes, their progress being monitored by a specific parliamentary commission.

[27] Yukio Sato, 'The Structure and Perspective of Science Technology Policy in Japan', in Philippe Larédo and Philippe Mustar (eds), op. cit.

[28] David Mowery, 'The US National Innovation System after the Cold War', in Philippe Larédo and Philippe Mustar (eds), op. cit.

financial, it is also, and mainly, linked to the role given to public-sector research in new policy initiatives, may these address SME innovation capabilities or societal problems.

At the same time, it is important to recognise that, in their shaping of public-sector research, national systems do differ. The status and role of universities vary from one country to another, and the role of 'national' and 'government' laboratories cannot be easily understood without a knwoledge of their historical evolution. Path dependency plays a large role in explaining the specificity of public structures. Still, there are converging developments, notably in the growing centrality of universities in the public research landscape, and in the progressive decoupling of certain types of institutions and research activities. Taking the case of France will help clarify the main features we see emerging in public-sector research –: its growing 'grass roots' diversity, and its independence from earlier institutional affiliations.

3.1- The growing role of universities

France is generally considered to have marginalised the research role of its universities by developing fundamental research through the CNRS. It has also been active in the creation of mission–oriented government laboratories. Well before the Second World War, French universities were considered weak in research. The CNRS, established in 1939 after two decades of discussion, chose after the second world war to develop its own laboratories. CNRS now employs 26,000 persons and over 14,000 researchers. It is by far the largest European institution dedicated to fundamental research. But can we still speak of it as a stand-alone institution? The answer is clearly 'no' -- for two main reasons. As early as the 1960's, the CNRS recognised that it had a role to play in relation to university research. It developed the concept of *équipe associée* which later evolved into *unité mixte de recherche (UMR)*. Today, four-fifths of CNRS research units are 'mixed' between CNRS and the universities; they are located on university campuses and employ over four-fifths of all CNRS personnel. The consequence is that the 1200 units that comprise CNRS now mobilize over 60,000 persons, each unit havung on average more university staff than CNRS researchers. Within the units overall, the centre of gravity is shifting towards the universities, with more than 10 recruitments to university positions for every one appointment made by the various *organismes de recherche* (i.e., THE CNRS and all other government laboratories).[29]

Whilst there continue to be debates about the appropriate division of time between research and teaching, and disagreements about the definition of 'full-time' research for the *enseignant-chercheurs*,[30] these two movements highlight the changing balance that is taking place in the

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[29] The reader should be reminded that both CNRS researchers and *enseignants-chercheurs* are civil servants recruited at junior level (after their Ph.D. thesis). He/she should be reminded that the terminology adopted to qualify higer education staff – i.e. *enseignants-chercheurs* – translates the fact that, by status, they are supposed to undertake both activities (teaching and research) on an equal footing, and thus do not have, unlike in some Anglo-Saxon countries, to buy back their teaching time from the University to undertake research activities.

[30] The reader should also be reminded that full-time researchers are supposed, by status (through the 1982 law which turned them into civil servants), to devote time to expertise, dissemination and transfer of results (including teaching!) and to the management of research activities. A study made at INRA (CSS, Bilan de la

French academic research landscape. This change has also produced new contractual procedures – *contrats quadriennaux*, four-year contracts – between the Ministry and each university. Begun in 1988, today more than 90% of ministry Funds allocated to university research are channeled through these contracts, which also take into account the CNRS's UMRs. In a way, CNRS has turned into a new type of research agency for university research – new, because it supports collective structures instead of individual projects, and because it allocates personnel rather than money. One could argue, when looking at debates about career paths in the US,[31] that this is specifically adapted to the changing knowledge environment. Even in a country famous for partitioning public research, the role of the universities has come to the fore.[32]

3.2 - PUBLIC-SECTOR RESEARCH: INSTITUTIONAL DIFFERENTIATION BUT CONVERGING ACTIVITIES

It is longstanding practice to associate government laboratories with 'applied' or 'mission–oriented' research. This derives in part from the famous linear model of innovation, according to which different types of research activities are assumed to require different competencies and organisational settings, so that it is necessary to establish specific institutions to apply the basic knowledge developed by fundamental research to the problems of a particular sector. When the problems were industrial, France created 'technical centres', paid for by the profession; where the problems concerned the public interest, France established 'goverment laboratories'. This approach was conceptualised by policy-makers who, in the 1970's, spoke of the 'three circles' of research (i.e fundamental research, applied research and industrial development). Still today, these government laboratories – including the research institutions created to accompany large programmes – [33] represent around 20,000 researchers and engineers.

In 1982, most of these laboratories changed status, being turned into EPST (*établissements publics à caractère scientifique et technologique*).This change had a dual effect on the dynamics of these institutions. First, their budgets were taken from their sectoral ministry; and given to the Ministry of Research, which assumed *de facto* responsibility for them. This change was all the more significant as the sectoral ministries had not developed programmes large enough to enable them to enter, as in the UK, customer–contractor relationships with client institutions. Second, researchers were transformed into civil servants and made subject to career rules

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campagne, INRA internal document, 1996) showed that these other activities represent, on average, half of researchers' time, putting them theoretically on a near to equal footing to *enseignants-chercheurs* in term of time devoted to direct research activities.

[31] See Paula Stephan and Sharon Levin, 'The Critical Importance of Careers in Collaborative Research', Revue d'Economie Industrielle, 79, (1997), 45-61.

[32] Readers knowing the French situation could argue that this does not take into account the very specific nature of French *Grandes Ecoles*. On the contrary, the movement has even been greater for them. It is enough to mention that, in their areas of intervention (mainly engineering sciences), they deliver over 20% of all Ph.D.s awarded in France with 6% of the total higher-education workforce.

[33] Such as CEA for nuclear, ONERA for aeronautics or INRIA for computer and information S&T.

similar to those OF CNRS staff. Even though 'knowledge transfer' was part of A researcher's duties, career evaluation focused on traditional criteria. Fifteen years later, this has produced a clear trend towards academic research, and evaluation practices and diversified career paths are now the subject of considerable debate.

Some institutions did not participate in the changes of 1982, remaining or being turned into EPICs (*établissements publics à caractère industriel et commercial*). This was the case of CEA (the french atomic energy agency) and of IFREMER (in charge of ocean research) which together employ significant numbers of researchers. However, they have *de facto* behaved in the same way, mixing early recruitment (at junior positions) with life employment (as for civil servants).

How has this development influenced research? The experience of INRA illustrates the massive repositioning which has taken place in a single decade. In INRA, it was common to find teams active in innovation interacting closely with the agricultural world – in, for example, developing a new variety of chicory that transformed the national and European market, or helping in the re-creation of a traditional cheese, like Beaufort.[34] Today, such teams, which Joly and Mangematin call 'technical centres' serving given professions, are seldom found.[35] Their survey, undertaken in 1993-1994, show that most teams have 'mutated', developing other logics, linked to the creation of generic tools or to 'specialised basic research'. This does not mean that they withdrew from economically productive activities. However, they did experience a changing relation with the economic world. This changing relation is based upon new partnerships, in which professional associations are being replaced as privileged partners by large firms (individually or grouped in *ad hoc* clubs) with their own research facilities. These new relationships rely mainly upon contractual terms which take into account the professionalism of both partners. This means that co-operative research tends to privilege relations between equals, and that it is up to the internal capabilities of firms to master and mobilise the results deriving from the academic work developed by INRA researchers. INRA as an institution can no longer be defined by the type of research it undertakes, but by the domain upon which its units focus.[36]

Convergence in research is not only a question of making government laboratories more academic. The process also reflects a changing pattern of university/CNRS relations with industry. The contracts between units linked to CNRS and industry provide an even clearer marker of this transformation. These contracts have multiplied by ten in only one decade, and today average three per unit.[37] The regional observatory developed by one French region has

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[34] For an analysis of innovation trends at INRA, see INRA, Les chercheurs et l'innovation. Regards sur les pratiques de l'INRA (Paris: Institut National pour la Recherche Agronomique, 1998).

[35] Pierre-Benoit Joly and Vincent Mangematin, 'Profile of Public Laboratories, Industrial Partnerships and Organisation of R&D: The Dynamics of Industrial Relationships in a Large Research Organisation', Research Policy, 25 (6), (1996), 901-922.

[36] For a further development of this argument, see Philippe Larédo, 'Government Laboratories or Public Institutions of Professional Research? The Case of France', in Deborah Cox et al. (eds), op. cit., 114-127.

[37] Philippe Mustar, Les Chiffres Clés de la Science et de la Technologie (Paris: Economica/OST, 1998).

shown that industrial contracts represent over 30% of the non- permanent resources of all research groups present in the region.[38] There is thus more and more difficulty in differentiating research groups merely by their institutional affiliation. More and more, they tend to follow a similar trajectory -- mixing academic research, which gives rise to publications, and contracts with external partners, including not only industry but also the whole range of public authorities – from regions to THE EU. We have used the term 'collaborative academic research' to describe this new relationship.

3.3- Strategic choices made at the 'grassroots' level of research units

These trends towards convergence do not, in themselves, imply homogeneity. For example, the Anjou observatory has identified seven different profiles, which cross disciplinary and institutional borders.[39] A study of 400 European laboratories working in human genetics,[40] arrives at a similar conclusion, identifying four 'activity profiles', describing the different ways in which laboratories mix academic research, training activities, and outputs that are geared toward public issues or linked with industry. This study showed that these 'activity profiles' bear only a limited relationship to the institutionnal affiliation of laboratories. Similarly, as far as the mix of research activities is concerned, there is no clear relationship with the country in which these laboratories are located.[41] It is too early to generalise such results. What is important to note, however, is the growing diversity of such 'research collectives' – i.e. the operational structure in which research activities take place – and that diversity cannot be systematically assimilated with institutional affiliation. Thus, it is not because a laboratory is affiliated to CNRS or/and to a university that it performs 'fundamental' research. Nor is it because the institution is described as mission–oriented, that it focuses on 'applied' research. As policymakers like to say in the Anjou region, laboratories are the 'enterprises' of research. It is thus normal to see diversity both in type (small vs. large firms), in positioning (mass vs niche markets), in production (generic vs tailored) and in performance. All make unique choices which must be monitored and evaluated in their own terms, and not simply by looking at their institutional affiliation. This entails a radical shift about our conception of public-sector research -- a shift whereby institutions (whether CNRS, universities or government laboratories) must be

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[38] AURA (Angers), Deuxième Rapport de l'Observatoire de la Recherche Angevine, 1999.

[39] For the methodology used by the Observatory and the main results arrived at, see Philippe Larédo and Philippe Mustar, 'Laboratory Activity Profiles: An Exploratory Approach', Scientometrics, 47, 3, (2000), 515-539.

[40] Jacqueline Senker et al., European Comparison of Public Research Systems, Final report, TSER Programme (Brighton: SPRU, 1999). For a summary of results, see Philippe Larédo, 'Benchmarking of R&D Policies in Europe: Research Collectives as an Entry Point for Renewed Comparative Analyses', Science and Public Policy, 28, 4, (2001), 285-294.

[41] Activities should not be confused with resources gathered: the same study shows clear linkages between the country of origin and the ways through which laboratories access their resources.

taken as an 'intermediary layer',[42] whose role is to foster the shaping of the operational research structures, whether they be called laboratories, research units (as in France), institutes (as in Germany) or centres (as is becoming common in the US).

3.3- Governance issues within public-sector research

Contrary to the assumptions of those who foresse the coming of 'Mode II' research practices in which traditional universities are largely overtaken, this changing landscape puts the universities at the very centre of future developments. However, the universities are themselves changing. In France, the rise of 'research units' had as a consequence a progressive decoupling of activities – with departments in charge of teaching activities, and research units in charge of research by *enseignants-chercheurs* – and a progressive hybridization of management with the involvement of resarch institutions on top of universities themselves. Elsewhere, the NSF's engineering centres in the United States, the new centres established by the research councils in the UK, or the policies of the Dutch NWO demonstrate new structural approaches to management of research. Furthermore, smaller countries like Sweden, Finland and Norway have developed a policy to promote 'centres of excellence', while the Dutch government has initiated a policy of 'Top Technology Institutes'. All these call for a transformation in the ways that public-sector research is governed. Seen from a laboratory perspective, three new sets of questions are emerging.

- First, there are questions dealing with equipment. We can hypothetise that the more a laboratory requires 'heavy' equipment, the more it will be dependant on the non-university institution that supports it, be it the CNRS or a research council, or any domain-oriented institution (like INRA). This calls for a re-definition of the modes of intervention of domain-oriented institutions. It does not diminish their role in developing in-house research capabilities, but it redefines the borders between what is done within university structures and what remains largely beyond the scope of universities.

- Second, the changing role of universities goes hand in hand with the increasing role of 'regional' authorities. In any given locality, universities provide the most likely facilities for 'proximity' public research, and are thus a central focus in the endeavour to foster innovation among local firms. Whatever the prevailing institutional affiliations of universities, we should thus witness an increasing involvement of regions (including the individual States in the US and the *Länder* in Germany) in the strategic management of universities and the shaping of their research. The economic diversity of regions should be reflected in differentiation and diversity among universities. The work within the Anjou region tends, for example, to show that the traditional divide between 'research' and 'non research' universities is no longer relevant. Research activities are or will be present in most, if not all, universities, but the relevant mix of laboratory 'activity profiles' can easily differ, and with it, the nature of the universities' response. Those research universities which compete scientifically on a world level, and care little about regionalL issues, will become only one configuration among many, and will

[42] Barend Van der Meulen and Arie Rip, Mediation in the Dutch Science System, Research Policy, 27, (1998), 757-769.

probably – rather like global firms, in relation to employment – represent only a limited share of the entire public research and training enterprise.

- Third, there are questions of governance aside from relations with research councils (and their equivalents) and regional authorities. The universities will see many changes in their relations with the external world. Laboratory studies have shown the importance of privileged relations with an external partner, be it a large firm, a non-profit organisatio,n or a public priority programme. There has been a tendency to enter into a longer term more structural relation, as is with 'mixed laboratories' between CNRS and some firms, or with public labotarories located on the premises of non-profit organisations. In a way, laboratories that have had EU contracts on the same topic running through three successive Framework Programmes are *de facto* in the same position. The same applies to laboratories involved in long-term 'problem-solving' programmes managed by agencies such as ANRS for AIDS or ADEME for energy saving and environment-friendly technologies in France. Privileged 'customers' are thus another source of diversification between laboratories. From this analysis, national and European priority programmes face a new challenge, of developing instruments to enter into durable relationships. The choice made by the sixth EU Framework Programme to focus its funding on multi-annual 'networks of excellence' and 'integrated projects' can be interpreted as a response to the need to establish new relationships.

The internal re-organisation of universities, their relations with research councils and government laboratories, their articulation with regional innovation policies, and the rethinking of instruments for national and EU 'problem solving', are developments tht are accompanying the convergence of public-sector research around its new operational structures.

4- Conclusion

This paper has highlighted the growing role of public-sector research, linked to changes that have taken place – principally in Europe – during the last decade. These changes have occured in a wider context of disengagement by governments in Europe from large military and civil programmes. This probaly translates to the evolving industrial world scene where large firms are seen by national governments as more and more 'global', less and less a source of new employment, and probably no longer the major national source of new high-tech, radical innovations. At the beginning of the 21st century, we see a progressive repositioning of science and technology towards supporting SME's and grass-roots developments in new high-tech firms. Policies have been both direct (including financial support and tax incentives), and indirect, through the mobilisation of public training and research facilities. Public-sector research has also experienced a political rediscovery, in hopes of finding solutions to growing problems of health, environment, and safety. As partners in this process, universities have grown in importance, as have government laboratories. However, both have undergone significant transformations in the ways in which their research is performed. Taking France as an example, we have shown convergences in the ways research activities are performed, with the rise of 'research collectives'. This leads us to the conclusion that the traditionally close association between universities and fundamental research, on the one hand, and that between government laboratories and applied research, on the other, no longer holds, and that we must look to the future evolution of public-sector research as a broader canvas on which to project and describe their future relationships.

Against this changing framework, using France as a casestudy, we have identified four major issues. Two address the governance of research activities – the internal organisation of universities, where research activities are being separated from teaching in research 'collectives'; and where increasing hybridisation with other research public bodies (research councils and government laboratories) is forcing a rethinking of their respective roles. The other two issues go hand in hand with the emergence of the regions and the European Union in the research enterprise, and with territorial specialisation. In a growing number of European countries, policy for Higher education and research is being shared between national and regional governments; and in nearly all countries, regional innovation policies are booming. This has been concomitant with a growing interest among national governments and the EU on 'problem solving' policies, moving public-sector research away from individual project, and increasing the number of centres and networks of excellence.

These movements question our prevailing approaches to public research. How will the growing interest in the collective dimension of research activities impact on our over-dominating individual approach to science (symbolised by nobel prices)? Similarly, the growing differenciation between research and training activities will no doubt question the solely research-led criteria that organise university career paths. In most conceptualisations, from mode II to the triple helix[43], public policy is seen as one and assimilated to national government; how can one assume such unicity when faced with three and even four different public authorities[44] acting on the same territory and which have no over-arching reason to share the same objectives and can easily enter into competition about the priorities set? If we assume, as we do, that public-sector research is growing in importance as a policy response to new challenges faced, the questions multiply about the implementation of this policy priority. This advocates for putting very high on the research agenda of science studies, issues relating to the dynamics, organisation and management of public-sector research.

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[43] Cf. Helga Nowotny, Peter Scott and Michael Gibbons, Re-thinking Science, (Cambridge: Polity, 2001); and Henry Etzkowitz and Loet Leydesdorff, Universities in the Global Knowledge Economy, A Triple Helix of University – Industry – Government Relations (London: Pinter, 1997).

[44] If we count not for profit associations which behave as quasi public authorities in their field of activity, cf. the work on the French Association on neuro-muscular diseases (AFM): Michel Callon and Vololona Rabeharisoa, Le pouvoir des malades (Paris: Presses de L'Ecole des Mines, 1999).

on the dynamics of research collectives (P. Larédo). They have recently edited, jointly, Research and Innovation Policies in the New Global Economy (Edward Elgar, 2001).

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THE DYNAMICS OF INNOVATION: FROM NATIONAL SYSTEMS AND "MODE 2" TO A TRIPLE HELIX OF UNIVERSITY-INDUSTRY-GOVERNMENT RELATIONS

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Abstract

The Triple Helix of University-Industry-Government Relations is compared with alternative models for explaining the current research system in its social contexts. Communications and negotiations between institutional partners generate an overlay that increasingly reorganizes the underlying arrangements. The institutional layer can be considered as the retention mechanism of a developing system. For example, the national organization of the system of innovation has historically been important in determining competition. Reorganizations across industrial sectors and nation states, however, are induced by new technologies (biotechnology, ICT). The consequent transformations can be analyzed in terms of (neo-)evolutionary mechanisms. University research may function increasingly as a locus in the "laboratory" of such knowledge-intensive network transitions.

1. Introduction: From the Endless Frontier to an Endless Transition

The "Triple Helix" thesis states that the university can play an enhanced role in innovation in increasingly knowledge-based societies. The underlying model is analytically different from the National Systems of Innovation (NSI) approach (Lundvall 1988 and 1992; Nelson 1993), which considers the firm as having the leading role in innovation, and from the "Triangle" model of Sábato (1975), in which the state is privileged (cf. Sábato and Mackenzie 1982). We focus on the network overlay of communications and expectations that reshape the institutional arrangements among universities, industries, and governmental agencies.

As the role of the military has decreased and academia has risen in the institutional structures of contemporary societies, the network of relationships among academia, industry, and government have also been transformed, displacing the Cold-War "Power Elite" trilateral mode of Wright Mills (1958) with an overlay of reflexive communcations that increasingly reshape the infrastructure (Etzkowitz and Leydesdorff 1997). Not surprisingly, the effects of these transformations are the subject of an international debate over the appropriate role of the university in technology and knowledge transfer. For example, the Swedish *Research 2000 Report* recommended the withdrawal of the universities from the envisaged "third mission" of direct contributions to industry (see Benner and Sandström, this issue). Instead, the university should return to research and teaching tasks, as traditionally conceptualized. However, it can be expected that proponents of the third mission from the new universities and regional colleges, which have based their research programmes on its premises, will continue to make their case. Science and technology have become important to regional developments (e.g., Braczyk *et al.* 1998). Both R&D and higher education can be analyzed also in terms of markets (Dasgupta and David, 1994).

The issues in the Swedish debate are echoed in the critique of academic technology transfer in the U.S.A. by several economists (e.g., Rosenberg and Nelson, 1994). The argument is that academic technology transfer mechanisms may create unnecessary transaction costs by encapsulating knowledge in patents that might otherwise flow freely to industry. But would the knowledge be efficiently transferred to industry without the series of mechanisms for identifying and enhancing the applicability of research findings? How are development processes to be carried further, through special grants for this purpose or in new firms formed on campus and in university incubator facilities?

The institutional innovations aim to promote closer relations between faculties and firms. "The Endless

Frontier" of basic research funded as an end in itself, with only long-term practical results expected, is being replaced by an "Endless Transition" model in which basic research is linked to utilization through a series of intermediate processes (Callon 1998), often stimulated by government.

The linear model either expressed in terms of "market pull" or "technology push" was insufficient to induce transfer of knowledge and technology. Publication and patenting assume different systems of reference both from each other and with reference to the transformation of knowledge and technology into marketable products. The rules and regulations had to be reshaped and an interface strategy invented in order to integrate "market pull" and "technology push" through new organizational mechanisms (e.g., OECD 1980; Rothwell & Zegveld 1981).

In the U.S.A., these programs include the Small Business Innovation Research program (SBIR) and the Small Bussiness Technology Transfer Program (STTR) of the Department of Defense, the Industry/University Cooperative Research Centers (IUCRC) and Engineering Research Centers (ERC) of the National Science Foundation, etc. (Etzkowitz *et al.*, 2000). In Sweden, the Knowledge Competency Foundation, the Technology Bridge Foundation were established as public venture capital source, utilizing the Wage Earners Fund, originally intended to buy stock in established firms on behalf of the public. The beginnings of a Swedish movement to involve academia more closely in this direction has occasioned a debate similar to the one that took place in the U.S. in the early 1980s. At that time, Harvard University sought to establish a firm jointly with one of its professors, based on his research results.

Can academia encompass a third m ission of economic development in addition to research and teaching? How can each of these various tasks contribute to the mission of the university? The late nineteenth century witnessed an academic revolution in which research was introduced into the university mission and made more or less compatible with teaching, at least at the graduate level. Many universities in the U.S.A. and worldwide are still undergoing this transformation of purpose. The increased salience of knowledge and research to economic development has opened up a third m ission: the role of the university in economic development. A "Second Academic Revolution" seems under way since W.W. II, but more visibly since the end of the Cold War (Etzkowitz, forthcoming).

In the U.S.A. in the 1970s, in various Western European countries during the 1980s, and in Sweden at present, this transition has led to a reevaluation of the mission and role of the university in society. Similar controversies have taken place in Latin America, Asia, and elsewhere in Europe. The "Triple Helix" series of conferences (Amsterdam, 1996; Purchase, New York, 1998; and Rio de Janeiro, 2000) have provided a venue for the discussion of theoretical and empirical issues by academics and policy analysts (Leydesdorff and Etzkowitz, 1996 and 1998). Different possible resolutions of the relations among the institutional spheres of university, industry, and government can help to generate alternative strategies for economic growth and social transformation.

2. Triple Helix Configurations

The evolution of innovation systems, and the current conflict over which path should be taken in university-industry relations, are reflected in the varying institutional arrangements of university-industry-government relations. First, one can distinguish a specific historical situation which one may wish to label "Triple Helix I." In this configuration the nation state encompasses academia and industry and directs the relations between them (Figure 1). The strong version of this model could be found in the former Soviet Union and in Eastern European countries under "existing socialism." Weaker versions were formulated in the policies of many Latin American countries and to some extent in European countries such as Norway.

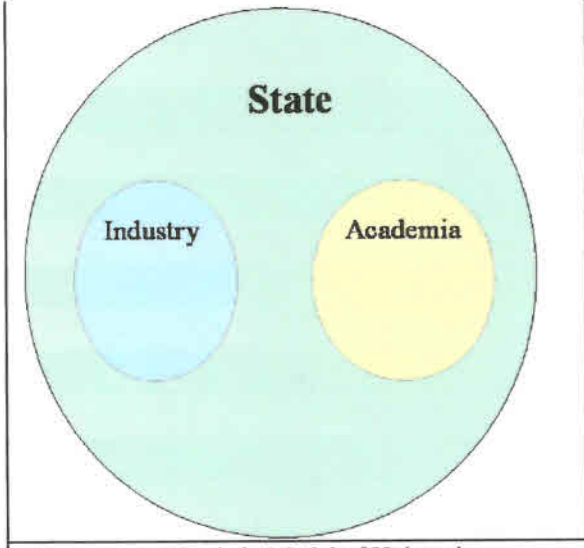
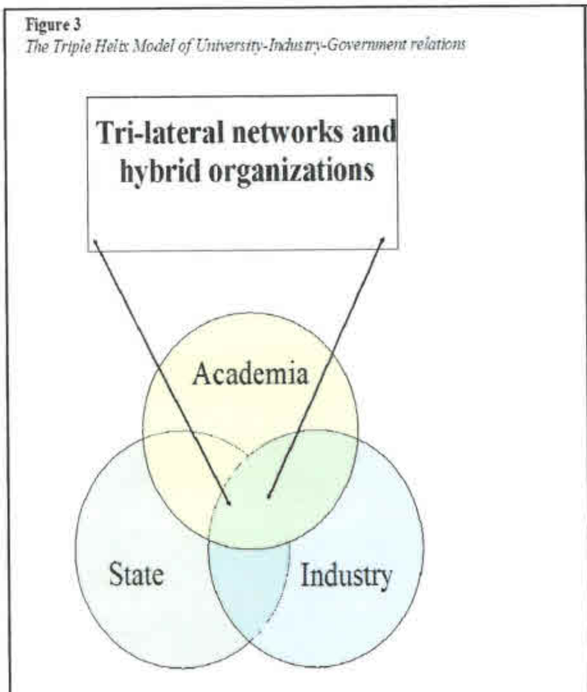


Figure 1. An Etatistic Model of University-Industry-Government Relations

Figure 2. A "laissez-faire" Model of University-Industry-Government Relations

A second policy model (Figure 2) consists of separate institutional spheres with strong borders dividing them and highly circumscribed relations among the spheres, exemplified in Sweden by the noted *Research 2000 Report* and in the U.S. in opposition to the various reports of the Government-University-Industry Research Roundtable (GUIRR) of the National Research Council (MacLane 1996; cf. GUIRR 1998). Finally, Triple Helix III is generating a knowledge infrastructure in terms of overlapping institutional spheres, with each taking the role of the other and with hybrid organizations emerging at the interfaces (Figure 3).



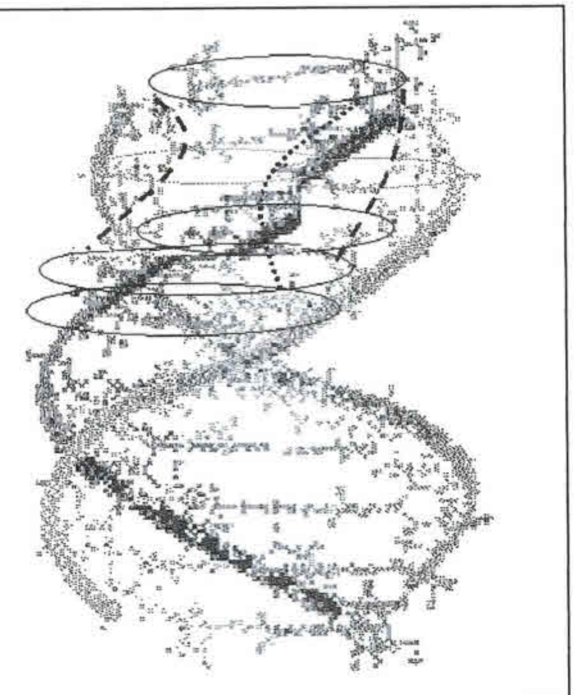


Figure 3
The Triple Helix Model of University-Industry-Government relations

Figure 4
The overlay of communications and expectations at the network level guides the reconstruction of institutional arrangements

The differences between the latter two versions of the Triple Helix arrangements currently generate normative interest. Triple Helix I is largely viewed as a failed developmental model. With too little room for "bottom up" initiatives, innovation was discouraged rather than encouraged. Triple Helix II entails a *laissez-faire* policy, nowadays also advocated as shock therapy to reduce the role of the state in Triple Helix I.

In one form or another, most countries and regions are presently trying to attain some form of Triple Helix III. The common objective is to realize an innovative environment consisting of university spin-off firms, tri-lateral initiatives for knowledge-based economic development, and strategic alliances among firms (large and small, operating in different areas, and with different levels of technology), government laboratories, and academic research groups. These arrangements are often encouraged, but not controlled, by government, whether through new "rules of the game," direct or indirect financial assistance, or through the Bayh-Dole Act in the U.S.A. or new actors such as the above mentioned foundations to promote innovation in Sweden.

3. The Triple Helix of Innovation

The Triple Helix as an analytical model adds to the description of the variety of institutional arrangements and policy models an explanation of their dynamics. What are the units of operation that interact when a system of innovation is formed? How can such a system be specified?

In our opinion, typifications in terms of "national systems of innovation" (Lundvall 1988; Nelson 1993); "research systems in transition" (Cozzens *et al.*, 1990; Ziman 1994), "Mode 2" (Gibbons *et al.*, 1994) or "the post modern research system" (Rip and Van der Meulen 1996) are indicative of flux, reorganization, and the enhanced role of knowledge in the economy and society. In order to explain these observable reorganizations in university-industry-government relations, one needs to transform the sociological theories of institutional retention, recombinatorial innovation, and reflexive controls. Each theory can be expected to appreciate a different subdynamic (Leydesdorff 1997).

In contrast to a double helix (or a coevolution between two dynamics), a Triple Helix is not expected to be stable. The biological metaphor cannot work because of the difference between cultural and biological evolutions. Biological evolution theory assumes variation as a driver and selection to be naturally given. Cultural evolution, however, is driven by individuals and groups who make conscious decisions as well as the appearance of unintended consequences. A Triple Helix in which each strand may relate to the other two can be expected to develop an emerging overlay of communications, networks, and organizations among the helices (Figure 4).

The sources of innovation in a Triple Helix configuration are no longer synchronized *a priori*. They do not fit together in a pregiven order, but they generate puzzles for participants, analysts, and policy-makers to solve. This network of relations generates a reflexive subdynamics of intentions, strategies, and projects that adds surplus value by reorganizing and harmonizing continuously the underlying infrastructure in order to achieve at least an approximation of the goals. The issue of how much we are in control or non-control of these dynamics specifies a research program on innovation.

Innovation systems, and the relationships among them, are apparent at the organizational, local, regional, national, and multi-national levels. The interacting subdynamics, that is, specific operations like markets and technological innovations, are continuously reconstructed like commerce on the Internet, yet differently at different levels. The subdynamics and the levels are also reflexively reconstructed through discussions and negotiation in the Triple Helix. What is considered as "industry", what as "market" cannot be taken for granted and should not be reified. Each "system" is defined and can be redefined as the research project is designed.

For example, "national systems of innovation" can be more or less systemic. The extent of systemness remains an empirical question (Leydesdorff and Oomes 1999). The dynamic "system(s) of innovation" may consist of increasingly complex collaborations across national borders and among researchers and users of research from various institutional spheres (Godin and Gingras, this issue). There may be different dynamics among regions. The systems of reference have to be specified analytically, that is, as hypotheses. The Triple Helix hypothesis is that systems can be expected to remain in transition. The observations provide an opportunity to update the analytical expectations.

4. An Endless Transition

The infrastructure of knowledge-intensive economies implies an Endless Transition. Marx's great vision that "all that is solid, melts into air" (Berman 1982) underestimated the importance of seemingly volatile communications and interactions in recoding the (complex) network system. Particularly, when knowledge is increasingly utilized as a resource for the production and distribution system, reconstruction may come to prevail as a mode of "creative destruction" (Schumpeter 1939 and 1966; Luhmann 1984).

Can the reconstructing forces be specified? One mode of specification is provided by evolutionary economics in which the three functional mechanisms are: technological innovation provides the variation, markets are the prevailing selectors, and the institutional structures provide the system with retention and reflexive control (Nelson 1994). In advanced and pluriform societies, the mechanisms of institutional control are again differentiated into public and private domains. Thus, a complex system is developed that is continuously integrated and differentiated, both locally and globally.

Innovation can be defined at different levels and from different perspectives within this complex dynamics. For example, evolutionary economists have argued that one should consider firms as the units of analysis, since they carry the innovations and they have to compete in markets (Nelson and Winter 1982; cf. Andersen 1994). From a policy perspective, one may wish to define "national systems of innovation" as a relevant frame of reference for government interventions. Others have argued in favour of networks as more abstract units of analysis: the semi-autonomous dynamics of the networks may exhibit lock-ins, segmentation, etc. (e.g., David and Foray 1994). Furthermore, the evolving networks may change in terms of relevant boundaries while developing (Maturana 1978).

In our opinion, these various perspectives open windows of appreciation on the dynamic and complex processes of innovation, but from specific angles. The complex dynamics is composed of subdynamics like market forces, political power, institutional control, social movements, technological trajectories and regimes. The operations can be expected to be nested and interacting. Integration, for example, within a corporation or within a nation state, cannot be taken for granted. Technological innovation may also require the reshaping of an organization or a community (Freeman and Perez 1988). But the system is not deterministic: in some phases intentional actions may be more succesful in shaping the direction of technological change than in others (Hughes 1983).

The dynamics are non-linear while both the interaction terms and the recursive terms have to be declared. First, there are ongoing transformations within each of the helices. These reconstructions can be considered as a level of continuous innovations under pressure of changing environments. When two helices are increasingly shaping each other mutually, co-evolution may lead to a stabilization along a trajectory. If more than a single interface is stabilized, the formation of a globalized regime can be expected. At each level, cycles are generated which guide the phasing of the developments. The higher-order transformations (longer-term) are induced by the lower-order ones, but the latter can seriously be disturbed by events at a next-order system's level (Schumpeter 1939; Kampmann *et al.* 1994).

Although this model is abstract, it enables us to specify the various windows of theoretical appreciation in terms of their constitutive subdynamics (e.g., Leydesdorff & Van den Besselaar 1997). The different subdynamics can be expected to select upon each other asymmetrically, as in processes of negotiation, by using their specific codes. For example, the markets and networks select upon technological feasibilities, whereas the options for technological developments can also be specified in terms of market forces. Governments can intervene by helping create a new market or otherwise changing the rules of the game.

When the selections "lock-in" upon each other, next-order systems may become relevant. For example, airplane development at the level of firms generates trajectories at the level of the industry in coevolutions between selected technologies and markets (e.g., Nelson 1994, cf. McKelvey 1996). Nowadays, the development of a new technological trajectory invokes the support of national governments and even international levels (like the EU), using increasingly a Triple Helix regime (Frenken and Leydesdorff, forthcoming).

We have organized this theme issue about the Triple Helix of University-Industry-Government Relations in terms of three such interlocking dynamics: institutional transformations, evolutionary mechanisms, and the new position of the university. This approach allows us to pursue the analysis at the network level and then to compare among units of analysis. For example, both industries and governments are entrained in institutional transformations, while the institutional transformations themselves change under the pressure of information and communication technologies (ICT) or government policies. Before explaining the organization of the theme issue in detail, however, we wish to turn briefly to the analytical position of the Triple Helix model in relation to other non-linear models of innovation, like "Mode 2" and "national systems of innovation."

5. Non-linear models of innovation

As noted, non-linear models of innovation extend upon linear models by taking interactive and recursive terms into account. These non-linear terms can be expected to change the causal relations between input and output. The production rules in the systems under study, for example, can be expected to change with the further development of the input/output relations (e.g., because of economies of scale). Thus, the unit of operation may be transformed, as is typical when a pilot plant in the chemical industry is scaled up to a production facility.

By changing the unit of analysis or the unit of operation at the reflexive level, one obtains a different perspective on the system under study. But the system itself is also evolving. In terms of methodologies, this challenges our conceptual apparatus, since one has to be able to distinguish whether the variable has changed or merely the value of the variable. The analysis contains a snapshot, while the reality provides a moving picture. One needs metaphors to reduce the complexity for the discursive understanding. Geometrical metaphors can be stabilized by higher-order codifications as in the case of paradigms. The understanding in terms of fluxes (that is, how the variables as well as the value may change over time), however, calls for the use of algorithmic simulations. The observables can then be considered as special cases which inform the expectations (Leydesdorff 1995).

Innovation, in particular, can be defined only in terms of an operation. Both the innovator(s) and the innovated system(s) are expected to be changed by the innovation. Furthermore, one is able to be both a participant and an observer, and one is also able to change perspectives. In the analysis, however, the various roles are distinguished although they can sometimes be fused in "real life" events. Langton (1989) proposed to distinguish between the "phenotypical" level of the observables and the "genotypical" level of analytical theorizing. The "phenotypes" remain to be explained and the various explanations compete in terms of their clarity and usefulness for updating the expectations. Confusion, however, is difficult to avoid given the pressure to jump to normative conclusions, while different perspectives are continuously competing, both normatively and analytically.

Let us first focus on the problem of the unit of analysis and the unit of operation. In addition to extending the linear (input/output) models of neo-classical and business economics, evolutionary economists also changed the unit of analysis. Whereas neo-classical economics focused on markets as networks in terms of input/output relations among individual (rational) agents, evolutionary economists have tended to focus on firms as the specific (and bounded) carriers of an innovation process. Both the unit of analysis and the unit of operation were changed (Andersen 1994; cf. Alchian 1950).

Lundvall (1988, at p. 357) noted that the interactive terms between demand and supply in user-producer relations assume a system of reference in addition to the market. The classical dispute in innovation theory had, in his opinion, referred to the role of demand and supply, that is, market forces, in determining the rate and direction of the process of innovation (cf. Mowery and Rosenberg, 1979; Freeman, 1982, p. 211). If, however, the dynamics of innovation (e.g., product competition) are expected to be different from the dynamics of the market (e.g., price competition), an alternative system of reference for the selection should also be specified. For this purpose, Lundvall proposed "to take the national system of production as a starting point when defining a system of innovation" (p. 362).

Lundvall added that the national system of production should not be considered as a closed system: "the specific degree and form of openness determines the dynamics of each national system of production." In our opinion, as a first step, innovation systems should be considered as the dynamics of *change* in systems of both production and distribution. From this perspective, national systems compete in terms of the adaptability of their knowledge infrastructure. How are competences distributed for solving "the production puzzle" which is generated by uneven technological developments across sectors (Nelson & Winter 1975; Nelson 1982)? The infrastructure conditions the processes of innovation which are possible within and among the sectors. In particular, the distribution of relevant actors contains an heuristic potential which can be made reflexive by a strategic analysis of specific strengths and weaknesses (Pavitt 1984).

The solution of the production puzzle typically brings government into the picture shifting the dynamics from a double to a triple helix. The consequent processes of negotiation are both complex and dynamic: one expects that the (institutional) actors will be reproduced and changed by the interactions. Trilateral networks and hybrid organzations are created for resolving social and economic crises. The actors from the different spheres negotiate and define new projects, such as the invention of the venture capital firm in New England in the early post-war era (Etzkowitz, forthcoming). Thus, a Triple Helix dynamics of University-Industry-Government Relations is generated endogeneously.

Gibbons *et al.* (1994) argued that this "new mode of the production of scientific knowledge" has become manifest. But: how are these dynamics in the network arrangements between industries, governments, and academia a consequence of the user-producer interactions foregrounded by Lundvall (1988)? Are national systems still a relevant unit of analysis? Since the new mode of knowledge production ("Mode 2") is characterized as an outcome, it should, in our opinion, be considered as an emerging system. The emerging system rests like a hyper-network on the networks on which it builds (such as the disciplines, the industries, and the national governments), but the knowledge-economy transforms "the ship while a storm is raging on the open sea" (Neurath *et al.*, 1929).

Science has always been organized through networks, and to pursue practical as well as theoretical interests. Centuries before "Mersenne", was transmogrified into an Internet site, he was an individual, who by visits and letters, knitted the European scientific community together. The Academies of Science played a similar role in local and national contexts from the 16th century.

The practical impetus to scientific discovery is long-standing. Robert K. Merton's (1938) dissertation reported that between 40-60% of discoveries in the 17th century could be classified as having their origins in trying to solve problems in navigation, mining, etc. Conversely, solution of practical problems through scientific means has been an important factor in scientific development, whether in German pharmaceutical science in the 17th century (Gustin 1975) or in the British sponsored competition to provide a secure basis for navigation (Sobel, 1995).

The so-called "Mode 2" is not new; it is the original format of science before its academic institutionalization in the nineteenth century. Another question to be answered is why "Mode 1" has arisen after "Mode 2": the original organizational and institutional basis of science, consisting of networks and invisible colleges (cf. Weingart, 1997; Godin, 1998).Where have these ideas, of the scientist as the isolated individual and of science separated from the interests of society, come from? "Mode 2" represents the material base of science, how it actually operates. "Mode 1" is a construct, built upon that base in order to justify autonomy for science, especially in an earlier era when it was still a fragile institution and needed all the help it could get.

In the U.S.A., during the late 19th century, large fortunes were given to found new universities, and expand old ones. There were grave concerns among many academics that the industrialists making these gifts would try to directly influence the universities, by claiming rights to hire and fire professors as well as well as to decide what topics were acceptable for research and instruction (Storr, 1953). To carve out an independent space for science, beyond the control of economic interests, a physicist, Henry Rowland, propounded the doctrine that if anyone with external interests tried to intervene, it would harm the conduct of science. As President of the American Association for the Advancement of Science, he promoted the ideology of pure research in the late 19th century. Of course, at the same time as liberal arts universities oriented toward pure research were being founded, land grant universities, including MIT, pursued more practical research strategies. These two contrasting academic modes existed in parallel for many years.

Decades hence, Robert K. Merton posited the normative structure of science in 1942 and strengthened the ideology of "pure science." His emphasis on universalism and skepticism was a response to a particular historical situation, the need to defend science from corruption by the Nazi doctrine of a racial basis for science and from Lysenko's attack on genetics in the Soviet Union. Merton's formulation of a set of norms to protect the free space of science was accepted as the basis for an empirical sociology of science for many years.

The third element in establishing the ideology of pure science was, of course, the Bush Report of 1945. The huge success of science in supplying practical results during World War II in one sense supplied its own legitimation for science. But with the end of the war at hand and wanting to insure that science was funded in peacetime, a rationale was needed in 1944 when Bush persuaded President Roosevelt to write a letter commissioning the report (Bush 1980).

In the first draft of his report, Bush proposed to follow the then current British method of funding science at universities. It would be distributed on a per capita basis according to the number of students at each school. In the contemporary British system of a small number of universities, the funds automatically went to an elite. However, if that model had been followed in the U.S., even in the early post war era, the flow of funds would have taken a different course. The funding would not only have flowed primarily to a bi-coastal academic elite but would have been much more broadly distributed across the academic spectrum, especially to the large state universities in the Midwest.

In the time between the draft and the final report, the mechanism for distribution of government funds to academic research was revised and "peer review" was introduced. Adapted from Foundation practices in the 1920s and 30s, it could be expected that "the peers," the leading scientists who would most surely be on those committees, would distribute the funds primarily to a scientific elite. The status system of U.S. universities that had been in place from the 1920s was reinforced.

This model of "best science" is no longer acceptable to many as the sole basis for distribution of public research funds. Congresspersons who represent regions with universities that are not significant recipients of research funds have disregarded peer review and distributed research funds by direct appropriation, much as roads and bridges are often sited through "log rolling" and "pork barrel" processes. Nevertheless, these politically directed funds support also serious scientific research and instrumentation projects. Even when received by schools with little or no previous research experience, these "one time funds" are typically used to rapidly build up competencies in order to compete within the peer review system.

Indeed, when a leading school, Columbia University, needed to renew the infrastructure of its chemistry department, it contracted with the same lobbying firm in Washington DC as less well-known schools. Through public relations advice, Columbia relabeled its chemistry department "The National Center for Excellence in Chemistry." A special federal appropriation was made and the research facilities were renovated and expanded. To hold its faculty, the university could not afford to wait for the slower route of peer review, and likely smaller amounts of funding.

Increasing competition for research funds among new and old actors has caused an incipient breakdown of "peer review," a system that could best adjudicate within a moderate level of competition. As competition for research funds continues to expand, how should the strain be adjusted? Some propose shrinking the research system; others suggest linking science to new sources of legitimation such as regional development.

6. The Future Legitimation of Science

It is nowadays apparent that the development of science provides much of the basis for future industrial development. These connections, however, have been present from the creation of science as an organized activity in the 17th century. Marx pointed them out again in the mid-19th century in connection with the development of chemical industry in Germany. At the time, he developed a thesis of the growth of science-based industry on the basis of a single empirical example: Perkins researches on dyestuffs in the UK leading to the development of an industry in Germany.

The potential of science to contribute to economic development has become a source of regional and international competition at the turn of the millenium. Until recently, the location of research was of little concern. The relationship between the site where knowledge is produced and its eventual utilization was not seen to be tightly linked, even as a first mover advantage. This view has changed dramatically in recent years, as has the notion that high-tech conurbations, like Route 128 and Silicon Valley, are unique instances that can not be replicated. The more recent emergence of Austin, Texas, for example, is based in part on the expansion of research at the University of Texas, aided by state as well as industry and federal funds.

Less research intensive regions are by now well aware that science, applied to local resources, is the basis of much of their future potential for economic and social development. In the U.S.A., it is no longer acceptable for research funds to primarily go to the east and west coasts with a few places in between in the Midwest. The reason why funding is awarded on bases other than the peer review system, is that all regions want a share of research funding

The classic legitimation for scientific research as a contribution to culture still holds and military and health objectives also remain a strong stimulus to research funding. Nevertheless, the future legitimation for scientific research, which will keep funding at a high level, is that it is increasingly the source of new lines of economic development.

Newly created disciplines are often the basis for these heightened expectations. Such disciplines do not arise only from the subdivision of new disciplines from old ones, as in the 19th century (Ben David and Collins, 1966). New disciplines have arisen, more recently, through syntheses of practical and theoretical interests. For example, computer science grew out of elements of older disciplines such as electrical engineering, psychology, philosophy, and a machine. Materials science and other fields such as nano-technology that are on every nation's critical technology list were similarly created.

The university can be expected to remain the core institution of the knowledge sector as long as it retains its original educational mission (Etzkowitz, Webster, Gebhardt, and Terra, this issue). Teaching is the university's comparative advantage, especially when linked to research and economic development. Students are also potential inventors. They represent a dynamic flow-through of "human capital" in academic research groups, as opposed to more static industrial laboratories and research institutes. Although they are sometimes considered a necessary distraction, the turnover of students insures the primacy of the university as a source of innovation.

The university may be compared to other recently proposed contenders for knowledge leadership, such as the consulting firm. A consulting company draws together widely dispersed personnel for individual projects and then disperses them again after a project, solving a client's particular problem, is completed. Such firms lack the organizational ability to pursue a cumulative research program as a matter of course. The university's unique comparative advantages is that it combines continuity with change, organizational and research memory with new persons and new ideas, through the passage of student generations. When there is a break in the generations, typically caused by a loss of research funding, one academic research group disappears and can be replaced by another.

Of course, as firms organize increasingly higher level training programs (e.g., Applied Global University at the Applied Materials Devices Corporation, a semi-conductor equipment manufacturer in Silicon Valley) they might in the future also, individually or jointly, attempt to give out degrees. Companies often draw upon personnel in their research units, as well as external consultants, to do some of the teaching in their corporate universities. Nevertheless, with a few notable exceptions, such as the RAND Corporation, they have not yet systematically drawn together research and training into a single framework. However, as the need for life-long learning increases, a university tied to the workplace becomes more salient.

7. Implications of the Triple Helix Model

The Triple Helix denotes not only the relationship of university, industry and government, but also internal transformation within each of these spheres. The university has been transformed from a teaching institution into one which combines teaching with research, a revolution that is still ongoing, not only in the U.S.A., but in many other countries. There is a tension between the two activities but nevertheless they co-exist in a more or less compatible relationship with each other because it has been found to be both more productive and cost effective to combine the two functions.

The Triple Helix overlay provides a model at the level of social structure for the explanation of "Mode 2" as an historically emerging structure for the production of scientific knowledge, and its relation to "Mode 1." First, the arrangements between industry and government no longer need to be conceptualized as exclusively between national governments and specific industrial sectors. Strategic alliances cut across traditional sector divides; governments can act at national, regional, or increasingly also at international levels. Corporations adopt "global" postures either within a formal corporate structure or by alliance. Trade blocks like the EU, NAFTA, and Mercosul provide new options for breaking "lock-ins," without the sacrifice of competitive advantages from previous constellations. For example, the Airbus can be considered as an interactive opportunity for recombination at the supra-national level (Frenken, this issue).

Second, the driving force of the interactions can be specified as the expectation of profits. "Profit" may mean different things to the various actors involved. A leading edge consumer, for example, provides firms and engineers with opportunities to perceive "reverse salients" in current product lines and software. Thus, opportunities for improvements and puzzle-solving trajectories can be defined. Note that analytically the drivers are no longer conceptualized as *ex ante* causes, but in terms of expectations that can be evaluated only *ex post*. From the evolutionary perspective, selection (*ex post*) is structure determined, while variation may be random (Arthur 1988; Leydesdorff and Van den Besselaar 1998).

Third, the foundation of the model in terms of expectations leaves room for uncertainties and chance processes. The institutional carriers are expected to be reproduced as far as they have been functional hitherto, but the negotiations can be expected to lead to experiments which may thereafter also be institutionalized. Thus, a stage model of innovation can be specified.

The stages of this model do not need to correspond with product life cycle theory. Barras (1990), for example, noted that in ICT "a reverse product life" cycle seems to be dominant. Bruckner *et al.* (1994) proposed niche-creation as the mechanism of potential lock-out in the case of competing technologies. A successful innovation changes the landscape, that is, the opportunity structure for the institutional actors involved. Structural changes in turn are expected to change the dynamics.

Fourth, the expansion of the higher-education and academic research sector has provided society with a realm in which different representations can be entertained and recombined in a systematic manner. Kaghan and Barett (1997) have used in this context the term "desktop innovation" as different from the laboratory model (cf. Etzkowitz, 1999). Knowledge-intensive economies can no longer be based on simple measures of profit maximization: utility functions have to be matched with opportunity structures. Over time, opportunity structures are recursively driven by the contingencies of prevailing and possible technologies. A laboratory of knowledge-intensive developments is socially available and can be improved upon (Etzkowitz and Leydesdorff 1995). As this helix operates, the human capital factor is further developed along the learning curves and as an antidote to the risk of technological unemployment (Pasinetti, 1981).

Fifth, the model also explains why the tensions need not to be resolved. A resolution would hinder the dynamics of a system which lives from the perturbations and interactions among its subsystems. Thus, the subsystems are expected to be reproduced. When one opens the black-box one finds "Mode 1" within "Mode 2," and "Mode 2" within "Mode 1." The system is neither integrated nor completely differentiated, but it performs on the edges of fractional differentiations and local integrations. Using this model, one can begin to understand why the global regime exhibits itself in progressive instances, while the local instances inform us about global developments in terms of the exceptions which are replicated and built upon.

Case materials enable us to specify the negative selection mechanisms reflexively. Selection mechanisms, however, remain constructs. Over time, the inference can be corroborated. At this end, the function of reflexive inferencing based on available and new theories moves the system forward by drawing attention to possibilities for change.

Sixth, the crucial question of the exchange media —economic expectations (in terms of profit and growth), theoretical expectations, assessment of what can be realized given institutional and geographic constraints— have to be related and converted into one another. The helices communicate recursively over time in terms of each one's own code. Reflexively, they can also take the role of each other, to a certain extent. While the discourses are able to interact at the interfaces, the frequency of the external interaction is (at least initially) lower than the frequency within each helix. Over time and with the availability of ICT, this relation is changing.

The balance between spatial and virtual relations is contingent upon the availability of the exchange media and their codifications. Codified media provide the system with opportunities to change the meaning of a communication (given another context) while maintaining its substance (Cowan and Foray 1997). Despite the "virtuality" of the overlay, this system is not "on the fly": it is grounded in a culture which it has to reproduce (Giddens 1984). The retention mechanism is no longer given, but "on the move": it is reconstructed as the system is reconstructed, that is, as one of its subdynamics.

As the technological culture provides options for recombination, the boundaries of communities can be reconstituted. The price may be felt as a loss of traditional identities or alienation, or as a concern with the sustainability of the reconstruction, but the reverse of "creative destruction" is the option of increasing development. The new mode of knowledge production generates an Endless Transition that continuously redefines the borders of the Endless Frontier.

8. The organization of the theme issue

As noted above, this issue is organized in three main parts, addressing (1) institutional transformation, (2) evolutionary mechanisms, and (3) the second academic revolution. Each part contains five contributions.

In Part One ("Institutional Transformations"), Michael Nowak and Charles Grantham open the discussion with a paper about the impact of the Internet on incubation as an institutional mechanism for technological innovation. The increased complexity of the process induces reflexivity about the choices to be made, and human capital becomes increasingly crucial for carrying the transformations.

The failure of the "opening to the market" as an answer to the state-dominated economies in the former Soviet Union, because of the neglect of the knowledge-intensive dimension, is discussed by testing three models against each other in Judith Sedaitis' paper entitled "Technology Transfer in Transitional Economies: Comparing Market, State, and Organizational Frameworks." The author concludes that processes of transfer in these cases can be understood at the intermediate network level.

Norma Morris, in "Vial Bodies: Conflicting Interests in the Move to New Institutional Relationships in Biological Medicines Research and Regulation," discusses normative issues that arise when the borders are no longer defined institutionally and governmentally. The case of the EU places the role of safety regulation at national and transnational levels on the agenda. In a paper entitled "The Evolution of Rules for Access to Megascience Research Environments Viewed from Canadian Experience," Cooper Langford and Martha Whitney Langford document what it means for the organization of Canadian science that government and industry relations are deeply involved in this enterprise. Are the Kudos-norms of Merton (1942) increasingly being replaced by a new set of norms (Ziman 1994)? If so, what are the expected effects on reward systems and funding? In a contribution to the latter question, Shin-Ichi Kobayashi argues that a third form of funding can be distinguished nowadays (in addition to peer recognition and institutional allocation). The author develops the new format using the metaphor of the audition system for the performing arts.

Thus, not only the institutions themselves are tranformed, but also their mechanisms of transformation. These evolutionary mechanisms are central to the second part of the theme issue. The contribution from the Aveiro team (Eduardo Anselmo de Castro, Carlos José Rodrigues, Carlos Esteves, and Artur da Rosa Pires) returns to the impact of ICT on changing the stage. How can institutional arrangements be shaped to match the options which telematics provide? How can a retention mechanism be organized as a niche or a habitat for knowledge-intensive developments?

While the Portuguese team focuses on the regional level, Susanne Giesecke takes the analysis to the level of comparing national governments in her contribution entitled "The Contrasting Roles of Government in the Development of the Biotechnology Industries in the U.S. and Germany." She notes the counter-effective policies of German governments which have operated on the basis of assumptions about previous developments. Policies have to be updated in terms of bottom-up processes and thus come to be understood in terms of reflexive feedbacks (instead of control).

Rosalba Casas, Rebeca de Gortari, and Ma. Josefa Santos from Mexico combine the issues of regional developments and differences between the technologies involved by cross-tabling them for the case of Mexico. These authors focus on what they call "the building of knowledge spaces." How is the interrelationship between knowledge-intensity, industrial activity, and institutional control shaped in terms of inter-human and inter-institutional relations? What is the function of shared culture, values, and trust? Is the region a habitat for the technology, or the technology a precondition for restructuring the region?

In a contribution entitled "The Triple Helix: An Evolutionary Model of Innovations," Loet Leydesdorff uses simulations to show how a "lock-in" can be enhanced using a co-evolution like the one between regions and technologies. A third source of random variation, however, may intervene, reversing the order in a later stage and leading to more complex arrangements of market segmentation (that is, different suboptima). A mechanism for "lock-out" can also be specified.

Koen Frenken takes the complexity approach one step further by confronting it with empirical data in the case of the aircraft industry. Using Kauffman's (1993) model of "rugged fitness landscapes" he shows the working of a Triple Helix in different phases of this industry (cf. Frenken and Leydesdorff, forthcoming). The model can be extended to account for the additional degree of freedom in international collaborations to develop new aircraft. The failure of Fokker Aircraft, for example, can be explained using these concepts: one cannot bet on two horses at the same time, since the markets are fiercely competitive, technological infrastructures are expensive, and learning curves are steep.

In the third part of the issue, we turn to the Second Academic Revolution. In their contribution entitled "The Place of Universities in the System of Knowledge Production," Benoît Godin and Yves Gingras argue against the thesis that the university would have lost its salient position in the university-industry-government relations of "Mode 2." Using scientometric data, they show that collaboration with academic teams is central to the operations of the networks which transform this knowledge infrastructure. Although based on Canadian data, the argument is made that this holds true also for other OECD countries.

From another world region, Judith Sutz reports about university-industry-government relations in Latin America. These young democracies, on the one hand, wish to free themselves from the limitation of the so-called "import substitution" regime by opening up to the market. On the other hand, the connections are then established through the world system, and regional infrastructures tend to remain underdeveloped. The issue will be central to the Third Triple Helix Conference to be held in Rio de Janeiro, 26-29 April 2000. How can social, economic, and scientific developments be networked at the regional level? What does niche management mean in an open system's environment?

In a contribution entitled "Institutionalizing the Triple Helix: Research Funding and Norms in the Academic System," Mats Benner and Ulf Sandström take a neo-institutional approach to the transformation of the university system in Europe. How does the system react (resist and embody) institutional transformation and neo-evolutionary pressures? In a further article, Eric Campbell and his colleagues raise the question of how this affects research practices in terms of "Data Withholding in Academic Medicine." Can characteristics of faculty denied access to research results and biomaterials be distinguished?

In a final article, Henry Etzkowitz, Andrew Webster, Christiane Gebhardt, and Branca Terra substantiate their claim that the transformation of the university system is a worldwide phenomenon. In addition to research and higher eduction, the university nowadays has a third role in regional and economic development because of the changing nature of both knowledge production and economic production. While a "hands off" may have been functional to previous configurations, the exigencies of today demand a more intensive interrelationship. As noted, a Triple Helix arrangement that tends to reorganize the knowledge infrastructure in terms of possible overlays, can be expected to be generated endogenously.

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The globalisation of technology and its implications for developing countries
Windows of opportunity or further burden?

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Abstract

On the basis of a categorisation of ways in which the generated knowledge is transmitted, this paper explores the impact of the different forms of the globalisation of technology on developing countries. Through travelling, media, scientific and technical workshops, Internet and many other communication channels, globalisation allows the transmission of knowledge at a much greater pace than in the past. However, this does not automatically imply that developing countries succeed to benefit from technological advances. On the contrary, this will strongly rely on the nature of the technology and of the policies implemented in both advanced and developing countries.

JEL classification: O30; O34; F23
Keywords: Technology transfer; Transnational corporations; Technological alliance; Scientific collaborations

1. Introduction

The international transmission of know-how, knowledge and technological expertise is growing and it is increasingly important in the world economy [1]. The weight of science-

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based commodities is constantly increasing in world trade [2], foreign direct investment (FDI) by transnational corporations (TNCs) is an important vehicle for the transmission of innovation across the world [3], transborder scientific and technological cooperation is absorbing more energies and resources of governments and firms [4]. New opportunities are now opening to benefit from the available stock of knowledge. But how important are they for less developed countries (LDCs)? Are they participating in these flows or are they rather staying aside and observing them? How are their technological capabilities affected by the considerable increase in the flows of knowledge?

The aim of the paper is to:

- Define the globalisation of technology with the use of a new categorisation.
- Report some evidence on the degree of developing countries' participation in the globalisation of technology.
- Discuss the relevance and impact of the globalisation of technology on developing countries, and its implication for their development strategies and policies.

The specific form and extent of technology globalisation for developing countries bears important consequences for their government action, and implies an especially active attitude towards innovation policies. It will in fact be argued that the globalisation of technology offers new opportunities for development, but that they are by no means available without deliberate effort to absorb innovation through endogenous learning.

This paper is organised as follows. The next section reassesses the concept of technology which informs this paper, since we believe that this is particularly important to design appropriate strategies and policies. Section 3 reports a taxonomy on the different forms that the globalisation of technology can take; this will help us measure the significance of globalisation and assess the various strategies undertaken by governments and firms. Section 4 documents to what extent developing countries are taking part in the globalisation of technology; although the evidence available is still unsatisfactory, it clearly emerges that the bulk of technological activities is produced in and exchanged among the most advanced countries. The Section 6 discusses the advantages and the disadvantages of the strategies available to developing countries to bridge their technology gap, and to integrate themselves among the more innovative and dynamic nations.

2. Lessons learnt on the nature of technology

Economists have often studied technology with the tools of analysis of competitive markets. Thus, if technology is studied like any other commodity, and if markets were freely working and perfect competition prevailed, then no problem of technology transfer would pose. Technology (from whatever source) would be easily and instantaneously transferred and utilised. The efficiency of its use would only be a matter of ensuring the conditions for efficient resource allocation in the context of exogenously determined technological alternatives. Technology policy would only consist of government sponsorship of institutes that collect, process and disseminate technical information, justified as a provision of public goods. This theory descends from two assumptions: (i) technology consists simply of a set of techniques wholly described by their 'blueprint'; (ii) all techniques are created in the developed countries, from which they flow at no or low costs to developing countries (for a recent reaffirmation of this old belief, see Ref. [5]).

However, several authors recognised, already a few decades ago, the special features of technology and technological change, leading to a perception of technology in more complex terms (see Nelson [55]). Thus, first of all, no existing technique is completely expressed by the sum and combination of their material inputs and the codified information about it. In fact, much of the knowledge on how to perform elementary processes and on how to combine them efficiently is tacit, not easibly embodied, nor codifiable or readily transferable, and 'a firm will not be able to know with certainty all the things it can do, and certainly will not be able to articulate explicitly how it does what it does' (Nelson [6], p. 84).

This means that technology is not simply a set of blueprints, or of instructions, that if followed exactly will always produce the same outcome. Although two producers in the same circumstances may use identical material inputs with equal information available, they may nonetheless employ two really distinct techniques due to their different understanding of the tacit elements. Thus, techniques are sensitive to specific physical as well social circumstances (Evenson and Westphal [7], p. 2212).

Moreover, technology is not instantaneously and costlessly accessible to any firm: a firm does not simply select the preferred option from the freely available international technology shelf, as there may be obstacles and difficulties in obtaining the desired technology. Simply choosing and acquiring a technique does not imply operating it efficiently ('at best practice'). Individual firms do not have a complete knowledge of all the possible technological alternatives, their implications and the skills and information they require. The individual firm does not know the entire production curve, illustrating an infinite number of alternatives, as neo-classical theory assumes. To the extent technologies are tacit, firm production sets are fuzzy around the edges (Nelson [6], p. 84).

Understanding technology in these more complex and realistic terms implies that tangible and intangible investments in technology are required whenever technology is newly applied. This applies to domestic as well as foreign imported technologies. Each firm has to exert considerable absorptive efforts to learn the tacit elements of technology and gain adequate mastery. This is at the opposite extreme from the neo-classical premise that technology, as well as productive inputs and outputs, is perfectly known. This knowledge is not instantaneously and costlessly available to all firms, and technology transfer poses substantial problems of adaptation and absorption that are related to investments in technological capability, i.e. the complex array of skills, technological knowledge, organisational structures, required to operate a technology efficiently and accomplish any process of technological change.[2] This dynamic technological effort implies a process of learning that is qualitatively

[2] References on the theory of technological capabilities include Bell and Pavitt [51], Enos [9], Fransman and King [52], Katz [12], Lall [13] and Pack and Westphal [53].

different from the traditional 'learning by doing', as it involves an active attitude. Learning may be pursued in a variety of ways [8] and the passive 'learning from operating' is only one possibility.

A powerful way of learning is by training within producing firms. This has the disadvantage that training will probably stay at a level below what would be socially optimal, because of the well-known problem of incomplete appropriability of its results, but in-firm training will be more appropriate as the firm will provide exactly the kind and quantity of training necessary for the absorption and advancement of technology (Enos [9], p. 80). Furthermore, learning itself has to be learnt, as it is a highly specialised process, that involves the organisation of the accumulation of technical knowledge [10].

In addition, even if the need for learning efforts is acknowledged, investing in learning does not ensure success. This is due to the stochastic nature of the learning process, which is influenced by the external environment and by firm's actions, and results from dependence on historical circumstances, entrepreneurial skills and luck. Therefore, different firms may reach persistently different levels of efficiency and dynamism also in competitive markets [11].

Within this broader context, technology transfer becomes an important issue that has to be assessed jointly with a country's capability to make use of technology, absorb it and adapt it to local conditions. In other words, technology transfer links foreign technology access and acquisition to its efficient use for economic development, and to the catching up of the relatively technologically backward countries [7].

Thus, the access to and acquisition of foreign advanced technology, by itself, is not sufficient to ensure local technological and industrial development. Several other elements are needed. An additional central component of a country's industrial development policy strategy is technological effort oriented to the absorption, adaptation, mastery and improvement of technology. This itself implies a continuous process of technological change [12,13,54,62].

Once this notion of technology is accepted, it is much easier to understand that the globalisation processes have distinctive features in the technology domain, and that there is no reason to assume that globalisation will provide benefits to all regions and agents. In particular, it emerges that globalisation changed the transmission of know-how in the following ways:

- The codified component of knowledge can be transferred at low or negligible costs from one part to another part of the world. This is, however, not necessarily good news for developing countries since in order to benefit from codified knowledge, the receiving agent should already know the code and have the capabilities to use it effectively. And codes are increasing in complexity along with the increase in importance of codified knowledge.
- The tacit component of knowledge continues to be less mobile and transferable, since it still requires important face-to-face interactions. There is abundant evidence that, in spite of globalisation, the generation of knowledge in specific fields tend to concentrate in "hubs" where competencies agglomerate [14,15].

- The core of innovating firms is moving from trading embodied innovations to disembodied innovation. As shown by Naomi Klein [16], large corporations with managerial, financial and technological advantages tend to profit from their ideas, trademarks, expertise and technological innovations, while contracting out the production. This has substantial implications for the generation and transmission of know-how, which tends to become much more dependent on intellectual property rights (IPR). In turn, it is creating a new international division of labour where "wet-ware" and "soft-ware" are generated in the North, and "hard-ware" is localised in the South.

The next section presents a taxonomy of the globalisation of technology which may help identify the various forms to exploit and acquire know-how.

3. A taxonomy of the globalisation of technology

In the last few years, too many heterogeneous phenomena have been lumped together under the label of 'globalisation of technology', and the concept has thus lost much of its significance. We thus attempted [17,18] to find our way in such labyrinth by identifying three main categories:

1. The international *exploitation* of nationally produced technology;
2. The global *generation* of innovation;
3. Global technological *collaborations*.

The aim of this taxonomy is to classify individual innovations according to the ways in which they are produced, exploited and diffused internationally. Innovations are therefore classified according to the method in which they are generated. Both at single enterprise and at national levels, the categories are complementary, not alternative. Enterprises, especially large ones, may generate innovations following all the three procedures described. From a historical point of view, these categories emerged in three different stages, even though the second and the third added to, rather than substituted, the oldest one. The categories of this taxonomy and the main forms through which the three processes manifest themselves are shown in Table 1 (for an empirical assessment in advanced countries, see Ref. [18]).

3.1. The international exploitation of technology produced on a national basis

The first category includes the attempts of innovators to obtain economic advantages by exploiting their technological competencies in markets other than the domestic one. We have preferred to label this category 'international' as opposed to 'global', since the players that introduce innovations preserve their own national identity, even when such innovations are diffused and marketed in more than one country. Firms may opt for a variety of strategies in order to obtain economic returns from their innovations in foreign markets.

Table 1
A taxonomy of the globalisation of technology

Categories	Actors	Forms
International *exploitation* of nationally produced innovations	Profit-seeking firms and individuals	• Exports of innovative goods. • Sale of licences and patents. • Foreign production of innovative goods internally generated.
Global *generation* of innovations	Multinational firms	• R&D and innovative activities both in the home and the host countries. • Acquisitions of existing R&D laboratories or greenfield R&D investment in host countries.
Global techno-scientific *collaborations*	Universities and public research centers	• Joint scientific projects and R&D networks. • Scientific exchanges, sabbatical years. • International flows of students.
	National and multinational firms	• Joint ventures for specific innovative projects. • Productive agreements with exchange of technical information and/or equipment.

Source: adapted from Archibugi and Michie [17].

The oldest form which firms have used to profit from their innovations in overseas markets is to trade products with a technology-based competitive advantage. New products and processes have often been exempted from trade restrictions since the importing countries were not able to generate competitive domestic alternatives, or to device timely restrictions to trade. It is however well known that exporting technology-intensive products provides an advantage to the exporting countries (for example, in terms of more stable prices, higher rents and profit margins, and positive and dynamic externalities), and that in turn the importing countries increase their know-how dependence unless they are able to bridge the gap in competencies.

Exports are not the only form to exploit firms' technological advantage in overseas markets. Another way is to transfer their know-how to foreign firms, for example, by selling licences and patents. This form of technology transfer would however require that the host country firms already have the capital equipment and the capabilities to exploit new ideas and devices into production. It is likely that in the long run the importing country will be able to move upstream in the value-added chain, and to become able to generate autonomously at least part of the know-how relevant for production.

There is a third important form of exploiting the innovation generated at home in overseas markets: to install FDI productive facilities in host countries and produce in loco new products and processes. Of course, we consider here only production plants in host countries which do not contribute significantly to the generation of the know-how, but that simply replicate and produce already designed artefacts. If, on the contrary, the host country plants significantly contribute to the design of the products and processes, we move from the first to the second category of this taxonomy.

3.2. The global generation of innovations

The global generation of innovations includes innovations generated by single proprietors on a global scale. Only innovations produced by multinational enterprises fit into this category since it requires the existence of international but intrafirm R&D labs and technical centers. The authentic global generation of innovations requires organisational and administrative skills that only firms with specific infrastructure and a certain minimum size can attain. This can be achieved both through the acquisition of existing laboratories or with greenfield investments in host countries.

The determinants and impact of TNCs have been widely studied over the last years (for reviews, see Refs. [19,20]). Bartlett and Ghoshal [21] have singled out three main strategies of TNCs.

3.2.1. Center-for-global

This is the traditional 'octopus' view of the TNC: a single 'brain' located within the company headquarters concentrates the strategic resources: top management, planning, and the technological expertise. The 'brain' distributes impulses to the 'tentacles' (that is, the subsidiaries) scattered across host countries. Even when some overseas R&D are undertaken, this basically focuses on adapting products to the needs of the local users.

3.2.2. Local-for-local

Each subsidiary develops its own technological know-how to serve local needs. The interactions among subsidiaries are, at least from the viewpoint of developing technological innovations, rather weak. On the contrary, subsidiaries are integrated into the local fabric. This may occur with conglomerate firms, but also in the case of TNCs which follow a strategy of technological diversification through tapping into the competence of indigenous firms.

3.2.3. Local-for-global

This is the case of TNCs that, rather than concentrating their technological activities in the home country, distribute R&D and expertise in a variety of host locations. This allows the company to develop each part of the innovative process in the most suitable environment: semiconductors in Silicon Valley, automobile components in Turin, software in India. The effectiveness of such a strategy relies on intense intrafirm information flows.

3.3. Global technological collaborations

In recent times, a third type of globalisation of innovative activities has made a forceful entry into the scene. This, in some ways, is intermediate to the two preceding categories.

Technological collaborations occur when two different firms decide to establish joint ventures with the aim of developing technical knowledge and/or products. Three conditions need to be respected: (i) the joint venture should be something more than an occasional and informal collaboration; (ii) firms preserve their ownership; (iii) the bulk of the collaboration is related to sharing know-how and/or the generation of new products and processes (see Mowery [22], p. 347).

We have witnessed an increasing number of agreements between firms for the joint development of specific technological discoveries [23,24]. Such collaborations often take place among firms of the same country, but in many cases they involve firms located in two or more countries, thus emerging as authentically global ventures.

These forms of collaboration for technological advances have promoted a variety of mechanisms for the division of costs and the exploitation of results. In a way, the need to reduce the costs of innovation—and to cope with its increasing complexity—has created new industrial organisation forms and new ownership structures, which today are expanding beyond the simple technological sphere.

It was not the private sector that discovered this form of knowledge transmission. The academic world has always had a transnational spectrum of action: knowledge is traditionally transmitted from one scholar to another and thus disseminated without always requiring pecuniary compensation. Since the involvement of the academic community into the business world is more and more demanded, the forms of diffusion of know-how within Universities and other public research centers have become of increasing importance for industrial development.

4. Evidence on developing countries' involvement in the globalisation of technology

The forms of the globalisation of technology singled out in the section above have significant implications for the national economies. Each of them will have a different impact on learning and, eventually, on local economic development. This section, on the basis of the available evidence, documents the involvement of LDCs in each of the three categories discussed above.

First of all, it is important to stress that LDCs' generation of new technologies and innovations is still negligible. The production of knowledge is heavily concentrated in the Triad countries, as shown by a variety of converging indicators of scientific and technological activities. This especially applies to the more formalised forms of knowledge creation. Although data are not always comparable since countries collect them according to different criteria, the evidence is so strong that it does not depend on the indicators selected. Some evidence based on bibliometric indicators and patents granted in the USA are reported in Table 2.

Scientific papers appeared in the journals monitored by the Institute for Scientific Information show that developed countries concentrate more than 84% of the world scientific production. Developing countries have only marginally increased their participation to the scientific community. Scientific articles are classified by country according to the institutions.

Table 2
On the generation of innovations in developed and developing countries

	Scientific papers		Average annual growth[a] rate (%)	Articles per million population		U.S. patents granted		Average annual growth[b] rate (%)	U.S. patents per million population	
	1986–1988 (%)	1995–1997 (%)		1986	2000	1986 (%)	2000 (%)		1986	2000
Developed countries[c]	84.3	84.5	1.4	419.8	472.5	98.7	93.9	12.4	75.9	160.4
Eastern Europe	9.3	6.7	2.2	117.2	94.0	0.5	0.3	0.6	1.0	1.0
East Asian NICs[d]	0.6	2.2	37.9	33.0	145.6	0.4	5.3	312.1	3.6	105.5
Latin America	1.2	1.8	7.2	11.0	18.1	0.2	0.2	21.1	0.2	0.7
Other Asia and Africa	4.6	4.8	2.0	5.0	6.0	0.2	0.3	24.7	0.04	0.1
Total	100.0	100.0	1.4	75.7	85.0	100.0	100.0	13.6	11.7	26.0

Source: National Science Foundation [25,30,49].
[a] Annual growth from 1986–1988 to 1995–1997.
[b] Annual growth from 1996 to 2000.
[c] OECD (22) plus Israel.
[d] Taiwan, South Korea, Hong Kong, Singapore.

Articles authored by scientists born in developing countries but working in developed countries will be classified in the latter group and vice versa. The number of scientific papers per million population shows much more clearly how the generation of new knowledge is concentrated in the North and how small is the participation of the South. There is a notable exception, represented by the East Asian Tigers (South Korea, Taiwan, Hong Kong and Singapore). These countries have managed to generate a scientific output comparable to some OECD countries.

Table 2 also reports data on patents granted in the US. We have chosen the US since it is the largest market of the world, and inventions and innovations of a significant nature are very likely patented there. Patents are assigned to countries on the ground of the home address of the inventor. As in the case of scientific articles, data do not take into account the nationality of the inventor, but his/her country of residence only. The data show an even greater concentration in advanced countries, which in the year 2000 totaled as much as 94% of patents. Although the position of developing countries has improved (passing from around 1% in 1986 to nearly 6% in 2000), it clearly emerges that legally protected inventions and innovations are still mainly generated in the North.

Again, it is remarkable to notice that only a minuscule number of developing countries—again the East Asian tigers—have managed to bridge the gap. These countries concentrate a much higher number of patents than their share of scientific publications, further revealing the technical and industrial orientation of their innovative activities. If we exclude the East Asian tigers, it is quite clear that developing countries are not bridging the scientific and technological gap with developed countries.

One crucial issue is to identify what is the contribution of talents coming from developing countries to the scientific and technological activities developed in the North. As already mentioned, statistics on scientific publications and patents do not allow to further disaggregate between the contribution provided by nationally born and foreign-born scientists and engineers. However, some data are available for the United States. In 1999, as much as 27% of the doctorate holders in science and engineering in the United States were foreign-born, with peaks of 46% and 45% in Computer Sciences and Engineering ([25], pp. 3–29). The USA long-term attraction of intellectual capital from all over the world is continuing. Much of this labour force was trained in the USA, especially at the doctoral level.

Certainly, this labour force would have provided a larger contribution to the knowledge-base of their country if they had been allowed to have professional opportunities at home. However, many of these scientists and engineers lacked opportunities in their nations. In many developing countries, the obstacle is not the lack of individual scientific and technological talents, but the lack of appropriate institutions and infrastructures.

On the other hand, we cannot argue that this brain drain from developing to developed countries (and most notably to the United States) has produced only disadvantages for developing countries. In fact, foreign-born scientists working in North American institutions often continue to have a preferential tie with their own country and provide the link for upgrading the social, scientific and technological capabilities at home. The countries which experienced the most spectacular growth in their Science and Engineering (S&E) capabilities are also those with the higher number—in proportion—of scientists and engineers working abroad. There are 37,900 S&E doctorate holders born in China and 30,100 born in India in the United States. However, the number of S&E doctorate holders working in the United States born in small countries such as Korea and Taiwan is, in proportion, much higher and equal to 4500 and 10,900, respectively ([25], Appendix Table 3-52). The evidence reported in the following parts of this paper will refer to countries' institutions and countries of residence of scientists and engineers and not to their country of origin.

The discussion above on the nature of technology has pointed out that R&D and formalised knowledge-generating institutions do not represent the only component of technological change. We are well aware that papers and patents reflect mainly the formalised component of scientific and technological knowledge. The making of national technological capabilities also requires the ability to diffuse, assimilate and imitate the knowledge generated in other countries. Other indicators of the available skills, such as the education level, show that the gap between developed and developing countries is somehow smaller (see Ref. [26], Table A2.2; see also Ref. [27]). But, above all, they show the existence of great differences *within* developing countries. It is certainly noteworthy that countries having better skills and education indicators also report a remarkable and growing share of R&D and patents.

4.1. Evidence on the international exploitation of technology produced on a national basis

Concerning trade in technology-intensive products, received theory would lead us to expect an international division of labour where developing countries export raw materials and low skills products, and rely on advanced countries to import high-tech products.

Table 3 shows export growth and shares for industrial and developing countries. Developing countries have uniformly higher growth rates for all manufactures, expected given their smaller starting base. However, what is less expected is that their lead *rises with technological complexity*, to reach its peak for high-technology exports ([28], Chapter 2, [57]). Are the data a statistical artefact, reflecting the relocation by TNCs of simple processes in high technology industries? Or, do they reflect genuine local capabilities, which implies considerable skill formation and technical effort? The explanation is a mixture.

Table 3
Growth and shares of manufactured and high-technology exports

	Growth rates 1980–97 (% p.a.)				Developing country shares (%)		
	World	Industrialised countries	Developing countries	Difference: developing – industrialised	1985	1995	Change in share
All exports	7.0	6.5	8.5	2.0	25.0	26.9	1.9
Total manufactures	7.9	6.8	13.5	6.5	14.7	24.0	9.3
High-technology exports	11.4	9.8	21.2	11.4	10.2	27.1	16.9
Electronic	13.0	10.9	21.7	10.8	13.4	33.1	19.7
Other High Tech	8.4	7.9	17.3	9.4	4.3	8.3	4.0

Source: adapted from Lall and Pietrobelli [28].

Industrialised countries include Israel and Central and Eastern Europe. Developing countries include the new NICs (Indonesia, Malaysia, Philippines, Thailand), Turkey and South Africa.

A significant part of the growth of high-tech exports reflects the spread of low technology assembly. At the same time, such assembly in the developing world is highly concentrated, so that the figures reflect the success of a few countries. Among these, there are two groups. First are those that depend almost wholly on TNCs to export sophisticated products as part of integrated global production; these include Malaysia, Thailand, Philippines, Mexico and China. Second, there are a few that have built up competitive capabilities in domestic enterprises and spawned their own international networks, led by Taiwan and South Korea [29]. These countries have started as imitators of Western technological capabilities, but certainly they cannot be regarded any longer simply so. In 1999 they registered, 3693 and 3562 patents, respectively, in the United States ([30], Appendix Table 6-12), becoming the fifth and seventh countries in the world in terms of their patent production. These data alone prove that they trade products that embody a strong endogenous technological component.

However, the spread of high-technology manufactures and exports to the developing world is clearly confined to very few countries, as Table 4 confirms, with the bulk of South Asian and African countries still excluded by such transformation.

4.2. Evidence on the global generation of innovations

TNCs have a limited propensity to base their R&D and innovative activities in host countries. The quantitative evidence based on R&D and patents [18] indicates that not more than 10% of TNCs' technological effort is carried out in host countries. And not more than 1% of the technological activities generated by TNCs of the North comes from

Table 4
Shares of regions in developing world exports: manufactures and high-tech manufactures

	1985	1990	1995
Total manufactured exports			
East Asia	66.5	74.0	75.3
South Asia	5.2	5.0	3.7
Latin America and the Caribbean	19.4	13.9	15.2
North Africa and Middle East	4.9	4.6	3.6
All Sub-Saharan Africa	4.0	2.5	2.2
Sub-Saharan Africa less South Africa	1.2	0.8	0.5
High-technology exports			
East Asia	90.1	94.2	90.5
South Asia	1.2	1.1	0.6
Latin America and the Caribbean	5.8	4.1	8.0
North Africa and Middle East	0.7	0.3	0.6
All Sub-Saharan Africa	2.2	0.4	0.3
Sub-Saharan Africa less South Africa	0.2	0.1	0.0

Source: adapted from Lall and Pietrobelli [28].

North Africa and the Middle East includes Turkey but excludes Israel, which is counted as part of the industrial world.

subsidiaries based in the South ([31], p. 97). In other words, developing countries collect the crumbs of the transnationals' innovative activities.

It is rather clear that TNCs do not find it convenient to locate technological activities in developing countries, in spite of the significant wage differentials. But although these cases are sporadic, it is insightful to focus on them, since they might illustrate what the conditions are for a successful strategy. In this case, some significant lessons can be gathered not only by the East Asian NICs, but also by the Indian experience [32–34]. Some leading TNCs in the field of information and communications technologies (including Texas Instruments and Microsoft) have found it convenient to start up R&D facilities in India. This has been facilitated not only by wage differentials, but also by: (i) the presence of good Universities, (ii) the (related) availability of qualified engineers and (iii) the existence of a fabric of related activities.

It is of course very difficult to draw causal links among the various factors which have facilitated the birth of knowledge-intensive industrial clusters in developing countries. In many cases, the presence of an important TNC active in a new field might generate externalities and induce the public sector to give prominence to associated Faculties and other public research centers. Take the example of Bangalore, where Texas Instruments opened already in 1985 an R&D center specialised in design circuits, which now employs 500 engineers. In the absence of a counterfactual, it is difficult to assess if a hub of excellence would have existed in the area without this initial decision. Still, if Bangalore is today an area where many firms are active in Information and Communication Technologies (ICTs) and software, this is also because there have been active public polices, and mainly those that have made qualified engineers available, to assist and reinforce the specialisation in the field.

We may ask if and when firms in developing countries may find it convenient to locate their R&D and innovative activities in developed nations. There is some evidence that large companies from LDCs find it useful to own selected establishments in developed countries since these are finalised to assimilate best-practice techniques that they then transfer also to domestic production. Thus, data on the United States show that South Korea has a number of establishments in the country larger than advanced countries such as the Netherlands, Canada and Switzerland ([35], p. 308). Not surprisingly, this investment is concentrated in computer hardware, telecommunications and electronic components, where Korea already enjoys a strong specialisation at home. This supports the view that technology-intensive FDI by companies based in developing countries, if any, is mainly meant to reinforce the expertise already existing at home.

4.3. Evidence on global technological and scientific collaborations

Technology agreements have become an important and growing channel to transfer know-how across countries. Quantitative information reports that strategic technological partnerships among firms have increased from 212 in 1980 to 574 in 2000 ([25], Appendix Table 4-39). A substantial share of these agreements involves firms based in different countries. How are developing countries exploiting this source of knowledge transmission? Narula and

Sadowski [36] report some data on the total number of strategic technology partnering (STP). More than 93% of the recorded STP in 1987–1994 involve countries based in the developed world only. The share of agreements in developing countries is negligible, and equal to less than 7%. Moreover, 91% of the recorded STP are North–South: firms in developing countries undertake agreements mainly with firms in developed countries (Table 5). Pietrobelli [37] reports similar evidence.

The countries more involved in these collaborations are the East Asian NICs, which alone absorb more than half of the agreements (even if their share has slightly declined between 1980–1987 and 1987–1994). Equally important and dramatically increasing is the participation of Eastern Europe, which has nearly tripled its share of agreements after the fall of the Berlin wall. Africa and Latin America record a negligible and decreasing participation in STP.

It is certainly no surprise that, given the small amount of resources devoted to technology, developing countries are also marginal in technological collaboration. It is, moreover, a worrying signal that the few collaborations that involve developing countries are likely to be North–South rather than South–South. This also questions the nature of the technological activities carried out. There are some research agendas which are specific to developing countries and that are likely to be dismissed by developed countries.

A slightly different outcome emerges from global collaborations in science rather than in technology. The share of internationally co-authored scientific papers provides a way to measure them: they have increased from 7.8% of the total in 1986–1988 to 14.8% in 1995–1997. As expected, the distribution of internationally co-authored papers follows closely the distribution of published papers reported in Table 2 (since internationally co-authored papers are a subset of scientific papers). The share of internationally co-authored papers by developing countries has increased substantially, reaching nearly 20% of the total. By looking at the distribution among countries, it emerges that other parts of the world, and not only the East Asian tigers, are involved in scientific collaborations (Table 6).

Table 5
Newly established strategic technology alliances in developed and developing countries, 1980–1994

	1980–1987	1987–1994	Annual average growth rate (%)
Percentage of STP in developed countries	94.5	93.1	4.2
Percentage of STP in developing countries *of which*	5.49	6.89	5.0
Eastern Europe	0.7	2.5	n.a.
East Asian NICs	3.5	3.8	n.a.
Latin America	0.3	0.2	n.a.
Other Asia and Africa	0.9	0.3	n.a.
Percentage of STP of developing countries involving firms in developed countries	90.29	92.19	n.a.

STP: strategic technology partnering.
Source: elaboration on Narula and Sadowski [36].

Table 6
Co-authored scientific papers in developed and developing countries, 1986–1997

	Percentage scientific papers co-authored		Annual average growth rate (%)
	1986–1988	1995–1997	
Developed countries[a]	84.2	80.8	12.2
Developing countries	15.8	19.2	18.5
of which			
Eastern Europe	5.7	8.9	26.9
East Asia[b]	0.9	2.1	44.7
Latin America	2.5	2.9	17.4
Other Asia and Africa	6.7	5.3	8.3
Total co-authored scientific papers	100.0	100.0	13.2

Source: elaboration on National Science Foundation [30].
[a] OECD (22) plus Israel.
[b] Taiwan, South Korea, Hong Kong, Singapore.

The UNDP ([26], p. 98) reports some significant cases of research activities which have been generated in the South and for the South: Thailand's drug to fight malaria, Cuba's meningitis vaccine, Bangladesh oral rehydration therapy, Brazil's basic computer, India's wireless Internet access are some of the examples reported. There is no need to overemphasise these success stories. As already seen above, the scientific and technological innovations developed in the South are still negligible compared to those developed in the North. What is here at stake is that some significant South-generated breakthroughs are possible, and they might be beneficial for other regions of the South as well. But so far, they have not led to increasing South–South cooperation, exchange of know-how, diffusion of expertise and best practice methods.

5. Strategies for technological and industrial development

The evidence reported is incomplete and fragmentary, but the conclusion emerging is straightforward: developing countries have a marginal participation in the generation and diffusion of technology. They participate to a minimal extent to the globalisation of technology, and differently from what occurs in trade and finance. Globalisation is offering new technological opportunities, but these are not seized by developing countries. There is, of course, the remarkable exception of the East Asian NICs. These countries continue to be, even from the globalisation of technology viewpoint, the only case of a successful catching-up strategy in technological capacity as well as in income levels.

The taxonomy here reported might hopefully help policy analysis. It emerges that the label "globalisation of technology" includes a heterogeneous set of phenomena, each of which could lead to different policy implications. We are here mainly addressing the North–South knowledge flow, and given the scientific and technological muscles of the two areas, this is naturally the most significant component of technology transfer. How could the South benefit from these flows in order to start off and improve its own autonomous competencies? To on low wages; some Indian firms, for example, have managed to penetrate Western markets selling software services and products [32]. An increased open economy generally leads domestic firms to upgrade their technological capabilities [44]. This has been possible because of some key characteristics of the industry (such as the standardisation of the product, the low cost of data transmission, the technical possibility of daily exchanges between suppliers and purchasers). Indian firms do not sell their products to final consumers, but rather they have become specialised suppliers for developed countries' firms. This would have not been possible without the existence of specific engineering expertise in India, and without the links with some developed countries' firms. This example indicates that if an appropriate market niche is identified, and this is combined to existing and potential capabilities, and to crucial links in developed countries' markets, it is possible to acquire a market share in technology-intensive industries even in the most developed countries.

5.2. The policy implications of the global generation of innovations

There is a wide literature on the nations' advantages and disadvantages associated to FDI [45]. The issue here at stake is how the South can benefit from the FDI of the North in terms of acquisition and dissemination of know-how and incentives to local learning. Once foreign production facilities are accepted in the country, it is certainly an advantage if they also include a technological component since the latter will generate externalities which are beneficial for the whole economy. Substantial investments by foreign firms in a country do not occur in the absence of some negotiations between the firm and the host government. Government policies have therefore an important role to use FDI as a learning opportunity, and as a channel of technology transfer.[3]

Developing countries have adopted a variety of strategies vis à vis TNCs' investments. Some countries, such as South Korea and Taiwan, have traditionally preferred to pursue a strategy of industrial development based on national firms [15,46]. This has required the active attitude of governments opening alternative channels of knowledge flows, for example, by fostering scientific and technical collaboration with developed countries at the highest degree available, while simultaneously investing in technological capabilities and infrastructures at home [39,47]. Many other countries, including South Africa, Chile, Brazil, India, Malaysia and Thailand, have encouraged foreign firms to operate in the country and have tried to use them for acquiring productive, managerial and technological expertise. In some cases, however, these governments willing to accept FDI in their territories have not given enough emphasis to linking it to the building of local technical competencies, whenever they implicitly assumed that the latter are directly and automatically associated to production. In other words, in some cases, industrial policy through FDI has not been linked to technology policy through FDI. While certainly production involves the mastering of certain technical know-how, there is a specific technological component within FDI that can be negotiated.

[3] UNCTAD [61], with its *Investment Policy Reviews*, is making an interesting effort to help developing countries' governments in designing and implementing the appropriate policies to attract and benefit from FDI.

Multinational corporations can decide to locate either at home or in the host country many skill-intensive functions, including R&D and technical laboratories, engineering units, standards setting and implementing units. The more the FDI includes these activities, the more it is likely that the host country will benefit from useful- and learning-enhancing externalities.

In other cases, the localisation of one or a few TNCs has generated an endogenous net of local firms supplying or imitating what the TNCs do. The experience of some "hubs" in developing countries would illustrate this point [26].

An excessive concentration of technology-intensive activities in the hands of foreign TNCs would have the disadvantage to increase the dependence on the strategic choices of foreign firms and sometimes even to obstacle the growth of domestic firms. Governments keen to host FDI should therefore not only negotiate the presence of a technological component, but at the same time adopt policies to allow other parts of the economy outside the foreign firm to benefit from the expertise developed. A policy fostering externalities and spillovers is therefore desirable.

5.3. The policy implications of global technological collaborations

Cross-border technological collaborations, in industry and in the academic community, appear to benefit both the parties involved since they allow an increase in learning and an exchange of information. Each country has an advantage to become a junction of techno-scientific information. In order to be engaged successfully in these collaborations, it is however relevant to have appropriate institutions, and in particular, firms with a sufficiently sophisticated technical expertise to be of interest for potential partners.

As in any marriage of convenience, one of the partners may get greater benefits than the other one. In principle, the partner that has more knowledge has more to teach but is also quicker in learning. As we have seen, firms of the South are involved in collaborations mainly with partners from the North. This is hardly surprisingly given the worldwide distribution of scientific and technological capabilities. In general, it seems that collaborations provide better learning opportunity for the South than FDI, since they allow to start a learning process within South-based firms and institutions, and they are more likely to set up "two-way" knowledge and technology flows [37,48]. However, it is unlikely that the partner from the South will be the one to drive the technological agenda. On the contrary, the partner from the North may steer the direction of research and technological development towards its own interests.

This provides an incentive to increase the number of collaborations among firms in the South. There are a few significant cases where firms and public institutions in the South have generated innovations which are addressing problems specific to developing countries (a selection of significant cases is reported in UNDP [26], p. 98). These innovations could be disseminated among Southern countries, and the best vehicle to do is to use cross-border scientific and technological collaborations. But it is unlikely that this will occur without active policies to support and promote local firms and other research organisations. The role of international organisations can be vital in order to achieve multilateral, rather than bilateral collaborations, and of a South–South nature to spur research relevant to LDCs' industrial and technological development.

Another important form of knowledge acquisition is by training human resources in developed countries. Many developing countries provide financial facilities in order to allow some talented students to study in Universities abroad. This is a successful strategy to acquire expertise, especially when this is strongly embedded in human skills. This strategy has, however, also its risks: it often happens that the most talented students of the developing countries, sent to study abroad at taxpayers' expenses, decide to stay abroad. In fact, more than

Table 7
Strategies for developing countries for the access and use of international know-how

Categories	Targets	Instruments
International exploitation of national innovations	• Achieve lower foreign dependency and fill technology gaps	• Promoting collaborations between national firms and leading firms in the field.
	• Increase learning relevant to national industry	• Incentives to selected FDI in the country and to their learning–enhancing modes of operation.
	• Obtaining competitive supply prices of technology-intensive products	• Negotiations on imports with foreign firms.
	• Obtaining IPRs at fair conditions	• Multilateral agreements on IPRs and licences.
Global generation of innovations by TNCs	• Use TNCs to enhance national technological capabilities	• Providing real incentives to the location of new innovative activities with foreign capital.
	• Benefit from local technological activities of TNCs	• Upgrading S&T infrastructures and institutions. • Supply qualified workforce. • Monitoring the technological strategies and location choices of TNCs.
	• Disseminate TNCs expertise locally	• Associate TNCs centers to hubs of specific knowledge and industrial firms located in developing countries.
Global techno-scientific collaborations	• Use the foreign academic community to upgrade the scientific competence of the nation	• Scientific exchange programmes. • Student flows to developed countries. • Incentives to international scientific projects. • Participation to international S&T organisations.
	• Allow the country to become a junction of technical and industrial information	• Developing infrastructures for techno-collaborations (scientific parks, consortia, etc.).
	• Apply knowledge to production	• Promoting University/industry linkages and their international reach. • Participating to international organisations for technical and industrial collaborations.

80% of PhD students in the United States in natural science and engineering from China and India plan to remain there ([49], vol. 2, Table 2-34). This implies a transfer of talents from developing to developed countries, rather than the contrary, as it would be necessary. It is not surprising that the governments of many developing countries, including Indonesia and Thailand, provide grants to their students to study abroad under the condition that they will return to work in their native country. The magnitude of the "foreign legion" (that is, scientists and engineers born in the South but working in the North) is so relevant that developing countries should consider institutional policies to link the Diaspora to their native homeland.

In addition, LDCs governments may actively raise the attractiveness of local employment of their foreign-trained talents by encouraging TNCs to locate their S&T departments abroad, and employ them there. This has recently occurred in the electronics and software sectors, especially in India [33]. Table 7 recapitulates the policy implications of our analysis.

6. Conclusions

Globalisation offers a new opportunity for knowledge dissemination, but this does not mean that all the nations and institutions will equally benefit from it. On the contrary, it seems that the institutions that have managed to benefit most from globalisation are those that already are at the core of scientific and technological advance.

Developing countries are not automatically excluded from the advantages. They can benefit from globalisation of technology if they implement active policies designed to increase learning and improve access to knowledge and technology [39]. A few success cases have been pointed out here. A larger number of successful cases are presented by Conceição et al. [50]. We are aware that these cases, unfortunately, represent an exception, not the rule, and that huge parts of the world are not benefiting yet from the opportunities offered by technological change and its globalisation. However, the few success stories can be instructive in order to indicate a suitable development strategy.

We have also argued that the three categories of the globalisation of technology require different learning strategies, and therefore that, if a country has a choice, it might have good reasons to prefer one form to another. In particular, we have argued that the import of foreign technology, either embodied or disembodied, has a negligible learning impact per se, unless when accompanied by local policies to promote learning, human capital and technological capabilities. Public policies should therefore try to induce foreign firms to move from exporting their products to producing locally, and transferring a technological component.

Furthermore, it is often more advantageous for a developing country to set up interfirm strategic technological agreements than simply hosting production facilities of foreign firms. Public policies should therefore also try to "upgrade" FDI to strategic technological partnering. We have argued that collaborations among public and business organisations can provide substantial benefits to developing countries. Policies at both the national and intergovernmental levels should therefore consider these collaborations as a preferential channel to transfer and acquire technological competencies.

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Clase 15/06/2005

Concepto Tecnología

Magíster en Gestión Tecnológica
mención Biotecnología

Fundamentos
de la Gestión
Tecnológica

TECNOLOGIA, CONCEPTO Y UNA REFLEXION CRITICA DE SU HACER

Técnica, un concepto diferente

Historia de la Técnica y la Tecnología

- En su aspecto material, la historia de la civilización occidental es la historia de la técnica y la tecnología.
- En general, en la historia de la técnica y la tecnología de Occidente se rehuyen las dificultades de determinar e incorporar el papel desempañado por la inventiva del Oriente.

Desde la Antigüedad a la Actualidad

La Antigüedad	Edad Media	Siglos XVII - XVIII	Siglos XIX -XX	Siglo XXI
El surgimiento de Grecia y Roma	La Alta Edad Media	El Renacimiento		
El Imperio Romano	La Baja Edad Media	El surgimiento del Mundo Moderno		

Técnica (práctica técnica)

Tecnología (actividad tecnológica)

Historia desde Occidente

"El periodo mejor conocido de la historia antigua, es la historia del surgimiento de Grecia y Roma. En el campo de la política y la literatura hay, en verdad, razones obvias para aceptar esta preeminencia tradicional; pero desde el punto de vista tecnológico las glorias de Grecia y Roma han sido a menuda exageradas. Cuando los griegos y los romanos, sucesivamente, vencieron a las antiguas civilizaciones del Oriente Próximo se apropiaron - y heredaron- muchas cosas, pero también destruyeron mucho, y lo que crearon para sustituirlo fue pocas veces mejor, y a menudo inferior, a los logros técnicos de los primeros tiempos" (Derry & Williams, 1997:24, Vol. I).

Historia desde Occidente

"Nuestras historias de tecnología suelen ser poco más que historias de la mecanización y hablan poco de todo lo demás, se describen por encima las aportaciones del mundo islámico, se citan las de la tecnología china -sin aceptar, no obstante, que los "grandes inventos que iban a permitir la llegada de los tiempos modernos en Occidente" sean en lo fundamental legados del saber chino, como quieren los sinólogos-, y las civilizaciones autóctonas de América y del Africa negra, carentes de máquinas, no son siquiera mencionadas o se las arroja a la 'prehistoria' " (Fontana,1994:125).

Técnica

La técnica como aquellos procesos que consisten en una determinada forma de producción, utilizada en una circunstancia dada, cuya efectividad es empírica, es decir, no se ha inducido o deducido de conocimientos anteriores aplicando el método científico. Como también la técnica vista como aquellas prácticas precientíficas, en principio escasamente o nada racionales, basadas en el conocimiento empírico de los hechos (Ortega y Gasset,1992; Sanmartín,1990).

Técnica

- La técnica se caracteriza por operaciones adquiridas por medio de aprendizaje y perfeccionamiento sin cesar a lo largo del tiempo, producto de una amplia práctica (destreza, habilidad) de carácter artesanal no uniforme y con grandes poderes de adaptación y recuperación.

  "La técnica es lo contrario de la adaptación del sujeto al medio, puesto que es la adaptación del medio al sujeto" (Ortega y Gasset,1992:31).

  "El hombre no vive ya en la naturaleza sino que está alojado en la sobrenaturaleza que ha creado en un nuevo día del Génesis: la técnica" (Ortega y Gasset,1982:14).

Técnica

La Antigüedad | Edad Media | Siglos XVI-XVII | Siglos XIX - XX | Siglo XXI

Técnica
- Técnica del artesano — Ortega y Gasset
- Técnica democrática — Lewis Mumford
- Acción técnica — Jacques Ellul

Práctica

Tecnología
- **Técnica del técnico o ingeniero**
- **Técnica autoritaria**
- **Fenómeno técnico**

Actividad

Técnica y Tecnología

Las diferencias entre la técnica y la tecnología, se presentan en función de los métodos y medios utilizados para realizar las modificaciones en el entorno, que tienen relación con:

- ✓ El conjunto de conocimiento utilizado
- ✓ El método empleado
- ✓ El tipo de propagación (alcance, riesgo e impacto)
- ✓ Los requerimientos y la infraestructura necesarios
- ✓ El vínculo con lo social y cultural

Técnica y Tecnología

Carácter hereditario

Tradición Biológica Ecológica y Social → **Técnica** → Modos de vida

Incertidumbre

Grado de responsabilidad científica, expertos

Manejo de la Incertidumbre

Cultura Científica → **Tecnología** → Modelo de vida

Paradigma *Newtoniano Cartesiano*

La tradición de hacer pan
- Pan:
  - Sabroso
  - Necesario
- Carácter artesanal
  - Aprendizaje
- Práctica
  - Destreza
  - Habilidad

Técnica

Tecnología

La industria del pan
- Producto:
  - Calidad
  - Rentable
- Proceso
  - Eficiente
  - Estándares
- Actividad
  - Maquinaria
  - Organización
  - Gestión

El artesano telar

- Telar:
  - Estético - Representativo
  - Necesario
- Carácter artesanal
  - Aprendizaje
- Práctica
  - Destreza
  - Habilidad

Técnica

Tecnología

La industria textil

- Producto:
  - Calidad
  - Rentable
- Proceso
  - Eficiente
  - Estándares
- Actividad
  - Maquinaria
  - Organización
  - Gestión

Técnica: una practica

Toda técnica involucra procedimientos o secuencias de cómo debe procederse, por medio de actos definidos y coordinados, para lograr un determinado propósito.

Las técnicas de cocinar, de contar cuentos, de pintar y conducir vehículos, entre otros, pueden ser vistas como

"Un conjunto de procedimientos puestos en práctica para obtener un resultado determinado"

Tecnología: una actividad

Se caracteriza por integrar distintas clases de conocimiento (empírico, científico)

que proviene de distintas fuentes (inventos, cambios, descubrimientos).

a través de diversos procedimientos (desarrollo, adaptación, innovación, copia)

organizados de alguna manera (diseño y planificación) para cumplir con objetivos económicos y sociales (valor de uso, valor de intercambio)

Actividad tecnológica v/s Práctica técnica

Universal	Local / contextual
Cerebral	Sensorial / emocional
Impersonal / descarnado	Encarnado en el espacio y tiempo
Conocimiento Articulado / explícito	Saber Implícito
Mirada Analítica	Mirada Hólistica
Producto de la aplicación del método	Multiples vías de acceso, surge en la Crianza (idea de cuidarse mutuamente, no hay crianza que no sea mutua, es decir, criamos, criándonos)
Oposición sujeto/objeto	Inmediatez
Teórico, Simbólico	Vivencial, Mítico

Técnicos y tecnólogos

El técnico es quien se sirve de procedimientos ya establecidos y que, al haber sido entrenado para ello por algún proceso social de aprendizaje, es competente para hacerlo.

Los tecnólogos son los creadores de técnicas, los que en su actividad realizan labores de diseño y aplicación experimental de nuevas técnicas.

Técnica y Tecnología

"El fenómeno técnico puede resumirse como la búsqueda del mejor medio en todos los dominios, que se caracteriza por siete caracteres claves de la técnica moderna: la racionalidad, la artificialidad, el automatismo de la elección técnica, el autocrecimiento, la indivisibilidad, el universalismo y la autonomía" (Mitcham,1989:79).

Clase 16/06/2005

Riesgo en la Actividad Tecnológica y Etica en la Práctica Tecnológica

Magíster en Gestión Tecnológica
mención Biotecnología

Fundamentos
de la Gestión
Tecnológica

TECNOLOGIA. CONCEPTO Y UNA REFLEXION CRITICA DE SU HACER

Riesgo en la actividad tecnológica.
Ética en la práctica tecnológica

Ética

(del griego, carácter, y, según Aristóteles, de éthos costumbre)

Rama de la filosofía cuyo objeto de estudio es la moral. Si por moral hay que entender el conjunto de normas o costumbres (mores) que rigen la conducta de una persona para que pueda considerarse buena, la ética es la reflexión racional sobre qué se entiende por conducta buena y en qué se fundamentan los denominados juicios morales.

Ética

Las morales, puesto que forman parte de la vida humana concreta y tienen su fundamento en las costumbres, son muchas y variadas (la cristiana, la musulmana, la moral de los indios, etc.) y se aceptan tal como son.

Ética

Mientras que la ética, que se apoya en un análisis racional de la conducta moral, tiende a cierta universalidad de conceptos y principios y, aunque admita diversidad de sistemas éticos, o maneras concretas de reflexionar sobre la moral, exige su fundamentación y admite su crítica, igual como han de fundamentarse y pueden criticarse las opiniones.

¿Qué es la Ética?

En resumen, la ética es a la moral lo que la teoría es a la práctica; la moral es un tipo de conducta, la ética es una reflexión filosófica.

Ética social

Etica de responsabilidad solidaria o donde el accionar individual se ordena respecto de la comunidad social a la que pertenece.

Responsabilidad social empresarial

Concepto de RSE: "La RSE es una visión sobre la empresa que concibe el respeto a los valores éticos, a las personas, a las comunidades y al medio ambiente como una estrategia integral que incrementa el valor agregado y, por lo tanto, mejora la situación competitiva de la empresa".

Criterio orientador de la Etica social

Un criterio orientador es aquel índice o indicador del grado de "Eticidad" que la sociedad manifiesta en su comportamiento social.

Criterio orientador de la Etica social

La justicia

La Justicia

Es uno de los núcleos primarios en los que se expresa y configura la conciencia ética Occidental.

"Dar a cada uno lo que le conviene"
Simónides

"Dar a cada uno lo suyo"
Platón

La justicia

(del latín, justicia, conformidad con el derecho)

Término de difícil definición concreta por la multiplicidad de significados y contextos:

Ámbito religioso: justicia como «justificación» por la fe.
Ámbito social: justicia legal, distributiva, social.
Ámbito privado: justicia como virtud.
Ámbito público e institucional: justicia como poder judicial.
Referida al ordenamiento social justo: una teoría de la justicia viene a ser una teoría de la sociedad justa.

Implicancias de este criterio

La Justicia como ideal utópico de igualdad
La aspiración a la igualdad o a la equidad es el principio y meta del ethos social.

La justicia como critica anterior al orden establecido
La justicia es una instancia ética que trasciende el orden establecido y lo critica.

La justicia como dinamizadora del cambio
La justicia dinamiza la sociedad hacia su cambio permanente.

El bien común

Es el objetivo ético de la realidad social

Que es el bien común

Traducción de la expresión latina bonum commune, utilizada sobre todo por Tomás de Aquino , con la que se designaba la orientación u objetivo social de toda ley. El concepto, no obstante, proviene de la filosofía de Platón y Aristóteles, y especialmente de la de Cicerón.

Bien común

Tanto Platón como Aristóteles subordinan el bien privado al bien común y publico, y este último pone en el bien común la característica definitoria del «buen gobierno» o de la forma correcta de gobierno.

Bien común

En todos estos casos, el «bien común», el «interés común» o la «utilidad pública» no se identifican con la suma de los bienes particulares de los individuos, sino que, siempre y en todo caso, el bien común de la sociedad es superior y a él ha de subordinarse el bien particular de los individuos, y ambos se presentan en una especie de difícil equilibrio que el gobierno justo debe proponerse como finalidad y objetivo.

Bien común

No obstante, el bien común se ordena, de algún modo, al bien de los individuos particulares, puesto que no puede existir sin el bien de las personas individuales. Pero, en la forma concreta de definir esta relación entre bien común y bien de las personas, entran en consideración las circunstancias históricas del desarrollo de la cultura y de la sociedad.

SIN ETICA NO HAY NEGOCIO

MUNDOS CONTRARIOS

ETICA → EQUIDAD

ECONOMIA → EFICIENCIA

EN QUE SE SUSTENTA LA ECONOMIA

LA RACIONALIDAD

LA RACIONALIDAD INSTRUMENTAL

LA RACIONALIDAD ECONOMICA

QUE ES LA RACIONALIDAD

Capacidad humana que se manifiesta en las creencias, las decisiones y las conductas que se consideran acordes con la razón, o simplemente racionales.

QUE ES LA RACIONALIDAD

Algo es conforme a la razón si se adecua a la función primaria del entendimiento humano, que es el conocimiento o el saber, o a la obtención de los diversos fines que el ser humano se propone en sus actuaciones.

RAZON INSTRUMENTAL

Desarrollado por escuela de Francfort, es un concepto que parte de la racionalidad basada en un modelo lógico que confía a la razón la principal tarea de concordar fines y medios, racionalidad que, a la larga, se ha mostrado destructora de si misma y que merece el apelativo de «razón instrumental».

RAZON INSTRUMENTAL

Frente a ella, la teoría crítica plantea la racionalidad como una crítica a todas las formas de ideología y dominio que aparecen en la sociedad actual, históricamente derivadas de un concepto de razón (como instrumento) que, persiguiendo el dominio de la naturaleza, ha terminado por dominar al mismo hombre. La raíz irracional de esta razón, endiosada durante la etapa de la Ilustración, se ha mostrado de forma ostentosa a través de las diversos extremos del presente

¿UNA ETICA ECONOMICA?

SI, POR VARIAS RAZONES:

- La ética es una actividad racional
- Que la racionalidad económica no puede ser amoral
- La economía no es moralmente neutral, como no lo es ninguna de las actividades humanas que tienen incidencia social

¿UNA ETICA ECONOMICA?

Cualquier actividad social que hoy quiera presentarse como legítima debe, pues, atenerse a los criterios de justicia entendida como equidad, lo cuál no esta reñido con la búsqueda de la eficacia, sino todo lo contrario; puesto que el fin social de la economía es la satisfacción de las necesidades humanas.

¿PARA QUÉ NOS SIRVE LA ÉTICA?

Dentro de una administración participativa y horizontal la ética no es otra cosa que generar recursos para tomar mejores decisiones.

ETICA EMPRESARIAL CUATRO CONCEPTOS

EQUIDAD

SALARIOS
MERITO CORPORATIVO
PRECIO DEL PRODUCTO

DERECHOS

PROCESOS DE AUDIENCIA JUSTOS
PROTECCION DE LA SALUD DEL EMPLEADOR
INTIMIDAD PERSONAL
IGUALDAD DE OPORTUNIDADES
NO DISCRIMINACION

HONESTIDAD

REGALOS IMPROPIOS
SOBORNOS
SEGURIDAD DE INFORMACION COMERCIAL

EJERCICIO DEL PODER CORPORATIVO

SEGURIDAD DEL LUGAR DE TRABAJO
SEGURIDAD DEL PRODUCTO
SEGURIDAD DEL MEDIO AMBIENTE
CIERRE Y REDUCCION DE LA PLANTA

EL NEGOCIO ES EL NEGOCIO

Parece existir mayor distancia entre el mundo de la empresa y el ámbito de la moralidad

Para hacer negocio es preciso olvidarse de la ética común porque corriente los negocios tienen sus propias reglas del juego

La misión de la empresa consiste en maximizar beneficios, en términos de dinero prestigio y poder de suerte que es esta una guerra en la cualquier medio es bueno si conduce al fin

La ética debe limitarse en la empresa a unos mínimos, que en realidad coinciden con el cumplimiento de la legalidad y la sujeción a las leyes del mercado

EL NEGOCIO ES EL NEGOCIO

Cuál es nuestra idea de empresa

Una empresa es una mercancía de la que el propietario dispone libremente; es en definitiva solo una paquete de acciones que como tal se compra, y con el que se puede hacer cuanto se quiera, ya que en ella todo es cuestión de precio. De lo que se sigue que los colaboradores han de ser tratados como producto de un capital, como una mercancía

Una empresa es una corporación que se sabe responsable de los proyectos y sus realizaciones; necesita una finalidad que se inscribe en la cuenta de resultados pero va más allá de ella.

A MODO DE CONCLUSION

La ética de la empresa no es otra cosa que ética de la responsabilidad.

No solo los individuos son moralmente responsables, sino también las empresas.

A MODO DE CONCLUSION

La ética empresarial es una ética de la responsabilidad por las consecuencias de las decisiones que en ella se toman y que se relaciona con la satisfacción de las necesidades humanas.

Toda empresa o actividad empresarial tiene una finalidad que la legitima y de la que cobra todo su sentido. Queda deslegitimada la que olvide esta finalidad

A MODO DE CONCLUSION

Los consumidores son interlocutores válidos y es necesario tener en cuenta sus intereses

Los miembros de una empresa son interlocutores válidos, cuyos derechos tienen que ser respetados y donde quedan fuera las prácticas humillantes

Que el cambio de una empresa Taylorista a una post Taylorista no es una simple moda, sino una auténtica exigencia de la conciencia moral de estos tiempos

Responsabilidad Social

Responsabilidad Social Corporativa (RSC) o Responsabilidad Social de la Empresa (RSE)

Surge en Estados Unidos en los finales de los años 50 y principios de los 60 a raíz de la Guerra de Vietnam y otros conflictos como el Apartheid.

Responsabilidad Social: Global Compact, 1999

El 31 de enero de 1999, durante la celebración en Davos (Suiza) del **Foro Económico Mundial**, el Secretario General de las Naciones Unidas, Kofi Annan, hizo un llamamiento mundial a los líderes empresariales para que se unieran al llamado **"Global Compact" o "Pacto Mundial".**

Global Compact, promueve **nueve principios** derivados de la Declaración Universal de los Derechos Humanos, de la Declaración de la Organización Internacional del Trabajo y de la Declaración de Río sobre Desarrollo y Medio Ambiente.

Responsabilidad Social: Cumbre del Milenio PNUD, 2000

En la Cumbre celebrada en Nueva York en septiembre de 2000 que reunió a 147 jefes de Estado y de Gobierno y un total de 191 naciones.

Los líderes de los países convinieron en establecer objetivos y metas mensurables, con plazos definidos, **para combatir la pobreza, el hambre, las enfermedades, el analfabetismo, la degradación del medio ambiente y la discriminación de la mujer**, estableciendo como plazo final de consecución el año 2015

Pacto Mundial de las Naciones Unidas

El Pacto es una **iniciativa de compromiso ético** destinada a que las empresas de todos los países acojan como una parte integral de su estrategia y de sus operaciones los principios de conducta y acción en materia de **Derechos Humanos, Trabajo, Medio Ambiente** y **Lucha contra la Corrupción.**

Su fin es promover la **creación de una ciudadanía corporativa global**, que permita la conciliación de los intereses y procesos de la actividad empresarial con los valores y demandas de la sociedad civil, así como con los proyectos de la ONU, Organizaciones Internacionales Sectoriales, Sindicatos y ONGs.

Pacto Mundial de las Naciones Unidas

El pacto funciona como una red integrada de trabajo en:

Las Compañías participantes (más de 700, de 54 países de todo el mundo)

La ONU, sus organizaciones sectoriales (OIT, UNCTAD, ACNUR, etc.)

Las ONGs Globales (AI, HRW, WWF, etc.)

Las Uniones Sindicales Internacionales (ICFTU, UNI, TUAC, etc.)

Promueven los objetivos y principios del pacto en torno a cuatro componentes o instrumentos principales, que marcan el estilo de trabajo y las actividades que desarrollan.

Los nueve principios del Pacto Mundial

Acerca de los Derechos Humanos, se pide a las empresas:

1. Apoyar y respetar la protección de los derechos humanos fundamentales a nivel internacional dentro de su esfera de influencia.
2. Asegurarse de que sus propias corporaciones no actúan como cómplices en la violación de los derechos humanos.

Los nueve principios del Pacto Mundial

Acerca de las Condiciones Laborales, se pide que las empresas apoyen:

3. La libertad de afiliación y el reconocimiento efecto del derecho a la negociación colectiva.
4. La eliminación de todo tipo de trabajo forzoso u obligado.
5. La erradicación del trabajo infantil.
6. La eliminación de la discriminación con respecto al empleo y la ocupación.

Los nueve principios del Pacto Mundial

Acerca del <u>Medio Ambiente</u>, se pide a las empresas que:

7. Fomenten los enfoques preventivos ante los desafíos medioambientales.
8. Lleven a cabo iniciativas para fomentar una mayor responsabilidad medioambiental.
9. Faciliten el desarrollo y la divulgación de medios tecnológicos respetuosos con el medio ambiente.

Áreas que abarca RSE

Marco Regulatorio RSE

EL MR implica establecer **la base** a lo cual las empresas están obligadas a hacer con o sin RSE

El MR va estar implícito siempre dentro de la actividad de la empresa, no así la RSE, que corresponde a **una decisión voluntaria** de la misma.

La relación que se establece, entre marco regulatorio y RSE, implica que el marco regulatorio se **encuentra inserto**, formando una esencial parte de lo que es la RSE, por que supone un cumplimiento básico de ciertas normas de conducta por parte de la empresa.

Marco Regulatorio RSE

Las empresas están obligadas a respetar ciertos derechos laborales y medioambientales y no por eso quiere decir que se denominen empresas socialmente responsables.

RSE comienza una vez agotado el mínimo legal o marco regulatorio básico.

Una vez determinado el contenido del marco regulatorio se puede establecer cual es el punto de separación entre lo que se define como obligación legal y que es lo que corresponde al ámbito voluntario o compromiso externo de la empresa.

Las normas de conducta auto impuestas o auto exigidas son las que corresponden al territorio de la RSE.

Desarrollo Sustentable

- La definición de *Desarrollo Sustentable*[1] es la de satisfacer las necesidades actuales sin comprometer la capacidad de las generaciones futuras para atender a sus necesidades futuras.
- Se define, también, como el proceso de mejoramiento sostenido y equitativo de la calidad de vida de las personas, fundado en medidas apropiadas de conservación y protección del medio ambiente, de manera de no comprometer las expectativas de las generaciones futuras.

La definición propone que la empresa debe pensar en las generaciones futuras, cuidar el medio ambiente y garantizar la existencia de los recursos naturales renovables para su futuro uso a través de estudios de impacto ambiental y negocios que no dañen el entorno.

Relación equidad social-sustentabilidad ambiental-resultados económicos

Relación equidad social-sustentabilidad ambiental-resultados económicos

La RSE comprende en su propia esencia la **calidad de relaciones** que establece la empresa con sus públicos interno - externo y su ambiente.

¿Rol de la empresa en la sociedad ?

- **La perspectiva ética** de la RSE se basa en un análisis de la acción individual, esto involucra un conjunto de valores y actitudes a nivel empresarial.
- **La perspectiva sociológica** y **la perspectiva política** de la RSE se centra en la interrelación entre gobierno, empresa, sociedad o comunidades y otras instituciones sociales.

¿Rol de la empresa en la sociedad ?

- **Milton Friedman(1970)** considera que la única **responsabilidad social del negocio es la de aumentar sus beneficios**; solamente la gente tiene responsabilidades, el ejecutivo, dueño o trabajador que genera cada día utilidades a su empresa.

  Los mercados se harían cargo de sus responsabilidades sociales asumiendo que el mercado libre se haría cargo de ellas.

  Las economías neoclásicas de la empresa, refuerzan el interés puramente económico de los negocios.

¿Rol de la empresa en la sociedad ?

- **Freeman (1984)** propone la teoría de stakeholder, que plantea a la empresa como un sistema relacionado con la sociedad, no de un modo indefinido sino como un grupo de stakeholder representativos en una relación de doble sentido.

  Llamamos stakeholder a "cualquier individuo o grupo que puede afectar o es afectado por el logro de los objetivos de la empresa".

  Responsabilidad Social Empresarial, Corporate Social Responsiveness o Reacción Social Empresaria, Desempeño Social Corporativo, Gestión de Stakeholders, Sustentabilidad y Ciudadanía Corporativa son los conceptos o formas en que se da a entender la RSE.

¿Rol de la empresa en la sociedad ?

¿Rol de la empresa en la sociedad ?

Stakeholder primarios, son aquellos que sin su continua participación la empresa no puede sobrevivir. Generalmente, están integrados por un grupo de privados; quienes son los accionistas, inversionistas, empleados, clientes y proveedores; y un grupo público que esta conformado por los gobiernos y comunidades que proporcionan la infraestructura y mercados, cuyas leyes y regulaciones deben ser obedecidas y a quienes se les deben pagar impuestos y otras obligaciones.

¿Rol de la empresa en la sociedad ?

- ***Stakeholders secundarios,*** son aquellos que influyen o afectan, o son influidos o afectados por la empresa; sin embargo, ellos no participan en las operaciones ni son esenciales para su supervivencia. Los medios y una amplia gama de grupos especiales de interés son considerados stakeholders secundarios, según esta definición. Tienen la capacidad de movilizar la opinión pública a favor o en contra de una empresa.

Responsabilidad Social Empresarial

RSE es la **"obligación directiva de actuar para proteger y mejorar el bienestar de la sociedad en su conjunto y el interés de la organización"** (Davis & Blomstrom;[1] McGuire, [2] Frederick[3]).

[1] Cfr., Davis, K. and R. W. Blomstrom, 1975, *Business and Society: Environment and Responsibili*

[2] Cfr., McGuire, J., 1963, *Business and Society*

[3] Frederick, W., 1978 (reprint-1994), From CSR1 to CSR2, *Business and Society 33*

Responsabilidad Social Empresarial

RSE es ***"La responsabilidad social de la empresa abarca las expectativas económicas, legales, éticas y filantrópicas de la sociedad, en un momento determinado del tiempo"*** Carroll (1979)

RSE Total = Responsabilidades Económicas + Responsabilidades Legales + Responsabilidades Éticas + Responsabilidades filantrópicas

Responsabilidad Social Empresarial

RSE es ***"configuración organizacional de principios de responsabilidad social y procesos de respuesta social, así como también de políticas, programas y resultados observables, que se vinculan con las relaciones sociales de una empresa".***

Corporate Social Performance o Desempeño Social de la Empresa ha sido definido por Wood.

Responsabilidad Social Empresarial

- **Comportamiento ético**
- **Humanidad, la solidaridad** y por qué no decirlo, la inteligencia y el sentido común.
- **No es incompatible con el éxito económico**, es más, ambos convergen
- **No es dar limosnas ni salirse de la misión de la empresa**, es... integrarla
- **Conocimiento y emoción**
- **Es entendimiento**, el cual nos lleva al ***desarrollo***, relacionado con el aumento en la calidad de vida.

Responsabilidad Social Empresarial

Transformación empresarial asociada a RSE

Empresa **inconsciente** del impacto socio-ambiental de su quehacer y preocupada principalmente en generar beneficio para sí

Empresa **ética** y **conciente** de su responsabilidad con las personas y la naturaleza en busca de un desarrollo articulado entre lo social, ambiental y económico

Clase 17/06/2005

Innovación y Transferencia Tecnológica

INNOVACIÓN Y CRECIMIENTO ECONÓMICO

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MSc. Economía Aplicada

"Dentro del campo de la economía, existe un creciente consenso de que, junto a la acumulación de capital, el progreso tecnológico y sus innovaciones subsecuentes constituyen las fuerzas centrales del proceso de crecimiento económico y aumento de bienestar en las naciones."

Griliches, Z. y Lichtenberg, F. (1996).

I. Innovación, Difusión y Transferencia Tecnológica : Conceptos y evidencia empírica de recientes evaluaciones

II. Justificación Económica y estrategias de Intervención Publica : Crecimiento y Desarrollo Económico

III. Elementos del diagnóstico cuantitativo para Chile

IV. Propuestas para fortalecer el sistema nacional de innovación

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Existen al menos 2 clasificaciones mundialmente aceptadas:

1. Aquella que utiliza como criterio clasificatorio el grado de novedad de la innovación

Innovación Incremental: Se trata de pequeños cambios dirigidos a incrementar la funcionalidad y las prestaciones de la firma, si bien aisladamente son poco significativas cuando se suceden continuamente de forma acumulativa pueden constituir una base permanente de progreso. Así se observa como el crecimiento y el éxito experimentado por las empresas de automóviles en los últimos tiempos responde, en gran parte, a programas a largo plazo caracterizados por una sistemática y continua mejora en el diseño de productos y procesos.

Innovación Radical: Implica una ruptura con lo establecido. Son innovaciones que crean nuevos productos o procesos que no pueden entenderse como una evolución natural de los ya existentes. Aunque no se distribuyen uniformemente en el tiempo como las innovaciones incrementales, sí surgen con cierta frecuencia. Se trata de situaciones en las que la utilización de un principio científico nuevo provoca la ruptura real con las tecnologías anteriores (Un ejemplo puede ser la máquina a vapor o el microprocesador).

I. Innovación, Difusión y Transferencia Tecnológica : Conceptos y Evidencia Empírica de recientes evaluaciones continuación...

2. **Aquella que atiende a su naturaleza (tecnológica/comercial/organizativa**

Innovación Tecnológica: Surge tras la utilización de la tecnología como medio para introducir un cambio en la empresa. Este tipo de innovación tradicionalmente se ha venido asociando a cambios en los aspectos más directamente relacionados con los medios de producción.

Innovación Comercial: Aparece como resultado del cambio de cualquiera de las diversas variables del marketing. El éxito comercial de un nuevo producto o servicio esencialmente depende de la superioridad del mismo sobre los restantes y del conocimiento del mercado y la eficacia del marketing desarrollado al efecto. Entre las innovaciones de dominio comercial destacan: nuevos medios de promoción de ventas, nuevas combinaciones estética-funcionalidad, nuevos sistemas de distribución y nuevas formas de comercialización es el sistema de franquicias o el comercio electrónico.

Innovación Organizativa: En este caso el cambio ocurre en la dirección y organización bajo la cual se desarrolla la actividad productiva y comercial de la empresa. Es un tipo de innovación que, entre otras cosas, posibilita un mayor acceso al conocimiento y un mejor aprovechamiento de los recursos materiales y financieros. Entre las innovaciones organizativas de posible aplicación en la empresa distinguimos 2: las que actúan a un nivel externo y las que lo hacen a un nivel interno. Las de nivel externo con mayor relieve son las que se refieren a la constitución de redes entre empresas y otros agentes del sistema económico para favorecer la cooperación entre ellos y con ello abordan la expansión internacional del negocio de la empresa. AS nivel interno, destacan aquellas que van dirigidas a mejorar el trabajo en grupo, bien a través de la gestión de interfaces o del funcionamiento interno del equipo.

I. Innovación, Difusión y Transferencia Tecnológica : Conceptos y Evidencia Empírica de recientes evaluaciones continuación...

No debemos pensar en estos tipos de innovaciones como si se tratase de sucesos independientes se tratase, sino mas bien de sucesos interrelacionados entre si, de tal forma que muchas veces las innovaciones tecnológicas implican o promueven innovaciones organizativas o comerciales o viceversa. Prueba de esta interrelación son los robots industriales, máquinas programables capaces de realizar tareas repetitivas de acuerdo con una secuencia establecida,que, a su vez, han permitido la optimización de las líneas de ensamblaje y la organización de la producción de acuerdo con los sistemas "just in time".

Difusión Tecnológica: Corresponde a la acción de dar a conocer a la sociedad mediante diversos mecanismos la utilidad de una innovación específica.

I. Innovación, Difusión y Transferencia Tecnológica : Conceptos y Evidencia Empírica de recientes evaluaciones continuación...

La transferencia de Tecnologia **o de conocimiento técnico aplicado la entendemos según un doble aspecto:La transferencia entre empresas (Transferencia Horizontal) y la transferencia entre agentes generadores de conocimiento (Universidades e Institutos Publicos y/o privados de Investigación) y las empresas (Transferencia Vertical).**

Para las empresas, la transferencia de tecnología **se refiere a las ventas o concesiones, hechas con ánimo lucrativo, de un conjunto de de conocimientos que permitan al arrendador o arrendatario fabricar en las mismas condiciones que el arrendador o vendedor.**

La T.T. se entiende como una etapa **del proceso global de comercialización y se presenta como la transferencia del capital intelectual y del know-how entre organizaciones con la finalidad de su utilización en la creación y el desarrollo de productos y servicios viables comercialmente.**

El concepto de TT se haya relacionado **con otros conceptos, como son la difusión tecnológica y la diseminación de conocimientos. Si entendemos por transferencia de tecnología aquel proceso voluntario y activo para diseminar o adquirir nuevas experiencias o conocimientos, la difusión tecnológica nos indica el proceso de <u>extensión</u> y divulgación de un conocimiento tecnológico relacionado con una innovación. La transferencia conlleva un convenio, un acuerdo, y presupone un pago: la difusión aparece como un proceso normalmente, abierto, libre de transacción económica, entre investigadores: se halla mas ligado a la transferencia de conocimientos, entendido como el proceso de comunicación de conocimientos científicos por medios abiertos, como artículos, conferencias y comunicaciones, utilizados por los grupos de investigación.**

I. Innovación, Difusión y Transferencia Tecnológica : Conceptos y Evidencia Empírica de recientes evaluaciones continuación...

Problemas en la evaluación de los beneficios de la transferencia tecnológica

Beneficios no económicos

La repercusión social de la TT no puede ser valorada en términos económicos: mejora de la calidad de vida, mejoras asistenciales promovidas por la incorporación de nuevos fármacos o procesos innovadores en clínica, protección del medio ambiente, etc. La transferencia ligada a la incorporación de personal formado en general o de doctores en la industria es una labor habitual en las instituciones universitarias que no se incorpora como indicador de productividad ni de calidad. Sin embargo, mas recientemente se ha comprobado cómo los entornos mas dinámicos en este tipo de intangibles, en el marco de ciudades o regiones innovadoras, se traduce en una mejora social a través de mayor empleo, mejores servicios e infraestructuras, mayor atracción de inversiones, etc.

Beneficios económicos

No es fácil encontrar un modelo que explique de forma cuantitativa la creación de valor surgida de la TT entre Universidades, Centros de I+DT y las empresas mediante nuevos productos o procesos. Uno de los métodos clásicos del cálculo de los beneficios económicos se basa en el modelo lineal de innovación, el cual ha sido ampliamente discutido, aceptándose que la realidad se explica mejor mediante un proceso más complejo con fuertes interacciones y feedbacks, mejorando así la explicación lineal. Hoy por hoy se utiliza un análisis que se basa en expresar los beneficios de la TT en términos de la relación costo - beneficio, o dicho de otra forma, como el grado de retorno en función de costo o inversión necesaria para el funcionamiento de dicha unidad generadora de tecnología.

I. Innovación, Difusión y Transferencia Tecnológica : Conceptos y Evidencia Empírica de recientes evaluaciones continuación...

a. Para comprender los procesos de transferencia hay que analizar las diferentes estructuras de intermediación existentes, así como las modificaciones o mejoras que conducen a su mayor efectividad. Según la evidencia internacional con denominaciones diferentes, pero con roles similares, identificamos las siguientes estructuras de intermediación tecnológica:

a1. Estructuras Consolidadas

- Oficinas de Transferencia de Resultados de la Investigación (OTRIS) (RedOTRI de cada Universidad)
- Centros de Innovación y Tecnología (CIT o CTT) (Inasmet, Robotiker, AIMME,etc)
- Laboratorios de Homologación, Ensayos, metrología y calibracion
- Parques Tecnológicos (Zamudio, Sa Sebastian, Sillicon Valley, etc.)

a2. Estructuras menos Consolidadas

- Servicios de Apoyo a la Investigación Tecnológico e Innovación
- Centros de Patentes (Centros de valorización comercial de la Propiedad Intelectual)
- Las Incubadoras de EBT (Empresas Innovadoras)
- Parques Científicos (Parc Cientific de Barcelona, Adelaide Science Park-Australia, Karolinska Science Park-Suecia, Otaniemi Science Park- Finlandia, Laval Technopole-Canadá)
- Programas de Preincubación o Cuasi empresas (IDEAS, EMBYRO, PRODEM)

I. Innovación, Difusión y Transferencia Tecnológica : Conceptos y Evidencia Empírica de recientes evaluaciones continuación...

Para realizar el proceso de TT desde las fuentes generadoras de tecnología a las empresas, las estrcuturas de intermediación no son suficientes, ya que requieren de unos instrumentos que dinamicen y faciliten esta trasferencia. Los utilizados intensivamente en EEUU, Canadá y UE son:

- Contratos, patentes y Licencias
- Movilidad de Recursos Humanos (Pasantías intra empresas de Tecnólogos)
- Servicios de Apoyo a la Investigación
- Incentivos Fiscales
- Creación de Empresas de Base Tecnológica (EBT)
- Marco Jurídico (LRU) que promueve en las Universidades la Cultura Emprendedora (Ley de IT de Stevenson-Wydler y Bayh-Dole (1980) en EEUU)
- Marco Jurídico y Tributario que promueve en las empresas la Cultura Innovadora

II. Justificación Económica y estrategias de Intervención Publica : Crecimiento y Desarrollo Económico

CRECIMIENTO: LA EXPANSIÓN CUANTITATIVA DE LA ECONOMÍA (aumento del PIB), VALORANDO LOS BIENES A PRECIOS DE UN AÑO BASE.

DESARROLLO: LA CONSTRUCCION DE CIERTOS ASPECTOS CUALITATIVOS CRUCIALES, QUE HARIAN POSIBLE ALCANZAR LOS NIVELES DE VIDA MAS ALTOS EN UNA ÉPOCA HISTÓRICA.

UN MINIMO ACEPTABLE DE OPORTUNIDADES.

UN PROCESO DE CRECIMIENTO SUSTENTABLE.

EL CRECIMIENTO ES UNA CONDICIÓN NECESARIA .PERO NO SUFICIENTE.

FINANCIAMIENTO PARA ACUMULACION DE CAPITAL *per capita*

$$y^* = A^* + \beta k^* + \delta h^* \qquad (\beta + \delta) < 1$$

FOMENTO DE LA INNOVACION Y EL EMPRENDIMIENTO PARA AUMENTAR LA PRODUCTIVIDAD TOTAL DE LOS FACTORES

FOMENTO DE LA GESTIÓN DE CALIDAD Y LA ASOCIATIVIDAD PARA OPTIMIZAR LA PRODUCCIÓN DADOS LOS RECURSOS DISPONIBLES

La acumulación de capital en términos de instalaciones, equipos, disponibilidad de recursos naturales y otras formas de capital no humano, sin innovación tecnológica y sin acumulación de capital humano, presenta rendimientos decrecientes

La especialización concentrada en unos pocos rubros puede saturar ciertos mercados internacionales, generando fases prolongadas de deterioro en los precios de distintos productos de exportación que, si están relativamente sincronizadas, pueden producir considerable inestabilidad.

CRECIMIENTO Y DESARROLLO

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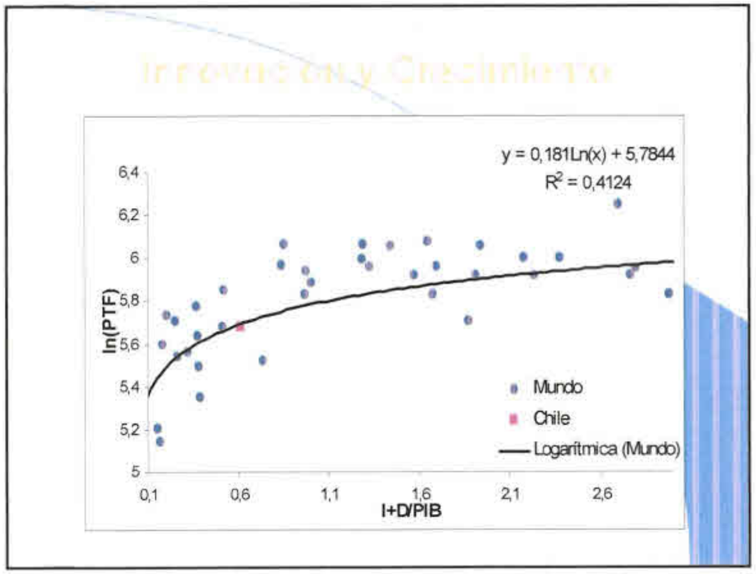
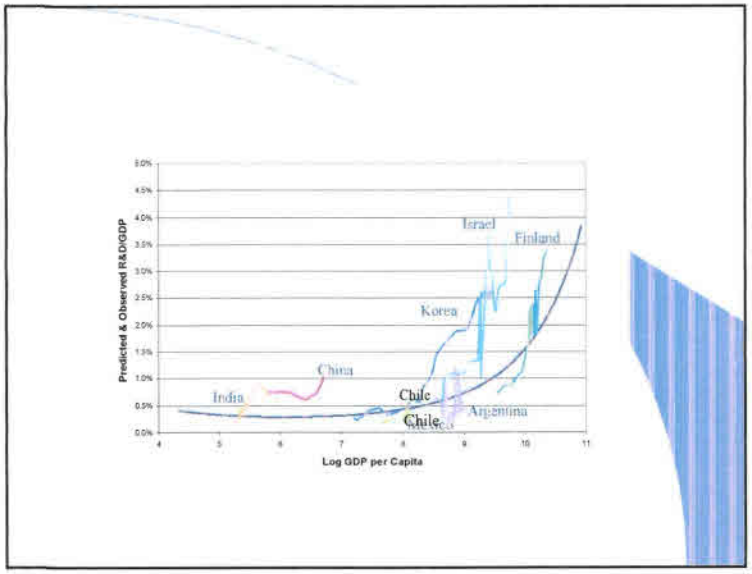
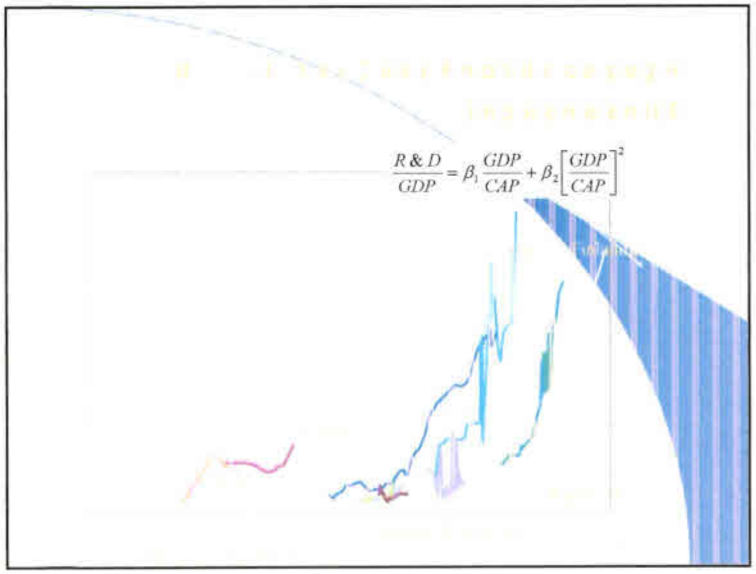
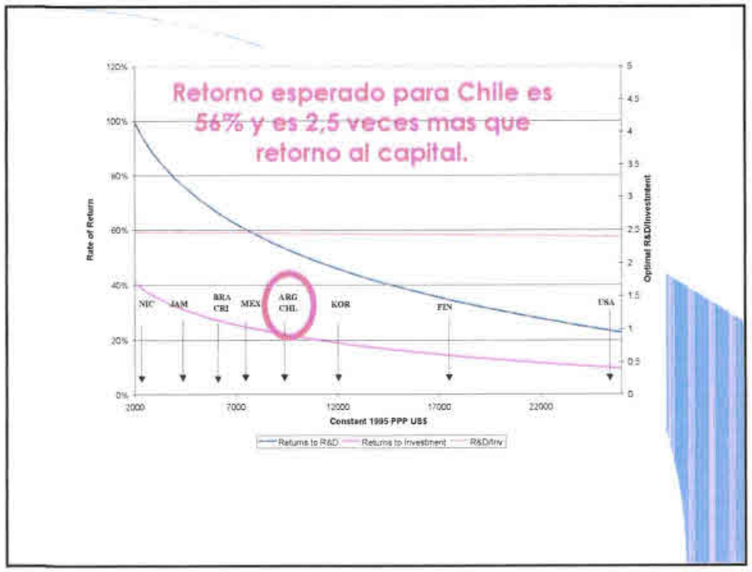
la acumulación de capital humano,
que no se computa como inversión,

- **Hay fallas del mercado relacionadas con innovación:**
  - **Cuasi-bien público: no se puede excluir a otros de su conocimiento**
    - **Invención: desbordamiento ("spillover") 30% del costo.**
    - **Difusión del conocimiento del exterior**
  - **Indivisibilidades en tecnología**
  - **Riesgos poco diversificables**
  - **Problemas de coordinación: retro-alimentación de innovación- proceso no-lineal**
    - **El libre mercado produce insuficiente innovación**


y = 0,181Ln(x) + 5,7844
R² = 0,4124
ln(PTF)
I+D/PIB
Mundo
Chile
Logarítmica (Mundo)


Israel
Finland
Korea
China
India
Chile
Argentina
Predicted & Observed R&D/GDP
Log GDP per Capita


$$\frac{R\&D}{GDP} = \beta_1 \frac{GDP}{CAP} + \beta_2 \left[\frac{GDP}{CAP}\right]^2$$


Retorno esperado para Chile es
56% y es 2,5 veces mas que
retorno al capital.
Rate of Return
Optimal R&D/Investment
NIC
JAM
BRA CRI
MEX
ARG CHL
KOR
FIN
USA
Constant 1995 PPP US$

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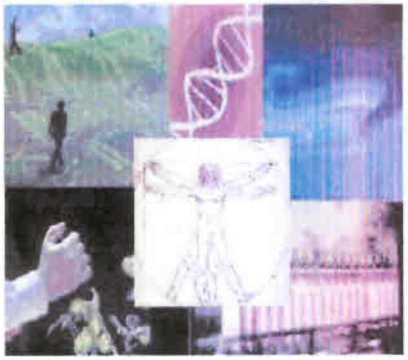
Innovación y Transferencia
Tecnológica (modelos)

Magíster en Gestión Tecnológica mención Biotecnología



Fundamentos de la Gestión Tecnológica

Innovación

"Los productos pueden tener éxito internacionalmente por su precio, por su calidad, por su diseño, sencillamente, porque se dispone de una red comercial más amplia o se ha hecho más publicidad. Pero ¿cómo ha sido posibles que estos productos sean competitivos?, ¿cómo se han generado?. La respuesta es: a través de las innovaciones" (Escorsa, Valls, 1997:15).

1.- EL CONCEPTO DE INNOVACIÓN

El término innovación ha sido **ampliamente estudiado**, desde **distintos puntos de vista**, como **un todo (Shumpeter,** 1939), **como proceso de información (Tushman, 1977), según** la **competitividad (Porter,** 1990), **como un proceso de aprendizaje (Muñoz-Seca, 1992), etc.**

Hord (1987) define a la innovación como *"cualquier aspecto nuevo para un individuo dentro de un sistema".*

1.- EL CONCEPTO DE INNOVACIÓN

"La innovación es la introducción a un mercado (económico o social) de productos, procesos o servicios nuevos o mejorados"

Informe "Ciencia Tecnología e Innovación. Programas y Políticas en Chile", realizado por la Comisión Nacional de Investigación Científica y Tecnológica (CONICYT) y el Centro Internacional de Investigaciones para el desarrollo (CIID) de Canadá

1.- EL CONCEPTO DE INNOVACIÓN

- ✓ Un proceso creativo de amplio alcance.
- ✓ La clave para obtener ventajas competitivas.
- ✓ Romper con patrones establecidos.
- ✓ Poner en práctica una idea dentro de una cultura.
- ✓ Un buen negocio y por último introducir productos.
- ✓ Procesos o servicios nuevos o mejorados a un mercado.

1.- EL CONCEPTO DE INNOVACIÓN

Rothwell (1992) percibe a la innovación como un proceso de acumulación de Know How y de aprendizaje, donde las principales ventajas se obtienen a partir de la gestión dinámica de la información, y donde la conexión entre áreas internas y con su entorno externo (proveedores, distribuidores, clientes) busca realizarse en tiempo real y paralelo.

- Novedad
- Aplicación

2.- LOS TRES ESTADOS FUNDAMENTALES DE LA INNOVACIÓN.

DESCUBRIMIENTO

V/S

INNOVACIÓN

La Invención → La innovación → La difusión

2.- LOS TRES ESTADOS FUNDAMENTALES DE LA INNOVACIÓN.

La Invención, como creación de una idea potencialmente generadora de beneficios comerciales, pero no necesariamente realizada de forma concreta en productos, procesos o servicios.

2.- LOS TRES ESTADOS FUNDAMENTALES DE LA INNOVACIÓN.

La innovación, consistente en la aplicación comercial de una idea. Innovar es convertir ideas en productos, procesos o servicios nuevos o mejorados que el mercado valora. Lo que incluye no sólo los servicios o productos, sino que también la forma en que los produce, comercializa u organiza.

2.- LOS TRES ESTADOS FUNDAMENTALES DE LA INNOVACIÓN.

La difusión, que supone dar a conocer a la sociedad la utilidad de una innovación. Éste es el momento en que un país recibe los beneficios de la innovación, pues el cambio posee un objetivo primordial de convertir las mejoras individuales en globales para la sociedad.

3.- TIPOS DE INNOVACIÓN

3.1. Según Grado de Novedad de la Innovación

¡RADICAL!

¡INCREMENTAL!

¡ADAPTATIVA!

3.- TIPOS DE INNOVACIÓN

3.2. Según Naturaleza de la Innovación

Innovación Tecnológica

Innovación en métodos de gestión

Innovaciones sociales

Innovación Tecnológica

De producto

- ✓ Creación de un producto nuevo.
- ✓ Innovación gradual de un producto existente.
- ✓ Reformulación radical de un producto ya comercializado.
- ✓ Nuevas utilizaciones de un producto.

De proceso

- ✓ Creación de un nuevo proceso.
- ✓ Introducción de una nueva materia prima en el proceso de fabricación.
- ✓ Nuevo sistema organizativo aplicado a la producción.
- ✓ Otros tipos (ahorro de energía, mejoras en la logística, mejora en los sistemas, etc.)

Innovación en métodos de gestión

- Introducción de nuevas tecnologías en el diseño.
- Introducción de nuevos procedimientos en la organización, información y control.
- Innovaciones comerciales:
  - ✓ Nuevos mercados geográficos.
  - ✓ Nuevos segmentos de mercado.
  - ✓ Cambios introducidos en la presentación y el acondicionamiento de los productos.

Innovación sociales

- Creación de nuevas funciones (cambios organizacionales).
- Mejora de las condiciones de trabajo.
- Formación de equipos creativos.
- Descentralización de las tareas.

4.- FORMAS DE ACTIVAR EL PROCESO INNOVADOR

"Tirón de la demanda" (Pull)

"Empujón de la ciencia" (Push I+D)

La empresa, su comportamiento

Una empresa domina la variable tecnología cuando:

- ✓ Internaliza en todos sus niveles el proceso de innovación.
- ✓ Administra profesionalmente la función de I&D.
- ✓ Promueve el espíritu creador e innovador.
- ✓ La tecnología es una práctica organizacional *¿Es así?*

Las empresas invierten en tecnología para:

- ✓ Buscar nuevas oportunidades.
- ✓ Desarrollar una capacidad tecnológica nueva.
- ✓ Mejorar la calidad.
- ✓ Modernizarse.

¿Para qué todo esto?

5.- ¿Qué relación existe en el proceso?

INVESTIGACION

TECNOLOGIA

COMPETITIVIDAD

DESARROLLO

EFICIENCIA

CRECIMIENTO

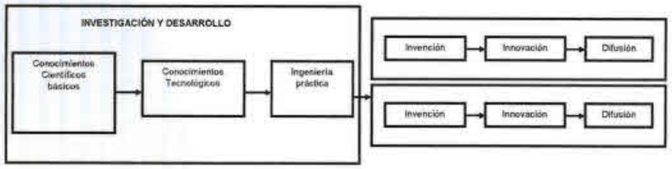
INNOVACION

TRANSFERENCIA TECNOLOGICA

¿Cuáles son las relaciones?, ¿Cómo se da proceso?

5.- Relación: modelos de innovación

MODELO LINEAL



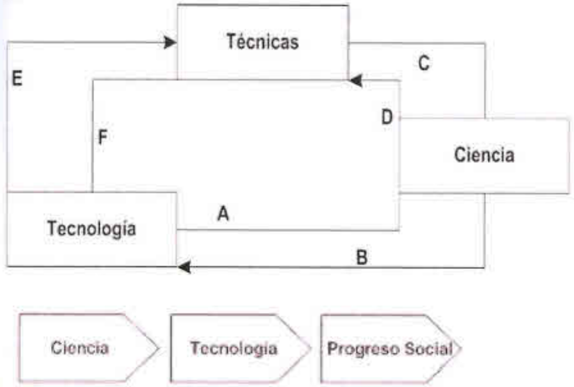
¿Cuáles son los supuestos?

5.- Relación: modelos de innovación

MODELO DE ENLACES EN CADENA

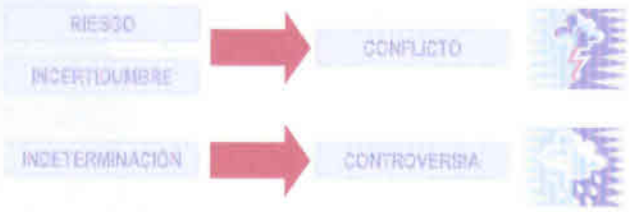
¿Cuáles son los supuestos?

PROPUESTA DEL PARADIGMA CLASICO



QUIEBRE DEL PARADIGMA CLASICO

CONFLICTOS Y CONTROVERSIAS SOBRE TECNOLOGÍA



QUIEBRE DEL PARADIGMA CLASICO

CONFLICTOS Y CONTROVERSIAS SOBRE TECNOLOGÍA

En las últimas tres décadas, respecto del paradigma dominante de tecnología, han surgido una serie de conflictos y consecuencias del desarrollo y aplicación de tecnologías:

1. La Legitimación Social
2. Contestación Social
3. Los Riesgos de la Nueva Calidad
4. Perdida de Legitimación del "Progreso Automático"
5. Sin Evaluación y Planificación Social la Tecnología es Ineficaz
6. Pérdida de Capacidad de la Gestión Pública
7. Aceptación de la Posibilidad de Control de la Tecnología

Evaluación del Sistema de Fondos Tecnológicos de Chile

(.... y de las políticas explícitas e implícitas que los sustentan)

Cristian M. González Urrutia
Julio, 5 y 6 de 2005

Nota Introductoria

- Este estudio fue comisionado por el Programa de Innovación Tecnológica del Ministerio de Economía.
- Incluyó la revisión de numerosos reportes previos, la realización de encuestas a usuarios, entrevistas a ejecutivos de los Fondos Tecnológicos (FIA, FONDEF, FONTEC y FDI), así como a empresarios, autoridades gubernamentales, universidades e institutos, sobre temas de política tecnológica y sobre los Fondos mismos.
- Este documento no pretende ser un recuento detallado y metodológico de los resultados, sino mas bien una síntesis comunicacional de aspectos relevantes desde el punto de vista de formulación de políticas.

SUBTITULO LARGO: ¿Cómo lo vamos a hacer en este país, para, por ejemplo...

- ..Pasar de US$ 1000 a 4000 millones de dólares de exportación en productos derivados de la acuacultura??
- ..Convertirnos en el principal exportador de software educativo en español en el mundo??
- ..Crear una verdadera industria educativa, proveedora de insumos, bienes y servicios para la educación de clase mundial??
- ..Crear una supercarretera informática que transforme el quehacer público y las exportaciones del país??
- .. Pasar a ser un país atractivo para que grandes multinacionales en el campo de la alta tecnología escojan a este país como sede para sus inversiones??
- .. Convertirnos en un exportador neto de tecnologías ambientales, de combate a la desertificación, y de manejo integrado de cuencas fluviales??
- Ayudar a internacionalizar a nuestras medianas empresas de alto contenido tecnológico??
- Convertirnos en un exportador neto de servicios de ingeniería y consultoría??
- .. Generar a través de estos esfuerzos empleos suficientes, de alta productividad y remuneración??

CIERTAMENTE... una primera respuesta es que...

.... así como vamos.... probablemente ..

.... no lo vamos a lograr !!!!

CONTENIDO

- CONCEPTOS BASICOS
  - El concepto de innovación.
  - Políticas Macro vs. Instrumentos
  - El entorno socioeconómico de los Fondos
  - El "triángulo de la demanda"
  - El "efecto Mateo"
- EL ROL DE LAS EMPRESAS
- EL ROL DE LOS INSTITUTOS
- INSTITUCIONALIDAD
- MONTO DE RECURSOS
- DESTINO DE LOS RECURSOS
- MODALIDADES DE FINANCIAMIENTO
- PROYECTOS Y PROGRAMAS
- INCENTIVOS TRIBUTARIOS Y CAPITAL DE RIESGO
- RECURSOS HUMANOS
- OPERACION DE LOS FONDOS
- ASPECTOS DE COORDINACION
- CONCLUSIONES Y RECOMENDACIONES

CONCEPTOS BASICOS

Antes de iniciar la descripción del sistema, es conveniente fijar cinco conceptos fundamentales:

I: Entenderemos por INNOVACION TECNOLOGICA cualquier modificación en productos, procesos, maquinaria, organización o servicios, que es introducida exitosamente en la producción y el mercado.

Las innovaciones pueden ser radicales o menores, pueden ser desarrolladas internamente o adquiridas. La multiplicidad de tamaños y formas de los cambios tecnológicos debe ser entendida y aceptada en el momento de formular políticas y diseñar instrumentos para su promoción.

CONCEPTOS BASICOS

II: Desde hace 30 años sabemos que, para el adecuado fomento de la innovación en las empresas, el contexto de políticas macro es tanto o más importante que los instrumentos específicos de política tecnológica o industrial. No debemos nunca olvidar eso.

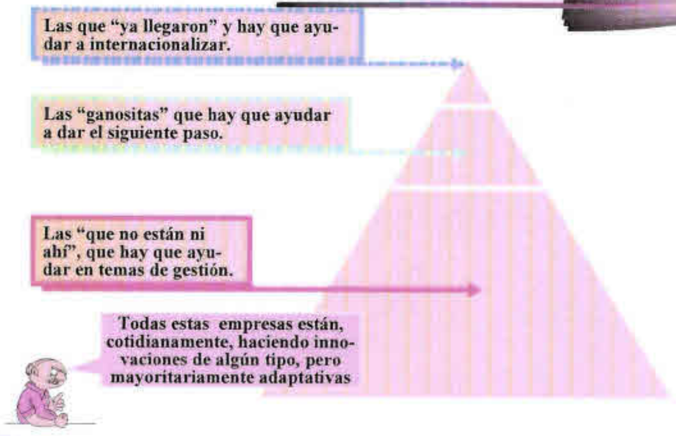
III: La historia económica de Chile hasta la fecha ha estado marcada por la producción (y procesamiento primario) de materias primas, con una base industrial manufacturera relativamente precaria. Dado que las fuentes de tecnología del sector primario son muy "peculiares", la extensión de esos conceptos al resto de la economía genera importantes distorsiones en el discurso empresarial y en las discusiones en el medio político.

CONCEPTOS BASICOS

IV: Cualquier política de fomento tecnológico debe realizar una distinción clara entre tres tipos de empresas: a) las que "ya llegaron ahí" (que en Chile deben ser muy pocas), b) las "ganositas" que andan tratando de introducirse a ese mundo (en Chile deben ser unas 2000 a 5000), c) y las que "no estan ni ahí", cuyos problemas son muy serios, pero de otra naturaleza (que en Chile son... todas las demás). Nota: las a), b) y c) no son, necesariamente, grandes , medianas y pequeñas!!

V: Hace muchos años que se describió el "efecto Mateo", que dice que, si las dinámicas de fomento son estrictamente concursables, los sectores fuertes se hacen mas fuertes, y los más débiles ... siguen igual de débiles. Volveremos sobre este tema más adelante.

Así es el "triángulo de la demanda por instrumentos tecnológicos"



EL ROL DE LAS EMPRESAS

Resulta evidente que el sector productivo tiene una baja participación formal en el sistema de Fondos: en su fijación de políticas, en los sistemas de evaluación, en el financiamiento, en la ejecución, en su grado de conocimiento de los Fondos.

Lo anterior NO significa necesariamente que los empresarios chilenos no innovan. Lo hacen por otros canales, importando maquinaria, contratando asesores, viajando, etc.

Tambien pesa la base conceptual anteriormente referida. Las grandes fortunas del país NO se han hecho con innovación tecnológica endógena, y son escasas las empresas que incorporan la variable tecnológica en sus discusiones a nivel de Directorio.

En rescate del sector empresario, también debe decirse que éste tampoco ha sido un gran tema en la agenda de los sectores políticos, hacendarios ni gubernamentales.

Pero... también es claro que, en lo general, los empresarios que SI han sido usuarios del sistema de Fondos (mayormente pequeños y medianos) están contentos con el apoyo recibido, y en general la cartera de proyectos apoyados ha sido de buena calidad y resultados.

En Chile existe una política e institucionalidad clara para programas de desarrollo tecnológico e innovador, que se expresa con nitidez a través de los Fondos	3.5
Se debería diseñar en Chile un sistema de incentivos tributarios que sustituya parcialmente o complemente a los Fondos	4.3
En Chile todavía se necesita una mayor intervención del estado en sistemas de capital de riesgo orientados a la innovación	4.2
En Chile se debe avanzar comparativamente más en el financiamiento de programas estratégicos de gran envergadura, que en financiar proyectos aislados	2.7

Sobre estos temas retomaremos la discusión más adelante

EL ROL DE LAS EMPRESAS

Da la impresión de que aquí hay problemas de comunicación y semántica: para las grandes empresas, que forman lo esencial de la cúpula empresarial, el tema "tecnológico" cae un poco en la "canasta de la ciencia, el arte y la cultura", y cuando hacen cambios tecnológicos... no lo llaman innovación.

Es evidente que la relación del sector público con el mundo empresarial en esta materia requiere una reingeniería mayor.

Esta reingeniería debe distinguir claramente instancias de diálogo con las que "ya están ahí", diferentes a las instancias de diálogo con las "ganositas". Las que "no están ni ahí" deben ser tratadas con otro tipo de instrumentos de fomento.

El discurso debe cambiar de "Ud. que NO hace nada, aquí hay la oportunidad para hacer algo", a .. "ya que Ud. SI hace, venimos a ayudarle a que lo haga más y mejor".

EL ROL DE LOS INSTITUTOS

A pesar de no ser materia de este estudio, el tema brotó y rebrotó espontáneamente. He aquí algunos comentarios recibidos:

- "Se están desmantelando y transformando en consultoras".
- "Hay que diseñar mecanismos de contratos de desempeño de largo plazo para estabilizar su financiamiento. Se requiere explicitar mejor la función pública de los institutos, y darles una garantía de funcionamiento de esa función pública".
- "Los Institutos deben morir o fortalecerse, ya que no pueden seguir desprestigiando una actividad importante. Hay que tomarlos en serio".
- "Los institutos estatales, descentralizados y sectorizados, deben jugar un rol importante dentro de sus ministerios".
- "Se requiere una política coherente de financiamiento, gobierno y gestión de institutos. Hay que darles más autonomía".
- "Se requiere autorizarlos e inducirlos a formar empresas".

INSTITUCIONALIDAD

- Abundaron los "epítetos": descoordinación, fragmentación, duplicación, "mejor mantener la política oculta para que no te la torpedeen", Fondos que se "estiran" para incursionar en otros temas, mala determinación de prioridades, políticas contradictorias, falta de una institucionalidad de alto nivel donde se discuta en serio, proliferación de Fondos, "al final Hacienda lo decide todo", el "mal ejemplo Milenio", "hay instituciones claras pero no hay una política", etc. etc.
- ..pero, como dijo Galileo, "... y sin embargo... se mueve". Uno creería, después de escuchar estas afirmaciones... que el Sistema es un caos, y... claramente no lo es.
- Conviene entonces preguntarse en qué materias, concretamente, se expresan estas fallas institucionales, y resolver esas fallas, antes de entrar a diseños que a lo mejor aumenten la entropía.

INSTITUCIONALIDAD

- La primera, se verá más adelante, se refiere al destino de los recursos: hay severas distorsiones en cuanto a esta materia, *y no existe una instancia sólida para discutir este tema con Hacienda.*
- La segunda tiene que ver con traslapos de modalidades de financiamiento entre distintos Fondos. La "competencia" entre Fondos, en sí, no es mala, siempre y cuando esté clarificada y decantada. Los traslapos y confusiones entre FONDEF y FDI son los más relevantes.
- Falta mayor vinculación entre la política tecnológica y la política de fomento productivo, y una mejoría a la institucionalidad del mundo académico y del mundo productivo.
- ¿Cómo manejar la innovación en Obras Públicas, Agricultura, Transporte y Telecomunicaciones, etc.? ¿Desde Economía? En suma .... el viejo problema ¿cómo manejar un tema multisectorial en un gobierno fuertemente "ministerializado"?

MONTO DE RECURSOS

- Del 90 al 94 el gasto público subió de 0.47 a 0.61% del PIB. De ahí en adelante hay una suave baja... al 0.55% donde parece haberse estabilizado.
- Nadie opina que esta cifra, por la ruta de los Fondos, deba subir fuertemente. Debe subir, pero.... lentamente... tal vez hasta el 0.7 a 0.8%... siempre que la velocidad de crecimiento del gasto privado sea mayor.
- El problema no es ese.... sino... ¿qué va a pasar con el desmantelamiento de los reintegros a la exportación?
- En la práctica, al ser las empresas exportadoras las de mayor competitividad, es evidente que, formal o informalmente, estaban dedicando parte de esos significativos recursos a innovación. Si ahora este gasto público se va únicamente a sectores sociales, el país habra experimentado un FUERTE RETROCESO en su apoyo a la innovación empresarial.... en una época en que todos los países están AUMENTANDO sus subsidios directos a este tema.

DESTINO DE LOS RECURSOS

- Lamentablemente, la mayor parte de los recursos liberados por los incentivos de exportación... se estarían yendo según los acuerdos recientes... una vez más... al gasto social, al apoyo a Pymes (básicamente, las que "no están ahí"), y al sector primario: agricultura y riego.
- Sin duda, estos sectores, de Pymes, el social y el agrícola, son muy importantes. Pero uno debe preguntarse hasta qué punto los incentivos de fomento productivo del país se continuarán dirigiendo, en cada vez mayor profundidad, al sector primario de la economía y a los sectores más atrasados. En otras palabras ¿es así como el país podrá generar un número suficiente de empleos de alta productividad y remuneración?.
- No cabe duda que, hasta ahora, han habido empresas exportadoras de la punta tecnológica, que habían estado aprovechando los incentivos de exportación como fuente de financiamiento - sin ataduras ni restricciones- para sus desarrollos tecnológicos. Es al desaparecer esta fuente de financiamiento, probablemente más importante y más expedita que los recursos de los Fondos, y asignarla al sector primario, que estaremos experimentando el retroceso arriba referido.

DESTINO DE LOS RECURSOS

- Aquí es donde está uno de los problemas!!!!
- Del total de US$ 350 millones gastados en 1998, sólo el 29,6% se fué a los Fondos, y el resto a apoyos institucionales. Si, GENEROSAMENTE, concedemos que un 50% de ese 29,6% termina realmente en el mundo empresarial, concluimos que el 85% de los recursos públicos de fomento a la I&D nacional están gastados por el sector público, para el sector de universidades, empresas públicas e institutos, y que estamos haciendo MUY poco para incentivar adecuadamente la innovación empresarial privada.

Datos interesantes:
1. El apoyo a innovación empresarial es aproximadamente de US$ 45 millones, cuando las importaciones anuales de bienes de capital superan los US$ 5000 millones.
2. Si bien no se sabe con exactitud, sólo el 20-30% de la capacidad formalizada de innovación "mayor" esta al interior del sector productivo. Esto contrasta con cifras del 60-80% en países industrializados.

DESTINO DE LOS RECURSOS
(problema 2)

- El efecto Mateo. Hay sectores estructuralmente incapacitados para generar buenos proyectos... por lo que los recursos se van más a la capacidad de oferta que a las necesidades, y esto se agrava si el 85% de los recursos se van a... financiar la oferta.
- Aquí resultó difícil recabar cifras (ya que carecemos de una base de datos comun entre Fondos, con descriptores equivalentes)
- Pero la opinión generalizada es que el destino de los recursos es inadecuado, y que el grueso de los fondos se va a recursos naturales en la parte tecnológica y a ciencias biomédicas en la parte científica. Se mencionan sectores claramente "damnificados", como industria educativa, manufactura, telecomunicaciones, servicios, recursos genéticos, o ambiente.

La "lógica de los concursos" no es suficiente para resolver todos los problemas de un país, ni en las áreas atrasadas, ni en los temas emergentes o estratégicos!!!

MODALIDADES DE FINANCIAMIENTO

- En una escala de 1 a 5, el nivel promedio de probabilidad de éxito tecnológico de los proyectos es más que alto (4.2). Son generalmente adaptaciones tecnológicas al entorno nacional.
- Esto no es en si mismo ... ni bueno ni malo. Es, mas bien, insuficiente como mecanismo, pues se financian proyectos cuyo "mérito innovador" es relativamente bajo.
- Es evidente que el sistema de evaluación ha sesgado los proyectos en la dirección de las "sandías caladas".
- Pero a la vez, es evidente que en el país continua habiendo un enorme espacio para proyectos de bajo riesgo, corto plazo y alta rentabilidad (los más apetitosos!!) y que esta modalidad debe continuar.
- El problema no es ese, sino que no tenemos un espacio ni mecanismos para hacer apuestas de mayor riesgo, mayor plazo.. y por supuesto, aun mayor rentabilidad.

MODALIDADES DE FINANCIAMIENTO
¿Qué estamos financiando?

Al estar el sistema evidentemente sesgado en favor de la oferta de universidades e institutos (incluso de la oferta de las empresas), es evidente que los aspectos más descuidados tienen que ver con hacer que la oferta se "materialice" en el mercado:

- Sesgos "cientificistas" en la evaluación de proyectos, que descuidan temas de mercado, estrategia de negocios, canales de comercialización, etc.
- Persistencia de un "black hole" en el financiamiento a los aspectos comerciales y de gestión en la fase de la innovación exploratoria.
- Persistencia de un "black hole" financiero en materia de escalamiento productivo (a pesar de la incipiente caución solidaria de CORFO), y/o de capital o garantías de riesgo, tanto para empresas existentes como para creación de empresas de base tecnológica.
- Escasa difusión de los resultados en proyectos asociativos o de interés común.

Ojo: los Comités evaluadores no son "accountable" por el éxito final de los proyectos en lo productivo !!

MODALIDADES DE FINANCIAMIENTO
¿Qué estamos financiando?

El consenso mayoritario es que es necesario reforzar prioritariamente las modalidades de proyectos relacionadas con transferencia, estudios y pruebas de mercado, formación de recursos humanos en empresas e instituciones, y contratación de expertos extranjeros.

En particular, se considera necesario darle un gran énfasis a la transferencia masiva y replicable, así como a facilitar la etapa del escalamiento productivo y comercial en proyectos individuales.

También es interesante la idea de dar niveles diferenciales de subsidio según el mérito innovador y el nivel de externalidades de los proyectos. Podrá ser "discrecional", pero estamos maduros para ello, y existen metodologías suficientes para el manejo del tema.

No puede haber una inversión más rentable que lograr que los resultados de los estudios se difundan!!

MODALIDADES DE FINANCIAMIENTO
¿Qué estamos financiando?

Destacamos la necesidad de que los Fondos estén "más abiertos" a la posibilidad de financiar la adaptación de tecnologías traídas del exterior, cuando éstas tengan un mérito innovador relevante. Si bien no se veta el tema, y se apoya a través de giras y traída de expertos, no se percibe una señal clara en cuanto a que un proyecto consistente en importar una tecnología y adaptarla al país sea algo "bienvenido". La mayor parte de la tecnología que necesitan las empresas chilenas está, con toda probabilidad, disponible afuera del país.

Asimismo, los Fondos debieran estar más abiertos a financiar, como parte de sus proyectos, componentes más significativas de formación de recursos humanos. Nuevamente, este tema no está "vetado", pero está poco difundido y consagrado. También se podría crear un "SENCE de alto nivel tecnológico".

Por otro lado, si es que los incentivos tributarios son "políticamente difíciles", tambien cabe destacar que existe un espacio para que los Fondos proporcionen un incentivo "semi-automático", que sea una especie de "híbrido" entre un Fondo y un incentivo tributario. Este consistiría en la aprobación "automática" y financiamiento de contratos de ciertos tipos, entre empresas, y laboratorios o empresas certificadas para "vender" cierto tipo de proyectos.

PROYECTOS Y PROGRAMAS

Uno de los temas más reiterados en las entrevistas es que el sistema chileno está permitiendo "financiar árboles, mas no bosques".

La opinión mayoritaria es que, siendo adecuado el sistema de Fondos y concursos, hay que adicionar un sistema que cubra áreas estratégicas, con visión de largo plazo, formación de recursos humanos, etc. Hay que hacer algunas "apuestas" que introduzcan cambios significativos en el país.

Se mencionan varios temas susceptibles de ser tratados por esta vía: tecnologías de información, industria educativa, desertificación, acuacultura, etc. Asimismo, se sugiere que el mayor incremento de recursos sea por la ruta de licitaciones temáticas.

Como se vio anteriormente, este no es un tema que entusiasme mayormente a los empresarios usuarios de los Fondos ... pero tambien es natural que asi sea.

Cabe destacar que los financiamientos BID de C&T en otros paises ya están comenzando a incorporar esta modalidad.

En Nueva Zelandia, el Estado no es "aséptico", y prioriza Programas. En los países de la OECD, 2/3 de los recursos de C&T se gastan en focalizaciones programáticas !!!

Una pequeña nota bibliográfica...

Si bien no cabe en este reporte una bibliografía detallada, bien vale citar sólo una: "A Silicon Valley of the East: Creating Taiwan's Semiconductor Industry", J. A. Mathews, California Management Review, 39, No. 4, 1997, pp. 26-54.

Esta es un fascinante reporte de la historia de un éxito: el planificado desarrollo de la industria de los semiconductores y la informática en la zona de Hsinchu.

La fase preparatoria (del 65 al 73) fué liderada por el gobierno y la asociación de industriales electrónicos.

La fase de siembra (del 74 al 79) implicó la creación de un instituto (ITRI), un Fondo específico para el desarrollo del sector, y acuerdos internacionales de transferencia tecnológica.

La fase de difusión (del 80 al 88) implicó la creación de un parque tecnológico-industrial y una corporación gubernamental.

La fase de sostenibilidad (del 89 al 95) implicó grandes proyectos de I/D, establecimiento de industrias de apoyo, y mayor refinamiento de los apoyos gubernamentales.

Hoy, las 180 empresas de Hsinchu venden arriba de 11 billones de dólares.

INCENTIVOS TRIBUTARIOS

La opinión francamente mayoritaria, incluyendo en particular a los empresarios, es que SI sería conveniente incursionar en esta materia.

Sus ventajas:

- Facilita y automatiza la masificación del incentivo.
- Da una señal política importante al empresariado.
- Facilita la contabilización del gasto.
- La solidez tributaria chilena lo permite mejor que en otros países.

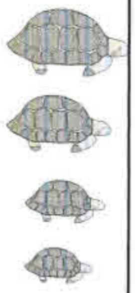
Las desventajas:

- La posible evasión y dificultad de control.
- La fuerte resistencia de los "teólogos hacendarios".

•Se ha sugerido la modalidad de "gasto incremental".
•Podría pensarse en una prueba piloto.
•Es más fácil hacerlo en las modalidades de subcontrato.
•Esto generaría una redefinición de los Fondos.

CAPITAL DE RIESGO

- Los usuarios empresariales lo quieren.
- Los "policy makers" lo quieren.
- Se necesitan instrumentos diferentes para empresas establecidas, que para "start ups" tecnológicos, que requieren mas bien de "capital semilla".
- En Chile hoy día no hay un verdadero "*venture capital*", y cuando lo hemos intentado, ha sido "mucho *capital* y poco *venture*".
- .... Pero estamos enredados y no sabemos cómo!!!
- Estamos de acuerdo en que la intervención del Estado debe ser de segundo piso....
- O bien, via Fondo de Garantía (a ver si ahora sí, el FOGAPE funciona!!)



RECURSOS HUMANOS

Hay amplia coincidencia en cuanto a que la carencia de personal de alta calificación, y la formación de recursos humanos de alto nivel, está insuficientemente abordada en el sistema chileno, y que no ha habido políticas, ni estrategias ni recursos para superar este problema estructural.

Tambien es claro que ésta no es necesariamente una responsabilidad del sistema de Fondos, los cuales lo pueden hacer sólo en el contexto de sus proyectos. (en promedio se entrenan o capacitan 9 personas por cada caso).

Aquí tambien hay evidencia de descoordinación institucional: CONICIT, AGCI, MIDEPLAN, MECESUP, etc.

Estaría faltando a) un SENCE de alto nivel, y/o b) recursos más significativos para que empresas e instituciones puedan enviar a formar personal fuera del país. Se requieren tanto entrenamientos cortos como becas de postgrado.

CORFO dió 520 mil UF en créditos para post-grado en 1998. La complementación de estas becas con subsidios en tópicos prioritarios puede ser la base de la solución.

OPERACION DE LOS FONDOS

- Hay amplia coincidencia en que el sistema de fondos ha operado en lo general bien, y que ha generado cambios saludables en el manejo de recursos.
- Las empresas usuarias se ubican mayoritariamente en el rango de ventas de 1 a 3 millones de dólares, y los grados de éxito de los proyectos son elevados (lo cual confirma las múltiples evaluaciones ya realizadas en esta materia).
- Los mayores impactos "colaterales" de los proyectos en las empresas han sido en: el prestigio institucional, el clima interno, la generación de nuevos proyectos o líneas, la difusión de conocimientos a otros entes, y el aprendizaje de los participantes en gestión de la tecnología.
- En el caso de instituciones, estos impactos han sido en: prestigio, clima interno, generación de nuevas posibilidades y proyectos, aprendizaje en gestión, y en vinculación con empresas y entes extranjeros.

OPERACION DE LOS FONDOS

- Es notable el grado de satisfacción con la operación de los Fondos que muestran sus usuarios (Empresas e instituciones).
- Lo mejor: según las empresas, la calidad de la relación con el ejecutivo de proyectos (4.5 en la escala de 1 a 5), y según las instituciones, la pertinencia del Fondo y sus líneas de financiamiento (4.4).
- Lo peor: según las empresas, la eficiencia y celeridad en el proceso de tramitación (un buen 3.9), y en instituciones, el mismo proceso de tramitación (3.4)
- Vale mencionar la percepción de que FONDEF y FDI son demasiado generosos con los montos de los financiamientos, y la necesidad de financiar proyectos exploratorios antes de pasar a etapas más grandes.
- Como dijimos, hay bastante crítica en cuanto a que el sistema es mucho más "technology push" que "demand pull".

OPERACION DE LOS FONDOS

- Se percibe la necesidad de mejorar la evaluación y seguimiento que hacen los Fondos después de la ejecución de los proyectos. (Cosa muy relevante si de lo que se trata es de justificar el uso de recursos públicos en esta materia).
- Se percibe la necesidad de que las regiones jueguen un rol más preponderante, especialmente en lo referente a la determinación de prioridades, aunque se percibe un grado de precaución en cuanto a la generación de muchos "fondos regionales", introduciendo rigideces en la asignación de recursos, y descoordinación en los proyectos de posible impacto nacional.
- Es SORPRENDENTE el escaso nivel de conocimientos que tienen los usuarios de algun Fondo, sobre los otros Fondos. (¿cómo será con los no-usuarios????) Asimismo, es escaso el nivel de conocimiento que los ejecutivos de un Fondo tienen sobre las líneas de los otros Fondos.
- Pregunta: un "Fondo" sujeto a presupuestación anual ¿es verdaderamente un "Fondo"?

ASPECTOS DE COORDINACION

- Se percibe un grado de coordinación entre los Fondos que, a juicio de los "policy makers", es "moderadamente adecuado", y a juicio de los ejecutivos de los propios Fondos, es "inadecuado".
- Hay una relación amigable y una coordinación semi-formal a nivel de los Consejos.
- Pero hay un importante espacio por avanzar en materia de:
  - Ventanilla única (institucional o virtual) para orientar al usuario.
  - Base de datos común.
  - Formatos con elementos comunes.
  - "Joint ventures" de financiamiento.
- Asimismo, se percibe una importante carencia de coordinación con otros instrumentos, especialmente Prochile, y el sistema bancario y financiero (en este caso, faltan los instrumentos para que la coordinación sea interesante). Poca coordinación PROFOS-Fondos... o bien, consultores FAT que saben poco de FONTEC.

CONCLUSIONES

- Es claro que el accionar de los Fondos ha tenido en la última década un impacto positivo y significativo en el desarrollo de las universidades e institutos, y en su vinculación con las empresas.
- En las empresas, el impacto ha sido positivo, mas no significativo, y se ha dado con mayor intensidad en las "medianas ganositas" y en las "pequeñas innovadoras que ya están ahí". Probablemente no estemos llegando más alla de un 20% del universo más importante... el de las "ganositas".
- Se ha generado en el país una nueva dinámica de "accountability" de la actividad de I&D, a través de la disciplina de presentar proyectos con objetivos verificables.
- Asimismo, es claro que han sido dineros bien invertidos, y con una rentabilidad social y privada positiva.

CONCLUSIONES

Sin embargo, también es claro que los Fondos no pueden resolver por si sólos todos los desafíos nacionales en este tema, y que hay algunas carencias relevantes, siendo algunas propias de los Fondos, y otras que los trascienden:

El sistema de Fondos no requiere "reingeniería", sino mas bien "mejoramiento continuo"

I: La endeble institucionalidad, las dificultades de manejo de un tema multisectorial, y la carencia de objetivos claros y bien difundidos de política.

II: La carencia de mecanismos que permitan "financiar bosques, y no sólo árboles", en temas estratégicos.

III: La escasa participación del sector empresarial en su operación ... su bajo conocimiento de los Fondos, y el escaso volumen comparativo de recursos que se orienta a ese tipo de instituciones... donde la innovación se materializa.

CONCLUSIONES

IV: La excesiva concentración de los recursos en algunos sectores... y el consecuente desamparo de otros.

V: La precaria situación de los institutos públicos.

VI: La excesiva orientación del sistema, y de los métodos de evaluación de proyectos, a financiar la "oferta tecnológica".

VII: La carencia de mecanismos de financiamiento al "black hole" del escalamiento productivo.

VIII: La carencia de un sustituto claro frente al desmantelamiento de los incentivos a la exportación.

IX: La carencia de mecanismos y de recursos para el tema con el más indudable impacto en el largo plazo, y de mayor externalidad: la formación de recursos humanos de alta calificación dentro y fuera de Chile.

Después de una década de exitosa experiencia con el sistema de Fondos tecnológicos...

... Ha llegado la hora de un "apretón de tuercas" significativo en nuestro sistema nacional de fomento a la innovación...

...Este "apretón" constituye un ingrediente fundamental para revertir la tendencia al descenso de la competitividad del país que hemos experimentado recientemente....

.... Y como todo en la vida, requerirá de decisión política y de hacer algunas apuestas significativas .... no se hacen tortillas sin romper huevos.

RECOMENDACIONES DE POLITICA

El tema tecnológico es uno de los cuales, aun en este ideologizado país, un liderazgo fuerte puede provocar identidad, consenso político y efectos significativos en el desarrollo. Para ello, hay que hacer algunas apuestas que, bien concebidas, no debieran resultarle indiferentes ni al empresariado ni a la clase política. Esto requiere... de la involucración real del tema en la agenda presidencial y en la institucionalidad vigente.

La gran pregunta: ¿queremos un país que venda productos cada vez más caros, o un país que se dedica únicamente a abaratar el costo de lo que ya produce?. ¿Qué nos conviene más en el largo plazo, si nuestra productividad es hoy 5-10 veces inferior a la de países industrializados?

Lo primero es lo primero: **¿cuáles son los objetivos de política que habría que fijarle al sistema nacional de innovación, antes de definir institucionalidades e instrumentos?????**

6 Objetivos de Política Tecnológica

1. Definir, de común acuerdo con el sector privado y las instituciones de investigación, una agenda de temas estratégicos para el desarrollo socio-económico del país, y abordarlos integralmente con recursos, institucionalidad y procedimientos.
2. Generar una institucionalidad que permita una asignación racional de recursos y modalidades de financiamiento para la totalidad del gasto público en esta materia.
3. Generar en los Ministerios la institucionalidad, *presupuestación* y procedimientos que permitan fomentar y financiar la innovación tecnológica y de gestión de sus sectores.

Quiere temas estratégicos??.
Aqui van algunos:
•La carretera informática nacional.
•Chile, potencia acuícola.
•Bienes de capital e insumos mineros.
•Id. agropecuarios.
•Industria educativa.
•Medio ambiente.
•Conservación de recursos genéticos.
•Combate a la desertificación.
•Aprovechamiento integral de cuencas.

6 Objetivos de Política Tecnológica

4. Triplicar la participación porcentual verificada del sector empresarial en el esfuerzo tecnológico nacional, diseñando para ello los instrumentos directos y estímulos fiscales que así lo permitan, y reorientando una fracción significativa de los incentivos a la exportación con este propósito.
5. Generar los mecanismos e instrumentos que permitan abordar el fenómeno innovador integralmente, desde la concepción de los proyectos, hasta su implantación exitosa en la producción y el desarrollo.
6. Destinar una fracción significativa de los recursos financieros hacia la formación de recursos humanos de alto nivel, en el país y en el extranjero, por medio de la asignación directa de becas para universidades, institutos y empresas, y por medio de deducciones fiscales ad-hoc.

Una nota sobre el objetivo de política No. 2

"Generar una institucionalidad que permita una asignación racional de recursos y modalidades de financiamiento para la totalidad del gasto público en esta materia."

Esto implicaría un ente pequeño, con una institucionalidad estilo "CONAMA", probablemente en la esfera de la SEGPRES.

Debiera a su vez haber dos "sub-consejos", uno en la esfera académica-científica, muy cercano al CONICYT, y otro en la esfera de innovación-fomento productivo.

En este escenario, la SEPIT pasaría a ser la secretaría ejecutiva de este segundo sub-consejo, saliendo de la esfera del MINECON.

Los ministerios con actividad tecnológica, el mundo académico y el sector productivo debieran tener representación adecuada.

Si este ente no tiene un peso adecuado para la negociación presupuestal con Hacienda, dado por el propio Presidente, mejor no vale la pena hacer nada y dejarlo todo en la ambiguedad actual.

Otro elemento de la institucionalidad sería, ahora sí, resolver los mecanismos de presupuestación, misión y autonomía de los institutos públicos.

Una nota sobre el objetivo de política

"Generar en *todos* los Ministerios la institucionalidad, *presupuestación* y procedimientos que permitan fomentar y financiar la innovación tecnológica y de gestión de sus sectores."

Esto, que puede parecer una sugerencia burocrática, tiene implicaciones profundas. De lo que se trata es de incorporar la variable tecnológica directamente en, p. ej. el presupuesto de concesiones de obras públicas, el presupuesto de mejoramiento de gestión hospitalaria, etc. Mientras la variable tecnológica parezca exógena a ese sector, dependiente de fondos "horizontales" y transversales, más lejos estaremos de que estos sectores se "apropien" verdaderamente del tema.

Con este fin, habría que diseñar una metodología, base de datos y procedimientos *comunes* a todos los ministerios, para controlar adecuadamente este gasto.

Por cierto, una sugerencia al BID y Banco Mundial. En lugar de dar préstamos de ciencia y tecnología... ¿porqué no mejor forzar la aparición de la variable tecnológica en sus préstamos agrícolas, de educación, infraestructura, salud, etc.??

Hoy día el sector público gasta aproximadamente 0.55% del PIB. 70% es por asignación de presupuestos institucionales, y 30% vía Fondos. Esto, habría que dejarlo razonablemente igual, generando una estabilidad de largo plazo y autonomía a los institutos, y aumentando algo los recursos de Fondos.

La propuesta, en lo general, consiste en asignar, crecientemente y a lo largo los próximos seis años, un adicional de hasta 0.35% del PIB y repartirlo, en lo principal, aproximadamente en cinco quintos: a) para programas estratégicos, b) para formación de recursos humanos, c) para un programa experimental de incentivos tributarios a la innovación y la formación de recursos humanos de alta especialización en las empresas, d) para los presupuestos ministeriales de innovación, y e) para aumentar los recursos de los Fondos.

Deseablemente, una fracción significativa de esos recursos podrían provenir, precisamente, del desmantelamiento de los incentivos de exportación.

- Mejorar la coordinación, formularios y bases de datos de los Fondos.
- Mejorar la coordinación con otros instrumentos de fomento, tanto dentro de CORFO como con Prochile.
- Evitar los "sesgos cientificistas" en la evaluación de proyectos, y considerar en más profundidad los aspectos del "negocio".
- Usar sistemas de precalificación para evitar frustraciones, y proyectos exploratorios antes de financiar proyectos grandes.
- Perfeccionar y aumentar los proyectos de difusión y transferencia, y las licitaciones.
- Premiar más el alto riesgo y las externalidades.
- Mejorar el seguimiento ex-post de los proyectos.
- Mejorar significativamente la difusión de los Fondos.

- Mejorar la evaluación y asignación de recursos al "black hole" del mercado, a los proyectos de mayor riesgo, y el escalamiento productivo.
- Ampliar y perfeccionar las cauciones solidarias de CORFO y un "FOGAPE tecnológico", de manera que se puedan otorgar garantías a aquellos proyectos de inversión que tienen una componente manejable de riesgo tecnológico.
- Mejorar el esquema de segundo piso para capital de riesgo y modificar la Ley 18.815 de Fondos de Inversiones.

- Para las que "ya están ahí", lo esencial es ayudarlas a internacionalizarse, lo cual pasa por modificar los esquemas intrínsecamente asociativos de Prochile, y complementarlos con esquemas de apoyo a empresas más individualizadas. Asimismo, éstas son empresas que están en óptimas condiciones para abordar "programas estratégicos" como los que se mencionan más atrás.
- Para las "ganositas", los mecanismos ideales son los Fondos, complementados por incentivos tributarios o semi-automáticos que permitan la masificación. En caso contrario, será difícil llegar a todas ellas.
- Para las que no están "ni ahí", lo básico son los esquemas tipo FAT, PAG, PROFO o SERCOTEC de mejora en la gestión.

En adición al apoyo del Programa de Innovación Tecnológica del Ministerio de Economía, que financió y colaboró extensamente en el desarrollo de este estudio, es necesario agradecer a las autoridades y personal de los Fondos, que brindaron todo tipo de facilidades, así como a los usuarios de los Fondos, a los numerosos entrevistados, y a los diversos autores de estudios previos.... muchas de las ideas aquí mencionadas no son más que un "recocido ordenado" de conceptos emitidos por algunos de ellos.... lo cual no nos exime de las responsabilidades por el conjunto.

Mario Waissbluth y Alan Farcas.

INVERTEC IGT, Julio, 1999.

Ricardo Badilla	**Gonzalo Herrera**	**Aldo Cipriano**
Mauricio Sarrazin	**Alfredo Lassen**	**Jaime Crispi**
Tomas Vial	**Andres Vicens**	**Enrique D´Etigny**
Jorge Yutronic	**Alvaro Diaz**	**Ivan Lavados**
Jorge Leiva	**Gonzalo Rivas**	**Sally Bendersky**
Joaquin Cordua	**Margarita D´Etigny**	**Fernando Mujica**
Fernando Agüero	**Jorge Olivares**	**Fernando Raga**
Carlos Alvarez	**Eduardo Bitran**	**Pedro Sierra**

... y los ejecutivos de proyecto de los cuatro Fondos

Clase 23/06/2005

Vigilancia y Prospectiva Tecnológica (métodos y técnicas)

Magíster en Gestión Tecnológica mención Biotecnología

Fundamentos de la Gestión Tecnológica

1

TECNOLOGIA. CONCEPTO Y UNA REFLEXION CRITICA DE SU HACER

"... se está"

INNOVACION Y TRANSFERENCIA TECNOLOGICA

2

7.- Vigilancia y prospectiva

Permite conocer en una determinada área diversos aspectos, tales como:

- ✓ Las tecnologías y productos en los que se está investigando.
- ✓ La dinámica de la tecnología.
- ✓ La detección temprana de las tecnologías emergentes.
- ✓ Las líneas de investigación y las trayectorias tecnológicas de las principales empresas que compiten en el área considerada.
- ✓ Los centros de investigación, los equipos y los expertos líderes en la generación de nuevas tecnologías en el área.

3

7.- Vigilancia y prospectiva

LOS BENEFICIOS DE ANTICIPAR Y DETECTAR LOS CAMBIOS

- *Alerta amenazas provenientes de sectores distintos al de la empresa.*
- *Evita barreras no arancelarias en mercados exteriores.*
- *Alerta si los demás nos están copiando.*

LOS BENEFICIOS DE PROGRESAR Y DETECTAR LOS DESFASES

- *Detecta oportunidades de inversión y comercialización.*

4

7.- Vigilancia y prospectiva

LOS BENEFICIOS DE DETECTAR NUEVAS IDEAS Y SOLUCIONES

- *Ayuda a decidir el programa de I+D y su estrategia.*
- *Contribuye a abandonar a tiempo un determinado proyecto de I+D.*

LOS BENEFICIOS DE IDENTIFICAR OPORTUNIDADES DE COOPERACIÓN

- *Identifica socios adecuados en proyectos conjuntos de I+D ahorrando inversiones.*
- *Facilita la incorporación de nuevos avances tecnológicos a los propios productos y procesos.*

7.- Vigilancia y prospectiva

Pere Escorsa (2001), es *"la vigilancia consiste en realizar de forma sistemática **la captura, el análisis, la difusión** y **la explotación de las informaciones técnicas** útiles para la supervivencia y el crecimiento de la empresa.*
La vigilancia debe alertar sobre cualquier innovación científica o técnica susceptible de crear oportunidades o amenazas".

MECANISMO SENSOR

7.- Vigilancia y prospectiva

La vigilancia transforma la abundacia de información en tendencias.

FILTRO DE VARIEDAD

7.- Vigilancia y prospectiva

F.Palop y J.M.Vicente (1999), la **vigilancia e inteligencia competitiva** consiste en *"un sistema organizado de observación y análisis del entorno, seguido de una correcta circulación interna y utilización de la información en la empresa".*
Un procedimiento para procesar de forma sistemática y estructurada la información relevante del entorno que puede afectar a la empresa y **que ha de servir para la toma de decisiones de carácter estratégico.**

INTERPRETACIÓN ESTRATEGICA (SENTIDO)

7.- Vigilancia y prospectiva

7.- Vigilancia y prospectiva

El término vigilancia se asocia más con las acciones de observación, captación de información y análisis de la misma para convertir señales dispersas en tendencias y recomendaciones para tomar decisiones.

El término inteligencia competitiva recoge más las fases de difusión de los resultados del análisis hacia quien debe tomar decisiones o ejecutar acciones y su uso en el proceso de decisión.

7.- Vigilancia y prospectiva

Los motivos que llevan a una vigilancia tecnológica son los siguientes:

1. **ANTICIPAR:** Detectar los cambios que tienen lugar en el exterior en lo que se refiere a nuevas tecnologías, maquinaria, mercados, competidores.

2. **REDUCIR RIESGOS:** Detectar amenazas procedentes de patentes, nuevos productos, reglamentaciones, alianzas, nuevas inversiones.

7.- Vigilancia y prospectiva

3. PROGRESAR: Detectar los desfases existentes entre nuestros productos y las necesidades de los clientes, o bien entre nuestras capacidades y las de otros competidores.

4. INNOVAR: Detectar ideas y nuevas soluciones como, por ejemplo, economías en I+D, mejora de procesos.

5. COOPERAR: Conocer nuevos socios como, por ejemplo, clientes, expertos, investigadores.
(Palop y Vicente, 1999; Martí Oliva, 2002)

7.- Vigilancia y prospectiva

LA PROSPECTIVA TECNOLÓGICA es un método que busca elaborar estrategias de ataques ante posibles escenarios futuros.
Es un método que considera aspectos pasados (como vigilancia tecnológica) y busca la planificación de un futuro deseado, y desde ahí formular estrategias de acción ante posibles escenarios probabilísticos.
La aplicación de la prospectiva es de tipo preactiva, dirigida a la acción y a la definición de prioridades, no considera sólo un plan de acción sino varios escenarios adoptando una visión global de sistema. Incluye además factores de tipo cualitativo (como el comportamiento de los agentes) y usa distintos tipos de análisis y metodologías de aplicación (Mario Oliar, 2002).

PROCESO ESTRATEGICO

7.- Vigilancia y prospectiva

Pronóstico Tecnológico (Technology Forecasting):
Previsiones probabilísticas de desarrollos tecnológicos futuros.
Evaluación Tecnológica (Technology assessment):
Evaluación sobre los impactos futuros sobre la economía y la sociedad, de tecnologías nuevas conocidas.
Prospectiva Tecnológica (Technology Foresight):
Identificación de prioridades científicas y tecnológicas presentes a raíz de proyecciones hipotéticas hacia el futuro de desarrollos económicos, sociales y tecnológicos.

Complejidad y cambio

- "EL CAMBIO ESTÁ, EN SÍ MISMO, CAMBIANDO CONSTANTEMENTE"

R. ACKOFF

- "LO IMPORTANTE DEL CAMBIO ES LO QUE PERMANECE CONSTANTE"

H. MATURANA

Clase 24/06/2005

Sistemas Nacionales de Innovación

Magíster en Gestión Tecnológica mención Biotecnología

INNOVACIÓN Y MECANISMOS DE INNOVACIÓN

¿QUÉ ES INNOVACIÓN?

Innovación es la introducción de nuevas ideas, productos, servicios y prácticas con la intención de ser útiles (aunque algunas no lo consiguen vistas con perspectiva). Un elemento esencial de la innovación es su aplicación exitosa de forma comercial. La innovación ha delimitado y cambiado la historia humana. Los planificadores económicos ven toda innovación como el arreglo de toda crisis del capitalismo (por ejemplo, conseguir la sostenibilidad medioambiental y reparación de daños) y es el elemento central de muchas políticas para aumentar la competitividad a nivel corporativo o nacional.

¿QUÉ ES INNOVACIÓN?

•**Innovación:** Aplicación de nuevas técnicas o procesos productivos o introducción de nuevos productos en el mercado. Las innovaciones exitosas abren la posibilidad de producir los mismos bienes utilizando menores recursos o producir bienes nuevos o de mejor calidad, constituyendo un elemento importante para el crecimiento económico. Se distingue entre la concepción de un nuevo producto o técnica de producción (inversión) y la aplicación de ella a un uso concreto. Estrictamente la innovación corresponde a esta última etapa.

INNOVACIÓN UNA VISIÓN CLÁSICA

•NOVEDAD
•COMERCIALIZABLE

TIRON (PULL) DE LA DEMANDA

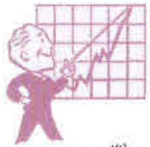
EMPUJE (PUSH) DE LA CIENCIA

TIPOS DE NNOVACIÓN

•INCREMENTAL
•RADICAL

CÓMO MEDIR LA INNOVACIÓN

"La capacidad de una regiónpara introducir con éxito innovaciones tecnológicas le permite ser más competitiva, tener un crecimiento económico y por ende una mejor calidad de vida" (Lugones & Salazar, 2000. OEA)



COMO UN PORCENTAJE DEL PIB %

CANTIDAD DE PATENTE SOLICITADAS

5

SISTEMAS NACIONALES DE INNOVACIÓN

"Un conjunto de las instituciones cuyas interacciones determinan el desempeño innovador... de las firmas nacionales." (Nelson, 1993).

"Las instituciones nacionales, sus estructuras de estímulo y sus competencias; eso determina la tasa y la dirección del aprendizaje tecnológico (o el volumen y la composición de actividades para engendrar el cambio) en un país." (Patel y Pavitt, 1994).

"Una red de instituciones del sector público y privado, cuyas actividades y acciones inician, importan, modifican y difunden nuevas tecnologías." (OECD, 1997).

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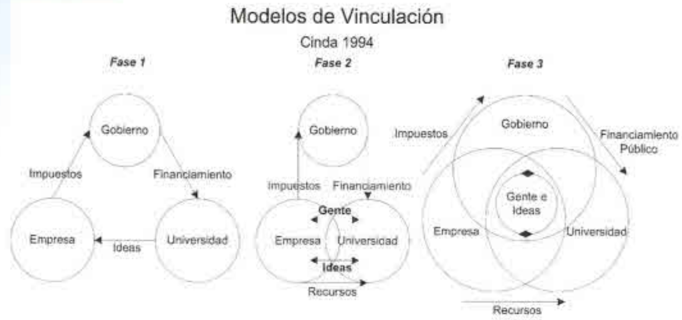
SISTEMAS NACIONALES DE INNOVACIÓN

El término de SNI, tal como menciona Arocena & Sutz (1999), aparece a finales de la década de los 80s, específicamente en una publicación de Freeman (1987 Cit. en Sutz, 1999:1) sobre la innovación en Japón, donde se refiere a él como: "la red de instituciones en el sector público y los sectores privados cuyas actividades e interacciones, importan, modifican y difunden las tecnología nuevas",

7

SISTEMAS NACIONALES DE INNOVACIÓN

Son una representación expost del nivel de vinculación en un país



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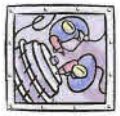
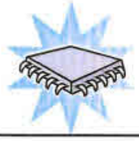
SISTEMAS NACIONALES DE INNOVACIÓN

- SISTEMAS REGIONALES DE INNOVACIÓN

- SISTEMAS SECTORIALES DE INNOVACIÓN



- SISTEMAS TECNOLÓGICOS



SISTEMAS NACIONALES DE INNOVACIÓN

- CLÚSTER DE EMPRESAS

Para **Almquist** et. al. (1998 Cit. en Navarro 2001b) las "redes industriales, sistemas industriales, sistemas tecnológicos y áreas de recursos son otros términos que tienen un significado similar al de cluster". Para la **OECD** (1998, Cit. en Ibid. 2001b) son "redes de producción de empresas fuertemente interdependientes (incluyendo proveedoras especializados), ligadas unas a otras en una cadena de producción que añade valor".

SISTEMAS NACIONALES DE INNOVACIÓN

- CLÚSTER DE EMPRESAS

Cadena de Valor (Michael Porter)

SISTEMAS NACIONALES DE INNOVACIÓN

- CLÚSTER DE EMPRESAS

- La concentración de mano de obra, proveedores, infraestructura e instituciones especializadas, que se encuentran más accesibles o a un menor costo (Krugman, 1996).
- El fortalecimiento del proceso de innovación y de aprendizaje, ya sea entre empresas de un mismo sector, que producto de la proximidad, les resulta más sencillo la observación y comparación de trayectorias (Benchmarking); o entre empresas ubicadas en distintas fases de la cadena de valor, que al especializarse en sus competencias esenciales, potencian su capacidad innovadora y pueden traspasarla a toda la cadena.

MECANISMOS DE VINCULACIÓN

- **OFICINAS DE VINCULACIÓN INDUSTRIAL**
  Sus funciones básicas son la identificación de recursos disponibles, creación y mantención de bases de datos y de otras formas de información requerida, promover y comercializar los conocimientos científicos y tecnológicos y servicios, negociar y asesorar sobre contratos e identificar fuentes de financiamiento para llevar actividades conjuntas con la empresa.
- **CENTROS DE VINCULACIÓN INDUSTRIAL**
  En general lleva a cabo las mismas funciones que una oficina de enlace, excepto que realiza una identificación de las necesidades reales de las industrias.
- **CENTROS DE INVESTIGACIÓN INDUSTRIAL**
  Son centros de apoyo a la industria altamente especializados y de carácter interdisciplinario, de modo de satisfacer oportunamente las necesidades de los sectores con los cuales se relacionan.

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MECANISMOS DE VINCULACIÓN

- **INCUBADORA DE EMPRESAS**
  Organismo de interlocutores públicos y privados, que ponen en marcha y ofrecer, en un territorio que presenta un potencial empresarial suficiente, un sistema completo e integrado de actividades y servicios de excelencia para la pequeña y mediana empresa, con el objetivo de crear y desarrollar actividades innovadoras e independientes. (Dirección de Política Regional de la Comisión de las Comunidades Europeas, 1984) (SBA en los Estados Unidos).

Incubadora Santiago Innova - Municipalidad de Santiago.

OCTANTIS - Universidad Adolfo Ibáñez.

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MECANISMOS DE VINCULACIÓN

- **PARQUE TECNOLÓGICO**
  Una gran área estratégicamente localizada y desarrollada para ofrecer un entorno de prestigio que consiga atraer a nuevas pequeñas empresas o a secciones de las grandes, ambas de alta tecnología. Universidades, organismos públicos de investigación, servicios de distinto tipo, etc., forman parte de este entorno en el cual las empresas pueden no sólo investigar, sino también producir, y en algunos casos, comercializar los resultados de su investigación. (Martínez, 1987).

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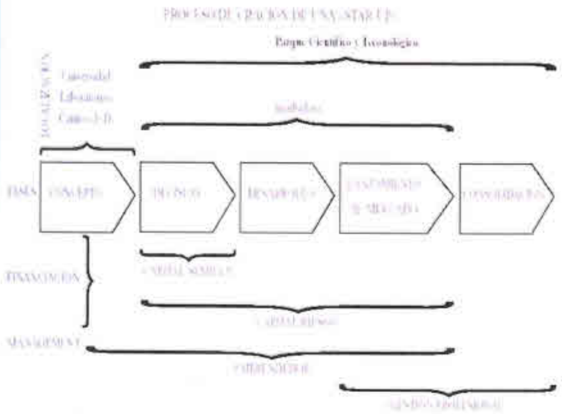
PROCESO DE CREACIÓN DE UNA "START UP"



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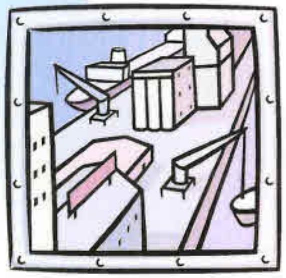
MODELOS DE TRANSFERENCIA TECNOLÓGICA



Cuando se habla de transferencia de conocimiento o tecnología, se entenderá según un doble aspecto: la transferencia entre empresas (transferencia horizontal) y la transferencia entre los agentes generadores de conocimiento (universidades y organismos públicos de investigación) y las empresas (transferencia vertical)

1.- MODELO GRIEGO

PRAXE: fomentar la explotación de los resultados de investigación en el mercado a través de la creación de empresas spin-offs académicas.

TANEO: subvencionar fondos de capital de riesgo del sector privado especializados en la financiación de siembra para nuevas empresas de base tecnológica.

ELEFTHO: apoyar el desarrollo de incubadoras y de parques de ciencia y tecnología, tanto nuevos como ya creados, y proporcionar incentivos para sus arrendatarios.

KETA: crear 13 centros regionales para el desarrollo empresarial y tecnológico y proporcionar información y servicios de consultoría a las empresas.

Jóvenes Emprendedores: para hombres y mujeres de 18-35 años que desean crear sus propias empresas en los sectores de manufactura, comercio, servicios o turismo.

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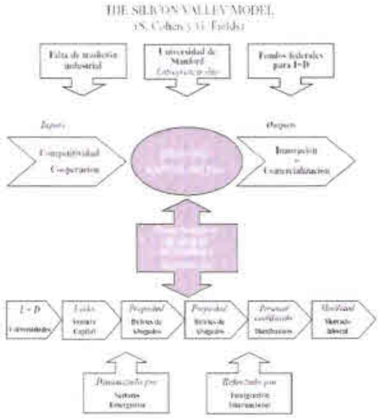
2.- MODELO ITEM (MÉXICO)

"**Sistema Tecnológico de Monterrey**", debido a la enorme red de sedes que posee a través del territorio mexicano, se fundamenta en dos grandes sistemas: una red de centros de investigación, que orientan su actividad hacia la empresa por medio de consultorías en áreas tales como manufactura, tecnologías digitales, electrónica y comunicaciones, medio ambiente y recursos básicos –como agua y energía, calidad y biotecnología, entre otras y una red de 25 incubadoras de empresas instaladas en las distintas ciudades en que el Sistema Tecnológico de Monterrey posee sedes.

3.- MODELO SILICON VALLEY



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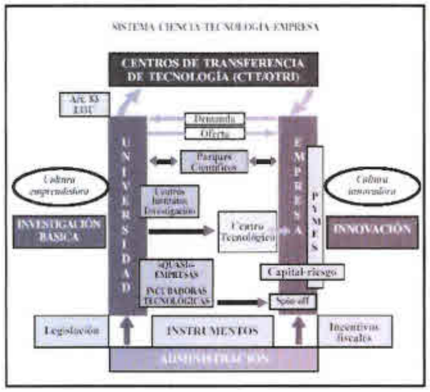
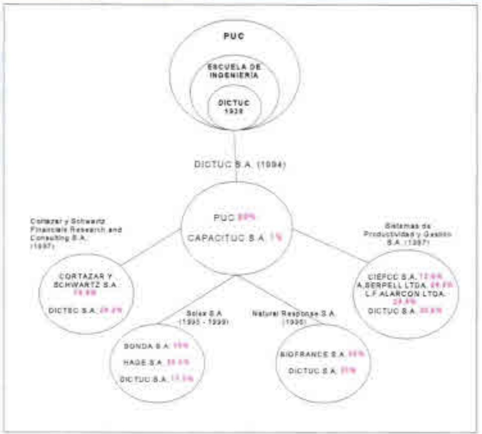
4.- MODELO TRIPLE HÉLICE



4.- MODELO PUC



COMPARACIÓN DE MODELOS

Modelo de Transferencia	Participa	Énfasis necesario para el éxito	Recursos	Característica Principal
Modelo Español	Universidad – Empresa - Gobierno	Generación Estructuras de vinculación y sus interacciones	Creación de instrumentos de gobierno o Universitarios o empresariales o mixtos en cualquier combinación	Crea en las Universidades Centros de Transferencia de tecnología u Oficinas de Transferencia de Resultados de investigación
Modelo Anglosajón	Universidad – Empresa - Gobierno	Proliferación de estructuras de intermediación tanto en el sector publico como en el privado	Fuerte apoyo de la Empresa privada	Crea en las Universidades Oficinas de Transferencia de tecnología como un servicio de la investigación y creación de empresas para externalizar la negociación con el sector empresarial
Modelo de Silicon Valley	Universidad - Empresa	Proximidad de la Universidad de Stanford y Recursos Humanos altamente calificados	Fuerte apoyo de la empresa privada	Generación de Redes de contactos y circulo virtuoso por deseo de las empresas en participar del centro mundial de la innovación

COMPARACIÓN DE MODELOS

Modelo de Transferencia	Participa	Énfasis necesario para el éxito	Recursos	Característica Principal
Modelo griego	Universidad – Empresa – Gobierno	Generación de incubadoras y desarrollo de jóvenes emprendedores	Creación de instrumentos de apoyo a las iniciativas de innovación	Fuerte apoyo gubernamental a la creación de condiciones favorables para el fomento de nuevas industrias
Modelo del Sistema Tecnológico de Monterrey, México	Universidad – Empresas – Gobierno	Existencia de una red de centros de investigación, y una amplia red de incubadores de empresas	Recursos de la Banca y de Gobierno	Alianza con diversos organismos, para la creación y desarrollo de proyectos de empresa de estudiantes, egresados y comunidad empresarial
Modelo de la Pontificia Universidad Católica de Chile	Universidad - Empresa	Recursos Humanos altamente calificados	Utilización de financiamiento CORFO y DICTUC S.A.	Generación de empresas desde DICTUC S.A. con la participación de alumnos y profesores de la Universidad