WHITE PAPER

ULAB

MODELLING THE TECHNICAL RESEARCH UNIVERSITY OF TOMORROW

HOW TO BUILD THE TECHNICAL UNIVERSITY OF TOMORROW

Ulab is funded by the European Commission under the Science in Society program of the 7th Framework Program
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http://www.ulab-fp7.eu/

SEVENTH FRAMEWORK PROGRAMME

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White Paper:
How to build the Technical University of Tomorrow

Conclusions and recommendation from the Ulab activities

Ulab. European Laboratory for Modelling the Technical Research University of Tomorrow
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"Prediction is very difficult, especially about the future"

Niels Bohr (1885-1962)

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1. Ulab objectives

The main goal of the **Ulab project** (***U**niversity **Lab:** "Modelling the Technical Research University of Tomorrow"*) is to foster the **modernization of the structure** of European Technical Universities by enhanced efficiency and competitiveness in the provision of its three main missions: education, research and dissemination.

Ulab pay special attention to research and innovation aspects and to their interactions with the productive sector and society, in line with the Council's mandate stated in its Resolution on "*Modernising universities for Europe's competitiveness in a global knowledge economy*".

Figure 1 shows a high level structure of the **Ulab** project in its **four main work packages**. These projects are focused on key aspects driving structural reforms: the creation of research support structures and resources management, the valorisation of research results, the way that entrepreneurship is addressed and the value of outreach activities to link to society. Other relevant aspects in University life related to teaching activities or to the conventional academic research activities were not considered in the **Ulab** project.

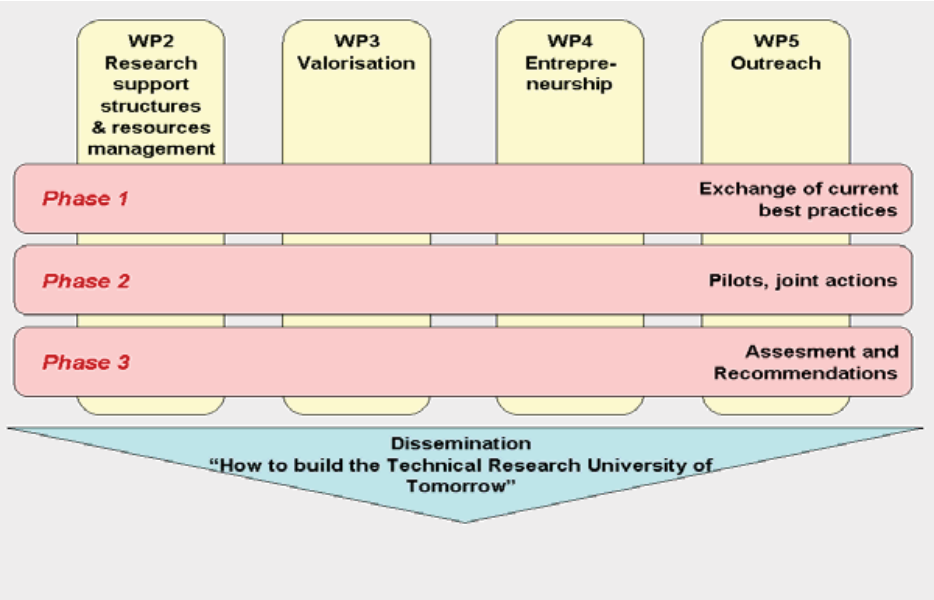

Figure 1. **Ulab** workpackages

Then, the **Ulab** workpackages goals were carefully selected to cover some relevant aspects under discussion in European universities which will affect the structure and mission of less consolidated parts of technical universities and their value to society.

Four of the **Ulab** partner universities can be considered as "technical universities" (TUM, POLITO, Paris Tech and UPM have focused their basic academic offer in technical degrees), Oxford is a more comprehensive university but with a large set of technological departments and research centres which offer a large number of technical undergraduate and postgraduate

degrees. Thus, for the purposes of this document, Oxford University has been used as a comparator case to develop our ideas and suggestions for the Technical University of the Future.

We are well aware that the limited scope of the project with only five universities involved in it avoids a direct extrapolation of **Ulab** findings, experiences or approaches to all European universities; however, world-wide, European, national or local actors could use some of the ideas contained here to feed up their own internal discussions and drive future structural reforms. We hope to contribute to this stimulating multi-actor dialogue and **Ulab** partners are ready to continue this process in the near future.

Figure 1 also summarizes the phases in the execution of the project. Phase 1 (exchange of current best practices) was carried out during 2011. Some of the identified practices or derivations from them were also implemented in other partners during the second phase of the project (pilots, joint actions). Based on the experience and the internal reflection among **Ulab** partners, the assessment and recommendations for the final phase 3 are envisaged. This document summarises the main findings in phase 3 with a conceptual framework for the discussion as the **"Synthesis White Paper"** to be delivered at the end of 2012 accordingly with the **Ulab** Description of Work (DoW). Figure 2 depicts this process.

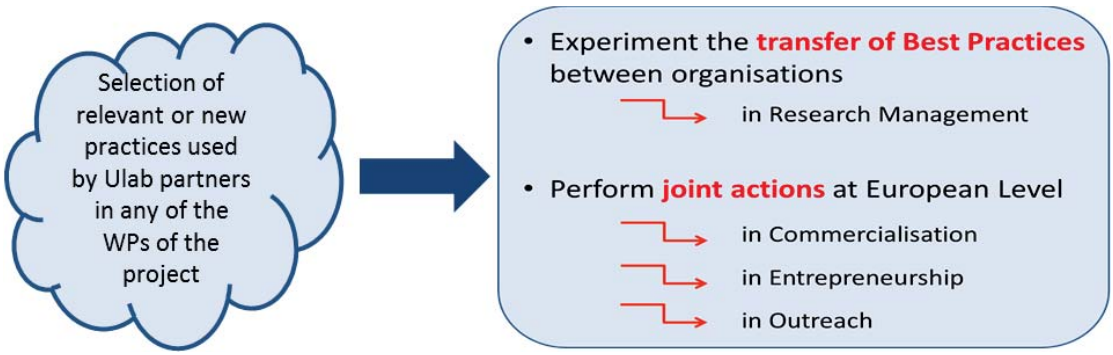

Figure 2. Pilot experiences

From the **Ulab** point of view, several main trends have been considered as catalysers for the structural reform of European universities. The following sections include the rationale behind those trends and some examples extracted from the **Ulab** identified practices[1]. The examples do not intend to be exhaustive but to offer a general feeling of the efforts conducted by **Ulab** partners in order to test new policy approaches.

The **trends** described in this document can be also found in many other universities in the world; they are not exclusive to EU universities'. Nevertheless, European diversity offers a wide range of solutions or pilot experiences which can take advantage of the approaches used in other universities and adapted to national contexts.

[1] A complete description of all identified practices is included in the **Ulab** deliverables produced during the first phase of the project.

The "boxes" scattered through the text shows some examples which reflect the interest of **Ulab** partners in exploring new ideas. These examples do not intend to enter into details of the results obtained in pilot cases developed in different workpackages of the **Ulab** project but to summarize main findings as a basis for discussion.

Ulab partners have prepared a comprehensive Web page (http://www.Ulab-fp7.eu/) where the different deliverables and other relevant documents related to the project can be downloaded.

2. Drivers for the evolution of European technical universities

2.1. Introduction

Modernization process of Universities arises as an answer to face the deep challenges which are putting at risk the traditional way of carrying out the University's mission in society and to ensure their societal value and competitiveness for the future.

This process was launched by the European Commission and endorsed by the European Council and European Parliament since 2007 as an answer to the general concern about the role played by European universities and the need to reinforce their relevance and attractiveness as a key factor for boosting growth and competitiveness in Europe.

The rationale behind the support to this modernization process within FP7 (Science and Society theme in the Cooperation specific programme) derives from the convincement on **the driving force of research and innovation support in the structural reform** within universities and the increased role played by the **valorisation** of their research results to boost **entrepreneurship** and **outreach**.

From our point of view, we are living in a transition process where the focus of university effort is widening. In addition to the academic offer and research structures (and their relationship) which characterises the structural models today, other aspects like valorisation, entrepreneurship, outreach, etc. emerge as relevant. It is true that some activities around them are in place in most part of technical universities but their relative importance will grow up in the future as figure 2 shows. Ulab project is explicitly devoted to experiment on these transformations.

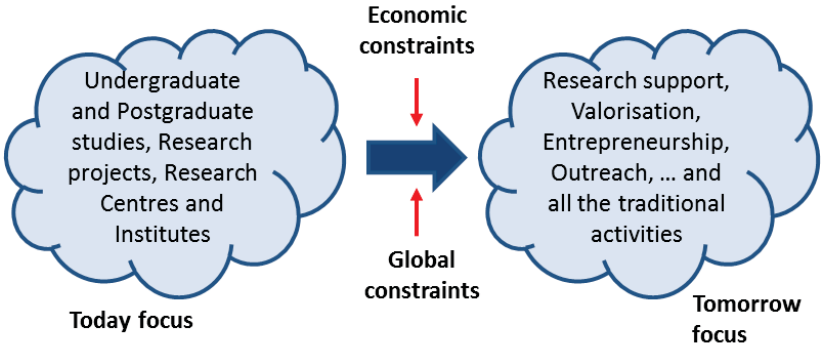

Figure 2. Shift in focus

There are striking differences within the diverse university systems in several European countries (with respect to their legal framework, funding structure, tuition fees, recruitment of faculty members, autonomy level, internationalisation, etc.) to adopt a unified model; but general trends and challenges for universities are quite general in the EU, even if solutions should be adapted to specific legal, socioeconomic and cultural contexts.

Ulab partners are well aware that public[2] **European technical universities** need to face challenges not very different from those ones facing the rest of European comprehensive universities. Many of the challenges identified by **Ulab** partners during the project execution are also common in all of them because they are linked to general trends in the evolution of society affecting all public institutions. Nevertheless, approaches taken and implemented by European technical universities to face those challenges came from their specificities, external pressures affecting them, the relative consequences of those challenges in their governance structures, and the experience gained from successful or bad experiences tested until now.

The interaction with non-technical areas is also relevant because, even if those areas are not formally covered by a single technical university, it will be much more common in the future to address societal challenges from a multidisciplinary approach where formal agreements with social sciences or humanities departments will become necessary.

The well known cases of biomedical technology, geo-engineering, web contents or social networks theory, etc. all of them covered today by technical universities show the interplay between technical and non-technical areas where universities are offering new innovative multidisciplinary-based degrees stimulated by intense world-wide competition to attract the vest students and faculties and to boost long-term alliances with other partners.

This section 2 offers a set of practices identified from **Ulab** partners during the development of the project. They reflect the institutional answer to main challenges in order to increase competitiveness in the global context. Practices are presented with a rationale from the drivers for structural reform which have been considered more relevant in the European context of public technical universities.

2.2. Globalisation and the efforts of Universities towards "smart specialisation".

Historically, universities' activities were strongly linked to a limited geographical area. A huge percentage of their students and faculty members, most part of the available resources for their annual budget, or even the relationship to other actors (both enterprises and other universities or research centres) had a deep local or regional root. Universities felt themselves as members of a social community rooted in a given territory where their campuses were located. In some cities (mainly on the small ones), the University became the core of the social life of the community.

Globalisation is a very general trend affecting all societal aspects. When it is applied to the European university context it refers to the potential wider role to be played by universities in

[2] Private universities could also share with public universities some of the challenges identified here but their barriers and solutions for change are radically different based on key differences in governance and funding models. This document refers exclusively to public universities.

order to keep or to strengthen their competitiveness in a deeply interconnected world which is rapidly modifying the situation found today.

It is true that knowledge generation was always considered as a global process and many faculty members or researchers collaborate with other colleagues working in other countries. Universities also participate in international R&D projects with other industrial or academic partners (as happens in the EU Framework Programme) and research results are published in international journals with international peer review; however, the **structural impact** of these international research activities in European universities was very low.

More specifically, the percentage of researchers involved with respect to the total payroll, the volume of funding obtained through the participation in those international programmes or the influence or contribution of the exploitation of research results to the global figures of the annual budget are very small in the large majority of European universities to drive deep structural changes. Nevertheless, other side-effect aspects derived from the globalisation process, however, have a clear structural influence as they will be discussed later in this section.

In practice, the majority of the European universities were considered themselves and by the national or regional governments who funds them as "national or regional universities"[3] with an institutional and governmental will to see them as a key factor for the socioeconomic and cultural development of their geographical environment

Within this context, it is very common for European universities to receive direct or indirect pressures from national or regional authorities to increase the research links with other national or regional entities (mainly with enterprises and national research centres) in international research programmes or through specific bilateral agreements. Then, the common worries expressed in the past by national authorities on the participation of "their universities" in international consortia (i.e. in the Framework Programme) where there were no other national entities reflect the will to use public universities as drivers for growth at the national arena (by assuming that efforts made by faculty members from national universities in those research consortia without other national entities will not contribute to national or regional progress).

This scenario deeply changed in the last two decades and more intensively since the beginning of the XXI century. Today, all universities should compete for the best students, researchers, professors, grants for research projects, jobs for their graduates, or economic resources in a global scale. The only use of local (national or regional) resources is not enough to guarantee international relevance and the increasing use of mobility programmes for students is making easier for them to select the preferred university in a wider geographical context.

As a consequence, the perceived quality and attractiveness of the University is not only a factor perceived national or regionally by a set of well defined local factors; it shifted to a

[3] Only in some European countries like Switzerland there is a formal difference between "federal universities" and others. Usually, the legal framework is the same within a given European country although the sources and volume of public finding could vary.

global competitiveness factor to ensure the long-term economic stability and relevance of Universities which is increasingly supported by national authorities.

National and regional authorities are also aware of this deep change and they have understood the importance of **promoting the internationalization of "their" universities** even if they like to see them anchored in some way to specific territory in order to boost growth and employment. A deep convincement on the possibility to combine both goals still persists although the right balance is difficult to set up a priori.

Universities are convinced that they cannot compete in all scientific domains. **Ulab** partners are well aware that for the majority of European universities to get international relevance and worldwide leadership in all the conducted activities in research, education and dissemination is not possible, except in a few exceptional cases. In the same way that other private entities or even local or regional entities are doing in the last years, the approach taken by European universities to ensure their international positioning come from their ***"smart specialization"*** in a global context[4].

The concept of *smart specialization* implies to focus the research, postgraduate teaching and innovation activities in some scientific and technical areas (both from the research and academic offer) where they could compete better for the resources mentioned above and to build up its international relevance based on them. This fact could have consequences in the allocation of internal resources (both material and human resources) and in the governance schemes to facilitate priority setting.

More specifically, this trend is characterised and accelerated by the combination of the elements described in the following sections. These elements were not explicitly addressed in any of the deliverables of the **Ulab** project but they were implicitly considered by **Ulab** partners in the analysis of their current situation

2.2.1. Students and faculty members are becoming less local to attract international talent.

Practically, many European universities are receiving the strong message from national authorities that they need to increase the number of **students from abroad**[5]. Globally speaking, this factor is considered as a proxy of international relevance (in some larger countries, the attraction of students from other regions of the country is also considered for the same reasons a valuable trend of increased relevance). In some cases, there is also a commitment to reach at predefined values in some indicators and to follow-up its evolution over time as a precondition to obtain the financial support received by universities from public

[4] The relative importance of universities in the definition of the "Smart Specialisation Strategy (S3)" of the European regions is growing up. The need of presenting the S3 to the European Commission as a pre-requisite for accessing structural funds in the period 2014-2020 is an excellent opportunity to rethink on the role of universities in the "Innovation Union".

[5] This message is not independent from the will of public authorities and universities themselves to ensure a minimum number of students enrolled in every degree offered by a public university.

authorities in multiannual contract programmes or similar systems. It reflects the political importance given to this internationalisation factor[6].

Another critical factor for the globalisation of students is the evolution of **tuition fees** in public universities. There is a general discussion in several European countries on the pros and cons in increasing dramatically the cost of tuition fees to approach them to actual costs and then, to be able to stabilize University budgets as soon as they introduce better accountability systems at the degree level. The inherent risk is the possible slowing down effect on the positive trend in international mobility for undergraduate students making much more important for public universities to sell the strong points they have as international universities.

The international competition between universities for attracting excellent students is being more intensively played at the master level. Specific strategies for selling the advantages of specific masters offered by universities will be more common in the future as it happening today with executive MBAs offered by business schools (i.e. in terms of future employability or faster professional development, better relationships to industry, active networking with alumni, etc.). The involvement of enterprises in the design and implementation of professionally-driven master degrees is also a recognition of the university will to close contacts with other actors. A similar situation is found for doctorate programmes where internationalisation is a must for the development of professional careers.

For **faculty members**, there is a progressive trend in opening teaching positions to international academics. Initially, this trend was motivated by research needs (i.e. to attract a very senior scientist or a brilliant post-doc to reinforce or launch a promising research line) where good labour positions (even permanent ones!) were easier to offer than the common provision of civil servants positions for international researchers.

This trend is also slowly moving to the provision of faculty members positions (associate or full professorships) although many legal constraints at the national or regional level still persist and they should be overcome (easier to solve in case of EU nationals) to become a common practice in many European countries. Unfortunately, there are striking differences between European countries in the way that faculty members could get a permanent position[7]. The lack of common approaches is still a barrier against the full realisation of the European Research Area as it was conceived in 2000. The European charter for researchers (COM, 2005) promoted several years ago by the European Commission and formally endorsed by the Council is not fully implemented yet.

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[6] One potential undesirable side effect which could appear due to the increased percentage of international students is the pressure from national ones (at the end, related to national tax payers) to have a "guaranteed" place in their nearest university or preferred study. This problem is even worse when tuition fees are higher for non-EU nationals because they don't like to see this trend linked to economic inputs.

[7] It is too early to assess the impact of the present economic crisis in some European countries on the attractiveness of open positions to researchers from abroad. Some informal signals in Spain show that the number of candidates received in some open research positions is decreasing when long-term stability is not perceived and the lack of local resources could difficult the decision or even to trigger a backwards process. The impact of extra-payments to overcome reluctance offered by some universities has not been studied yet.

As a consequence, we postulate that a continuous opening process to students and faculty members positions from other countries (European or non European) institutionally sustained during several years will deeply change the University character and its international visibility. To conduct this process no deep structural changes are necessary (with the exception of the creation of some services for helping newcomers in accommodation or the reinforcement of legal support and the redesign of internal procedures); however, a deep change of mentality is clearly required. Much more important from the structural reform standpoint are the derived consequences in other university relationships at the international level which will be addressed later on this document. The role of the European Research Council (ERC) is becoming more important as a crucial tool to increase the international attractiveness of European universities.

*Some of the innovative practices identified within **Ulab** partners refer to the recruitment of senior researchers and its connection to the creation of new research centres. Two examples are mentioned here:*

The Isaac Peral programme[8] co-funded with private entities in the UPM allows for the recruitment of senior researchers in permanent positions through an international selection process in specific S&T areas which are not well covered at the UPM or where a deeper effort is necessary. In order to increase attractiveness, these positions have minimum salaries higher than the basic salary for full professors in the Spanish University; the recruitment of the senior researcher is combined with the creation of a new "research group" through the initial allocation of 3 pre-docs, and 2 post-docs, a minimum of 100 m^2, and some funds to start research during the first year. After that period, it is assumed that the senior researcher will get additional funds from competitive calls to increase and maintain the new research group.

The TUM Institute for Advanced Study (TUM-IAS) plays a key role in the identification of excellent researchers. The essential concept is to allow not only selected guest scientists but also TUM faculty members to conduct top-level research while offering young scientists the chance to develop their talents in the inspiring environment of outstanding senior scientists.

2.2.2. The relative importance of rankings in policy evolution

The growing importance conceded by universities to the position occupied in **international rankings** also reflects the international competition (even if these rankings have been strongly criticized due to their bias towards some specific aspects of the university outputs forgetting others which could be even more important for specific contexts).

The growing attention paid by foreign countries' administrations, universities and entities to the position occupied by European universities in some **University rankings** is also affecting to some universities in the implementation of specific policies or structural reforms to improve their position. It is noticeable that some students fellowships offered by non-European countries to study abroad can only be supported if the student is going to a University included in some of the well known ranking systems (even if there is a common criticism about the indicators used for that).

[8] See www.upm.es for further details

The current effort made by the European Union towards a **multi-dimensional ranking** reflects the political relevance got by this factor and the need to increase information about the real value of rankings for specific purposes. Here is a challenge to disseminate a good understanding of rankings effects and their interpretation to industry, administrations, families and students. The use of rankings per theme is a very good approach for technical universities whichg could perform very well in specific disciplines but not necessarily in others which are maintained by other political or social reasons.

Ulab partners have also identified some policy actions to improve their positioning in international rankings[9]. As the size and critical mass of the University is one of the key elements for defining the position in rankings, aggregation or merging is a trend supported by public administrations of several European countries. However, Ulab partners did not consider the merging with other universities as an essential ingredient for their current priorities.

2.2.3. Relationships at the international level are moving from individual to institutional levels.

Today, the scientific cooperation with other researchers based on personal interests or pre-existent networking is in the basis of many of the international research activities carried out by faculty members; however, the evolution towards more complex (involving not only one person or a small team but a whole research group, research centre or department), expensive and permanent character of these interactions precludes their implementation through simple mobility schemes or "umbrella agreements" signed between institutions to ensure reciprocity without exchange of funds and with a minimum institutional commitment. Also, to be able to support cooperation on top of individual interests, other more elaborated agreements with economic commitments and specific governance schemes from both sides will frequently appear.

Both the European Union, individual Member States and US funding agencies are redefining their international cooperation strategies, priorities and tools looking for more intense cooperation with other international partners ranging from fundamental research to innovation activities. Within Universities this trend is moving from individual support to faculty members (i.e. through short stays or sabbatical periods) to institutional support directly agreed between two or more universities.

Internationalization is a difficult and lengthy process where governance complexity strongly varies depending on the considered level. Figure 3 depicts the situation in five separate levels from the complexity perspective. From the simple exchange of information between universities located in different countries (still far today from being a systematic process) to mobility programmes or participation in international research projects, practically all European universities cover the first three levels. Much less common is to find stable and consolidated examples in the last two levels because the institutional commitment is very

[9] Paris-Tech creation was also driven by the need to join efforts in a specific ranking by increasing the size and volume of activities. This experience shows the inherent complexity of this approach.

strong. The role of governments to support universities in moving up to these two last levels seems relevant.

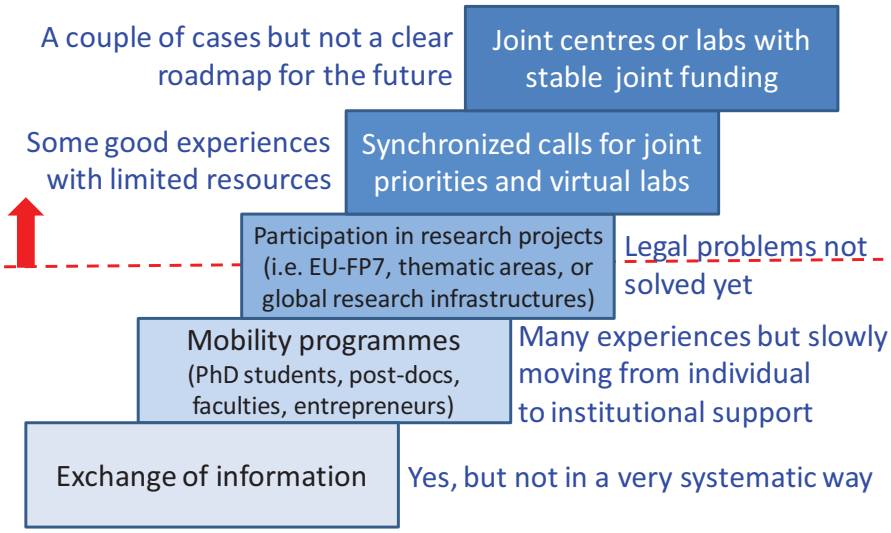

Figure 3. Internationalization levels

The agreements to create "virtual labs" supported by universities and in some cases national authorities are growing up (not only within the EU but also with other countries) as a mechanism to consolidate international relationships probably initiated in an informal way by the researchers themselves years ago.

As an example, the access to sophisticated research infrastructures (commonly found in engineering and experimental sciences) implies relatively high costs for the host institutions which should be supported by users or by their own institutions. This process implies a "money transfer scheme" (in cash or in-kind) which should be covered by specific institutional agreements, the use of specialised technicians, and the regulation of access to results.

When these relationships imply contract research with the private sector, complexity grows even more and also IPR, access to facility, litigation procedures, penalties, publication permits, etc. should be also regulated. Contract research with private entities from other countries does not imply too many differences. In case of consortia based projects in an international framework, the cooperation is usually regulated by the public administration in charge of the programme as happens in the EU Framework Programme.

Nevertheless, there is a **trend to move the collaboration scheme from specific contract research projects to other type of long-term agreements between private firms and universities** to support research lines and, if possible, by defining joint units, labs, centres or institutes. These schemes do not preclude the identification of contract research projects but they are launched in the context of the joint unit or long-term agreement.

The benefits derived from this type of interaction are twofold: to the private sector it is a powerful instrument to influence on the research agenda carried out by the university and modulate the support offered against the institutional effort, and from the university is a valid instrument to get the support to specific research lines and facilitate the transfer of the

potential results to the industrial world without continuously fighting to obtain short-term projects where the innovative level could be lower to attend short term targets.

From the structural point of view, this trend could have several consequences. From one side, specific mechanisms to create these joint units should be defined by governance bodies at the University level to have a stable context which does not depend on the high level managers in one specific moment. In some cases, it could also imply the creation of a new legal entity (usually, a not for profit entity likes a foundation). It is even more important to allow those companies enter into the governance life of the university by participating in advisory committees (for the whole university or attached to specific schools, faculties or departments).

*There are many examples within the **Ulab** partners at different levels in the staircase presented above. Just to show a couple of examples of the last level, Ulab partners have launched initiatives with countries outside the EU.*

TUM has a partnership with KAUST(King Abdullah University of Science and Technology in Arab Saudi. As a new university, KAUST is committed to collaborating with the best learning institutions in the world, including Berkeley, Stanford and Oxford. TUM is the only German university included in the Special Partnership Program. KAUST is investing around USD 21 million in three joint research projects in the fields of catalysis and information technology[10].

The UPM has created a joint research centre (without legal personality) with the University of Campinas (Brazil) for bio-energy research with the support of Repsol (Spanish multinational company in the energy sector) to contribute to the development of a new generation of biofuels.

Repsol has approved the launching of some research projects jointly presented by both universities and the Spanish Government has funded the UPM with some resources to purchase scientific equipment in Campinas. The University of Campinas provides space and basic resources in its campus. A joint master degree oriented towards industrial needs is under development between both universities.

Polito in China has also set a partnership mainly focused on postgraduate teaching.

2.2.4. Higher autonomy to define university priority strategies.

There is a general trend in Europe to give universities more autonomy than in the past. This autonomy in deciding on the academic offer, the recruitment of their staff, the distribution of the money received by public administrations or the capability to capture external funds, the internal governance model, and the internal regulations and distribution of resources is,

[10] The goal of the first project, entitled "Virtual Arabia", is to create a high-resolution 3D image of Saudi Arabia, depicting geological structures and seismic processes. The second project involves TUM scientists simulating CO_2 sequestration – in other words, the underground storage of carbon dioxide. Almost depleted oil reserves in Saudi Arabia are ideal for CO_2 storage and the injection process has the added bonus of pushing remaining oil reserves up to the surface. The third project investigates ways of feeding carbon dioxide back into process flows as a valuable chemical component in the production of new active ingredients and materials.

however, constrained by "general university laws or common regulations" approved at national or regional level which are mandatory for universities.

Nevertheless, even within such constraints, universities are able to define, if they like to do that, specific education or research strategies the derived internal organization and to focus the available resources on those ones. Priority setting is a difficult task at the University level because decision making is jeopardized by the internal balance of power between departments, schools or faculties and historical mechanisms to allocate resources. From our point of view, there is room for improvement if deep challenges in governance are addressed to cope with external funds and partners, exploitation of results and entrepreneurships. All of them, are progressively moving from a secondary activity to a central process to ensure the social value of public universities.

International positioning is one of the main drivers for priority setting. This trend is still true even when regional authorities are looking for better connection to the local industrial tissue and universities should pay also attention to the role played in the region where they are located. Universities are also committed to define and explain their strategies to public authorities but the specific orientation lies under the full responsibility of universities.

*Within **Ulab** universities this trend was found in the way that internationalization is addressed. From a central structure to deal with international affairs we noticed that international dimension has penetrated in all levels of university governance. Students, education, research and valorisation activities deal with international partners. Then, the traditional confinement of "international affairs" in one specific and specialized area of the university is being diluted.*

This trend introduces the need of better coordination at the international level because all the traditionally separated responsibilities in the research, educational planning, students or faculty member's recruitment areas are globally responsible for the international positioning of the University. This process is even accelerated by the physical location of some university facilities in other countries on the basis of partnerships with local actors.

2.2.5. Smart specialization looking for higher relevance in a wider context.

One logical consequence of this internationalization process is to suggest that the best way to increase "attractiveness" is through the specialization in the strong points identified by every University. It is also true that this strong specialization could also benefit as a side effect to other areas of the university not directly linked.

Smart specialization implies the identification of strong performance in one area (or clear possibilities to improve it in the near future by implementing some specific actions in case of emerging areas) and the institutional decision to move there a substantial part of the available resources from several dimensions: infrastructure, human resources, space, and institutional support for the creation of ad hoc research structures in a multiannual planning approved by the highest level decision making body of the University.

Strategies supported by governmental programmes like the *"Campus of Excellence"* or similar ones launched in several European countries (Germany, France, Spain) have also motivated an institutional effort to define thematic priorities and to get the governmental recognition

(helped by the access to some additional funds in case of success) based on them. These priorities were conceived under a knowledge triangle perspective by combining postgraduate education, research and innovation aspects in close cooperation with other public or private entities. The "aggregations" (long-term agreements with those entities and specifically between universities located in the same place) have been promoted to obtain the critical mass and excellence in some areas[11].

The definition of institutional initiatives in technical universities is being stimulated by the convincement of the need of breaking the conventional flat distribution of resources where everything has the same interest. For many European universities, government bodies have defined some promising areas (in many cases, by anticipating technology evolution) and use them as pilot cases for implementing innovative structures. It does not preclude internal discussions in the selection of these areas and the allocation of resources (even physical space!).

The institutional initiatives launched by some ULAB partners (i.e. the UPM experience with BioTech in the biomedical technology area or the POLITO initiative with the "Cittadella della Mobilità" shows the benefits of this approach looking for areas where they could have a competitive advantage in Europe. In both cases, long-term agreements with the industrial sector were considered essential.

The case of "Cittadella della Mobilità" by POLITO in the Industrial Design and Visual Communication and Automotive Engineering sector is an example of long-term activity in cooperation with the private sector in the automotive sector. It has implied the creation of a new campus. Around it, an ecosystem related to transportation with the participation of other SMEs is also pursued.

Paris Tech has launched an ambitious plan to move several engineering schools to the same place (plateau de Saclay) outside Paris was designed to take advantage of the centralization of services and benefits derived from proximity to launch interdisciplinary studies or large research projects.

A similar trend is noticed in POLITO with the creation in Mirafiori of the Torino's Mobility Campus. Here, the driver for the movement is the concentration of capacities in one specific theme.

In other cases, the identification of a broad area where the University should be more active is identified under a multidisciplinary perspective. Then, the launching of these actions are also used to provoke a convergence between isolated departments or research groups.

The case of BioTech-UPM reflects a political decision taken by the governing board of the UPM to support a long term strategy to improve the position of the university in a very promising interdisciplinary area: biomedical technology. From the convincement that engineering and

[11] Differences in the Excellence Campus initiatives can found from country to country. In some cases, the recognition is for the whole university; in other cases to specific projects related to some campuses presented by one or more universities. In all cases, aggregations at national or international level are important to obtain the recognition of excellence.

medical sciences are converging in searching new diagnostics and therapies by using sophisticated technologies, a multi and interdisciplinary strategy is needed.

The effort has been carried out since 2008 from the human resources, infrastructures, agreements with third entities, and the participation in large international projects dimensions in an integrated and coordinated action. A specific governance scheme defined at the Vice presidency of research ensures global coordination.

2.3. Economic crisis and the need to reinforce competitiveness through the efficient use of available resources

2.3.1. Competition for scarce resources in austerity times.

Public universities are experimenting in many European countries **growing difficulties to keep the volume of resources** directly received from the national or regional governments in previous years. This fact is also reinforced with more difficulties to keep the contract research volume with the private sector in areas strongly affected by the economic crisis (i.e. civil engineering or European Southern countries). Even if the intensity of this trend derived from the economic crisis affects European universities in different ways depending on the country or region, it is motivating a general attention on the need to increase the economic resources received from other external sources.

It is true that the relative importance of this trend changes from one country to another depending on the political priority given to universities and the margin of manoeuvre they have in their annual budgets, but there is a general trend driven by governments in forcing universities to increase their budgetary efforts to efficiently fulfil their mission. Speaking in general terms, the steady reduction in economic resources freely transferred to universities by national or regional governments in order to cover their salaries and operational costs in the last years has provoked a set of internal measures to cope with that.

The **institutional goal of getting additional funds from external sources** has motivated the creation of *"support offices"* for helping researchers in participating in large research projects (even in their coordination as it happens with the European Framework Programme) and in a more proactive way, to identify new sources of funds even outside Europe.

European technical Universities should be well aware that the percentage of success obtained by their research groups in national or international calls of research projects will decrease in parallel with the increased competition to obtain funds from external sources resulting from tight budgets at national level. To increase the success rate is much more relevant than in the past to be supported by the institution and to convert an individual (or research group) objective in an institutional one. To do that, specific support units should be created or reinforced.

*We have noticed this trend in the **Ulab** partners with the reinforcement of support offices for international projects (not necessarily limited to the participation in the Framework Programme) and the trend to give more relevance to the "promotion of the participation" and*

not only in the management of approved projects. The consequence is the insertion of activities on analysis of funding opportunities in national or international programmes (including partners searching), identification of proposals in the early stage of writing, specialised support to proposals writing, etc. To cover this type of activities, professional profiles are not easily found in Universities and external recruitment is needed.

*The cases of UPM and POLITO by establishing cooperation agreements between their "support offices for international projects" (with a focus in improving the participation in the EU Framework Programme) is a good practice which could be extended to other cases under discussion within **Ulab** partners.*

2.3.2. Creation of specialised services for technology transfer.

The need to offer to the university community a very specialized service which cannot be offered with the typical resources and manpower skills historically available at the University is another trend noticed between **Ulab** partners.

The case of services related to IPRs with the common use of intellectual property agents, or the case of spin-off creation where external specialised support is widely used reflects a common situation in the areas covered by the project. A similar situation is found with the creation of specialised "offices" to facilitate the participation in international R&D programmes where specialised expertise is needed. All **Ulab** partners have created this kind of offices. Finally, the commercialisation of results, is still a less mature area where (perhaps with the exception of Oxford University) **Ulab** partners are experimenting with new policy approaches and units.

In these cases, the professional skills required are not part of the historical structure of the university payroll. In fact, the problem arises from the lack of acceptance of these activities within the core activity of a public university. This consideration has been under discussion in the last decade but not a clear change in staff structure has been detected yet. Furthermore, the participation of the University in scientific or technological parks has been used as simpler and easier than to approve the creation of specialized internal structures.

Another main trend in technical universities is the need to increase the revenues from the commercialisation of University IP (not only patents but also registered software or specialised knowledge embedded in technological solutions. This goal has been experimented in Ulab partners from many different angles. Figure 4 summarises different structures related to knowledge commercialisation. As we can see, the creation of specific spin-offs or the licensing processes to specific ad hoc companies or through pre-existent companies requires a previous effort in technology identification, integration, and maturation.

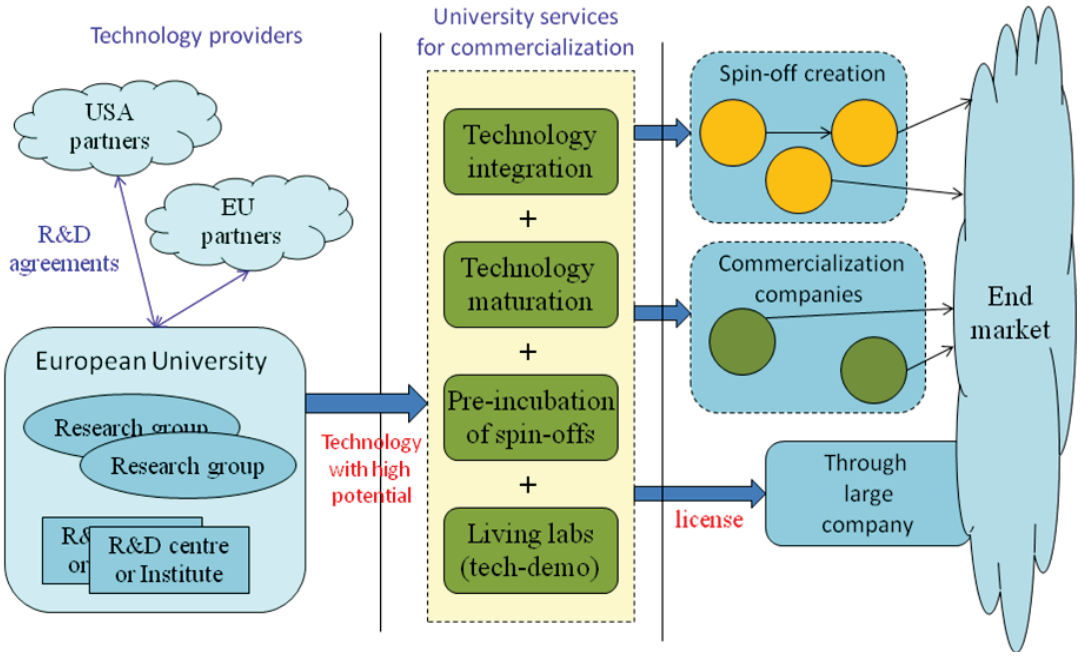

Figure 4. Approaches to commercialisation

Most European technical universities have implemented technology transfer offices (TTOs) and delegated the responsibility for IP valorisation to these new organisational units. The commercialisation of IP is potentially a way to diversify university funding . Also, universities are to step up their links with the industry. At this moment, the performance of these TTOs could often be improved. This suggests a potential to increase university performance in knowledge transfer, and to thereby strengthen the ties with the economy.

Some examples from Ulab partners show how when this process is mature it can be approached by creating specific entities with a own legal personality. In other cases, it is preferred to control it more closely as an internal unit.

*The case of Isis Innovation linked to Oxford University to support the valorisation of results is a very well-known case and the experience is being extrapolated to other Ulab universities like TUM. Isis manages the University's intellectual property portfolio, working with University researchers on identifying, protecting and marketing technologies through licensing, spin-out company formation, consulting and material sales. Isis funds patent applications and legal costs, negotiates exploitation and spin-out company agreements, and identifies and manages consultancy opportunities. Isis works on projects from all areas of University's research activities: life sciences, physical sciences, social sciences and humanities. Isis provides access to Oxford's expertise and provides researchers with advice on commercialisation*12.

The UPM has recently created (discussed and approved during the development of the Ulab project) a new "Centre for Support Technology Innovation". It has the mission of supporting IP exploitation, technology identification, spin-off creation, product maturation, and technology demonstration in close partnership with the industrial sector. The Spanish government has supported its creation under the Campus of Excellence programme.

[12] Taken from http://www.isis-innovation.com/about/index.html

2.3.3. Incentives for researchers, departments/centres and institutions

National or regional governments are trying to push funding models based on the performance obtained by their civil servants or universities (aggregated performance). These models mainly use the results obtained from the research activity to complement salaries or to define the total funding for the institution. In some cases, this incentive is distributed amongst the universities located in one geographical area. This approach is much more difficult to implement in teaching activities and models only consider the number of students and the success rate to pass.

In some cases, Universities have internally translated some funding schemes based on performance to their internal units by distributing part of the annual budget. In these cases, support to researchers, research groups, departments, research centres or institutes from the university budget consider the results obtained by the unit in the previous year or years as a tool to increase competitiveness and also to drive the attention of faculty members or units towards institutional priorities.

*Within **Ulab** partners some examples were found in Spain where UPM has an internal programme to support research groups with the distribution of economic resources based on the results obtained by the research activity of the previous year. The scientific publications, the number of doctoral thesis read, the patents or spin-offs generated or the volume of funding obtained in competitive calls for research projects are criteria to distribute funds allocate in the annual budget for this purpose; even more interesting is to generate an "annual quality ranking" amongst the units evaluated.*

Similar approach is used to evaluate the performance of research centres by using aggregate data. In this last case, the signature of specific agreements between the direction board of these centres and the UPM board is a complementary mechanism for adjusting the support on specific target indicators discussed individually with each of the research centres.

On the other hand, the participation of researchers or faculty members in research projects can be used to increase their salaries as the national regulation in Italy and Spain have defined.

2.4. Integration into the global open innovation system

2.4.1. Strategic alliances

The size and complexity of the challenges which universities face are so large that strategic alliances to improve performance are very important. The concept of "alliance" is used today with meanings not necessarily comparable.

Figure 5 depicts the potential value of strategic alliance form three complementary axes: 1) the budgetary intensity (i.e. the percentage of the annual budget committed in joint actions with other allies), the time commitment measured in years, and the thematic scope (i.e. focused on the set of the scientific or technical domains covered by the University compared to the whole set of activities).

We postulate that the "volume" occupied by the **"strategic alliance"** in figure 5 indicates how it affects the structural reform at the University. Small volume alliances could be accommodate with pre-existent structures but more ambitious ones will require the creation of ad hoc structure or even more, a redesign of all the pre-existent ones.

This concept of **strategic university alliance** is wider and deeper than the simple participation in a "university network" where the activity is limited to exchange of ideas and information but the level of joint commitments is not relevant. For that reason, it is possible to distinguish between short scope and large scope of a university strategic alliance.

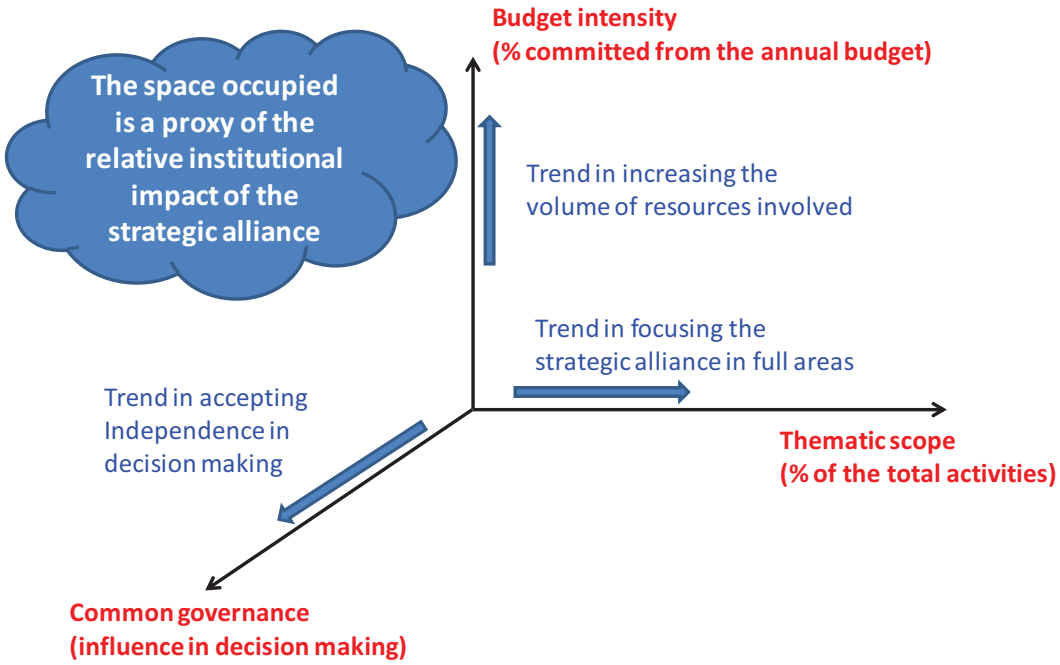

Figure 5. The value of strategic alliances

Short scope alliance. It is limited to the execution of activities funded through extraordinary or complementary resources (i.e. obtained from governmental programmes separated from the conventional budget of the University) or directly generated from the joint activity (i.e. through the exploitation of results), or within a limited time horizon (the agreement is only for two or three years linked to some specific output) or within a very limited thematic scope (i.e. only in biotechnology while the rest of areas is not affected at all).

The relative small weight of this type of short scope alliances does not modify the structure of the university and the impact on the modernization is very limited. It could have, however, a secondary effect in case of success to serve as a mobilising factor for launching other more ambitious alliances.

Large scope alliance. Strategic agreement during undefined period of time with common governance schemes in substantial areas of both institutions. This type of strategic alliance is characterized by committing substantial funding with a complementary educational offer and

joint research. It is linked to deep structural reforms which could affect the evolution of faculty members in some areas and in the distribution of students. For a specific university several alliances could coexist because the incompatibility schemes should be less strict than in business alliances. The experiences with public universities also reflect the governance complexity inherent to these alliances and the difficulties found to "isolate" these units with respect to the general governance structure which is usually kept.

ULAB partners have signed agreements for several strategic alliances with other European universities. The participation in EUA, CAESAR or ATHENS networks are commonly used to exchange information or to define common positions but there are also other more specific alliances to support research activities.

POLITO belongs to CLUSTER (a European network of technical Universities)[13] where there is also the interest to coordinate activities in some jointly defined research and education areas

Paris Tech and TUM have also agreed on a joint strategic partnership to reinforce the mobility of research groups in joint research activities. A periodic joint call allocates money for the inter-university collaboration.

TUM also belongs to the EuroTech Universities alliance founded in 2006. It brings together four top-class universities, enabling them to pursue common goals and programs in international research: Danmarks Tekniske Universitet (DTU), Technische Universiteit Eindhoven (TU/e), École Polytechnique Fédérale de Lausanne. This alliance of outstanding European universities is committed to finding technological solutions to the major challenges facing society in the fields of energy, climate change, mobility and infrastructure. The EuroTech Universities build on a number of joint research initiatives including a network for green technologies that gives PhD students and postdocs free access to the partner universities. The alliance defines spotlight topics in research, education, technology and entrepreneurship and makes an active contribution to public policy-making. This intensive collaboration between research and education also extends to university management. These alliances are also set up outside the EU.

2.4.2. Joint ventures with other entities

Joint research centres with the public sector (both with universities or public research bodies) are common in Europe. In some countries like in France, the CNRS is closely linked to universities and joint research centres are located in university campuses. Similar situation (with less emphasis) is also fund in Italy (with the CNR) or in Spain (with the CSIC). In all these cases, the agreements allow for the mobility of research staff of these public bodies to the universities' premises and to share sophisticated scientific equipments. On the other hand, some of the "excellence programmes" launched by European governments are also promoting some "fusion" of universities or at least, some of their activities by promoting the signature of ambitious long-term agreements.

[13] CLUSTER is composed by KTH Kungliga Tekniska Högskolan, Politecnico di Torino, K.U. Leuven, KIT - Karlsruhe Institute of Technology, EPFL Ecole Polytechnique Fédérale de Lausanne, Grenoble Institute of Technology, IST - Instituto Superior Técnico, TCD Trinity College Dublin, Aalto University, TU Darmstadt, TUE Eindhoven University of Technology, UCL EPL Ecole Polytechnique de Louvain, Universitat Politecnica de Catalunya BarcelonaTech.

Universities are looking for stable relationships not only with other universities or research organisations, but also with enterprises trying to combine their scientific and technical capacities. This trend is clearly visible in the case of technical universities where the relationships with the private sector are stronger in applied research (European firms are less prone to get agreements with universities in fundamental research than USA firms are doing).

This type of joint ventures could have legal or non legal structures. Universities tend to prefer to use simpler agreements to create new internal structures than the creation of another legal entity. Some problems with the distribution of assets and the difficulty to move University staff to those legal entities have made preferable to rely on conventional agreements even if the institutional commitment is weaker.

Apart from the signature of "umbrella agreements" with the private sector, the creation of joint centres with the private sector is becoming more common in recent years. This process is being motivated by the interest of large companies in approaching some of their more innovative units to the University campuses (or scientific parks managed by them) and to be able to capture knowledge in earlier stages. The progressive adherence to open innovation schemes is also fuelling up this process.

Examples of joint units with the private sector have been identified in several ULAB partners. The example in the UPM with the recent creation (2011) of the "Centre for Open Middleware" with the Santander Bank Group of enterprises shows the availability of this scheme. Other SMEs will be also invited to join to this open middleware initiative. The initial phase created the centre in one of the Campus of the UPM but in a second phase scheduled for 2013 the definition of international sites in two countries where Santander Bank has operations is envisaged. See www.upm.es for further details.

TUM with the creation of CoTeSys (Cognition for Technical Systems) has addressed the creation of a multi-disciplinary multi-institute community of researchers in Munich. CoTeSys is funded by the German Research Foundation (DFG) under the excellence initiative of the German Government (with 34M€ for the period 2006 through 2012). It comprises five institutions coordinated by TUM.

The institutional agreements for the Industrial Research Chair Programme and "Doctor for the Company" programme (both systems created by Paris Tech to provide an industrial orientation) are also interesting instruments to facilitate the international presence of European universities and to close positions to the interest of industry.

The creation of three *"Knowledge and Innovation Communities"* (KIC) by the European Institute of Technology (EIT) has constituted a major change in the way that entrepreneurship is supported by the EU. The support given to the EIT within the Horizon 2020 proposal and the new group of KICs identified open new possibilities to technical Universities in Europe to participate in them along with industrial partners.

Ulab partners are committed to increase their relationships with the EIT activities both as secondary nodes or managing co-location centres of a number of knowledge and innovation communities (KIC) in their campuses. This effort is conducted from the institutions and not as

any other bottom up research project proposal. In fact, it is addressed as another type of long-term alliance focused on the entrepreneurship domain.

POLITO is participating in the Inno-Energy KIC and the UPM will participate in the creation of a co-location centre for the ICT Labs KIC with other entities (IMDEA Software, Telefónica, BBVA, ATOS and INDRA) in its Montegancedo Campus agreed to start in 2013.

*Furthermore, UPM and POLITO are preparing a proposal for the Mobility KIC pre-identified in the Horizon 2020 proposal as a consequence of the institutional agreements derived from the participation in the **Ulab** project.*

3. Main lessons and recommendations from Ulab project

3.1. General approaches taken by Ulab partners

The term "**modelling the technical university of tomorrow"** used in the **Ulab** project reflects the common will to face common challenges by learning from the experiences of other institutions and the commitment to implement with their support some proven ideas in pilot exercises.

We are well aware that best practices selected from other Universities cannot be transferred directly to another organisation. All Universities have different legal, social, political and historical frameworks which make them singular. Good practices must be adapted to the particular structure and to the different legal and institutional framework. Moreover, as we are experimenting best practices transfer in public institutions, the decision for re-engineering any process or new structure must follow the appropriate decision process of the institution and of their governing bodies, and most of the time those democratic decision processes are often very long and require leadership and personal involvement.

As a synthesis exercise we have integrated the experiences found by **Ulab** universities to address current challenges in some general approaches for the evolution of technical universities. All of them have been extensively discussed within the **Ulab** project and pilot experiences were identified on them. It is not the intention of this document to repeat the documented results contained in the WPs deliverables. The interested reader can go to the Web page of the project where these documents can be freely downloaded.

The identified general approaches are as follows:

1. **Creation of flexible structures to address multidisciplinarity and strong specialisation**

   Historically, stability in the academic offer was seen as a must; both potential students and society at large keep a clear understanding of the way that universities were organized and on their academic offer. In some countries like Spain and France, engineering schools have been preserved for centuries apart from universities even if their curricula dramatically change over years. In all cases, Universities deeply evolved but they managed to keep the same role in society (for educating new generations and knowledge creation).

Today, we are living a very dynamic scenario where partners, priorities, and structures should be continuously adapted to changing needs derived from external pressures. As a consequence, there is a shared view that universities require enough internal capacity to define, create or shutdown specific structures depending on their needs and explain to society the rationale behind them.

From the research perspective, the creation of specialised units to address multidisciplinary challenges or to support special needs derived from the research itself or to the valorisation of results was necessary to bring together expertise spread out on different areas of the university. These new units or centres were also involved in some interdisciplinary master or doctorate programmes with the support of specific departments or doctoral schools. This process also intends to focus resources in some areas where international competitiveness is better obtained.

The experiences in the creation of joint research centres with other entities also show the interest of implementing the agreements without needing legal structures from scratch which are seen as lengthy and cumbersome processes.

2. Sharing knowledge and costs with other entities

Experiences to share scientific infrastructures or equipments based on reciprocity use are commonly found between European universities. Usually, one of the universities involved keeps the ownership of the facility but others can also provide some equipments or specialised personnel. This approach can be also complemented by strategic agreements to avoid duplication of efforts in large investments or technical staff. Then, a common planning process to purchase expensive equipments is a logical consequence of this trend which is strongly supported by public administrations.

Knowledge sharing became more common that in the past as the proliferation of joint research centres or joint degrees have demonstrated. However, there is room for improvements: common strategies to participate in international projects with better options to succeed than as separate partners (i.e. by using the concept of Joint Research Unit, JRU, in the FP7 context), presentation of common research offers to large industries on the basis of complementarity for research lines or preparation of joint proposals for public tenders are still in its infancy. **Ulab** partners postulate that this kind of agreements will grow in the near future on the basis of strategic alliances.

From the support service standpoint, the same goal applies. As an example, universities located in the same place could duplicate the IPR office or, by the contrary, could share the service or at least to specialize each unit in a different technological domain? Efficiency criteria (and the economic crisis) could stimulate it but mutual trust is a pre-condition which takes time to become a reality.

3. Progressive de-localisation of activities

Historically, universities have concentrated their resources and activities in specific campuses located in one geographical area. All activities were organized around them with clear advantages on efficiency and the easier creation of a sense of "community". It is true

that many universities have multi-campus structures but the key concept is the same: all activities are performed there and services are concentrated in the campuses. In case of multi-campus university there is also an opportunity to specialize them under the same principle of localization of common or related activities although historical evolution usually creates huge barriers to deep reorganisation.

This is still today the typical way to organize university activities; however fuzzy borders in time and locus are appearing as a result of the globalisation. Two different types of reasons are motivating its evolution:

1) The need to approach the activity of the university to students located in other countries. This process has motivated the creation of campuses located in other places with the support of some local partners. The proliferation of units located in China or Middle East countries used by some European universities with the support of their governments is a clear example. This approach is also boosted by intense use of e-education platforms which offers the possibility to obtain university degrees by (partly) distance education. The movement of large US research universities in order to offer their courses in open platforms with some presential support if needed should be a key factor for accelerating larger reforms in European universities.

2) The creation of ad hoc offer for postgraduate courses adapted to the needs of specific clients. In these cases it is common to carry out the activity in the client's premises (except if it is necessary to use equipment labs located at the university; even in this case, a mixed model could be used)

Notice the comparison of this rationale with decisions made by the private sector in its internationalization process: the approach to market (with or without local partners) and the creation of training processes to local people.

4. Integration of the exploitation of results in the institutional strategy

Another major trend is the increasing importance that valorisation of the research activity has within the university. For technical universities the exploitation of research results is an accepted role of the University and an opportunity for increasing their external economic support. Public authorities are pressing them to increase their outputs in terms of patents, licensees, royalties, spin-off creation, etc. and it also became an institutional goal although instruments and procedures are still in pilot phases in many European universities.

Valorisation is also related to another important issue: spin-off creation. It is true that the rationale for universities to emphasize an entrepreneurship mentality in students has a wider perspective than the valorisation of research results through the spin-off creation: it reflects the convincement in technical universities that their graduates should possess an entrepreneur's mentality in any way they decide to orient their professional career. Furthermore, the support of spin-offs generated by faculty members and (graduate) students as a tool for exploitation of research results is a clear driver which is also changing the way that this area is embedded into the university structures.

Here, the challenge is to find a balance between the efficiency in providing this set of services through specialised (even externalized) entities or by incorporating them into the university structures. Open questions refer to the best way to link with pre-existent structures and the type of personnel necessary to cover that. From the **Ulab** partners perspective, much more policy experimentation is needed to clarify constraints and better approaches in specific contexts.

5. Increasing the visibility of universities in society

. An important issue for all universities is the ways in which they connect to the wider world. Key questions include: how to increase the influence of technical universities in society?; how to reach at the average citizen?; how to increase their global visibility?.

The answers to the above mentioned questions are not universal because historical contexts in specific countries and the starting point of universities in their regions or cities should be taken into account. We are fully convinced on the need to devote specific attention to dissemination of activities, to engage citizens, to open doors because the level of support to universities will depend on the way that universities are understood as a part of the solution of societal problems and not a source of them.

A great deal of focus has been placed on dissemination to specialised scientific publications targeted to reach other colleagues, but other type of outputs have not been supported or promoted at the institutional level to a significant extent.

Within this context, technical universities have also an important and more specific role to play (shared with the science departments or other comprehensive universities): to inform better to citizens on the technology benefits and consequences. From a more pragmatic perspective, technical universities should become a locus for sound debate on controversial issues where technology plays a crucial role (i.e. nuclear waste, transgenic foods, cyber-security, data protection, etc.). In all these cases, to be able to inform society about the right use of technology and control mechanisms has a valuable impact on quality of life. Unfortunately, the effort paid today to this type of activity is still very low. From this perspective, we also conceive the technical university as a **"technology-based think tank"** which would recover or enhance its leading role in society.

3.2. Main findings on research support structures and resources management

WP2 has focused the efforts towards the understanding of the **evolution of "research structures"** as a consequence of the contextual changes presented above by identifying, analyzing and sharing best practices in the research management processes in three selected fields:

- **Research Strategy** (e.g. identification, alignment, finding synergies and complementarities, structures, quality control and impact assessment)
- **Research Support Services** (structures to support the researchers in their participation in R&D funding programmes, e.g. EU & National Project Offices, fund raising, R&D programme promotion, administrative, legal, auditing and financial reporting support)

- **Human Resources for R&D** (e.g. career management, education, incentives and reward system, mobility and internationalization

Technical universities do not live in an isolated context. They should compete over the world (and not only in the local context where they are located) for the best doctorate students, post docs or professors, for research projects or simply for attracting the interest of the private sector where multinationals address their demands to any university capable of solving their necessities. At the end, their global relevance will depend on the success in this international competition. For this reason, **research internationalization policy is not a secondary element in research strategy but a key element for ensuring their sustainable competitiveness**.

University clustering at international level has proved to be an effective way to facilitate the exchange of know-how and good practices among institutions. Alliances of Universities can contribute to find common solutions to face the current difficulties faced individually.

European universities are fully convinced that their participation in community activities within the EU or even outside Europe is an essential requirement. Nevertheless, the impact of this process in the internal structures is not always visible. We have noticed two different approaches: to create a specific "internationalization structure" (even at the vice presidency level) or to embed the internationalization in all university activities and units.

Research internationalisation dimension in the research strategy can be explained in a "staircase model" where lower levels are still useful when moving upwards:

- **Participation in international networks**. Universities are progressively linked to networks of universities at the national and international level. Some of them group universities with similar features (i.e. technical ones) while in other cases, are focused on specific domains. The participation in these networking activities constitutes an excellent mechanism to exchange ideas or experiences and it is widely accepted. Nevertheless, the commitments are very low and individual university policies are not directly affected by its participation in one specific network.
- **Participation in international projects**. A higher level of short-term commitment comes from the participation in a project with other entities. A good example of this type of activity is the participation in FP7, ESA or EUREKA to mention three different R&D international programmes. In spite of its relevance, global policies of the university are not altered although some universities have created specific units to support researchers in their participation. The most important constraint comes from the fact that the participation in a consortium is limited in time (3-5 years) and there is no commitment to pursue it at the end.
- **Creation of joint research centres**. A step forward in the definition of long-term agreements is the creation of a joint research centre. Under these terms we can find multiple possibilities (from small joint labs to large centres with huge investments). A common feature is the institutional will to give temporal stability to this type of adventure. Within this framework, a possible movement is to give these joint centres a different legal personality. Even if this approach is potentially more powerful, a lot of practical problems should be solved (funds, personnel allocations, etc.) before approving it.

- **Development of innovative models of interaction between universities and the private sector.** These include framework agreements, inclusive of research, technology transfer and education activities, which assume that the cooperation is managed at CEO-level, and more aggressive approaches based, for instance, on joint ventures between universities and companies, so as to enable joint risk and business benefits. These activities are basically agreed with big companies.
- **Location of university units in third countries**. Some European universities have started to deploy their activities in other countries (even outside Europe). In many cases, a local partner is used to facilitate the creation (even for legal constraints). Historically, these activities were generated from teaching and not for research purposes. Today, both types of activities coexist.

From the experience in running the WP2 experiences, the lessons learned from the process of adoption of a best practice indicates that the processes or restructuration have to start from an **internal analysis and identification of the weaknesses and strengths**, compared with the objectives of the Best Practice. In addition, all transformation of an organisation implies time and costs. Therefore, the transfer would fail without a deep analysis of time and costs of the implementation. The benefits expected from the re-engineering or transformation of a service organisation must be quantified to be able to define a return plan of the initial investment.

To have a clear roadmap of all these steps, the drafting of an **action plan** is essential. The plan should include the different activities planned to transfer the good practice such as the organization of internal meetings to report on the visit at the originating institution, feasibility study, identification of the resources to be involved, production of supporting material, etc.

In this frame of reference, and based on their identified best practice, ULAB Universities propose the following **recommendations** for the improvement of the "Technical University of tomorrow":

Increase international dimension: research internationalization policy is a key element for ensuring the sustainable competitiveness of technical universities.

To reach this aim is strategic to consolidate working contacts among university similar offices (i.e. EU offices) so as to set up a systematic method to proceed and interact. It's similarly important to increase participation to international networks.

Go towards smart specialization: This concept implies to focus their activities in some scientific areas and the institutional decision to move there available resources.

Today, in any average university, all **scientific and technological areas** receive similar attention (weighted by the number of faculty members or enrolled students) in distribution of resources or in their participation in governance structures. The trend is that some **areas** which have received excellent external evaluations in some aspects (research, teaching, valorisation, etc.) are selected to build up the international relevance through additional resources and more weight in governance structures.

Figure 6 depicts the view of this specialisations process where some areas received more attention than others to increase the competitiveness of the university. This fact should be also reflected in the weight in the governance structures although internal balance of powers avoid, in practive, the full use of this scheme.

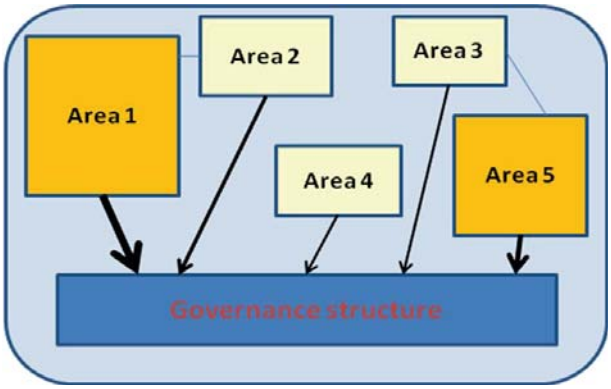

Figure 6. Smart specialisation

Smart specialisation allows addressing multidisciplinary challenges bringing together expertise spread out on different areas of the university. The domains chosen must be in accordance with the University's ecosystem and its industrial partners, most of the time limited to the regional level, but more and more considering the globalised market.

Widen the range of interaction with industry: University should combine various types of cooperation with industry not only at local level but internationally, according to its needs.

This objective can be done starting from the usual framework agreements, inclusive of research, technology transfer and education activities, to more aggressive approaches based, for instance, on joint ventures between universities and companies until to the co-habitation in the same campus of universities and companies.

Human resources management for research constitutes an aspect of fundamental importance where special attention should be paid to the following three aspects:

- Investing in Doctoral Training, not only as preparatory phase for academic career but also for employability in the private sector.
- Implementing the Charter and Code proposed by the European Commission in order to attract excellent researchers on a worldwide scale,
- Involving industries or other non academic bodies in the doctoral projects, so that excellent PhD candidates can work together with innovative firms, in order to develop industrial doctorate programs of high quality.

As a summary, **Ulab** partners consider that technical universities should:

☼ Reduce the **internal fragmentation** and valorise excellence, implementing large scale multi-disciplinary R&D structures

- Develop **joint initiatives and models of relations** between the university and external organizations, particularly businesses
- Pay attention to the **horizontal aspects** which are fundamental to face the actual challenges:
- **"Internationalisation"** as main stream for today's University development
- Take benefits of collaborating in **International University networks** to exchange/share know-how and practices

The experience under the Ulab WP2 could be the vehicle to motivate partner universities to move forward in each mentioned area, with a need to expand the initial effort in Ulab and continue to track the success of initiatives in these fields.

3.3. Main findings on valorisation

The agenda for the modernisation of Europe's higher education system[14] invites universities to diversify their income streams, to strengthen the knowledge triangle between education, research and business, and to strengthen ties with the regional economy. As technical universities generate research results and new technologies, which form their intellectual property (IP), the commercialisation process of their intellectual property can be seen as a way to potentially achieve these aims.

Most European technical universities have implemented technology transfer offices (TTOs) and delegated the responsibility for IP valorisation to these new organisational units[15]. The commercialisation of IP is potentially a way to diversify university funding[16]. Also, universities are to step up their links with the industry[17]. At this moment, the performance of these TTOs could often be improved[18]. This suggests a potential to increase university performance in knowledge transfer, and to thereby strengthen the ties with the economy.

The Ulab project aims to support university TTOs in stepping up the commercialisation or valorisation of university IP. This is done by exchanging current best practices in the areas of IPR management, patenting and licensing, and commercialisation in order to support the valorisation of research results and IP. Best practices along the technology valorisation process have been collected at the partner universities in the first phase of the project and are documented in the project document "D3.1 Best Practices on Valorisation".

[14] European Commission (2011, September 20). Supporting growth and jobs - an agenda for the modernisation of Europe's higher education system. COM(2011) 567 final. Brussels.
[15] Organisation for Economic Co-operation and Development, OECD (2003). Turning science into business. Patenting and licensing at public research organisations.
[16] European Commission (2011)
[17] European Commission (2011)
[18] Chapple, W., Lockett, A., Siegel, D., &Wright, M. (2005). Assessing the relative performance of UK university technology transfer offices: Parametric and non-parametric evidence. Research Policy, 34 (3), 369–384.

Best practices on valorisation

The following section aims at giving a summary of the research conducted in the first phase of the project. A detailed description of best practices and results can be found in D3.1.

Technology identification. Basic research yields practical applications, often as an unanticipated outcome of major science and technology breakthroughs. However, if these outcomes remain undetected, they can neither be leveraged for the university, the society nor the industry. Therefore it is very important that universities make use of appropriate means for technology identification. In general there are two strategies concerning the identification of new technologies, which are based on the decision whether to conduct active technology scouting or not and let researchers contact to the TTOs on their own initiative. In contrast to universities in the United States, active technology scouting is not common in European universities mainly due to the high cost involved. European universities mostly follow a rather passive approach which leads to a greater responsibility of the researchers. Although some researchers have incorporated patent strategy into their work methodology, a fundamental problem concerning technology identification exists. Traditionally, academics are researchers and teachers, who lack the economic experience concerning the management of IP and the protection of research results. In order to complement the basic university activities - research and education - the Ulab universities have started to introduce information programmes. These programmes aim to make researchers aware of the need for protection and to inform them about the supporting structures that exist within the universities' framework.

Management and protection of results. Universities should raise awareness among researchers about the importance of protecting the IP originating from researchers' inventions and discoveries. Also, it must be identified when a result is suitable for protection. Then, support must be provided for patenting.

All Ulab universities are strongly *committed to the development and management of an IP portfolio.* The intellectual property rights (IPRs) may or may not be owned by the university. In the case of UPM, TUM, Polito and Oxford, all IP generated by the academics working at these universities is *owned by the university*. For Polito, in some cases, the professors own the IP. ParisTech mentions a quite different approach. IP is usually assigned to the university or industrial research partners with the aim to maintain and expand the existing IP base and to support the respective missions of the research partners. Thereby, especially the continuation of research and teaching for ParisTech and the exploitation of the IP for the industrial partners are important aspects.

All Ulab universities experience that *good and clear regulations* are the basis to managing and commercialising their IP. These regulations on university IP are often a mix of national law and university policy, which is often developed by the university itself.

The organisational structure that deals with IP at the Ulab universities is remarkably similar. Commonly, academic inventors are to disclose their invention to the university office that deals with IP. This office is part of the professional services of the university. For all Ulab universities except ParisTech, each invention is assigned a dedicated patent manager that takes care of the entire process from protection to commercialisation of the invention. The

actual commercialisation of the patent can then be done by the university itself (TUM, Polito), but is sometimes also done by a specialised external company (Oxford).

The whole process from invention to commercialisation is supported by structured forms for the disclosure of inventions. These forms are meant to clarify the procedure to all parties involved in the intended patent application. The information provided with these forms is needed to assess whether the IP is patentable and if there is a commercial outlet for the invention that is sufficiently large to justify the investment of resources.

Commercialisation of research results. Once patented, a professional body must valorise the results, write information sheets to describe the technology, analyse the market and identify potential licensees. The Ulab universities all make a clear decision whether to commercialise an invention or not. Typically, inventions are commercialised when mid-term sales (3 to 5 years) are expected, or a customer has been found. Most Ulab partners are rather proactive in finding transaction partners for their IP, whereas there are also occasions where universities are contacted by industrial parties in order to obtain technologies. In this case, the patent functions as a promotional tool that shows that the university has capacities in a certain field. This demand-side approach can be facilitated through information on the website and databases with expertise of the research groups and academics. Oxford, Polito and TUM mentioned using one-pagers to communicate the technologies and patents available for licensing.

In the proactive approach, IP is typically presented to a network of potential customers, which makes relationship building a key success factor of technology commercialisation. Therefore the organisational structures and processes to support the establishment of new relationships or to maintain existing relationships with industry partners and potential licensees are very important.

After having established contacts to parties that are interested in a technology or an invention owned by the university, licensing contracts and royalty agreements need to be negotiated. In addition to establish new and maintain existing relationships to industry partners, i.e. potential licensees, it is important that universities offer the appropriate support to the inventors in order to make the negotiation of licensing contracts with the licensees successful. At all Ulab partner universities, the TTO and sometimes in addition the office in charge of research contracts are responsible for the negotiation of licensing contracts. Often professionals of the legal department or even external patent attorneys then support the writing of the contracts.

Universities as regional gates to the high-tech highway

Based on the best practices identified in the first phase of the project, a pilot project was carried out in the second phase. For detailed description of the pilot project, the methodology and research results, see project document D3.2 “Universities as regional gates to the high-tech highway: A pilot of universities creating infrastructure to better enable a region to access international knowledge and technology and international business”.

The concept of the pilot Ulab work package 3 – amongst other things – set an aim to step up commercialisation activities for university IP on an international level, enhance awareness of

universities as business partners, try to attract companies of the region to the universities and try to connect regional clusters internationally.

To achieve this aim, a pilot project was designed that involved the five Ulab partners visiting several international fairs across Europe: Genera (Madrid, May), Venturefest (Oxford, June), Nanotech Italy (Venice, November), and Materialica (Munich, October).

The pilot project has been designed to create a comprehensive understanding on the topics mentioned. Currently, agenda for the modernisation of Europe's higher education system[19] invites universities to focus on the region they are located in. This pilot is an experiment for the Ulab universities to strengthen the innovative performance of the region they are located in by becoming a gate to other regions to import and export knowledge and technology internationally. The pilot aims to complement the exchange of knowledge (e.g. academic papers) with an exchange of technology and innovation. Note that Ho & Verspagen (2004)[20] find that, even within multinationals, patent citations remain predominantly within a region, suggesting that the international transfer of technology (excluding commercial products) is challenging. This aspect, together with the aim to step up IP valorisation both in quantity and internationality, have shaped the design of the pilot project, which is based on the visit of trade fairs on an international level and presenting locally developed technologies.

The benefits aimed for Potential benefits of this pilot project - universities visiting international fairs - would be a shift in activities from the mostly national university technology valorisation towards the more valuable international patents. The fairs presumably offer a larger share of potential partners in innovation that have two necessary preconditions: the capacity to absorb this knowledge, and the open approach to innovation required for collaboration. Especially companies having both preconditions are expected to take part in the technology trade fairs selected. Moreover, trade fairs are usually focused on specific topics, sectors, or technologies and thus could potentially provide a good platform for universities to liaise with industry partners. As side effects, the universities may promote the innovative focus of the region internationally (e.g. cars, nanotechnology, ICT) and thereby attract similar innovative activity to their region and moreover could position universities as potential innovation partners for companies. Ultimately, universities would become a region's gate to the "world library of knowledge & technology".

The outcomes of the pilot Based on the research strengths of the universities participating in the events, fairs across Europe were selected to present university technology. The full procedure to identify both fairs and technologies to present at those fairs has been disclosed for use by other universities (see chapter 3 of D3.2).

The participants to the fairs received a questionnaire after their participation. The answers to these questionnaires give an impression on the outcomes of the fair participation. The people participating in the fairs were mostly academics or staff of the TTO. They presented mostly between two and six technologies or patents at the fair, preferably through keynotes,

[19] European Commission (2011)

[20] Ho, M. H. C. & Verspagen, B. (2004). The Role of National Borders and Regions in Knowledge Flows. Unpublished manuscript, Eindhoven Centre for Innovation Studies, Eindhoven, The Netherlands.

multimedia presentations and personal talks. The participation in the fair was mostly seen by the participants as a success for the participating institution, which brings potential to step up the commercialisation of university technologies and intellectual property, and is well worth the effort. This all also holds for the international level. For most participants, the fairs typically should have a focus on a specific technological topic.

The TTOs of the Ulab partners that hosted the (access to) the fairs were generally happy to have the (technologies of) other Ulab partners presented at the fairs. The participants all gained a range of (international) business contacts, and one feasibility study was initiated. Possibly, the results increase with both time, and the number of technologies presented at fairs. The participants emphasised that the contacts gained can be expanded to stable (international) collaborations. Participation in fairs stimulates learning processes. Participating universities learn on possible applications of their technology, and enhance their skills in fair participation. Companies become more aware of the possibility to partner with universities for the purpose of innovation.

Policy recommendations

Universities are recommended to further explore the opportunities to step up commercialisation by visiting fairs. This strengthens the knowledge triangle between research, education and business. Moreover, the university strengthens the ties with the regional economy. Moreover, by inviting international partners in innovation, universities can become a region's "gate" to international knowledge, technology and business. The participation of international partners in innovation helps to connect excellence across Europe.

Governments and the European Commission are recommended to support universities willing to further develop similar initiatives.

3.4. Main findings on Entrepreneurship

Modern societies are convinced on the need of increasing the role of Universities in providing better hopes for graduates if they are prepared to launch their own business. Then, apart from the necessary technical knowledge in one specific engineering field, students should also understand other technical knowledge related to business issues. Furthermore, they should master some non-technical skills related to entrepreneurship.

To be able to cope with this challenge, technical universities should have not only specific courses or seminars where these skills can be obtained; they should also have an entrepreneur mentality. This mentality is not an isolated feature; it is firmly rooted in the entrepreneur mentality of the context where the University is located. Both internal and external perspectives interact and complement each other.

In the past decades, some experiences in **spin-off creation** or the evolution of **business incubators** have proliferated in European universities. Organizing **business plan competitions** makes possible numerous and various benefits, going from invention of new business idea, to dissemination of entrepreneurial spirit.

These competitions have permitted to launching of many spin-offs in the recent decade, but also have an educational dimension, in order to acquire relevant skills in the field of project management and business unit management. They help them to socialize and get them ready to understand and practice teamwork values.

Inside this motherhouse, it will help changing behaviour, mentalities and attitudes toward innovation, and also help installing a spirit of initiative and creativity, with cross-fertilisation between the various components of, for example, an university (laboratories, professors and researchers, staff, students, alumni, industrial partners, parents associations, local authorities, etc.).

Outside, it may initiate a salutary change of image (like a quality and efficiency label), facilitate alliances and play a bridge-building role. For a manufacturer or an independent laboratory, spin-off or spin-in opportunities can be brought. New research contracts might result from these relationships.

For these reasons, it is essential to master and manage the whole processes of creation for such a structure: goals to achieve, services to provide (also in terms of the quality of services), rules and ethics, duration of housing, incubator's own business model, choice of resource management modality, etc.

Concerning entrepreneurship, a dual current trend exists among the ULAB partners:

- A **centrifugal trend** with a convergence in areas such as business plan competition, team building of training, etc.
- A **centripetal trend**, when universities must choose the model appropriate to their level of resources and to their economic and technological environment. In that context, the way they will prioritize their practices about supporting entrepreneurship will be the expression of local constraints and opportunities.

From the experience in the Ulab project, there is a consensus to incorporate **entrepreneurial skills in all level of education**, grade, master and doctoral with the goal of training the European entrepreneurs of tomorrow.

This objective implies the support to researchers and students to create start-ups and to give support to start-ups in their early life with the following activities:

- Business plan training
- Access to venture capital
- Provide office room and services (incubators)
- Facilitate international contacts and infrastructure network

The core of the WP4 Pilot is focused on start-ups and spin-offs having entered an active phase, and at every stage of the business life cycle. In particular it intends to facilitate partnerships,

business-to-business linkages and for example strategic agreements for commercialization of integrated services and products within their respective markets.

From this perspective, this Pilot must not be regarded just as a series of cooperation actions, but above all as a challenge taken up by five partners, requiring solidarity and adaptability to other members. This challenge requires a high level of expertise and professionalism from all the members, and involves a subtle alchemy between junior and senior entrepreneurship practitioners: creating partnerships between start-ups from different countries is a complex and multi-faceted task.

The geographical scope of this Pilot is not confined to the five countries represented by these universities, but it can move outside these limits. For example, Madrid UPM can be viewed as a gateway to Spanish speaking countries such as South and Central America: "Access to Iberoamerican Entrepreneurship network (RedEmprendia sponsored by Santander Bank) considering U-lab companies as UPM ones"

-This network of incubators or science & technology parks can be seen as a community where each member will open its services to other members, on a reciprocal and transparent basis. More accurately, WP4 could be described as a network of networks, because each of its members has already forged local ties and industrial relationships with many interlocutors: industrialists, found raisers, venture capitalists, local authorities, researchers, students, professors, alumni, tutors and advisors, etc.

It is intended to have a general audience, including students and entrepreneurs at a very early stage (Torino's "Start-up weekend" and "Entrepreneurs night", Munich's "Start-up evening" and Summer school, etc: "Where researchers, students, entrepreneurs and start-ups can easily interact and work together is a critical factor" – Politecnico di Torino, "Where people and ideas come together. The event is a marketplace for ideas and talented people" - TUM).

"The Startup Weekend in Torino gave us an opportunity to put those ideas to the test among an entrepreneurial community. This has both, validated our thinking and provided an opportunity to pursue this idea further. "Before, the idea was academic and relatively abstract in conception."

The five institutions who gave their contribution are all active in this area, with business incubators or assimilated entities: -The Scientific and Technological Park of the Universidad Politecnica de Madrid, -The UnternehmerTum of the Munich TUM, -The Centre for Entrepreneurship and Innovation and ISIS innovation Ltd, University of Oxford, -The ParisTech Entrepreneurs incubator of ParisTech,-The I3P Incubatore of the Politecnico di Torino. Altogether, they represent a total of several hundreds of successful technological start-ups launched and supported. In order to provide a numerical example,

Furthermore, it would be necessary to jointly define and agree on a common metric summing up what "success" is, in order to quantify the results, especially in the long term. We do not believe that such a universal metric could exist.

Offices of all ULAB S&T parks responsible for incubating and giving support to their spin-offs, are opening their services to other ULAB partners.

As well, ULAB is promoting alliances and partnerships for further establishment of synergies between the start-ups, exchange markets and definition of strategic agreements for commercialization of integrated services and products within their respective markets.

3.5. Main findings on outreach and connection to society

Public engagement efforts can support technology transfer and the diffusion of innovations; create connections between research and teaching; and help underpin the important contribution universities make to society. Indeed, outreach and public engagement is currently high on the agenda of many European universities, and increasingly academics are expected to effectively engage with the public; particularly in a context where science and innovation are viewed as central to the progress of a society (European Commission, 2006; Wilsdon and Willis, 2004) and where citizens are increasingly central within the process of scientific decision making (Benneworth, 2010).

We define outreach and public engagement in its broadest sense to incorporate all forms of interaction with individuals and organisations outside the university. This may include, for example, initiatives that engage with schoolchildren and / or their teachers, interactions with commercial organisations that lead to new technological developments, or activities that connect with policymakers and support the policy making process (Burchell et al., 2009; European Commission, 2008).

The nature of public engagement and outreach not only vary significantly in terms of the purposes and objectives of the activity, but also in the kinds of methods used, from surveys, focus groups, citizens' juries, stakeholder dialogues (Wilsdon and Willis, 2004) to social networking; and in the audiences (children, older adults, teachers etc) they seek to engage. Indeed, this diversity was reflected both in our data gathering within each of the five partner institutions (deliverable 5.1) and across Europe in the online competition (deliverable 5.2)

Through our activities for WP5 (a literature review, three workshops and the hosting of an online competition) it was apparent that **despite the obvious importance of public engagement, universities are facing a number of key challenges in this area**. In broad terms, these relate to determining the most appropriate ways of carrying out and evaluating outreach, creating organisational environments and supporting individuals, such as through rewarding, in ways that lead to meaningful and valued public engagement activities, and ensuring public engagement activities remain high on university agendas despite reductions in higher education funding felt by many European countries.

Below we briefly outline the outcomes and recommendations of this work package in line with these three areas:

Conducting and evaluating outreach and public engagement activities

This project has supported good practice in conducting and evaluating public engagement activities in four main ways:

1) A set of a wide range of good practice case studies from the five partner institutions (deliverable 5.1) that interested parties can apply to their own contexts.

2) The provision of a searchable, online repository of over 100 good practice case studies from across Europe that will continue to be available to all beyond the life of the project (http://www.engageawards.org/all-entries) that interested parties can apply to their own contexts. The website also includes an online bibliography of resources for designing effective public engagement/outreach initiatives, setting clear goals, and measuring impact. The website is popular, and received 35, 189 unique visitors between February and October 2012.

3) A planning worksheet for public engagement initiatives that we developed based on recommendations from the literature, funding bodies, national experts, and the competition winners. This worksheet is valuable for planning all phases of the initiative from inception to evaluation (see deliverable 5.2).

4) Highlighting and reiterating (Rowe and Frewer, 2005) the particular challenges of measuring the impact of public engagement, stressing the need to consider the most appropriate forms of measurement and questioning the extent to which we should be measuring depth versus breadth of impact. We suggest that there is a need to strive for multifaceted and longitudinal forms of evaluation and that this may best be achieved by designing engagement activities that are more closely embedded into the research process (see deliverable 5.1 and 5.2).

Capacity building and cultural change: from the bottom up to the top down

A key issue for European Universities is to try and build capacity and change the culture within the research community to support public engagement activity (e.g. Wolcott and Sengupta, 2010). This requires changes from all actors at all levels. While there can be no prescription for how this can be achieved, as university and country cultures vary significantly, we have aimed to support these needs via:

1) The holding of three events which provided a space in which to discuss public engagement and compare practice within and across different institutions. Each of these events had a focus on capacity building and cultural change and brought together actors from different levels (deliverable 5.1 and 5.2).

2) The hosting of the online competition where good practice in public engagement and outreach was recognized and rewarded. This was achieved via the requirement for all submissions to the competition to be supported by a member of senior management (thus ensuring recognition within the university) the use of a public vote and three prizes of 5000 EUR for the best entries (thus ensuring recognition institutionally and Europe wide). Recognition of the importance of outreach and the career benefits of engaging in activities are much needed to support cultural change (deliverable 5.2)

3) From our own activities, and building on the work of others (e.g. see Abreu, et al., 2009, Burchell et al., 2009) we have highlighted the potential benefits of seeing outreach and public engagement activities embedded within the lifecycle of the project, greater collaboration both within and across universities, additional outlets for academic publication on outreach, and organizational strategies that nurtures individual creativity and responsibility with regards to public engagement, whilst being supported by the institution (deliverable 5.1 and 5.2).

Supporting outreach and engagement in times of austerity

A central challenge for outreach and engagement is one of resources. To some extent public engagement and outreach is suffering in the current cost cutting climate for the higher education sector across Europe. This is often because it is difficult to demonstrate the impact or tangible value of outreach activities. While at the EU level (e.g. in the funding FP7 programs) and in some of the partner countries investment in engagement activities is apparent in various forms, there has, in the majority of European countries, been an overall reduction in resources for higher education. This reduction has implications for public engagement as central budgets to facilitate such activities have reduced in recent years. In the area of outreach, this problem is particularly acute, since many across the sector view outreach as not necessitating significant resource investment. This means that those working in outreach need to consider ways of achieving more with less. In this project we have:

1) Raised awareness of this issue by providing examples of possible ways to provide "more with less" both via the online repository of good practice cases (deliverable 5.2) and sharing of activities amongst the five partner organizations (deliverable 5.1).

2) By placing an emphasis on "sustainability" as one of the key criteria for the outreach awards. Sustainability is a multifaceted concept that can include considerations about the cost of activity, the level it was embedded into institution, the extent to which it could be / or had been copied or rolled out to other places, whether nationally or internationally, or evidence that it has created new dialogues and new structures around a particular topic. Sustainability was also often a challenging area for competition entrants to address (deliverable 5.2).

3) Recommended a range of potential strategies: from the use of new media to support multiplier effects, thinking about ways to increase the longevity or sustainability of the initiative, considering sponsorship, the development of marketable engagement kits that could be sold to schools or other audiences, collaboration, and the importance of considering institutionally about how activities can be maintained whilst having minimal impact on future resources (deliverable 5.1 and 5.2).

This approach provides options for individuals considering outreach across the universities of Europe, which can help them build on existing initiatives and further innovation in one of the most important strategic areas of universities in the global era of worldwide research.

4.Conclusions: towards a reform roadmap of European Technical Universities

The modernization of universities in the context of the European Union is still an open issue. The Horizon 2020 proposals presented last year by the European Commission and today in the middle of the negotiation process with the Council and Parliament will offer also a very rich context for European universities to reaffirm their role.

We postulate, however, that European technical universities should go from the discussion and description of their own initiatives to pilot experiences which should be shared in a more intra-European context. The term ***"modelling the technical university of tomorrow"*** used by **Ulab** project reflects the common will to learn from the experience, the commitment to implement at home some ideas previously explored by others and with their support. As

previous sections have demonstrated, these examples (briefly mentioned in "boxes" scattered through the text picked up from previous **Ulab** deliverables) address some of the global trends identified until now. Nevertheless, much more work is needed to extend the experiences and to embed them in sound and stable structural reforms.

Figure 7 summarizes the main high level structure of **Ulab** findings. Four main drivers for structural reform affect in a different way from the individual researcher to a cluster of universities located in different countries

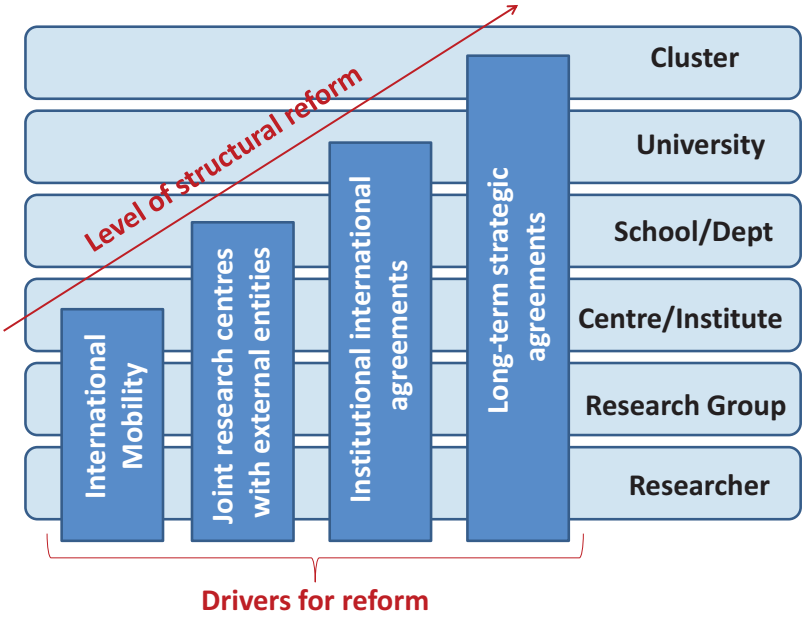

Figure 7. High level structure of **Ulab** findings

Individual universities should define their own roadmaps for implementing structural reforms. National or regional governments have enough tools to drive this process by simultaneously giving universities enough freedom to define their own way. All actors involved in the University system are committed in their success.

Four key areas for technical research universities to develop are addressed in the four Ulab workpackages, and here are ways to move forward in each area, with more or less confidence in particular initiatives, depending on the evidence to date, but with a need to expand the initial effort in **Ulab** and continue to track the success of initiatives in these areas.

Nevertheless, much more work is needed to extend the experiences and to embed them in sound and stable structural reforms. Of course European technical universities should go from the discussion and description of their own initiatives to pilot experiences which should be shared in a more intra-European context. European universities can therefore take advantage of the successful approaches used in other universities and adapt them to specific national contexts. For this reason Ulab partners firmly believe in the need of supporting internal reforms based on an international mutual learning.

At the beginning of this document (see section 1) we postulated that European technical universities are in a transition process where other elements are shaping the structural reform

of universities. Support to research internationalisation and strategic alliances, Valorisation, Entrepreneurship, and Outreach are jointly moving from isolated experiences or anecdotic structures in universities to become key factors to increase the role of universities in society. The cases presented in this document are witnesses of this major shift.

Figure 8 tries to summarize this evolution from the present situation. We are well aware of the difficulties, both internal and external, to carry out this process: it will take time and policy measures should be evaluated; but we firmly believe in the need to step up this process.

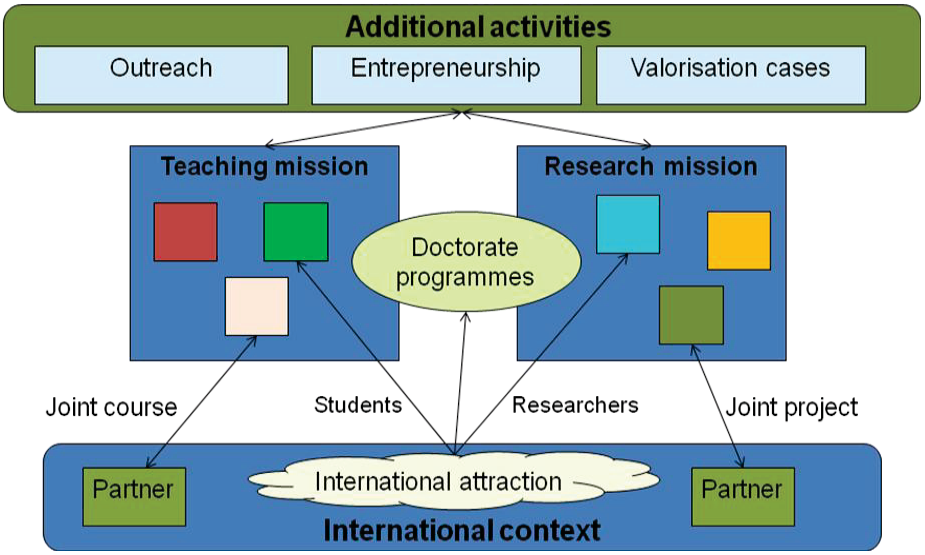

Figure 8. Present situation of European technical universities

This model is rapidly evolving when universities integrate the accumulated experience. The international context will be embedded in the daily operation of all functions of the university (teaching, research, outreach, entrepreneurship, valorisation, etc.). Simultaneously, the so-called additional activities (third mission) where valorisation, entrepreneurship and outreach could be placed will progressively enter into the main missions of the university because these ones cannot be fully realised without them. The new model of the **"technical university of tomorrow"** depicted in figure 9 will take time to be consolidated but the direction is open.

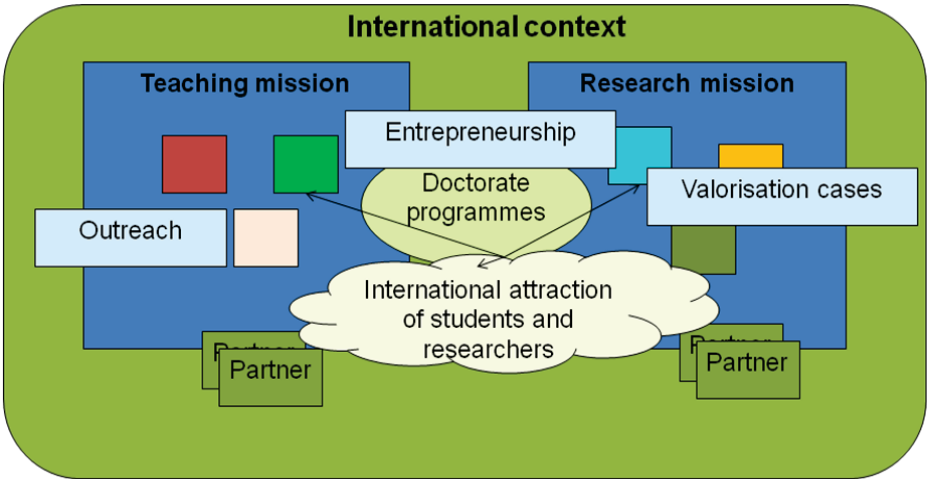

Figure 9. An integrated model of technical university

Let us finish with a cite found in a document issued by the European Commission ("The world in 2025") which expresses very well the present situation:

"Quand les contextes d'action s'étendent dans l'espace au point d'affecter des hommes à l'autre but du monde, et dans le temps au point de conditionner le futur d'hommes proches et lointains, il est clair alors que la plupart de nos concepts et de nos pratiques doivent être profondément révisés".

Ulab partners deeply agree with this sentence. European technical universities are also well aware of the historical change they are living and to need to face it with innovative approaches which will affect their structures and external positions.

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