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University Research Activities: On-going Transformations and New Challenges

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Abstract. *In times when excellence is at the top of the research agenda of all research and innovation policies, especially in Europe, research universities are the implicit reference model of most policy makers and most public debates. However, the implications, that is a major geographical concentration of public means and the existence of a dual system of training, are rarely highlighted; it is on the contrary, often when there are references to "cohesion". This paper suggests that, although this trend is clearly visible, the situation is more complex. In particular, the analysis overlooks another central role of universities:* they have also become the main proximity knowledge provider. Both trends combine and result in radical transformation of university organisation – the separation of teaching departments from research structures, may these be called groups, units, centres, institutes or laboratories. This leads to question whether their present organisation is relevant to the socio-economic environment: I argue that the very fast increase of not-for-profit associations/foundations closely linked to universities are a lasting and promising feature of the university-society connection. These changes call for more study of university governance, certainly a pressing issue in countries like France.*

* The word "university" is used here as synonymous to higher education institution. Readers will understand how important the difference can be in a country known for its parallel system of *grandes écoles*, even more when considering the author's institutional background!

Introduction[1]

Not being a specialist in education studies, I was struck by three main aspects of change brought forward by my colleagues during the work which took place in the High Level Group on Foresight for Higher Education/Research Relations initiated by the European Commission in 2002. They deal with quantity, trajectories (cf. the growing importance of biographical planning) and curricula (new competences required).

There seems to be a consensus that, after the very fast increase of the last decades, we are reaching a plateau or even that we shall see a slow decrease in numbers, in line with demographic trends. Does this mean that the current level of about 30% of an age group going through higher education should be seen as a maximum level (as with the mythical figure of 80% of an age group for the *baccalaureat* in France)? If we believe that we are entering a new type of knowledge society, is it unrealistic to expect that half of an age group could go through higher education 20 years from now? If this is the case, then whatever the demographic trend, there will still be an important increase in numbers.

Making assumptions about this trend leads to a second striking aspect: we can foresee very different trajectories. Lifelong learning is a central element in evolutionary economics; on the job training or training through experience are important in features mentioned to explain the different performances of "national systems of innovation". However, up to now formal training at higher education level has mostly been considered as a separate function, most of the times provided through "ad-hoc" settings and generally over short periods of time. "*Formation continue*" as it is called in French is even a fast growing market where private dedicated entities flourish. In France, more and more universities and grandes écoles take account of this market which represents as important an activity as initial training in some institutions (in engineering as well as in management), but they provide for it as a completely separate activity, often creating subsidiaries for it; furthermore, in all cases, these training activities are not part of tenured staff duties.

What we are then considering when we speak of "formal" lifelong learning – the adjective is for me essential in this sentence, and often forgotten -, and following the Bologna adoption of the European credit system, is a complete redefinition of student paths. Assimilating initial training with

university should disappear progressively, not only between levels (it is not uncommon in the United States for PhD students to come back after having worked for some time, at least in my field) but even within levels. Peter Alheit expresses it clearly when he writes (p. 10): "university learning remains no longer an activity of young students before starting their professional career. It begins to be a usual necessity of adults' working life creating links between periods of professional work and new and repeated periods of scientific training ".[2] What is at stake is not so much an institutional reshuffling, changing definition of degrees (see for instance the recent translation of the Bologna declaration in the new French decree creating licences and masters with no reference to duration nor years, as was the case in previous other official documents about the well known 3-5-8) nor accreditation of prior learning from experience being already legally formalised. The issue is mostly one of transformation of university practices, and, more bluntly, of professional practices – there are not many studies on the collective functioning of university professors and even less comparative studies, which should be a high priority on the agenda for research on higher education in Europe!).

The third aspect is linked to the new competences required of students. J.J. Paul speaks of the growing importance of "behavioural features": "educated individuals who have learnt to learn". P. Knight proposes an impressive list of such features: "willingness to learn, self-management skills, communication skills, effective learning skills, exploring and creating opportunities, action planning, networking, coping with uncertainty, transfer skills, self-confidence, team-working, managing others, critical analysis, being able to work under pressure, and imagination/creativity". These "are learned, may be stimulated but cannot be reliably taught" (Knight). These "complex outcomes of learning" thus require new approaches. Problem/project based learning (PBL) is, at the core of such transformation according to A. Kolmos. Whether this entails more "situated technological knowledge and competencies", as suggested by A. Kolmos, or whether the objective is to "define training according to competences more than according to occupations" (J.J. Paul) remains to be further analysed. However, the issue remains the same. A strong new component complements the traditional transmission of established bodies of knowledge conceived in a disciplinary way, disciplines becoming narrower and narrower over time. However, it is difficult for this complement to occur through simple addition, leaving the traditional curricula untouched. Yet, it remains highly hypothetical that we are going to see new "transdisciplinary curricula" emerge: it is not by adding behavioural focused courses or statistics to history, etc., that the curriculum becomes interdisciplinary. What is probably true and difficult to accept for many long established disciplines is that the shared "common core" will become so

important that faculty or department barriers will be reset, and that, in numerous cases, what previously appeared as a fully fledged unified curriculum will turn into a set of different specialisations in a wider curriculum. For engineers, the very specific French approach where grandes écoles train "generalist engineers" before they specialise (within the école, in other higher education institutions or on the job) might well become the general rule: this is ironic, considering the longstanding debates in France about the elitists grandes écoles and "mass" universities!

However, these trends are occurring within a wider debate where the production of new knowledge is considered increasingly essential for the development of our economies and societies, and where universities are increasingly considered as the central locus of this very specific production process. The following sections present the two essential transformations that research activities in universities are faced with in their relationships with the economy and society: the growing importance of "science districts" and the major role of universities as proximity knowledge providers. Impacts on the organisation of universities will then be addressed and some hypotheses about their positioning within public sector research at large will be made.

The changing role of universities in new leading sciences and technologies

The first transformation relates to the role of universities in today's "leading" sciences and technologies, and, to use an OECD term, the corresponding *secteurs de pointe*.

Our colleagues from Pisa (Bonnacorsi, 2002) think that we have changed "search regime" with info and bio sciences and technologies. The former regime largely related to post WWII physics was convergent, while the present one is largely divergent. If one accepts over-simplifications, the old *secteurs de pointe* exhibited three main characteristics:

1. Their emergence was organised around large complex technical objects, such as nuclear power reactors, the progressive shaping of which entailed the existence of a lasting dominant design.
2. They required large specific, dedicated research infrastructures.
3. And they were thus prone to, and even required, central co-ordination, whether by government or by an oligopolistic structuration of markets with frequent reference to theories about natural monopolies.

The new technologies and sectors differ widely. Info and bio technologies are characterised by a proliferation of directions and the dynamics are not

incremental, continuous improvements of one dominant design, but rather a rapid succession of radically different designs.

At the same time, initiative is decentralised and more and more sites are in a position to promote new paradigms. Critical infrastructures are no longer specific to one design but generic, spread over several areas, as much intangible as material: the focus on information highways and on the appropriation regime for knowledge are two essential elements of this trend.

In these new *secteurs de pointe*, the globalisation of firms does not only concern markets and production structures, as was essentially the case until the beginning of the nineties, it also concerns their research and innovation efforts. Numerous studies highlight this trend. We have studied French large firms for five years at the end of the nineties and have documented the rapid and important internationalisation of research and innovation efforts (Larédo and Mustar, 2001b). However, this trend highlights a very different pattern for the location of their production activities. As an illustration, I would say that large firms research facilities congregate 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 a sense, 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 trend, with the highest French concentration of public research capacities. There are active research institutions (especiallly CEA and LETI labs) and very fast growing research capacities of universities (University J. Fourier in particular) and *grandes écoles* (INPG), all supported by CNRS through mixed research units (see below) – one of the best known and studied Technopole is the ZIRST de Meylan – with hundreds of high tech SMEs, active incubators and seed-capital companies to encourage start-ups – and now four of the largest micro-electronics companies which have joined together to build a huge nano "lab-fab", (with billion Euros investment). Such a gathering gives an indication about the length of time required (most public facilities were largely developed for nuclear physics and energy). There are not so many such places in the world, thus a global company will either locate there or in another similar place. The nationality of this "pole" or "science district" is unimportant; what is important is the concentration of means, the room for synergies, and last but not least, the human competences available.

To stress the difference between the two "search regimes", I often say that, for public intervention, we have moved from a model of specialised research institution (where universities play a marginal role) to a model of incubator where research universities are at the core of developments. We are thus no longer in an era of large centralised programmes, an era which was

not specific to France (the Concorde was a joint French and British adventure, Euratom dreamed to develop **the** European reactor…) and which is not over (space is the archetype of a full fledged European policy, and civil aeronautics has finally succeeded in bringing even basic technological research at the European level in the sixth European Framework Programme). We enter a period where the issue is to favour the emergence and development of decentralised "poles" and "science districts". What are the implications of these trends for universities? I see two major issues.

The first one is linked to a redefinition of the concept of research universities. The classical models (from Oxford or Cambridge to Harvard) are comprehensive institutions, which are excellent and leading in all disciplines, from physics to humanities, from chemistry to economics, etc. Grenoble was selected as to illustrate a changing pattern: it shows the extent of means that have to be brought together to be a world leader in one "field"; its illustrates the fact that, however wealthy universities are, they will no longer be able to meet the whole range of knowledge challenges. Although comparisons with firms have definite short comings, one can say that universities are faced with the same trend as firms, that is to define their core competences, concentrate their efforts on them, and enter into lasting partnerships with other institutions and their complementary competences. The image helps to see three aspects of this trend: *i)* the inherent relative nature of competition: it is not enough to be excellent, one has to be better, if one wishes to attract others; *ii)* the end of the process is not a stabilised world, but an "organised" if not "oligopolised" world where only a few remain ahead, probably not because they do everything, but because they are in a position, thanks to the means brought together, to shape the research agenda and allocate roles and activities; and *iii)* as for firms (as shown by the computer and electronics markets, see Christensen, 1997 or Hamel, 2000), changes in positioning are mostly linked to "radical" innovations and "breakthroughs" that allow the cards to be reshuffled through the new opportunities provided.

To project ourselves in the future, my scenario is one of strong thematic concentration in a limited number of poles[3] and thus of "specialised research universities". One interesting and puzzling issue concerns the degree of specialisation. For instance, it is striking to see the importance of social sciences in experiments about potential new uses (such as those of the Medialab). I am also interested in the difference between nano-technologies which require massive equipment investments and genome research where the investment remains within the reach of any sizeable region with a pro-active policy in the field (cf. for instance the emergence of the Genopole in the South of the Ile de France).

The second issue lies in the bottom-up nature of the process. The question is no longer one of central decision-making, as was the case before

when each problem entailed the creation of a specialised research institution or agency, but of progressive aggregation of means (human, technical, financial, organisational) around a localised set of initiators. The Grenoble example is all the more useful as it takes place in a country known for it over-centralisation, where, even though political decentralisation started over 20 years ago, universities still do not have control over recruitment or facilities. Even with such a background, the whole development is made jointly by INPG and LETI (one *grande école* and the local centre of CEA) supported by a city and the surrounding towns gathered in a district, by the "*department*" (95 in France) and by the region. The central government has played a marginal financial role, its main activity being a labelling one.

Such a bottom-up process requires difficult choices (why favour nanotechnologies? Even in an engineering university like INPG, this is not obvious) and thus strategy making capabilities: are Universities organised for this? It also calls for public authorities to change their approach, and to clearly give an important role to territorial public authorities (cities, regions) to initiate, and more of a procedural role (based on incentives rather than on direct allocation) to central governments (national and European). There is another implication for public authorities in general: this trend, which sets universities research activities at the core of research intervention, leads to question the separation often encountered between the handling of training and of research policies. Since they are addressed to the same actor, it appears sensible to knit together the various analyses and to create coherence and synergies between both. In short, this trends calls for a unique department covering higher education and research at all levels, and at the European level first.

Universities and the support of SME innovation capabilities

The growing importance of territories is reinforced by another trend: the radical shift observed in all policies addressing industrial research over the last decade. A shift from large firms and "national champions" to mythical SMEs. 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. But it is always difficult, if not politically incorrect, to say 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 representatives have told us the importance of local resources in their growth and success. The proponents of regional systems of innovation insist on the role of proximity, proximity of knowledge producers with whom they collaborate, proximity of public support. In all our countries the importance of "subnational" level is

increasing, and everywhere policies focus on supporting SME innovation capabilities as well as the emergence of new high-tech SMEs.

These policies exhibit three main features, two of which are well known and studied. There has been numerous studies on financial aspects, differentiating between venture capital (more focused on established SMEs) and seed capital where directly or indirectly public aspects play a central role (Mustar, 1997). Examples abound on the critical role of proximity: even central agencies, such as ANVAR, have been driven to a strong decentralisation of their activities (see Technopolis evaluation of ANVAR activities, 2001) and governments focus more and more on "procedural approaches" (as illustrated in France by the *crédit d'impôt recherche*). Similarly, much attention has been devoted to intermediate structures: most regions in Europe support a wealth of "technology resource centres" or structures devoted to "technology transfer". If some of these structures develop their own capacities, most rely on existing capacities. An on-going comparative analysis shows that, even in Italian districts known for their active inter-firm exchanges, public capacities are central to the development of SME innovation activities.

In other words, and this is the third main feature, in the vast majority of cases universities are the main proximity knowledge provider. Here the issue is no longer one of being a world leader, even one of excellence in the traditional meaning of academic excellence; it is one of relevance (addressing the problems of SMEs and focusing on the main sectors in which they specialise) and of professionalism (being good enough to tap and adapt/tailor the relevant knowledge). The work I have done on some of these "local", "invisible" universities shows that they undertake both post-graduate training and research activities, often with important socio-economic impact. Anecdotal evidence also shows that there probably is a strong connection between this activity and the "professionalisation" of diplomas (at the licence and master – very fast growing DESS in France – levels). These results echo the argumentation of K. Smith who shows that traditional industries (such as petroleum extraction and treatment) and even usual activities (such as fisheries and food products) require the latest and most complex technologies, gathered in what he calls "distributed knowledge bases" (Smith, 2002).

What are, for universities, the implications of this second trend and how does it relate to the previous one? One very first aspect is that it does not require of a university to become a world specialist in order to be relevant for its proximity regional actors. One can thus expect that a university can provide answers to more than one problem shared by a set of firms, or specialise in more than one sector. However, different regions and territories feature very different focuses and/or specialisations. Thus, the more universities relate to their local environment, the more diverse they will be.

The concept of "distributed knowledge bases" does not only call for distribution among actors, it also entails a distribution among disciplines and traditional university departments. Contextualisation (as proposed by A. Kolmos for teaching) also plays an active role: ICT in food products may indeed be very different from ICT in petroleum industries. The question of how to organise research between "discipline oriented" and "problem solving" structures is a second problem that universities will have to face more often.

A third aspect relates to the tension between the two trends: can universities simultaneously be world class institutions and be relevant at the local level? To my knowledge, there has been very limited research work on university dynamics which address the two issues equally within the same conceptual framework. There are two "simplistic" answers which I consider counterproductive in anticipating the future. One is, the comprehensive all-encompassing university (being world leader in all disciplines). This view is mirrored in the traditional distinction made in the United States between research and non-research universities (using criteria such as publications or federal research funding) and in the "dual training" system associated with it. The other is to consider that all universities can participate in world leading research with pockets of excellence. It is part of the US rhetorics which claims that cohesion objectives can be compatible with the building of networks of excellence. Both views represent for me extremist scenarii: I believe neither in ultra-concentration nor in wide dispersion, nor do I think that new communication infrastructures and tools can replace geographical concentration.

Not all regions will thus have universities competing on world leading edge sciences and technologies. But nearly all regions will have universities with "sectoral" and "problem driven" pockets of relevance that go beyond (often by far) regional borders. Does this mean a dual system? Again, a parallel with firms can help locating the issue. Is a region without large global players a backward region? If the focus is on SME capacities, is it not because they are the active component in regional competitiveness and employment? The respective roles of small and large firms in employment creation (a crucial issue for training), at all levels, should be examined more carefully in order to assess needs. My guess is that we are witnessing a fast changing balance of roles between the two as is demonstrated by the growing role of SMEs in the restricted Frascati definition of R&D efforts. And 20 years from now, the present balance in employment will apply to university training requirements, the locally rooted needs becoming a determining feature for at least four out of five existing universities.

The conclusion about the two transformations above is quite clear. Diversity of higher education institutions is a key towards relevance for the knowledge based society we are aiming at. The institutional changes which

have been underway for 20 years in most European countries reinforce this trend. Even in centralised countries such as France and United Kingdom, we are witnessing the growing role of the "subnational" level. Thus we can expect to see a growing differentiation between regions, at university level, and that this differentiation will be as much, and may be more, intra-national as international.

The organisation of universities: emerging trends

These changes have implications for public policy making. My presentation has only focused on needs of companies, while similar trends occur for research concerned with public issues and needs; I consider this question to be even more essential than firms' competitiveness.[4] However the objective is not to address all the challenges that S&T policies face, but to focus on those which heavily impact upon universities. It is enough to say that the dual trend of high thematic concentration in science districts and of wide development of universities as local knowledge providers also applies for public issues, such as health. In this last section, I will highlight three emerging trends which show possible future main characteristics of university organisation. They concern the distinction between teaching departments and research structures, the use of not-for-profit bodies to link with society, and the relationships between universities and so-called government labs.

Structuring research and teaching activities separately

It is difficult to examine the organisation of research activities without taking major results of science studies into account. One major result (as early as the end of the 1970s) has been to highlight the importance of tacit dimensions in the making of science (Collins, 1974) and to "populate" laboratories. We have moved from a model in which scientists are surrounded by "shadow" executants to one where researchers work with technicians, doctoral students, and visiting colleagues who meet to progressively build this tacit knowledge and the new rules of the trade through experiments and with the instruments which support them all (Latour, 1987). The laboratory becomes a focal point, where what Gallison beautifully calls the "hardwiring" of theories takes place. In this context, interrelated statements extend beyond the domain of codified knowledge to link technical devices, human beings and inscriptions. Law speaks of "heterogeneous engineering" and Callon of "extended translation" to qualify these activities, characterised by blurred boundaries and hybrid situations (public/private, interdisciplinary, fundamental and applied at the same time, etc.). This explains the quest for more "connectivity" within systems and thus for more "networking" and

Mertonian approach	Latourian approach
Complete divide	Translation
Scientists	Researchers in laboratories
Republic of science	Hybrid collectives
Invisible colleges	Co-operations
Linear coupling to society: valorisation / transfer	Whirling, interactive coupling with society: network model
Certified knowledge as sole recognised output	Output "vector" linked to involvement in different environments: CSI research compass card model
Focus of analysis: individuals	Focus of analysis: laboratories and networks

"collaborative" research. The box below proposes a summary of the changing paradigm within which a new interest in laboratory studies has developed.

This framework recognises that research is a collective endeavour, mixing heterogeneous actors, competences and capacities. It puts the emphasis on the "collective" setting, intermediate between individual researchers and research institutions. In such a framework, policies/strategies cannot rely only on "content" dimensions *i.e.* thematic priorities, they have also to pay attention to organisational aspects. Questions such as "Do we have the right research groups? Are they inter-connected enough? What about their contacts with their environment?" are more and more pressing.

Therefore, an increase of programmes or actions dedicated to the emergence of research centres is not surprising: the Engineering Research Centres in the United States, the Collaborative Research Centres programme in Australia, programmes on centres of excellence in Sweden, Finland or Norway, the Top Technology Institutes in Netherlands or the research centres promoted by different Research Councils in the United Kingdom. In other countries, different initiatives have promoted the idea of "laboratories without walls" (or of "poles" as in Belgium). In France the "research unit" (*unité de recherche*) progressively became the standard entity, organising activities not only within given research institutions but more and more within universities, where teaching departments are no longer the sole locus of research activities. Furthermore, most research units are "mixed", meaning both that they are under the shared responsibility of two or more institutions (typically one university and one research institution, mainly CNRS) and that they bring together university "*enseignants-chercheurs*" and full time researchers from research institutions (Table 1). Similar trends, though less systematic, are also found in Italy and in Spain. It is argued that the research assessment of university capacities in the United Kingdom leads to similar arrangements (PREST, Policy Research in Engineering, Science and Technology, 2000). On the other hand Mayer Krahmer (2001) argues that todays's dispersed German University research is closely related to the university chair system; and the

Table 1. **The average composition of research units linked to CNRS**

	Percentage	Number
Enseignants-chercheurs ("teacher researchers")	14	29
CNRS researchers	9	18
Researchers from other public research institutions	2	4
Ingénieurs de recherche (other research staff with postgraduate degrees)	4	8
Other technical personnel	10	20
Doctoral researchers and Postdoctoral researchers	10	21
Total	**49**	**100**

Source: Larédo and Mustar, 2001.

Volkswagen Stiftung is developing a programme to support universities which are ready to depart from this system (Krull, 2001).

Whatever position the universities prefer, the trend towards an organisational separation of the entities in which individuals perform their activities of teaching and research is increasing. The separation of teaching departments and research groups is the first emerging trend which may well foreshadow the future organisation of universities. It raises numerous questions about the emergence, shaping, dynamics and overseeing of such "groups", "units", "centres", "institutes" or "labs". However, there has only been limited research efforts to clarify these aspects and go beyond the stereotyped well known positions, not even to have a better view of the mix of activities and the different "activity profiles" these labs exhibit.[5]

Relations with the economy and society

There is far less structured evidence of the second trend. However there is an increasing number of signs indicating its growing importance. Let us collect evidence. In Finnish Universities it has been a long standing policy to develop "transfer offices" connected to universities but with a different status to promote, facilitate and organise links with the economy. After a decade of operation, it was considered time to reorganise university management and to integrate these offices within normal university functioning. More in-depth analysis led to abandon this idea to and keep both entities separate (Ormala, 2001). This is part of a wider trend: we have already mentioned the fast rise of regional intermediate structures that connect firms with universities. But besides being intermediaries, more and more, not for profit organisations are used to address the needs of laboratories for specific infrastructures, equipment and instruments, and human resources. In Portugal the rise of university research capacities is strongly linked to the emergence of university connected NPOs (Henriques, 2001). In the United States, not-for-profit research centres located on university campuses and operated by university

professors have multiplied.[6] In France, after a freeze of nearly 20 years related to the institutional changes of the 1980s, this trend is active again and *Armines* (French Research Association "oriented" towards Industry) might soon be followed by others, offering a useful model to connect with the economy and society. The objective of *Armines* is to help bridge the gap between *grandes écoles* (and firstly the *École des Mines* de Paris) and actors in the economic and social sphere. The process is to enter into a lasting contractual arrangement with each higher education institution whereby research centres are transformed into "joint research units" for which *Armines* manages external relations/connections. Thanks to the resources collected *Armines* brings in new equipment and new human resources directly employed by Armines. One can measure the importance of such a construction by looking at the composition of joint labs between the *École des Mines* and *Armines*. Their staff includes about one thousand persons, nearly half of whom are employed by *Armines*. Such a structure has a major impact: it places research centres at the core of research development and gives a major role in strategy making to the directors of these centres who are responsible for decisions regarding both the *École* and *Armines*. Thus it creates a parallel hierarchy (to faculty heads) in the institution.

According to this model it is difficult, if not impossible, to manage teaching and research activities with the same instruments and processes. It also implies that the public dimension of teaching is quite strictly regulated, largely associated with public management. If one requires university research to be flexible, reactive and connected to economic and societal issues, another type of management is required. This is why, from Portugal to Finland – and here these two geographic extremes of Europe are symbolic of the general dimension of the issue -, there have been attempts to find new approaches in what is sometimes called the "third sector" (keeping the objective of public service while adopting more private sector methods of functioning, which is the case with many public utilities services but which requires specific developments for university research). The second emerging trend, largely related to the first one, is thus a separation of management with a growing importance of not-for-profit structures in the management of university research activities.

University research in the wider framework of public sector research

In OECD statistics (and under the Frascati manual), public performers of research are divided into three distinct categories: higher education, other government research institutions (often labelled government labs) and the often forgotten not-for-profit sector. A previous EC project devoted to a comparative analysis of European public performers has shown the continuum between these different types of performers and the blurring of

boundaries and roles. The wording "public sector research" has been adopted to account for these transformations (see the special issue edited by J. Senker in Science and Public Policy). The evolution of government labs has been further analysed by Cox *et al.* (2001) and is further documented in an important comparative EC project (Eurolab, final report, 2002). The main results can be summed up around two main points.

- Government laboratories, which were under strong pressure during the 1980s and the first years of the 1990s, have been stabilised and confirmed in their roles in most countries.
- The traditional association of basic research and universities on the one hand, and of government labs and applied research on the other, no longer holds. We have documented the blurring of activities. Using France as an example, we have shown a convergence of research activities at the operational level of research "groups", with all types of research activities in all types of institutional settings (Larédo and Mustar, forthcoming). This convergence occurs more and more when "mixed research units" (or "joint research groupings") are established and leads the so-called "mission oriented" government labs to become "domain oriented" labs, covering the full spectrum of research activities in their respective area of speciality (Larédo, 2001b).

The question is then whether this trend will lead mission-oriented institutions to progressively become another type of university research supporting agencies.[7] This hypothesis, which we have not proposed, can be summed up as follows: the more a "research group" requires "heavy" equipment and/or undertakes repetitive activities (such as tests), the more it will be dependent on the non university institution that supports it, whether CNRS or research council, or any domain-oriented institution (like INRA for agriculture and food products or INSERM for medical and health research in France). This calls for another definition of the modes of intervention of domain-oriented institutions within public-sector research. It does not diminish their role in developing in-house research capacities, but redefines the boundaries between what is done within university structures and what remains largely out of the scope of universities, requiring specifically tailored units and may be specific campuses. In other word, a third emerging trend consists in a redifinition of boundaries between different research areas within public sector research. Whether related to excellence at international level (as the example of nanotechnologies in Grenoble illustrate), or focused on relevance to local/sectoral actors, university research can no longer be thought of in isolation, without taking into account the context of other actors in public and not-for-profit research. This will lead to increasingly hybrid research operational structures, a trend fostered by and reinforcing the separation between university teaching and research structures.

Preliminary summary

All the studies on the "knowledge society" emphasize the essential role of universities, partly contradicting an over-simple interpretation of Mode II models. This concerns both activities undertaken by universities: training and research. This article has been focused on the latter.

However, three elements identified in the work done on teaching echo research activities and impact on them: 1) we may not have reached a plateau, not because of general aspects (decreasing demographic trends) but because of specific ones (an increasing proportion of an age group enter higher education); both aspects being closely related, this has indirect implications for the level of research activities, if only through criteria for recruitment and career development; 2) however it will be more and more difficult to think of training as "initial training", rather it will be lifelong learning which entails significantly different requirements and teaching practices; 3) at the same time, most authors insist on the importance of new competences required and on the impact both on teaching/learning practices and on curricula. Both trends indicate that, if only for teaching, the present organisation of universities in departments will have to undergo major transformations, a situation which may well reinforce the trend towards a separation of the structures in charge of education and research.

This article has argued that universities are also faced with wide ranging changes in their research activities. They have to face at the same time a global concentration on new leading edge sciences and technologies, and a fast rising need to serve as relevant knowledge provider for the local/regional communities in which they are embedded.

Addressing the long term future of university research raises the issue of how both roles can be articulated. Two opposite scenarios are formulated, often implicitly. The first one reproduces the stereotyped view of the US system described as a dual system, where a few research universities concentrate all world class research across all disciplines, while most others concentrate on professional teaching and locally relevant applied research. The second one considers on the contrary that both objectives can go together and that each university can answer both requirements, being simultaneously relevant to regional communities and developing pockets of excellence. A more sensible view is to recognise that both scenarios are unrealistic: on the one hand, the spread of excellence will be wider than proposed in the first scenario, as universities will be driven to specialise because of the resources needed; on the other hand, problem solving or sectorally driven research will represent the core of research needs, and, as demonstrated by K. Smith, will require more than applied research.

In both cases, development entails a profound transformation of the organisation and conduct of research activities in universities. The three emerging trends identified call for more in-depth analysis and may not be the only ones to consider. The major trend is that of separation of teaching and research structures, departments focusing on teaching and training challenges, while "research groups" should enable more "ad-hoc" structures, favouring interdisciplinarity or/and problem based research activities. Two other trends complement and reinforce this main trend. First, an increasing number of universities establish separate supporting management structures, and develop not-for-profit structures to promote and organise their relations with the economy and society. Second, these trends must be viewed in the wider framework of public sector research, taking into account the on-going transformations of government labs as regards both their research activities and the ways in which they undertake these activities: there is some evidence that more hybrid structures and the development of "joint" research groupings on university campuses are becoming more common. Taken together, these trends raise a set of questions about the "government of universities", not least by obliging them to have distinct strategy making processes for teaching and research. This is probably the greatest challenge facing universities.

List of acronyms

ANVAR	Agence Nationale de Valorisation de la Recherche, "Agence française de l'innovation".
CEA	Commissariat à l'Energie Atomique
CNRS	Centre National de la Recherche Scientifique
DESS	Diplôme d'Etudes Supérieures Spécialisées
ERA	European Research Area
FP	Framework Programme
ICT	Information and CommunicationTechnology
INPG	Institut National Polytechnique de Grenoble
INRA	Institut National de la Recherche Agronomique
LETI	Laboratoire Electronique de Technologie et d'Instrumentation
NPO	Not for Profit Organisation
OECD	Organisation for Economic Co-operation and Development
PBL	Problem/projec t Based Learning
PREST	Policy Research in Engineering, Science and Technology
SME	Small and Medium size Enterprise
ZIRST	Zone pour l'Innovation et les Réalisations Scientifiques et Technologiques

Notes

1. This positioning paper is based upon the work done on an international comparative analysis of research and innovation policies [Larédo and Mustar (eds), 2001], on longitudinal work on the development of public research activities in a regional setting (Larédo and Mustar, 2000) and on the comparative analysis of research collectives in human genetics (TSER PSR project, for a review of results, see Larédo, 2001). The main points have already been presented at the STRATA consolidating workshop on science and technology policies in Europe (Brussels, 22-23 April 2002).

2. We even start to find it translated into political programmes; see for instance the recent French presidential campaign and the proposal of some candidates to create a "right" to lifelong education; (this was seen, in one case, as five years of guaranteed income available to each person and to be used at anytime during his/her working life, after reaching majority).

3. Ironically, the Internet and its capacity for instant distant interaction play a more important role in "harmonising" production (from development of new products to production or access for users/customers) than in exploring new directions. The large potential of exploitation (following March's distinction) de facto implies a higher geographical concentration of exploration capabilities, and therefore of far reaching research and innovation efforts. However, one must always keep in mind that for firms, the bulk of the research and development effort concerns incremental work which can fully benefit from the new possibilities of distant activities.

4. I have developed this point in both my introduction to the STRATA consolidating workshop on science and technology policies in Europe and the Barcelona conference on "policy, institutions and citizens in the knowledge society". Briefly, the argument is that "public needs" have always been a major engine for private innovation activities. One cannot understand the US dynamics without taking into consideration the overwhelming role of Defense research. The issue for Europe is to consider whether there can be another public engine. I argue that public needs (in health, environment, training, culture …) can provide such an engine, but that this requires to go one step further in the ERA than simply updating the tools of a stabilised FP and of offering once more a process that has in fact demonstrated its limited scope of application (article 169).

5. For initial results, see Larédo and Mustar (2000) and the PSR project on labs in human genetics (results synthesised in Larédo, 2001).

6. Some consider it as an answer to the difficulties encountered in the traditional university career stages (see analyses by P. Stefan) while others see this trend as adaptation to conditions for public research with the growing need of full-time researchers.

7. The wording of funding agency is a restrictive interpretation of support. One should remember that a number of British research councils own specific labs and facilities which serve the community at large. Similarly, CNRS in France can be understood as another type of supporting structure for university research where financial support to individual projects is replaced by human and equipment support given to collective projects (embedded into the four year project of mixed research units). Readers should also realise that over 90% of the 15 000 CNRS researchers and engineers are located on university campuses in such mixed research units.

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Index to volume 14

The following section contains a list of contribution published in Volume 14/2002. The list is organised in alphabetical order of authors. The title of articles is listed only once in the case of multiple authors.

Appropriate articles are abstracted/indexed in Current Index to Journals in Education (ERIC).

Information for authors

Contributions to the IMHE Journal should be submitted in either English or French and all articles are received on the understanding that they have not appeared in print elsewhere.

Selection procedure and criteria

Articles are selected for publication by the Editor of the Journal and submitted to independent referees for review.

The Journal is primarily devoted to the needs of those involved with the administration and study of institutional management and policy in higher education. Articles should be concerned, therefore, with issues bearing on the practical working and policy direction of higher education. Contributions should, however, go beyond mere description of what is, or prescription of what ought to be, although both descriptive and prescriptive accounts are acceptable if they offer generalisations of use in contexts beyond those being described. Whilst articles devoted to the development of theory for is own sake will normally find a place in other and more academically based journals, theoretical treatments of direct use to practitioners will be considered.

Other criteria include clarity of expression and thought. *Titles of articles should be as brief as possible.*

Presentation

** Electronic submission is preferred. ***Three copies*** of each article should be sent if the article is submitted on paper only.

Length: should not exceed 15 pages (single spaced) including figures and references.

The first page: before the text itself should appear centred on the page in this order the title of the article and the name(s), affiliation(s) and country/countries of the author(s).

Abstract: the main text should be preceded by *an abstract of 100 to 200 words* summarising the article.

Quotations: long quotations should be single-spaced and each line should be indented 7 spaces.

Footnotes: authors should avoid using footnotes and incorporate any explanatory material in the text itself. If notes cannot be avoided, they should be endnotes typed at the end of the article.

Tables and illustrations: tabular material should bear a centred heading "Table". Presentations of non-tabular material should bear a centred heading "Figure". The source should always be cited.

References in the text: Jones and Little (1986) or Jones *et al.* (1988) in the case of three or more authors. However, the names of all authors should appear in the list of references at the end of the article.

References at the end of the article: references should be listed in alphabetical order under the heading "References". Examples of the reference style used in the Journal are:

- For periodicals: DUKE, C. (2000), "Beyond 'Delayering': Process, Structure and Boundaries", *Higher Education Management*, Vol. 12, No. 1, pp. 7-22.
- For books: DE WIT, H. and J. KNIGHT (eds.) (1999), *Quality and Internationalisation in Higher Education*, OECD, Paris.

The covering letter

This should give full addresses and telephone numbers and, in the case of multi-authored papers, indicate the author to whom all correspondence should be sent.

Complimentary copies

Each author will receive two complimentary copies of the Journal issue in which his article appears, in the original language.

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