SIX MAJOR CHALLENGES FOR PUBLIC INTERVENTION IN HIGHER EDUCATION, SCIENCE, TECHNOLOGY AND INNOVATION

KEYNOTE SPEECH FOR THE 4TH TRIPLE HELIX CONFERENCE, "BREAKING BOUNDARIES, BUILDING BRIDGES"

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INTRODUCTION

It is an honour for me to introduce this fourth triple helix conference on "breaking boundaries, building bridges". For some time, I was puzzled by the title since I saw the triple Helix as an attempt, while keeping differentiated groups of actors in the production of knowledge, to focus on both the fuzziness of borders and the continuity of activities beyond institutional devides. Which boundaries were then to break and which new bridges should we build. It may sound strange but my conclusion is that this applies more to each of the key component of the triple helix than to their relations. My presentation is dedicated to explaining this position and, by doing so, to listing six major challenges faced by public intervention in higher education, science, technology and innovation. Each word counting, I shall also devote my conclusion to the reasons which explain the choices made.

My starting point was to focus on the initial assumptions of the Triple Helix approach. I see three main dimensions in the approach: (i) the recognition of three constitutive "elements" or "blocks", government, industry and university, (ii) the co-constructed evolution (as emphasized by the notion of "endless transition"), that is the recognition that the relations between the components both shape their dynamics and are cumulative, and (iii) the implicit "national" dimension of the approach as exemplified by most of the empirical work done which could also be labelled under "national systems of innovation". This is of course an oversimplification. But let assume for a while that we accept it for addressing the challenges faced by "public policies". You are then faced to a set of issues on the constitutive elements of the triple helix.

- What relation there is between "government" and "public intervention", between "national policy" and "public policy" in our field of science, technology and innovation.
- Similalry when considering industry, we all know the debates about the globalisation of large firms on the one hand and the emphasis of public policies on SMEs on the other. How do we articulate these two faces of industry?
- Thirdly should we consider universities as an undifferentiated whole with the "research university" as a model as the Nobel prize winner is the model for scientific careers? Furthermore, are universities the sole source of public capabilities? Even if they have undergone

trouble times, government labs represent a significant source not to mention the thriving not-for profit sector.
- Finally, the image of the triple helix is there to tell us that content matters. Coming from a research group that puts at the core of science dynamics the instrinsic relationships between content and activity, nature and society, you will understand that I start my presentation with the dynamics of the present leading sciences.

CHALLENGE 1- CHANGING "SEARCH REGIMES" AND THE GROWING ROLE OF "SCIENCE DISTRICTS" AND "POLES"

It is commonplace to consider that governments have played a central role in the development of most post WWII major breakthrough innovations. So-called large programmes (military in the US, mostly civil elsewhere) played a central role, France being seen as an archetype with an extensive use both in sectors covered and in duration. It is thus all the more interesting to see that, apart from space, an investment shared by all large OECD countries, French government has retracted from all large programmes in less than one decade (Mustar and Larédo, 2002). Why is this so? Our colleagues from Pisa (Bonnacorsi, 2002) explain it by the converging dynamics of leading sciences of the time. What differs today and builds a radically different situation? Present leading sciences (Information technology and biotechnology) are divergent. In one word, our colleagues from Pisa consider that, with info and bio sciences and technologies, we have changed of "search regime".
If one accepts over-simplifications, the former regime, which was largely connected to post WWII physics, or, to use the OECD terminology, to the old secteurs de pointe, exhibited three main characteristics: (i) Their emergence was organised around large complex technical objects, such as nuclear power reactors, which progressive shaping entailed the existence of a lasting dominant design. (ii) They required large specific, dedicated research infrastructures (see Culham's JET or the LEP). And (iii) they were prone to, and even required, central coordination, may it be by government or by an oligopolistic structuration of markets (theories about natural monopolies being often mobilised).
The new technologies and sectors differ widely. Info and bio technologies are on the contrary characterised by a proliferation of trajectories and the dynamics is not one of incremental, continuous improvements of one dominant design, but rather one of rapid succession of radically different designs. This proliferation goes along with decentralised initiative and a multiplication of places in a position to promote new paradigms. Critical infrastructures are no longer specific to one design but generic, spread in space, as much untangible as material. In this context, central coordination is at best ineffective and even probably harmful.
In these new secteurs de pointe, the globalisation of firms does not only concern markets and production structures as it was the case until the beginning of the nineties, it also concerns their research and innovation efforts. There are numerous studies that highlight this movement. We have followed French large firms for 5 years at the end of the nineties and we have documented the rapid and important internationalisation of the research and innovation efforts (Laredo and Mustar, 2001b). This movement highlights however a very different pattern from this of the location of their production activities. To use an image, I would say that large firms research facilities agglomerate in the existing "science districts" largely linked to the presence of research

universities and their "poles of excellence", but also to the presence of a wealth of small high-tech firms and of competitors. In this meaning, the research and innovation efforts of large firms are no longer 'multi-national' but 'multi-local' or 'multi-pole'.
The example of Grenoble in micro- and nano-technologies illustrates this movement of agglomeration with in the same place the highest French concentration of public research capabilities – with both active research institutions (especiallly CEA and the famous LETI labs) and very fast growing research capabilities of universities (University J. Fourier in particular) and so called "grandes écoles" (INPG), all being supported by CNRS through mixed research units (see below) – one of the best known and studied Technopole (ZIRST de Meylan) - with hundreds of high tech SMEs, with active incubators and seed-capital companies that foster the birth of start-ups – and now four of the world largest micro-electronics companies which have joined together to build a huge nano "lab-fab" (the investment being in billion euros). There will not be tens of such places over the world, and a global conpany will either locate there or in another similar place. The nationality of this "pole" or "science district" does not count, what is important is the "territorial" agglomeration of capabilities, the room for synergies, and last but not least, the human competences available.

We are thus no longer into an era of large centralised programmes, an era which was not specific to France (remember that the Concorde was a joint French and Bristish adventure, that Euratom dreamed to develop THE European reactor …) and which is not over (space is an archetype of a fully fledged European policy, and civil aeronautics has finally succeeded in turning basic technological research at the European level in the sixth FP). **We enter a period where the issue is, for leading sciences and technologies, to favour the emergence and development of decentralised "poles" and "science districts". This is the first challenge faced by public intervention**.

I see two major consequences of this movement for public intervention which question its present assimilation with national policy. First, there is no need of large public coordination or of wide ranging collaborations for equipment. You can build leading edge capabilities in one place and in one region: see IMEC in Flanders for microelectronics. Genopole©, South of Paris, was started by a not-for-profit association and the core of the "technical plateau" has been paid for by territorial authorities. These examples emphasize the bottom-up nature of the process made of progressive aggregation of capabilities (human, technical, financial and organisational). They all demonstrate that the 'triadic' relationships are critical but at a far lower level than envisaged: it can play and be powerful in a "country-region" like Rhône-Alpes, Flanders or Finland. It also tells that the role of both national and European policies changes, being no longer in a "shaping" position rather in an accompanying one. We can discuss whether present policy instruments are adapted to this changing role, whether the move towards networks of excellence or integrated projects is an adequate answer, whether it should accompanied by other dimensions than financial (such as a European not for profit status), etc.

CHALLENGE 2: FOSTERING KNOWLEDGE CIRCULATION AND THE NEED TO REVISIT THE FOCUS ON PATENTING

This change in the dynamics of leading edge technologies clearly highlights a second requirement for generic infrastructures: the human genome map as well as the internet highways or shared rules about access and appropriation of knowledge. There is a "global" knowledge infrastructure (by the way a very marxian terminology) on the basis of which "local" systems (that is triadic arrangements) can develop and cooperate while entering into fierce competition (the imaged wordings of 'coopetition' and 'glocalisation' go together). This calls for a clear reconsideration of public intervention in the development of knowledge infrastructures: **as in the US we clearly need a federal level to address these issues**.

There is however nothing new into them. Chandler has beautifully shown how the railway networks have completely changed the competition rules and the dynamics of firms in the 19th century US. Similar analyses have been made on the electricity grid and telephone networks. There has even been economic theorisations about long waves linked to the pervasiveness of the new technologies in all economic activities. Not going as far, the work done on network externalities tells about the critical importance of such infrastructure. These infrastructures are not only tangible, they also are immaterial, as patenting reminds us, not only because most patenting offices are now two centuries old, but also because inventor protection was the object of a "world" agreement already in the 19th century.

One can thus understand that, if we turn into a new type of knowledge society, ownership of knowledge should be reconsidered. However it sounds as if there was one new best way to foster innovation activities, may they be or not embedded into technical devices: patenting and patenting and patenting again! This type of "pensée unique", as we say in French, frightens me. All the more since the few works done both on firms and on university patenting are not that positive! We all know of publication strategies by some researchers to avoid human gene patenting some years ago! How to link the positions towards software patenting and the growing societal movement towards open source software? How to take into account the problems linked to the construction and circulation of databases? How not to consider the post WWII debate on science, the Nuremberg declaration and the "open science" rules that derived from them (especially when considering what has recently happened under market pressures to another set of rules, on accounting)? The debates on this topic during the recent STRATA workshop and the suggestion of "hybrid" approaches to patenting reinforce the urgent need to fully reconsider the present approaches on the matter. **S&T policies cannot only focus on knowledge appropriation. They will have to address simulteously and in the same framework, issues of production, ownership, access and trading of knowledge.** This is a second challenge which, like the handling of nuclear waste in France, may well require delaying decisions until more is known about this central problem.

CHALLENGE 3: SME INNOVATION CAPABILITIES AND THE GROWING ROLE OF "REGIONS"

The decoupling in the localisation of large firms activities between use, production and new product development reinforces for territories the role of SMEs as the major lever for addressing the critical issue of employment. There are good reasons for this. Numerous studies have demonstrated that SMEs are the main local providers of employment, and in most developed

countries, the dynamic part of employment creation. It is thus not surprising to have observed a radical shift in all policies addressing industrial research over the last decade, a shift from large firms and 'national champions' to the mythical SMEs.

But it is always difficult, if not politically uncorrect, to recall that if they are SMEs, it is because they are small, that is locally rooted with limited means to access distant places, actors and policies. Italian districts have told us the importance of local ressources in their growth and success. The proponents of regional systems of innovation insist on the role of proximity, proximity of knowledge producers with which they collaborate, proximity of public support.

In all our countries the 'subnational' level is growing in importance, and everywhere policies focus on supporting SME innovation capabilities as well as the birth of new high-tech SMEs. These policies exhibit a striking feature, apart from finance: the main ressource on which they are based are universities as THE proximity knowledge providers. A lot of attention has been focused on intermediating structures (that are critical in increasing local connectivity), but little has been done on universities seen as local knowledge providers, and on the implications of such a view on the shaping of University research capabilities. Should we consider the elitist "research universities" as the only way to organise university research? The work I have done on some of these "local", "unvisible" universities shows that they undertake both post-graduate training and research activities, with often important socio-economic effects. It also shows that the more universities connect with their local environment, the more diverse they are. Diversity in the profile of higher education institutions is a key towards relevance in the type of knowledge based society we are aiming at.

Both movements (the evolution of search regimes and the issue of SME innovation capabilities) converge to question the role of territories and of regions, once account is taken of the wide differences in size between European nations. We all observe, even in centralised countries such as Fance and UK, a growing role of the "subnational" level. We can hypothetise without great risk that we shall witness a growing differentiation between regions and that this differentiation will be as much, and may be more, intra-national than inter-national. This means that for research and innovation we can no longer equate public policy with national policy. In this context can we still go on thinking of the ERA mainly as an issue of articulation between national and European levels, going on forgetting or putting aside the regional dimension? S&T policies will have to be thought of and conceived in a multi-level process involving not only co-ordination and complementarity, but competition and redundancy. **This multiplication of public interventions in research and innovation and their articulation constitute a third major challenge to any S&T policy formulation.**

CHALLENGE 4: THE COMPOSITION AND OPERATION OF PUBLIC SECTOR RESEARCH

The answers to these two movements highlight another phenomenon: the relevance of public policies largely depend on universities and more widely on public sector research. The use of the terminology "public sector research" is crucial here. It takes hold of the existence and recent dynamics of so-called government labs, and of the thriving not for profit sector, which, either through fiscal practices or more directly, largely depends on public funding. Here transformations abound in each of the components and in their relations.

First government labs: we just finished an EC project (EUROLAB) which shows that the troubled times they have been through are over, that privatisation has remained a marginal phenomenon and that their assimilation with "applied research" is an oversimplification (as had been already demonstrated 15 years ago by Crow and Bozeman). It is better to speak of "domain oriented" institutions which cover the range of research activities, from "services" to the most fundamental research activities. This however does not mean that all activities are undertaken in their own walls or campuses. More and more hybridisation drives to joint labs with universities, requiring that we rethink the too simple notions we have about institutional borders. Similarly, OECD data witness an increasing role in research expenditure of "not for profit" foundations, associations or firms (the denomination depending upon the national institutional situations). We still know little about them, enough however not to stick to the classical image of charities, especially if one takes into account the work done by Callon and Rabeharisoa about the French patient association on neuromuscular diseases and its critical role in the development of genetic research in France.

Universities on the other hand, have both witnessed a dramatic growth over the last 20 years, and are undergoing, in most countries a radical reorganisation of their research activities. The two tensions mentioned above – be critical to the cristallization of science districts and serve as the priveleged proximity knowledge provider – entail major changes in the higher education landscape. I see three main changes.

First, it requires that we reconsider our implicit categorization of higer education institutions in two subsets opposing teaching-only (or mainly) institutions to so-called research universities. The classical model of the research university is an all encompassing body which is excellent and leading worldwide in all disciplins, from physics to humanities, from chemistry to economics, etc. Grenoble was selected as an example to illustrate a changing pattern: it shows the extent of capabilities that have to be put together to be a world leader in one "field", its illustrates the fact that, however rich universities are, they will no longer be able to cover the width of knowledge challenges. If I may say, though comparisons with firms have strong limitations, universities are faced with the same movement as firms, that is to define their core competences, concentrate their own efforts on them, and enter into lasting partnerships with others and their complementary competences[1]. My scenario is thus one of strong thematic concentration in a limited number of poles[2] and thus of "specialised research universities".

Does it mean that we keep the opposition, simply reducing the scope of research universities. Again my scenario is different. To be relevant for its proximity regional actors, a university does not require to turn into a world specialist. We can expect that nearly all regions will have universities with "sectoral" and "problem driven" pockets of relevance, and again examples

[1] Pushing further the image, one could also consider areas where leading universities externalize pieces of knowledge production which they wish to keep an hand on, while considering that there are enough other places in a position to undertake these activities so as to focus their own research capabilities on more strategic aspects.

[2] Ironically, even though there is not enough room here for such developments, the internet and its facilities for instant distant interaction, play more for harmonised production (from development of new products to production or access to users/customers) than for the exploration of new directions. The wide potential of exploitation (following March s distinction) de facto implies a higher geographical concentration of exploration capabilities, thus of far reaching research and innovation efforts (one must however always keep in mind that for firms the bulk of the research and development effort is on incremental work which can fully benefit from the new possibilities of distant activities).

show that these pockets cross (and often by far) regional borders. Thus, in 20 years from now, the core of public higher education institutions may well be located between the "teaching only" type of higher education institutions (in a way more prone to "private" initiative) and the "specialised research universities". It will be constituted by universities that focus both their teaching and research actvities around key "sectors" and key "problems" faced by their region/state. My guess is that the present balance in employment (between large and small firms) will apply for university training requirements, making of the locally rooted needs the dominant feature of more that four-fifth of existing universities.

These two changes push towards a reconsideration of the presently dominating model which considers the "department" as the adequate organisational setting for both research and teaching. Here the results of the sociology of science, which puts the "research collective" at the core of science dynamics, join with empirical evidence. Programmes fostering the emergence of "centres" have multiplied in Nordic countries, in the UK and even in the US, not to mention France where the notion of "research unit" has become the standard reference for the organisation of research activities both in research institutions and in universities[3]. To aggregate capabilities on a leading edge science or technology or to organise problem solving driven research activities, the disciplinary department is no longer adequate, specific structures are needed to organise the research activities of university professors, whatever their terminology is – center, unit, group, institute or laboratory.

Though I have developed more the changes faced by universities, it is clear that similar changes take place in the other components and that the changes are interconnected, making it more and more difficult to consider their dynamics separately, if only in their relations with economic actors. This is why I consider that **universities and public sector research at large are a critical feature of any future S&T policy, that they should dealt with together and thus that we should rather speak of higer education, science and technology policy as a whole. They constitute the fourth major challenge that public intervention has to face.**

CHALLENGE 5: RETHINKING THE PUBLIC ENGINE TO INNOVATION IN EUROPE

Is it enough for public intervention to foster the emergence of "science districts", to support SME innovation capabilities and to adequately fund and shape public sector research? Or should we reconsider the classical dichotomy made between countries about their economic performance, and requestion ourselves about the existence of a public engine to innovation.

10 years ago, it was fashionable to oppose Germany and Japan to the US, the UK and France. The latter were the loosers in the world economic battle that was taking place and the argument was simple: their military investment was the main source of their problems, not only through money diverted, but also through capabilities mobilised and the type of innovation practice that derived from public procurement. 10 years ago we were also in one of the rare presidential campaigns in the US (but also in all our democratic countries) where research and innovation

[3] I shall not enter here into details about the growing mixity that makes that nearly all CNRS researchers are now in mixt research units located on university campuses. CNRS is no longer a stand alone research institution but a true research agency which, instead of giving money to academics on the basis of their individual projects, allocates human and technical capabilities to collective projects borne by research collectives .

was central to the political agenda. Clearly the focus on the information highways, on basic research, on SME innovation capabilities and on intellectual property were a unique anticipation of future needs. But there was another interesting and forgotten priority, the use of military expenditure to support new product development. The Technology Recovery Program did not last long but I see it as a signal of the need for a "public engine to innovation". We should not forget that the core of US Federal effort is not through NSF or through technological programmes (NIST and ATP have always played a marginal role), but is "mission oriented", via the ever-growing budget of the NIH and via Defence. Bozeman, analysing the US military research effort when it was at its LOWEST point, highlighted the fact that it represented "3/4 of all federal money to industry, support to university equal to NSF and NIH, 50% of federal money in federal labs…". If we add the national labs linked to nuclear energy and supported by DOE, the picture is even more revealing. We should not forget the role of DARPA in the construction of the internet (which was then arpanet). These "mission oriented" policies (which are not to be confused with funding applied research) build the core of US Federal support and incentives for research and innovation. And the planning of the 2002 budget was already witnessing a clear increase before the last 11 september events. One can wonder whether this was linked to the arrival of G. Bush to presidency or to the downturn of the so called new economy. Whatever the origin, the last september events have strongly reinforced this move, even giving NIH the military touch that it was yet missing!

Today the US alone represent nearly 75% of total military expenditures of OECD countries. Should we just forget it? Or should we ask ourselves about a similar European engine to innovation? Should we follow the US and build a European military research policy? Military-minded countries such as the UK and France have chosen the other way round and have drastically reduced their military research efforts (in France it went from 36% of all public R&D expenditure in 1992 to around 15% today!). Even if we consider that it is a priority for Europe to have an autonomous European army to play a role in the regional conflicts that multiply, will this require new research or simply new equipment out of the shelve or with "incremental" adaptations to what already exists and/or "reverse dual technologies" (as the Airbus derived air transport troop carrier)? Furthermore, can we imagin being other than followers in research expenditure when representing at best one fifth of world expenditure, furthermore fragmented and having difficulty to be coordinated (as the failure of Euclid recalls)?

You can understand that I do not consider military research as an answer to the challenge raised. And that I consider it necessary to look in other directions. Recent successes – such as GSM where EC programmes were central in fostering the establishment of the standard or Wind energy where again EC programmes were critical to the development of large wind mills and to their insertion into the electricity grid – highlight both the role of EU initial research investment and of the choice of a differentiation strategy. Both stories (and there are some others) share in common their focus on "collective goods" where private initiatives coexist with collective choices about the organisation of markets, regulatory authorities and an important public initial role in the development of new products/services. And there is an ample list of collective goods that require such investments. The last 15 years can be described by the growing list of public issues we have been and are faced with, whether we consider environment, health or food safety. There are numerous examples to illustrate the changing attitudes vis-à-vis this situation.

The UK foresight tells us that global warming is not only an issue for researchers. Urban and transport research programmes tell us that aging is not only a financial issue, but also, and probably far more important, an issue of changing city and social life. Tanker wrecks periodically recall us that economic pragmatism and permissive international regulations might have growing limitations. BSE has revived the partly forgotten importance of the framing of markets through sanitary policies. Small events as the story of soccer balls for the 1998 world cup tell us that price might not be the sole criterion to consider for globalisation. I could multiply the examples that show that research and innovation on collective issues is more and more on the forefront of S&T policy agendas.

There is however one lasting paradox: Whatever the efforts made by the Fifth framework programme, the problems are shared but the policies mainly remain national. It drives to suggest that the public engine to knowledge creation is in Europe different than this of the US, and that we replace military needs by collective issues. We need **to truly build, in research and innovation, a federal level addressing the main public issues we face**. This is at least my understanding of the wider terminology of "knowledge based society" and I consider it at the core of a pro-active building of the ERA. The approach is all the more feasible that we have facing us the example of a mixed top-down / bottom-up policy that is considered as a real success and which size (around 25 billion Euros a year) is adapted to the challenge faced: structural funds. The fifth challenge is thus to establish, on a similar footing and scale, a **European wide innovation fund dedicated to collective issues**.

CHALLENGE 6: STRATEGIC INTELLIGENCE AND PUBLIC DEBATE AT THE CORE OF POLICY-MAKING PROCESSES

All my presentation has been up to now focused towards new directions. There is however a large gap between direction and policymaking, especially if one takes into account the results of A. Rip and his colleagues about the critical importance of "implementation structures" in the relevance and performance of public policies. Here we are faced to two main issues.

I have already mentioned the first one: the multiplication of "public authorities" involved in the building of research and innovation policies. Public intervention can no longer be assimilated to national policy and to the action of one government which handles internally all the necessary compromises, a situation all the more common in our European countries that parliaments have rarely played in our field an active shaping role. In its initiating role, the European Commission re-invented the concept of "subsidiarity" to speak about the new relations that should establish between public authorities. It however remains weak for helping in the design of "implementation structures" that enable the emergence, problem after problem, of lasting compromises and of co-ordination rather than duplication and competition. There has now been enough experience both within countries (with the decentralisation movement in quite a few European countries, UK and France included) and between countries (if only with the last 20 years of technology policy) to start addressing this issue in other than normative terms.

Putting collective issues at the core of the research and innovation policies link with a second fast growing movement which M. Callon in his last book labels "technical democracy". Research and innovation policies will have more and more to consider the conditions under which problems are identified, defined and the research efforts shaped. Stories like those of the

French AFM, the patient association against neuromuscular diseases, tell us that we need also to reconsider our notions about legitimate policy-makers, especially when taking seriously the concept of "knowledge society". It is thus essential to reconsider the procedures, processes and instruments which are at the heart of the transformation of S&T policy formulation and implementation. Foresight, technology assessment, evaluation, evidence based policies or public debate in all its variants are critical to the shaping and conduct of future S&T policies. I shall not tell more about them since they feature high in all the discussions that will take place in the next days.

CONCLUSION

In the developments made, I have tried to show the following facts.

(i) We can no longer consider "government" as such but should address the fact that, whatever issue is considered, we are faced to multiple public authorities and multi-level policy making. Public intervention is thus a better suited terminology to take hold of this entangled situation and for not considering ex-ante that their sum builds an articulated "policy".

(ii) The innovation dynamics of locally rooted SMEs are completely different to those of global companies, which furthermore are developing specific R&D localisation strategies (different from their production and marketing ones). I have not elaborated further these issues, I have only tried to identify their consequences on the two other components of the helix, showing the critical role that "science districts" or "poles" are playing for large firms, and the importance of proximity for local players.

(iii) Both movements impact upon our conception of the third component. Can we only consider universities or should we have a broader definition including dedicated public research institutions (so called government labs) and not for profit bodies? I stand clearly on the enlargement side, and on considering "public sector research" at large. Within it, it is however clear that Universities play a central role, but here again we have to requestion our implicit assimilation of university to the elitist model of the "research university".

This explains my initial position: the borders to break stand more within the established components of the triple helix between them. Of course introducing variety in our approach to each component drives to highlight the numerous bridges that connect them. But are they new? What is may be new is the changing centrality of long-existing bridges, such as start-ups. A final comment: Where the triple helix is powerful at lies in the fact that we cannot explain the move in any of the components without refering to its articulation with others.

The same developments explain why I consider more relevant to speak or "public intervention" rather than "public policy" and why I have proposed not to separate S&T from innovation and from higher education. Let me then sum-up what I consider the six main challenges public intervention in higher education, science, technology and innovation are facing or will be faced to in the near future.

- First public intervention has to be conceived in a unique and rapidly evolving environment of multiple public authorities. This drastically questions our accumulated knowledge of "national policies".
- Second, it has to take account of the changing techno-economic dynamics where "new" technologies no longer require central coordination but public incentives to local emergence.

Policies favouring the emergence and development of "science districts" and "poles" are crucial to this dynamics.

- This goes along with a renewed view of what constitutes a favourable knowledge infrastructure. I see two components of it. The first is a complete reappraisal of the too often taken for granted patenting policies. Ownership, circulation, access and trading of knowledge are different facets of the same reality which requires a comprehensive approach and not a one-sided treatment linked to appropriateness.
- The second facet and the fourth challenge public intervention faces, is to take seriously the extend, composition, organisation and dynamics of public sector research, defined in a broad terminology, thus including universities, government labs and the thriving not for profit sector.
- Fifth, I suggest that there is a public engine to innovation, that Defense plays this role in the US, that it should be different in Europe and that we replace military needs by collective issues. I further consider it central to a pro-active building of the ERA by adding to the FP another innovation fund built along the lines of the present structural funds (both in its working and in its size).
- Finally, such a change does not only require that we invest more on these issues than we do presently, but also that we fully reappraise the locus and the dynamics of such "mission oriented" policies. In this reconsideration, strategic intelligence and public debate are for me two central key words.

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