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THE EVOLUTION OF UNIVERSITY-BASED KNOWLEDGE TRANSFER STRUCTURES

Stephen Trueman, Lidia Borrell-Damian and John H. Smith

EUA
European University Association

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This report is part of a series of EUA publications on the outcomes of the EUIMA project. Additional outcomes of this project include the EUIMA Collaborative Research Project Report, an Assessment Tool for University-Business Research Partnerships (U-B Tool – online self-assessment tool) and an EUA project paper by EUIMA senior adviser Dr David Livesey.

All materials can be found at www.eua.be

Authors' note

When we began our travels in Europe to look at what was going on in collaborative research across several universities who participated in the EUIMA Collaborative Research project[4] on a voluntary basis, we had an idea of how much university-business collaboration had changed in the approaches taken, and how much those changes were accelerating. But we needed confirmation of that and we wanted to see what these varied research environments were doing to react to the requirements of their economic environments.

Today, pulling together the threads of what we were told, and reflecting on some of the interesting ideas and projects that we were shown, it is satisfying to be able to show examples that demonstrate that universities are generally much better at change and adaptation than we might expect. Universities are often seen as elephantine institutions, slow to adapt their organisations, but they are also the sum of their researchers, many of whom regularly collaborate with industry, and who as individuals and with their research teams are capable of adapting to requirements very quickly. They are the real monitors of the relationship with external partners and of how it is changing.

Noticeably, little was said about patents. The traditional approach to Technology Transfer of organising research results and creating opportunities to transfer them to industry for licensing was generally perceived as the way things used to be. Generally, we were told about collaborations and joint initiatives where industry works alongside researchers in universities. We heard about students going to work in the companies with which they had collaborated. The shift was away from patents and towards knowledge, towards people and their competencies.

Open Innovation as an approach to innovation based on research outcomes has spread from the larger companies down to medium-sized and, in some cases, to small businesses. Clusters and networks are used to create the critical mass to make collaboration effective. Specific facilities for bringing in companies to work alongside researchers were seen as a must. Professors have now understood that the tools for collaborating with companies are not just researchers or doctoral students but also undergraduate students. This enables research knowledge to be complemented by the creativity that product development needs as much as, if not more than, achieving technological innovation.

We gathered these insights from our empirical case studies. A lot of the significance of that information was strengthened by the silence, the things we did not hear. We did not hear much about patents because they were not seen as the key to collaboration. Researchers wanted the companies to do the patenting, and give them reasonable conditions for publishing the results. The universities did not want to get rich on royalties but wanted to reinforce the research teams with personnel financed by industry and businesses.

[4] Details of the case studies and workshop presentations which constituted the EUIMA Collaborative Research Project are available at www.eua.be/euima-collaborative-research

What we also heard many times was that industry and business people needed to feel comfortable in the university environment and, similarly, that professors needed to feel comfortable being invited to talk in company boardrooms. Building trust and mutual understanding of respective interests was therefore seen to be at the core of successful collaborations.

This paper is an analysis of what we learnt, and reflects the spirit of these opening comments. Our objective is to make this useful, to share this experience and stimulate debate. Finally, we must add that while the views expressed in this paper have been developed as a result of many discussions with colleagues across Europe, any errors are those of the authors and not the EUA project participants.

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Introduction

The modernisation process of universities has historically highlighted the necessity of providing support structures to facilitate contacts and relationships between research groups and the outside environment, with the objective of increasing the quantity and improving the quality of collaborative research activity.

The first steps in this direction have been the internal Knowledge Transfer Offices (KTOs). Universities have created these internal technostructures[5] within a typically administrative culture. Whilst the benefit of such structures has been undeniable, a number of cultural issues have emerged which need to be considered within the overall picture of how to develop a KTO system. On the one hand, the existence of a technostructure within a highly traditional administrative culture such as the university administration has created a series of acceptability issues with administrative colleagues. On the other hand, research staff who are not used to accessing expert support from their internal administration have not immediately been prepared to profit from the new opportunities made available.

The activities carried out by these structures were initially aimed at pioneering communication with external players. However, as the collaborative culture of research has undergone incremental growth and the quantity of relationships and contracts has increased, so these internal offices have adapted their activities to the immediate requirements of their internal clients (researchers) by providing more routine support such as standard procedures and methodologies.

At the same time, the growth of external collaboration has motivated in particular the more active universities to extend their KTO activities and take them closer to the market, as well as to create "Innovation Ecosystems"[6]. We have found a wide variety of models across the case studies that we have examined, and we will provide an overview of these solutions in relation to their regional contexts. This will enable other universities to find some comparisons that they may wish to consider, whilst reflecting and planning their own specific strategies regarding their particular environments.

These ecosystems range from externalised offices fully owned by the university or, more often, by local

[5] A technostructure is a part of an organisation or business composed by a group of analysts, administrators and scientists who are specifically concerned with creating, adapting and changing an organisational structure, and with achieving stabilisation and standardisation among the parts of the organisation. In Henry Mintzberg's conception of the basic structure of organisations, the technostructure is one part of a five-part foundation for organisational structure (cf. Mintzberg, H., 1992, *Stucture in Fives: Designing effective organizations* (Upper Saddle River, New Jersey, Prentice-Hall). The analysts and experts that belong to the technostructure are detached from the operating workflow. They are the ones who design it or make alterations to it, but are not those who carry out the work for which the organisation or business is set.

These experts help the organisation or business to adapt to both internal and external changes. The extent of standardisation directly affects the size and hegemony of the technostructure. A large amount of standardisation will cut down the necessity for middle line managers to have direct supervision of the operating core of workers. Where the technostructure has less influence, the other parts of the organisation will increase their efficacy, whether it be the strategic apex, operating core, support staff, or middle line workers.

[6] For the purpose of this study, we define innovation ecosystems as complex structures formed by the interaction of the participating research organisations, researchers and innovators within an environment. A healthy ecosystem is one in which participants can thrive and grow, it self-regulates and adapts as market needs evolve.

institutional partners (including in some cases private partners), to science parks or joint laboratories which all maintain elements of the original university KTO services. The more universities reach out to industry or other institutions, the more these peripheral organisations become specialised, whilst also promoting the multidisciplinary aspects of the research being carried out. The involvement of national or regional organisations and funding varies according to the ability of the regions to coordinate research, industry and government activities (Triple Helix model[7]).

As KTO activities move across the border from universities' internal culture to the competitive external environment, so the emphasis changes from providing basic services to identifying and supporting new initiatives and seeking out new opportunities. The universities that we looked at provided extensive information on these activities and the specific contexts in which these were being carried out.

We found that in the case of well-established KTO strategies, many universities had clear mission statements linking their research objectives to economic regional development. This clarity of goals through the mission statement had two effects: (i) it facilitated the co-development of support structures to enable research outreach, and (ii) it supported single companies, through to industrial districts, in reinforcing their innovation capacities. Clearly the most effective regional systems had been developed by strong coordination between university, local politicians and industry, but the development of a clear and effective university mission statement has been seen as a catalysing factor.

Finally we found that the development of KTO activity as a whole is linked to (i) the internal 'research culture' of universities and their ability to converse with companies, (ii) the external 'technology and innovation culture' and its level of confidence in research structures, (iii) the KTO's own capacity to invest, and (iv) the level of development of the regional KT ecosystem. In all cases it was clear that the development of the first three factors is an incremental process over the years, and that regardless of how the KT ecosystem can be developed as requirements increase, it invariably has a fundamental role in promoting collaborative activities.

Where external KTOs (external to universities, science parks, and other joint facilities) were created, these new organisations were generally planned as complementary to existing KTOs, not as a substitute. Examples of this trend are Chalmers University of Technology: Innovation Office and Chalmers Innovation; Hamburg University of Technology: Innovation Office and TuTech Innovation; and Ruhr University Bochum: Internal KTO and Rubitec. We did not generally find that universities closed down their internal KT offices in favour of external ones; rather, they differentiated activities between the nodes of the KT ecosystem according to the requirements of their specific contexts, reserving the more administrative or routine support activities for the internal university KTOs.

[7] In recent decades we have witnessed a convergence and crossing-over of three worlds which were once very much separate: public research, business and government. This convergence has been represented and explained by Etzkowitz through the Triple Helix model (CESPRI, 1997 and Etzkowitz, undated), which was further developed by Leydesdorff who has provided theoretical systems with which to develop the idea (Jones-Evans, 1997, Leydesdorff, 1996 and 1997). This model refers to a spiral (versus traditional linear) model of innovation that captures multiple reciprocal relationships among institutional settings (public, private and academic) at different stages in the capitalisation of knowledge. These three institutional spheres which formerly operated at arm's length in liberal capitalist societies are increasingly working together, with a spiral pattern of linkages emerging at various stages of the innovation process, to form the so-called "Triple Helix". (see also Viale, R., & Ghiglione, 1998, 'The triple helix model: A tool for the study of European regional socio-economic systems', *IPTS Report,* 29, pp. 34-8. Available at http://aei.pitt.edu/51903/1/B0542.pdf).

The variety of structures and their mission, ownership and governance

Internal KTO

The EUIMA Collaborative Research case studies dealt with a number of more or less advanced KT systems, where the preliminary stages of their internal KTO could be considered historical events long since overcome. However, by looking at the activities actually carried out by some of these internal KTOs and the overall descriptions of the KT systems, it was possible to reconstruct a general reflection on these initial structures.

The internal KTO office is usually the first structure that a university establishes in a KT system. It is the first attempt to provide support to its researchers to:

- identify potentially interesting research results;
- patent and license those results;
- identify suitable industrial partners;
- establish Non-Disclosure Agreements (NDAs) and standard contract agreements;
- support dialogue and negotiation with companies;
- create spin-off companies.

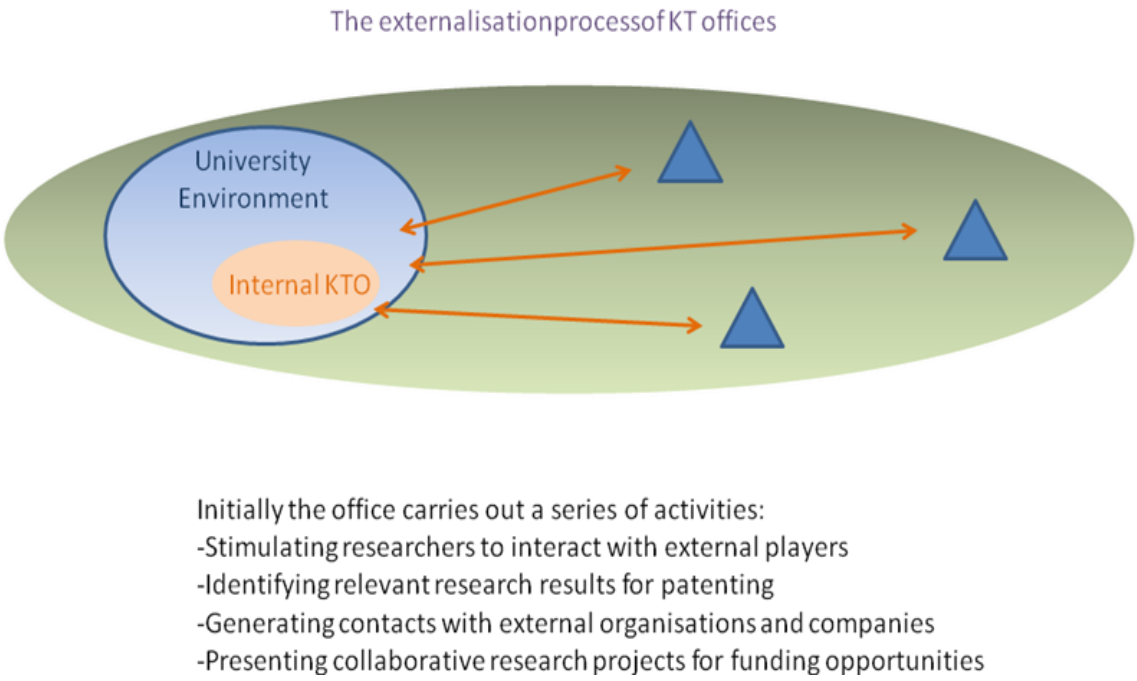
Technostructures, as new environments that embrace both university administration and faculty, can pose challenges in the context of traditional university structures (Mintzberg, 1992)[8]. The respective perceptions of administrative and faculty staff of each other can work to inhibit the development of the kind of relationship necessary for an effective use of such technostructures. Consequences can be varied, for example:

- KTO staff can meet with mistrust from more traditional university administrative units, such as student administration and human resources. This tends to impede adequate internal collaboration.
- KTO staff can find that researchers have difficulty in recognising their expert status, and whilst relationships with researchers can be developed over time, it is sometimes difficult to overcome initial barriers.
- Researchers can have difficulty in relating to the KTO staff, who can be perceived merely as "controllers" and appliers of procedures, leading researchers to seek expert advice outside of the university.

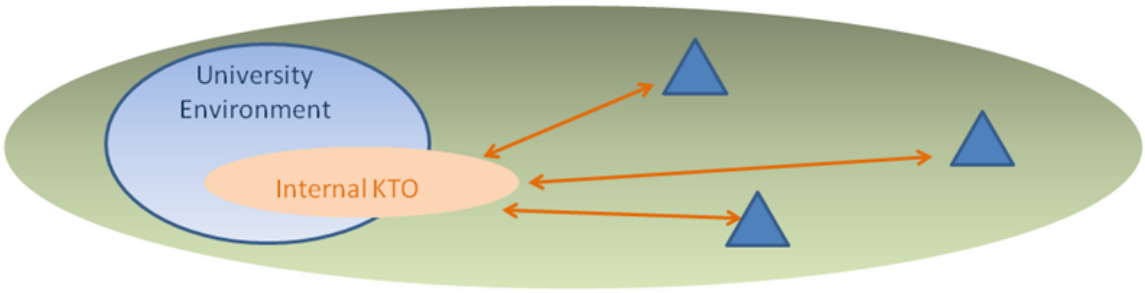
[8] Mintzberg, H., 1992, *Stucture in Fives: Designing effective organizations* (Upper Saddle River, New Jersey, Prentice-Hall).

It can be noted that, as the collaborative research activity of the university increases, the KT system is usually developed by externalising some of the more market-related activities and moving them closer to the industry. At this stage, the internal KTO tends to concentrate its efforts on supplying more routine support, such as templates for Non-Disclosure Agreements (NDAs), standard contracts and licensing agreements, and designing and applying university regulations to deal with the university's increasing collaborative research activities. The internal KTO is required to carry out fewer pioneering activities, such as developing relations with companies or directly promoting research results, as researchers are undertaking more of these themselves. Meanwhile, the external KT system is concentrating on more market-related activities.

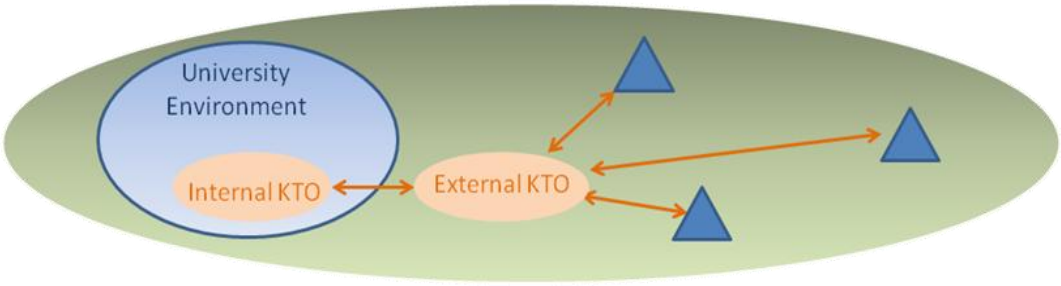
Consequently, over time, the internal KTO sheds much of its technostructure nature and returns to a more classic bureaucratic structure, therefore fitting more easily into the traditional university administration structure. Indeed, technostructures are a typical example of the evolution of management tools in times of change, such as in a modernisation process. The subsequent return to a bureaucratic culture following change is a well-documented process in the literature (Handy, 1985[9]), although it is not considered by all authors to be a positive phenomenon.



[9] Handy, C. B., 1985, *Understanding Organisations: An example of good practice* (Harmondsworth, Penguin).



As contacts increase :
-The KT office develops closer relations with external organisations
-More researchers collaborate directly with companies and rely on the KT office more for standard agreements and contracts
-The office increases its internal support activities whilst having to develop competencies for typically external activities such as business planning, commercial negotiation and licensing
-The office becomes stretched across a wide range of activities involving diverse competencies causing confusion over priorities



An external KTO is created:
-Tasks and competencies are divided between the two offices
-The internal KTO specialises in supporting the researchers and defending their interests
-The external KTO specialises in supporting external organisation's innovation requirements and linking with the University
-Roles and competencies are stabilised.

A reflection on the professional profiles of staff in KTOs is vital here. The evolution of the KT systems that we are analysing showed that the development of suitable human resources is fundamental to the success of the KT system. In the early stages of an internal KT office, expert profiles with specific characteristics such as project managers, licensing agents and business plan developers were involved. As the activities of the KT office become more of a routine, they require more administrative competencies. Consideration must be given to the risk of demotivation of potentially over-qualified personnel, and the opportunities and advantages of providing for their further professional development in the KT system as it evolves.

External KTO

As a university begins to explore its institutional role as part of a territorial knowledge system, so it begins to appreciate the relevance of linking and binding relationships with other territorial institutions involved in economic development, either politically or economically.

For this reason, externalising a KT function is not limited to considerations such as streamlining operations or introducing market-oriented objectives. More importantly, in the long run, it is about strategic partnerships with a view to specific missions and objectives that go beyond the internal strategy of the university itself and involve links with regional economic objectives and development.

From the collaborative research point of view, the push to externalise KT activities is closely linked to changes in the models for knowledge transfer. With the advent of "Open Innovation", the classic approach of using a KTO to transfer results to the market has been replaced by the "co-creation"[10] concept. This essentially means that researchers need to collaborate at an early stage with those that have a close knowledge of the market, whilst companies wishing to use technological innovations need to have a better understanding of these innovations earlier in the process of their development.

The traditional role of the internal KTO as a form of research results gatekeeper has to an extent been surpassed. Sourcing research results, choosing results to patent and then selecting a number of licensing strategies is proving to be an insufficient approach to knowledge transfer.

Therefore, one of the first key roles of the external KT structure is promoting and consolidating collaborative research partnerships. As the KT system evolves, this fosters co-creative working environments in which both multidisciplinary researchers and companies can work together to produce new knowledge and technological innovation.

As external structures are developed, it then makes sense to distinguish tasks between the internal and external KT structures, and above all, to establish strong, effective and beneficial relations between the two, although this is difficult and can take time.

In all EUIMA Collaborative Research case studies we found that the long-term success of external initiatives had been closely linked to the way these strategic partnerships had been set up (examples of this are: TuTech Innovation in Hamburg, Rubitec in Bochum, and NTNU Technology Transfer Ltd in Trondheim). The common characteristics leading to success have been:

- a clear strategic mission;
- a sustainable operational model;
- an effective relationship of the objectives to each partner's strategy;

[10] The term "co-creation" refers to a business strategy focusing on overall customer experience and interactive relationships. Co-creation allows and encourages a more active involvement from the customer to create a value-rich experience.

- an effective role of each external partner in the new organisation;
- a clear function of the external organisation in the KT system;
- clarity of roles and relations with the internal KTO.

Research structures with collective institutional goals between the external and the internal KTOs are typically referred to as “clusters”. They are generally based on non-profit models, are able to profit from the flexibility of the market and opportunities of entrepreneurship. But, on the other hand, they face the risks that this involves. Market forces can very rapidly push the organisation towards the easiest money-making situations, putting at risk its initial motivations on research-based innovations. A clear strategic mission is therefore essential, as is also the sustainability of the operational model. Whilst the drive of surviving on the market is a healthy motivator, care must be taken that the organisation is not driven towards activities that are far from its mission.

As in any organisation, the choice of partners is crucial. The presence of an organisation aiming at forming a strategic partnership with local research and innovation actors is paramount, and can determine the success or otherwise of the initiative itself. Equally, the partners of this “eco-system” must perceive the value – and understand the importance – of their own presence, and how this relates to their respective organisational strategies. This includes a clear understanding of the KTO missions in relation to (i) each partner’s strategy, (ii) the effective and active role of each partner in the new organisation, and (iii) the potential returns (i.e. financial, access to knowledge). Partners should also contribute towards defining these missions.

The development of the overall KT system usually goes beyond the university itself and involves political decisions. Although the development of the KT system may well be an incremental one, an overarching planning procedure is necessary and the collective KTO should have a clear position within the KT system. Clearly, the objective is that each organisation is synergistic to the rest and, more importantly, that functions are not duplicated or do not conflict strategically with other elements of the system.

Finally, and certainly the most critical point from the university’s point of view, is clearly defining the roles between the internal KT office and the external KT organisation. The university researchers should clearly benefit from the activities of the latter, otherwise the role and indeed the presence of the researchers in the latter would be debatable. The university should therefore promote its use, but in doing so clarify roles with the internal office, and clearly define relationships between the two.

As an indication derived from the case studies, the following table lists the basic task divisions between internal and external KTO:

Internal KTO	*External KTO*
IPR and patenting	Licensing
NDAs and standard contracts	Research contractor. Negotiate strategic partnerships
Support spin-off creation	Support spin-offs in the market
Organise entrepreneurial workshops	Carry out entrepreneurial training
Internal incubation	Facility provider (business incubator)

Sources for these lists have been taken from the following case studies: “Chalmers University of Technology”, “Ruhr University Bochum”, “Rovira i Virgili University”, “Aalborg University”, “Leuphana University of Lüneburg”, “Norwegian University of Science and Technology”.

Centres of excellence/Competence centres/Joint laboratories/Interdisciplinary centres

These are university-based facilities where a variety of disciplines are physically grouped with the aim of providing services, access to equipment and laboratories for collaborative research to one or more industrial sectors. The distinguishing characteristic of this type of organisation is its accessibility for industry. These structures usually comprise conference rooms for meetings with companies and for holding seminars to promote research knowledge and results for industry. They usually have a limited staff with competencies linked to those of the KT structures, but also with more discipline-specific backgrounds.

Science/Technology parks

The externalisation of centres of excellence in those regions where significant investment is viewed as a regional development strategy often takes the form of the creation of science or technology parks. Usually these are nationally or regionally funded and owned, but in most cases they are based on ongoing university-based research, and close research collaboration with industry. In some of our case studies

universities were partners in the parks themselves (Chalmers University of Technology, KU Leuven). Science or technology parks therefore become highly important players in the overall KT system, and are an excellent support for the university's KTOs; they also attract numerous technology-based companies, thereby increasing the potential for collaboration.

These structures usually involve the co-location of research laboratories and companies in a specific area or "park". The key advantage provided to both researchers and companies is the reduced distance between them, the use of a number of joint facilities, and often lease agreements which facilitate collaboration between research laboratories.

Industrial clusters/Networks/Matchmaker organisations

A number of our case studies have based their KT strategy on the development of industrial clusters around specific applied research themes where the university itself has particularly strong competencies. Both large and small companies are invited to join the clusters, and the university generally stimulates relationships with the clusters through a number of joint activities. The key objective of these is that of providing the cluster members with cutting-edge information on the latest technologies, whilst making its own laboratories and researchers available for providing services and/or research collaboration.

We found that these clusters were particularly useful in regions where regional policy has already supported and favoured the development of strong industrial sectors, making the cluster themes easily identifiable. Some clusters will be built on ongoing consolidated research collaborations emerging from active university research groups already collaborating with companies (Karlstad University was a particularly strong example of this).

University-based incubators/Innovation centres

For the purposes of this paper, the relevance of spin-offs in the overall scenario of collaborative research was not evaluated. However, within the overall KT systems, the value of internal structures supporting spin-offs or their pre-incubation is evident. Indeed, particularly in their early stages, spin-offs are the closest type of company that one can get to the research environment and, from a cultural point of view, they represent excellent partners in collaborative research projects.

Dedicated physical spaces within the university campus in the vicinity of the research laboratories, where such spin-offs are located, therefore become highly relevant for generating close collaborative research relationships. Usually such structures are run by specialised staff, but are generally very closely linked to the KTOs.

A particularly interesting example of an innovation centre is the Demola - New Factory in Tampere (Finland), a joint initiative between Tampere University of Technology, the University of Tampere and the Tampere University of Applied Sciences. Demola is, to use their own words, "an ecosystem of creative action for students, companies and universities".

The principle is surprisingly simple, and we think highly effective:

- Companies are invited to present challenges: ideas for further developing their own products or creating variations on their existing ones.
- If the challenges are accepted by Demola the company signs a project contract, and then provides supporting information and establishes a relationship with a team of students.
- The team of students is formed on a multidisciplinary basis, involving students from different degree courses. Demola facilitates and motivates the team, who also receive credits for their degree courses.
- After about four months a demo is presented to the company. Should the company feel that the demo and the outcomes are valuable, they can pay a reward for a shared or full licence, or even engage Demola for further development. On the other hand, if the company perceives no value they are free not to pay, and the students own the results created.

The opportunity provided to students of collaborating with leading companies, working in an inspiring atmosphere, and maybe even receiving a reward from the company for the work done, is an excellent incentive that universities can use as added value for their students. For companies, this is a way of boosting their R&D process with demonstrations and of building sustainable university-business collaboration. It is also an excellent means of attracting the best young talent.

Today, Demola is a network of centres located in several European countries: apart from those in Finland, in Tampere and Oulu, there are centres in Hungary, Latvia, Lithuania, Slovenia, Spain, Sweden. The network has carried out more than 250 projects since Demola - New Factory was established in Tampere in 2008. Of these, over 90% have resulted in successful reward agreements with the companies.

In the course of the EUIMA Collaborative Research project, we visited the Demola - New Factory centre, an open space area where teams were working on projects around us. The staff were evidently young, enthusiastic, and had themselves passed through the Demola system. The overall impression was of real collaboration between university and companies through the students, putting together their creativity and the knowledge of the professors, in order to achieve real KT initiatives.

The use of students raises an issue of “cheap labour”, along with the potential risk of downgrading the perceived value of research contracts. Indeed, recently companies have tended to avoid engaging universities in costly contracts, preferring to snatch up young well-trained bachelor, master or doctorate graduates. However, in the case of Demola, the advantages of stimulating companies into establishing links with the university through directly engaging students was perceived as building longer-lasting trust that would then lead to solid university-company relationships.

Other Types of Support Structures (identified from EUIMA Collaborative Research case studies)

- **Science-to-Business Marketing Research Centre - Münster University of Applied Sciences**

The Münster University of Applied Sciences (Münster UAS) provided us with a view of their structure dedicated to building collaborations between research and industry through a research marketing approach[11]: The Science-to-Business Marketing Research Centre (S2BMRC). The S2BMRC, integrated in Münster UAS, carries out extensive research on how university-business cooperation can be improved. There is intensive collaboration between S2BMRC, Münster UAS and the Transferagentur Fachhochschule Münster GmbH (transfer agency). The three institutions form what is called the "triangle of synergies", where Münster UAS adopts the strategic approach, S2BMRC the analytical approach and the transfer agency the operational approach.

The S2BMRC research and analytical approach is based on the idea that market principles and mechanisms also apply to research collaborations. All successful companies rely in marketing strategies defined through the understanding of the needs of their customers, and on their ability to make adjustments to their research and development priorities, and production processes, to meet their customers' needs. S2BMRC applies the same logic to research institutions and examines key factors for the successful establishment and sustainability of university-business cooperation which have been successful in the commercialisation of research competencies, capacities and results. It develops, validates and provides new models and instruments for research and technology commercialisation and research-based support for the realisation of market-oriented university-business partnerships. The research areas covered by S2BMRC include Partnering, Science-to-Business Marketing, Entrepreneurship, Knowledge and Technology Transfer, Commercialisation, Technology Evaluation and Innovation Management/Marketing.

- **Leuphana University of Lüneburg**

Leuphana University of Lüneburg offered us a view of its own unique approach to university-business collaboration, as a university which focuses on the theory of sustainable development and on how collaborative research relates to sustainable social and environmental impact. Indeed, these themes are related to the role of the wider university sector in providing knowledge leading not only to economic development, but also to improving the quality of life within and beyond their own geographical regions.

In its own words: “As a university which understands itself as a social institution shaping the society of the 21st century, Leuphana already started in the middle of the 1990s to become one of the first European universities aimed at integrating fundamental ideas of sustainable development throughout the university, including all of its internal as well as external activities. Leuphana is strongly committed to sustainability as

[11] Professor Thomas Baaken provided us with insights on how the Science-to-Business Marketing Research Centre works through his presentation on “Models of Collaborative Research and Science Marketing” (available at www.eua.be/euima-collaborative-research/torino).

one basic principle for self-determined lives, successful careers, and social responsibility in a changing global society."[12]

The University has identified a number of impacts that it has called "mediators" which are used to try to better understand the reasons behind the success or failure of collaborative research. They emphasise the importance of the form of participation within the process of university-business collaboration, the social outcomes in terms of learning, trust and acceptance, the substantive research outputs and outcomes, and also the environmental impact in terms of the changes in environmental quality.

Indeed, the social and environmental principles advanced by Leuphana were borne in mind across all the EUIMA Collaborative Research workshops as being elements of, if not drivers to, successful collaborative research. Competitive advantage in terms of purely financial return was considered important but not without considering these broader principles and impacts.

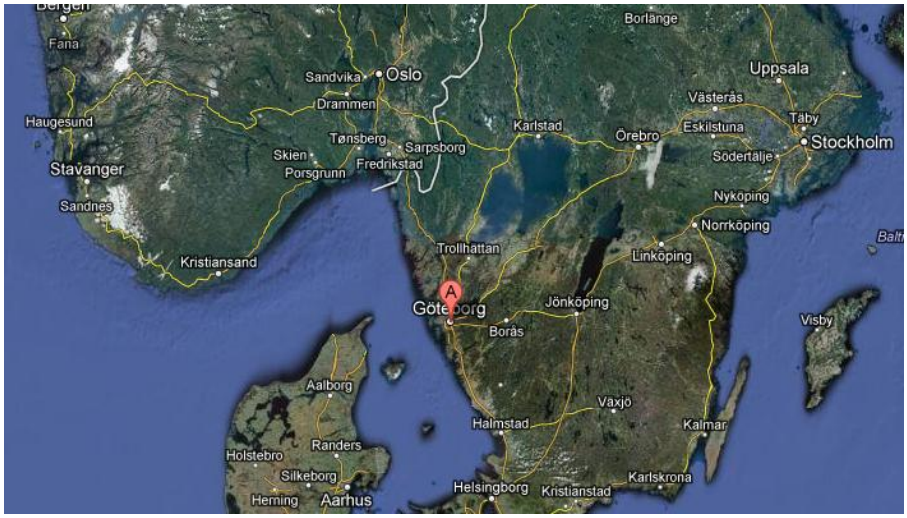
Some specific innovation ecosystems from the EUIMA Collaborative Research case studies

In the following descriptions of innovation ecosystems we have attempted to look at the wider picture that includes all those elements that may have some impact on the way the ecosystem has developed. In each case we start with the university itself, then expand our scope to look at the region and its political strategies in support of the ecosystem, analyse the industrial base in terms of its relevance for potential knowledge take-up, describe the regional innovation ecosystem as a whole, and provide a graphical overview of that ecosystem with respect to the university positioned within it. Each case is then rounded off with a conclusion that is intended to give a snapshot of the analysis we have just presented.

The cases demonstrate many aspects of good practices from which valuable experience can be drawn but, of course, there exist other models and strategic approaches not studied here that can be equally effective elsewhere. It should be noted that the information presented below was collected and analysed in the period between 2009 and 2012. Data were updated by participant universities in 2014.

[12] Prof. Daniel Lang and Prof. Jens Newig provided us with insights into collaborative research through their presentation: "Reflecting on Collaborative Research: Empirical Evidence for Challenges, Factors and Criteria for Success and Failure" (cf. available at www.eua.be/euima-collaborative-research/luneburg).

Chalmers University of Technology[13]



Map data © 2014 Google

The Chalmers University of Technology (Chalmers) is a Swedish university located in Gothenburg, with about 11,000 students, which focuses on technology, natural science and architecture. Its activities are paralleled by the University of Gothenburg, which has 24,900 students covering the Creative Arts, Social Sciences, Natural Sciences, Humanities, Education, Information Technology, Business, Economics and Law, and Health Sciences.

The two universities have managed to coordinate their efforts in knowledge transfer, particularly in ICT, whilst Chalmers has specialised as an entrepreneurial university. The metropolitan area of Gothenburg has a population of almost 1 million and is the second largest Swedish city after Stockholm.

[13] Sources:

- EUIMA case study – Chalmers University (case study submitted between 2011 and 2012)
- Chalmers University of Technology website: www.chalmers.se/en
- Wikipedia entries: “Chalmers University of Technology”, “Gothenburg”, “University of Gothenburg”, “Sweden”
- SP Technical Research Institute of Sweden: www.sp.se/en/Sidor/default.aspx
- SIK website: engwww.sik.se
- Swedish ICT website: www.swedishict.se
- Chalmers Industriteknik CIT website: http://www.cit.chalmers.se/en
- City of Gothenburg website: www.goteborg.com/en
- Business Region Gothenburg website: www.businessregiongoteborg.com
- Chalmers Innovation website: www.chalmersinnovation.com
- Chalmers Invest AB website: www.chalmersinvest.se
- CIP Intellectual Property Centre website: www.cip.chalmers.se

Region

The region, located in the south western part of Sweden, has a strong manufacturing component, including most of Sweden's automotive industry. Historically, strong industrial sectors, such as shipbuilding, have given way to more knowledge-intensive businesses, a process that is supported and amplified by regional and governmental initiatives.

Industrial base

A fundamental basis of Gothenburg is its industrial base with large companies such as Volvo Cars (owned by Geely), AB Volvo (lorries, buses etc.), SKF (ball bearings), Ericsson (telecoms), Saab (defence), Astra Zeneca (medical drug development). Although the head offices are not in Gothenburg, the companies have a long standing history in the city, employ thousands of employees and carry out R&D at an advanced level.

The regional innovation/ecosystem

Chalmers University of Technology is an entrepreneurial university which has developed a number of agencies, science parks and local clusters to support the transfer of research to society and industry. There are also research institutes in, or in close proximity to, Gothenburg: the SP Technical Research Institute of Sweden, SIK, Swedish ICT: Imego and the Victoria Institute, Swerea IVF. The research institutes employ some 300 people. Traditionally, in Sweden, advanced technology projects are developed at universities and not at research institutes.

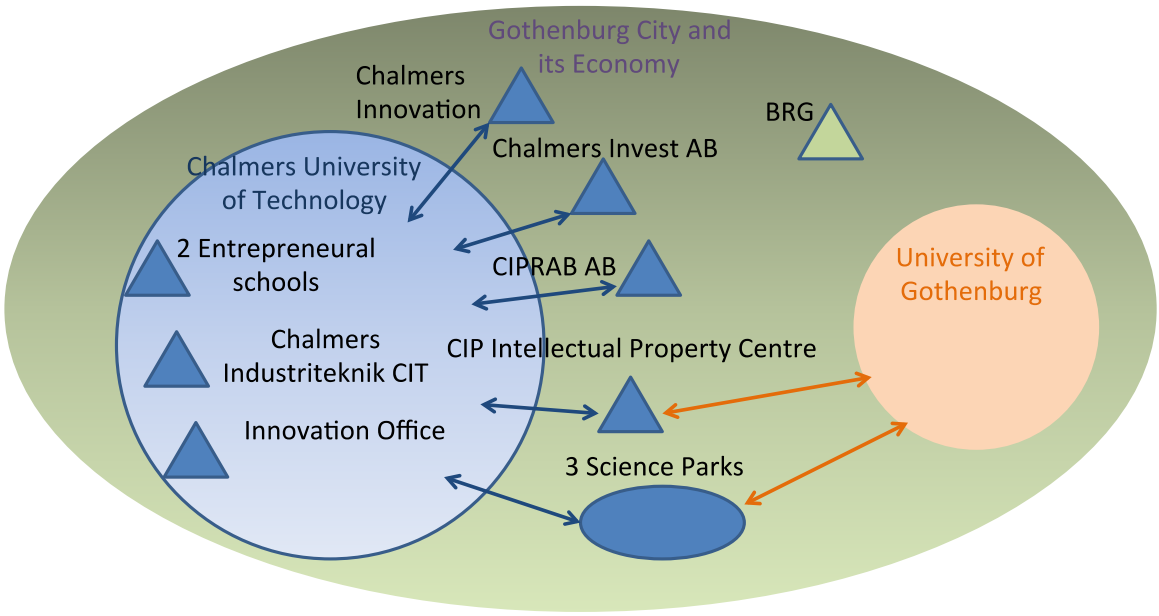
Chalmers University of Technology has founded the following agencies and structures:

- An incubator for Chalmers University of Technology spin-off companies (Chalmers Innovation)
- A venture capital company (Chalmers Invest AB – offering seed investments in start-ups)
- Two entrepreneurial schools for Masters students
- An intellectual property centre together with the University of Gothenburg (CIP)
- An IP-owning company for licensing (CIPRAB AB)
- A university-based institute for commercial-based R&D (Chalmers Industriteknik CIT)
- The Innovation Office, to coordinate all the innovation activities mentioned above, and in the surrounding universities in western Sweden.
- Three science parks with different and complementary profiles shared by the Chalmers University of Technology and the University of Gothenburg. These science parks are co-owned by public and corporate organisations, thus providing a meeting place where new businesses can develop and grow. At the science parks, infrastructure (buildings in particular) is available for universities, schools and small companies to interact and grow.

The city of Gothenburg, together with surrounding cities in western Sweden, has also founded their own company, Business Region Göteborg (BRG), to promote business and economic growth. BRG acts as an information hub and as a catalyst for selected areas where the growth potential is considerable.

Each of these centres focusses on a particular theme or technology, and is supported by public funding, university and corporate contributions in terms of both, resource allocation and steering functions. In general, these centres have been very successful and function as another mode for interaction between academic research and industrial development.

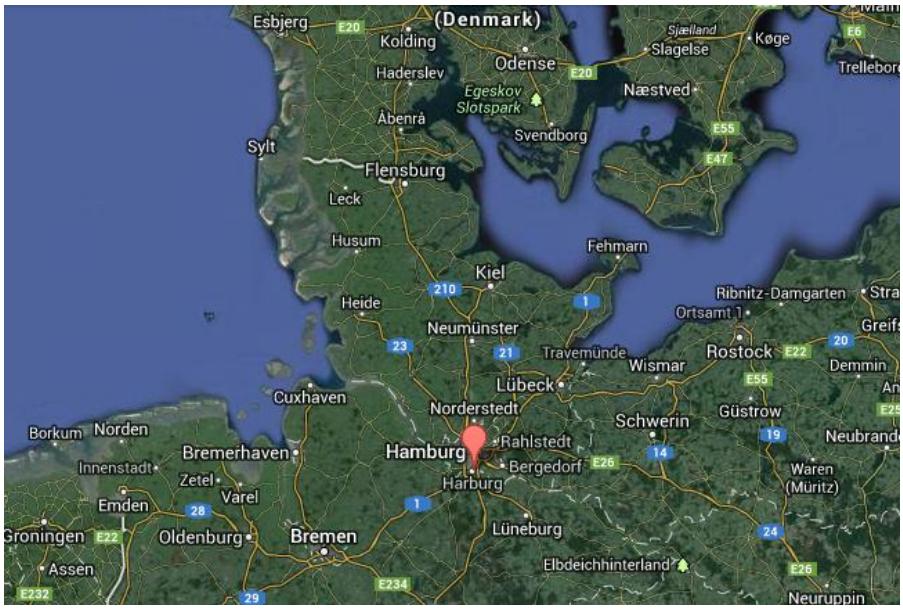
The Chalmers innovation ecosystem



Chalmers Innovation, Chalmers Invest and CIPRAB have been set up as an external organisation where the University is a partner, together with regional organisations and companies. The CIP and the science parks have been organised as a coordinated effort with the University of Gothenburg.

This ecosystem shows a high level of maturity, in which Chalmers University of Technology has built an identity in its entrepreneurial role. There is a strong presence of Sweden's dynamic large companies in Gothenburg, which clearly favoured this advanced development.

TuTech Innovation – The Hamburg University of Technology[14]



Map data © 2014 GeoBasis-DE/BKG (© 2009), Google

TuTech Innovation

One of the first technology transfer offices within a German university was founded in 1981 at the Hamburg University of Technology (TUHH). TuTech Innovation GmbH (TuTech) was founded subsequently in 1992 as the first private technology transfer company set up by a German university. TuTech supports the Hamburg University of Technology in all matters of technology transfer into industry. A second step in the development of TuTech was the integration of the City of Hamburg's "Technology Advice Centre", a public consultancy service for local companies run by the Ministry of Economics. This expanded the role of TuTech into a "one-stop shop" for technology transfer in Hamburg and it further gained national prominence as a role model for other German universities, based on its success as an interface between commercial and research interests. In August 2004, TuTech was merged with c:bs Channel Business Services, a Hamburg-based incubator, to form TuTech Innovation GmbH.

[14] Sources:

- EUIMA case study – TuTech Innovation - Bio Catalysis 2021 (case study submitted between 2011 and 2012)
- EUIMA case study – TuTech Innovation - Klimzug-Nord
- TuTech Innovation website: http://tutech.net/#1
- Hamburg Innovation: http://hamburg-innovation.net/
- Wikipedia entries: "Technical University of Hamburg", "Hamburg", "Hamburg Metropolitan Region", "University of Hamburg", "Hamburg University of Applied Sciences"
- Hamburg Metropolitan Region website: http://english.metropolregion.hamburg.de/
- Hamburg University of Technology website: www.tuhh.de/alt/tuhh/uni/welcome.html
- University of Hamburg website: www.uni-hamburg.de/index_e.html
- Hamburg University of Applied Sciences website: www.haw-hamburg.de/english.html
- HWF Hamburg Business Development Corporation website: www.hamburg-economy.de/business-location-hamburg

In association with their scientific partners, TuTech Innovation is especially active in the following fields of business:

- R&D Collaboration and Cluster Management
- International Cooperation & EU Office
- Business Start-ups and Innovation Funding
- Open Innovation & Social Media
- Patenting & Licensing
- Training & Continued Professional Development
- PR and Science and Society Communication
- IT and Web Design
- Conferences and Workshop Organisation
- Project Controlling Support

The Hamburg University of Technology (TUHH)

TUHH is a university with a clear profile in research, and with modern, practice-oriented learning methods. Plans for a university of technology in the Süderelbe area of Hamburg go back to the 1920s. Fifty years later, in 1978, the Hamburg University of Technology was created to promote structural change in the region. Today, TUHH has around 100 professors, 1 150 employees (consisting of 500 academic staff, including those with salaries from third-party funding) and around 5 000 students.

TUHH's is organised in schools: Civil Engineering, Electrical Engineering, Computer Science and Mathematics, Vocational Subject Education, Management Science and Technology, Mechanical Engineering and Process and Chemical Engineering, whilst Hamburg's main university – the University of Hamburg – with 38,000 students covers: Law; Economics and Social Sciences; Medicine, Education, Psychology, and Human Movement; Humanities; Mathematics, Informatics, and Natural Sciences. Hamburg's second largest university, the Hamburg University of Applied Sciences, has 14,000 students and it covers: Engineering & Computer Science, Life Sciences, Design, Media & Information, Business & Social Sciences.

The other universities in Hamburg are the Helmut Schmidt University Hamburg (University of the Federal Armed Forces); University Medical Centre Hamburg-Eppendorf; HafenCity University Hamburg – the University of the Built Environment and Metropolitan Development (HCU); the University of Fine Arts; the Hamburg University of Music and Theatre.

The three main state universities have managed to coordinate their efforts in knowledge transfer by creating Hamburg Innovation, in which TuTech is also a major shareholder and runs the business operations. TUHH's initiative as an early mover in generating TuTech has been a model for other universities to draw experience in developing their own KT activities.

The combination of TuTech Innovation and Hamburg Innovation is very much at the heart of the Hamburg Innovation Ecosystem. To quote from the website of Hamburg Innovation GmbH (HI):

"Cross-university Hamburg Innovation GmbH, jointly with its sister company TuTech Innovation GmbH, provides the right link between science and business. In these companies scientists, both university and corporate, have a competent partner to help them initiate and implement cooperation projects. HI and TuTech Innovation GmbH (TuTech) thereby also make up an important element in the Free and Hanseatic

City of Hamburg's business development policy. With this knowledge transfer tandem, including all of its universities, Hamburg is playing a pioneering role in Germany."

Region

The port of Hamburg, situated on the river Elbe, is the largest seaport in Germany, the second-largest in Europe (after the port of Rotterdam), and the tenth largest worldwide.

Hamburg is the second largest city in Germany and the sixth largest city in the European Union. The city is home to over 1.8 million people, while the Hamburg Metropolitan Region (including parts of the neighbouring Federal States of Lower Saxony and Schleswig-Holstein) has more than 5 million inhabitants.

Industrial base

Hamburg is a major transport hub in northern Germany and is one of the most affluent cities in Europe. It has become a media and industrial centre, with plants and facilities belonging to Airbus, Blohm + Voss and Aurubis. The radio and television broadcaster Norddeutscher Rundfunk and publishers such as Gruner + Jahr and Spiegel-Verlag are pillars of the important media industry in Hamburg. Hamburg has been a significant financial centre for centuries and is the seat of the world's second oldest bank, Berenberg Bank. In total there are more than 120,000 enterprises in Hamburg.

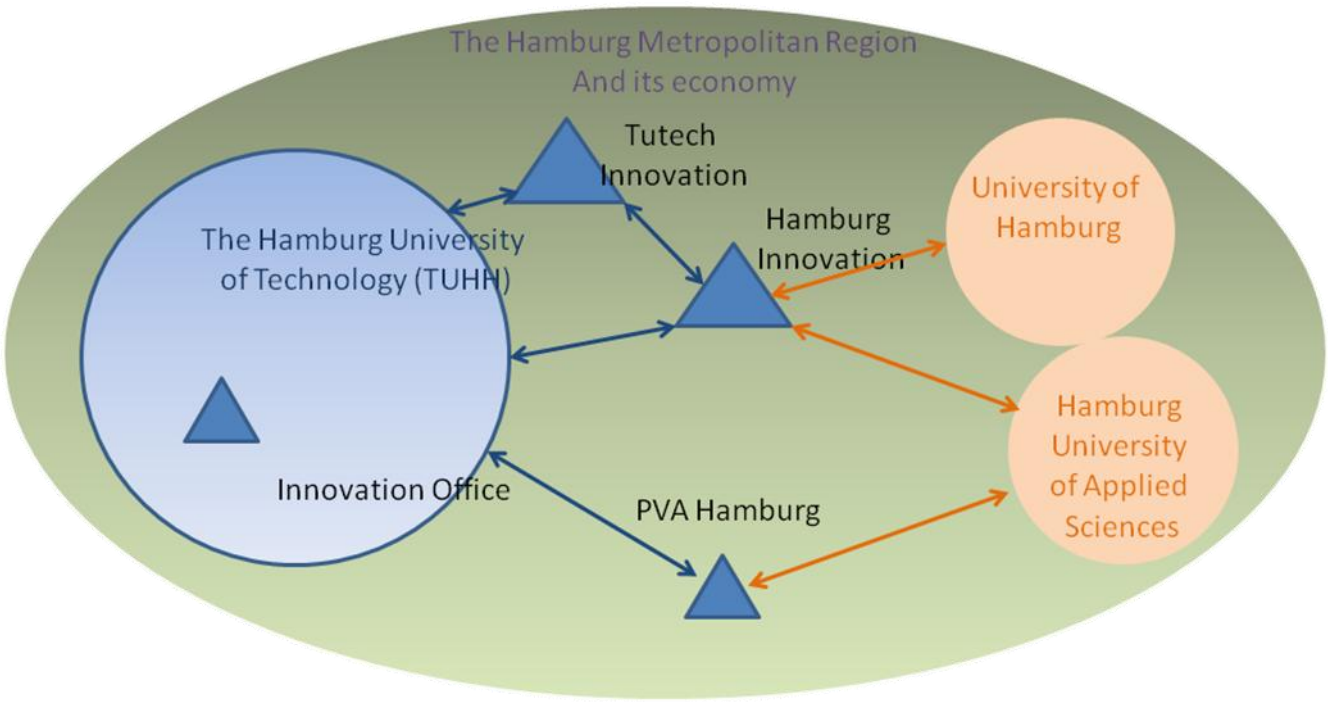
The regional innovation ecosystem

The Hamburg Innovation Ecosystem is complex, which is perhaps typical of a very large city. A vast number of higher education and research institutions (16 higher education institutions and some 13 research institutes, including three Max Planck and three Leibniz institutes) and a large number of companies (e.g. Airbus Industries, Philips Medical Systems, Lufthansa Technik AG, Beiersdorf AG, Eppendorf, Olympus Winter, Evotec and Ethicon) have centred the research initiatives in this region.

What seems to be a distinguishing feature of this type of ecosystem is not an apparent lack of a precise overall strategy, but rather the emergence of an innovation model based on success stories. The TuTech model was welcomed and adopted by Hamburg Innovation.

The City of Hamburg and the Federal Ministry of Economics and Technology (BMWi) have together established PVA Hamburg, financed under the SIGNO programme for universities, which undertakes professional invention and patent management.

The Hamburg (TuTech-HI) innovation ecosystem



This figure depicts only a small part of the Hamburg Innovation Ecosystem, but one that constitutes a very effective sub-set of an overall highly complex environment, and that is characterised by a high density of research and industry in a large city such as Hamburg.

Clearly TUHH and its decision to establish TuTech in 1992 represented a courageous strategy. The University of Hamburg had opted for a more traditional approach, creating the internal KTO “Office of Information and Technology Transfer (AWiTT)”. However, once the effectiveness of TuTech was demonstrated, the University of Hamburg abandoned its internal KTO office and all the Hamburg universities joined to create Hamburg Innovation, based on and run by TuTech.

It is difficult for large cities to develop their innovation ecosystems, largely due to multiple, diverse interests. Consequently, this system is an example of an effective approach in that context.

Katholieke Universiteit Leuven (KU Leuven, the Catholic University of Leuven) and LRD (Leuven Research and Development)[15]

Map data © 2014 Google

KU Leuven – the Catholic University of Leuven

KU Leuven, founded in 1425, is a large university (41,255 students and 18,635 employees) in a relatively small town (a population of 97,656). It is a classic university town, where the university itself represents a principal core activity and the town centre is dedicated to hosting the student population throughout the academic year.

KU Leuven has 14 faculties covering all the major academic disciplines. The faculties are subdivided into three groups: Humanities and Social Sciences; Exact Sciences – Science, Engineering and Technology; and Biomedical Sciences.

[15] Sources:

- EUIMA case study – KU Leuven (case study submitted between 2011 and 2012)
- KU Leuven website: www.kuleuven.be/english
- Stad Leuven website: www.leuven.be/en
- Wikipedia entries: "Katholieke Universiteit Leuven", "Leuven", "Flemish Brabant", "Haasrode Research Park", "Arenburg Science Park"
- IMEC website: www2.imec.be/be_en/home.html
- Arenburg Science Park website: http://wetenschapspark-arenberg.be/
- Leuven.Inc website: www.leuveninc.com/page/3/Leuven.Inc
- Dsp Valley website: www.dspvalley.com
- L-SEC website: www.l-sec.be

LRD – Leuven Research & Development

The KTO of the university, Leuven Research & Development (LRD), was established in 1972 to manage the business component of the university's science base, now representing 30% of research income and employing a support staff of 50 professionals. LRD has evolved from an initially isolated, though specialised, operation to a matrix structure that is fully embedded in, and diffused across, the university, delivering a number of specialised support services that are closely integrated with academic research groups. LRD has stimulated the exploitation of the university's research through a rich mix of mechanisms, promoting entrepreneurial behaviour within its many research divisions, as well as across a growing number of interdisciplinary open innovation platforms.

From its outset, LRD has been granted a significant amount of strategic, financial, administrative and human resource management autonomy within the university. This implies that LRD, although being fully integrated within the university, has the freedom to set appropriate strategic directions aimed at its valorisation; it organises its own administrative back-office activities and manages its own budgets, as well as the research personnel employed on those budgets.

The autonomy to develop various valorisation avenues has to be embedded alongside an appropriate organisational approach. Therefore LRD introduced the organisational concept of the "research division." Researchers belonging to different departments at the university, even belonging to different faculties, can decide to join forces and to integrate the commercial-industrial component of their knowledge portfolio in a research division at LRD. As a consequence, the research division concept introduces a "de facto" interdisciplinary matrix structure within the university. Today there are 54 research divisions operating across the various faculties and departments of the university. It is obvious that not all faculties are equally represented or involved in the research divisions, although the majority of them are present.

Furthermore, LRD research divisions are entitled to participate both intellectually and financially in the spin-off companies that they have grown and developed. Finally, as well as the aforementioned financial incentive mechanism at the level of the research division, incentives to stimulate university-business collaboration are also in place for individual researchers.

LRD has developed four major activity poles that underpin its role in managing the economic exploitation of academic R&D:

1. Contract Research
    - negotiation and legal support with respect to research contracts between university and industry
2. Management of Intellectual Property Rights
    - application of patent and licensing policy
3. Creation of Spin-off Companies
    - professional advice and support is provided to academic entrepreneurs
4. Promotion of High-Tech Entrepreneurship

- both within the university and in the region

LRD, in partnership with two major Belgian banks (KBC and BNP Paribas Fortis), created its own seed capital fund from 1997 onwards, i.e. the Gemma Frisius Fonds, which today has access to 25 million euros in (pre-) seed capital to fund start-up companies that exploit university-based know-how. By the end of 2009, the university had created 90 spin-off companies. Over 30 of them have so far received active investment support from the Gemma Frisius Fonds. Over the years 2006-2009, LRD directly invested about 4.5 million euros in its spin-off portfolio, while during that same period, the portfolio companies were able to raise an additional 325 million euros in capital from other investors. This is a leverage factor in excess of 70, pointing to the fundraising strengths LRD has been able to build and develop over the last decade. In order to assist the start-up entrepreneur, LRD also has access to an "Innovation & Incubation Centre" that is jointly owned and operated by the university and the Regional Development Agency. Accommodation and managerial support for LRD's spin-offs are provided through this "Innovation & Incubation Centre," which is located on the university's campus and, as such, promotes close proximity with university laboratories and research units. Recently, in a partnership with the Flemish Institute of Biotechnology (VIB) and a local company (AVEVE), LRD developed and built a dedicated Bio-Incubator facility, aimed at housing and supporting the portfolio of biotechnology start-ups that originate from the university.

In addition, several science parks have been created in the close vicinity of KU Leuven that are open to new innovative companies. These parks not only host spin-offs of the university and other research institutions, but also the R&D departments of existing companies. The development and exploitation of these parks is carried out in close collaboration with the City of Leuven and the development agencies of the province.

Region

The Flemish government has provided its universities with the necessary legal framework to engage in effective technology transfer activities (e.g. the delineation of IP rights with the university as sole owner of the intellectual property it generates, the possibility to participate in seed funds to support start-ups financially, the possibility to create science parks, etc.). This implies that the Flemish government has given its universities an explicit mission to economically exploit the research they generate. This has led to an extremely dense and intensive involvement of Flemish industry with Flemish universities. In 2009, 16.3% of the HERD (Higher Education Expenditure on R&D) was generated through R&D support from industry. This result makes Flanders amongst the very high-ranking OECD regions in terms of private support from the HERD.

In 2009 the Flemish GERD (Government Expenditure on R&D) amounted to 2.12%. The major R&D performers in Flanders are the companies (BERD [Business Enterprise Expenditure] = 1.39% of the GDP of the Flemish region). As far as basic research is concerned, the five Flemish universities and the four strategic research centres (IMEC – nano-electronics, VIB – biotechnology, IBBT – broadband technology, VITO – engineering technology) are the core actors. The government agencies FWO (fundamental research in universities) and IWT (innovation & technology in industry, universities and strategic research centres) are the most important funding agencies that support R&D projects in Flanders, along with structural funds for the universities and the strategic research centres.

Industrial base

Leuven has a relatively large number of innovative companies. They are concentrated in specific technology sectors such as life sciences, food, health, mechatronics, telematics, e-security and microelectronics/nanotechnology. Also, the city has multinationals that perform R&D in Leuven: Philips, Tyco Raychem, and ARM. The knowledge base is extremely well developed: the region has strong research institutes, both public and private. A major institute is IMEC, the Flanders independent research centre in microelectronics, nanotechnology and related technologies, which is an important player for the regional economy. It works as a magnet for specialised high-tech companies that want to be located in the vicinity of the centre. As far as urban scale is concerned, the city itself is small, but when one considers it as a part of the larger Brussels agglomeration, the city's small scale is not an impediment to its development. It is very near to Brussels International Airport and benefits from the metropolitan amenities of Europe's capital. Technology transfer from universities and research institutes to the private sector is very well developed, and there are many high-tech spin-offs from the university and other research institutes. There is therefore a strong institutional framework to support these university-business interactions.

The regional innovation ecosystem

In addition to the Gemma Frisius Fund KU Leuven to support early-stage KU Leuven spin-off companies, an Innovation and Incubation Centre was established in 1998. The province and the university together own about 36% of it whilst the rest of the shareholders are major local companies such as Agfa Graphics, KBC, GIMV, IMEC, InBev, Philips, Johnson & Johnson, SES and a number of smaller shareholders. The centre has an area of 2 400 m^2, 15-20 companies may be incubated at any one time.

The Haasrode Business and Research Park is divided into a research and science park and a trade park, and it houses an important variety of industries. It covers 130ha and accommodates about 150 companies, providing approximately 6 000 jobs. The Arenberg Science Park was founded by the university. The science park also accommodates a bio-incubator housing the biotech and pharmaceutical spin-offs. The development and exploitation of these parks is carried out in close collaboration with the City of Leuven and the development agencies of the province.

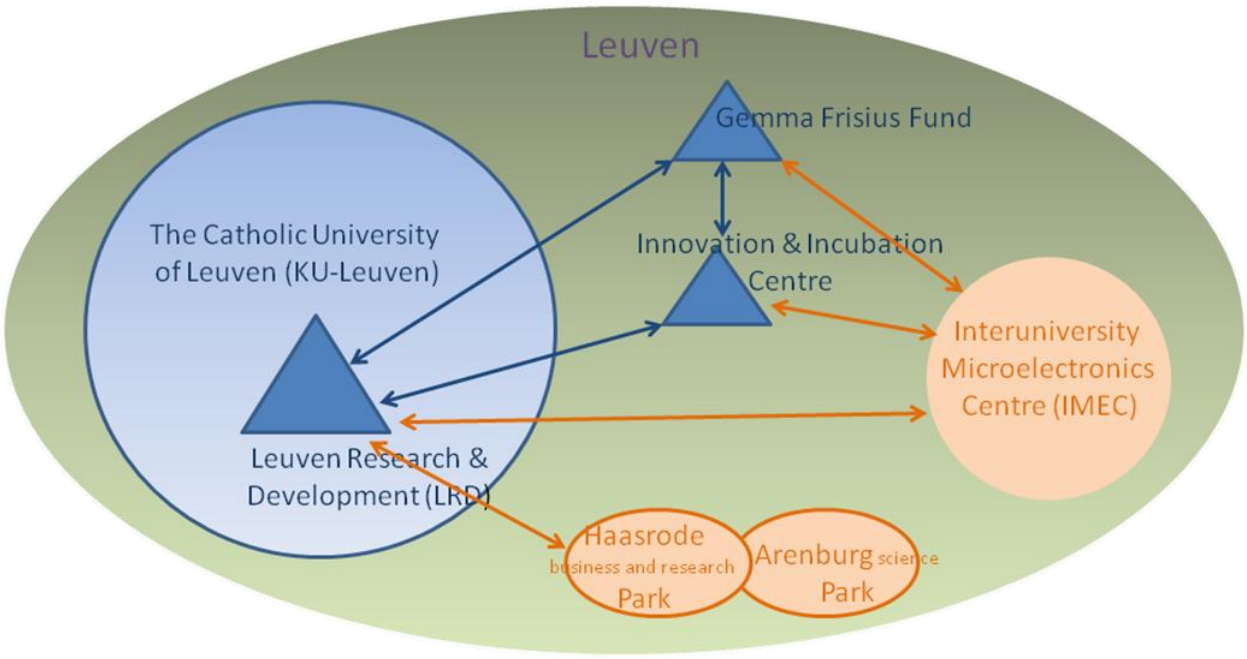
Horizontal Network

Established in 1999 by IMEC, KU Leuven, Arthur Andersen (Deloitte), Fortis Bank (BNP Paribas) and KBC, Leuven.Inc is a network organisation stimulating contacts between the university, IMEC, high-tech start-ups, innovation actors, support activities such as consulting agencies and venture capitalists, and established companies in the Leuven area.

Vertical Networks (technology clusters)

- DSP Valley focusing on the design of hardware and software technology for digital signal processing systems.
- L-SEC (Leuven Security Excellence Consortium), international, non-profit network organisation dedicated to promoting the use and advance of e-security.

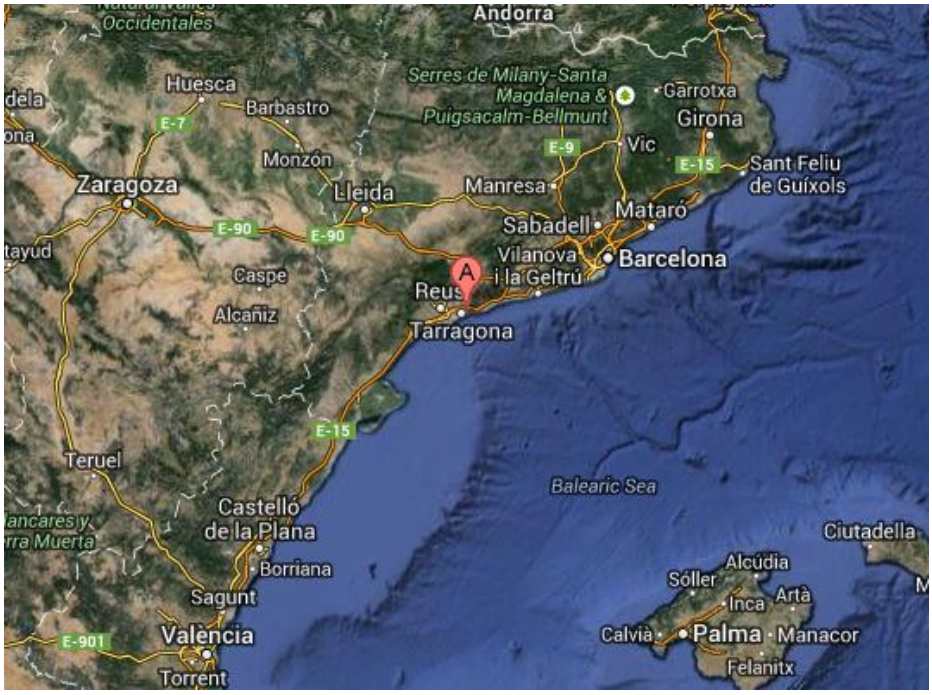
The Leuven innovation ecosystem



In Leuven there is clearly a strong relationship between KU Leuven and the town, or rather, the university has been a constant strategic element in both social and economic terms for the town's development. This is shown by the partnerships between KU Leuven and the region and province in all the development projects. Clearly IMEC represents a major partner for the university, and indeed they have joined forces in all the local developments.

LRD is an internal university organisation, although it is run as a separate business unit. Mandated by the University, it is in charge of dealing with issues relating to innovation and spin-offs. The university and LRD have managed to develop a very close relationship (matrix organisation) to the benefit of both. This capacity to innovate their organisation is probably linked to the strong (and stable) engagement in the local community, within which they represent a major player, and the sense of purpose and involvement that derives from that position. Clearly, the regional strategy and its consequent financial investments have gone a long way to making the model work.

Universitat Rovira i Virgili (Rovira i Virgili University)[16]



Map data © 2014 GeoBasis-DE/BKG (© 2009), Google, basado en BCN IGN España

To get a clear understanding of Rovira i Virgili University (URV), we must consider the origins of the ancient town of Tarragona (pre-Roman) that became an important Roman colony and has always been a logistical hub. Even in Roman times it was a major node on the Via Augusta (1 500 km). Today this strategic position is combined with its activity as a major Mediterranean port that has allowed the development of an important chemical industry. The region has implemented a strategy to reinforce its industrial and economic position by setting up a network of support structures including industrial parks, research centres and the URV itself as a key player in developing the strategy.

URV was created in 1991 by the Catalan Government (Generalitat de Catalunya) from existing university faculties and schools. Today, URV has 14,000 students and six campuses (two in Tarragona, one in Reus, one

[16] Sources:

- EUIMA case study – Universitat Rovira i Virgili (case study submitted between 2011 and 2012)
- URV website: www.urv.cat/en_index.html
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- Tarragona website: www.tarragona.cat
- ICIQ website: www.iciq.es
- ICAC website: http://www.icac.cat/index.php?lang=en
- Campus of international Excellence southern Catalonia: www.ceics.eu/index.html
- IRTA website: www.irta.cat/en-US/Pages/default.aspx

in Vila-Seca, one in Tortosa and a site in Coma Ruga). The province of Tarragona has a population of 800,000.

Ever since it was created, the main objective of the URV has been to provide the region with a knowledge structure with international outreach. To this end, the implementation of strategic plans developed for teaching, research, knowledge exchange and internationalisation have been fundamental in attaining an academic and scientific sound status. From the socio-economic and socio-cultural perspective, a wide variety of projects have been undertaken such as the Socio-economic Committee (unions, employers' associations and chambers of commerce); the Tarragona Knowledge Region Office (Tarragona Provincial Council), to encourage business innovation; and the Knowledge Antennae and Classes for Senior Citizens in collaboration with local councils.

URV has promoted the creation of several research institutes in the area, funded by the Generalitat de Catalunya. In the field of chemistry, the Catalan Institute of Chemical Research (ICIQ) was created in 2004; in 2000, in the field of archaeology, the Catalan Institute of Classical Archaeology (ICAC); in 2006, the Catalan Institute of Human Paleoecology and Social Evolution (IPHES); and, in 2008, in the field of biomedicine (in particular nutrition and health), the Pere Virgili Institute of Health Research (IISVP) in conjunction with the university hospitals. In 2008, the Catalonia Institute for Energy Research (IREC), was also created to be based in both Barcelona and Tarragona. Plans to create the Catalonia Tourism Research Institute (IRTUCA) and the Catalonia Oenology and Viticulture Research Institute are undertaken.

Apart from these legally independent centres, URV has created its own research centres: in the field of engineering, the micro/nano/systems and Materials Engineering Research Centre (EMAS); in the field of psychology, the Behaviour Evaluation and Measurement Research Centre (CRAMC) and, in the field of law, the Tarragona Environmental Law Studies Centre (CEDAT). In addition, the recently created Climate Change Research Centre (C3), located in the far south of Catalonia, in Tortosa, enabled collaboration with the already existing research centres in the region, the Sant Carles de la Ràpita Aquaculture Centre (IRTA) and the Ebro Observatory. Together, they work to identify and strengthen research activity in environmental sciences. Finally, the Industrial Economy and Public Economy Research Centre (CREIP) in the field of social sciences (July 2010), and the Medical Anthropology Research Centre (MARC) in the field of Humanities (December 2013) were created.

Furthermore, it is important to mention the Agrifood Technologies Research Centre (IRTA), with which URV collaborates widely. IRTA, in the region of Tarragona, has a centre in Constantí dedicated to olive growing, olive oil production and nuts, as well as animal nutrition and the already mentioned centre in Sant Carles de la Ràpita, dedicated to aquaculture and aquatic ecosystems. The presence of private technology centres is also substantial: the Mestral Technology Centre – created by ENRESA (the public entity responsible for the management of all the radioactive waste generated in Spain) and located in the dismantled Vandellós I nuclear plant facilities – works closely with the URV within the framework of a stable collaboration programme; the European Technological Centre in Valls, which is owned by Lear, a multinational automotive company, has a broad and sustained collaborative research programme; and the Global Water Technology Development Centre, being built in Tarragona by Dow Chemical, is another outcome of a long standing scientific collaboration between a multinational company and the URV.

URV has promoted the creation of a network of science and technology parks (STP), some of which are based around a technology centre. They are:

- PCT de Tarragona (PCTT), where the Chemical Technology Centre of Catalonia (CTQC) is located;
- Nutrition and health STP (TECNOPARC), where the Nutrition and Health Technology Centre (CTNS) is located;
- Tourism and Leisure STP (PCTTO);
- Oenology Industry STP (VITEC).

Parallel to the creation of this network of knowledge transfer structures, URV promotes actions through the URV Foundation (FURV), an entity that also acts as a link between URV and the companies managing the different STPs and TCs.

The Centre for the Transfer of Technology and Innovation (CTTi) of the FURV was created to promote and strengthen the relationship between society and the University. CTTi works to facilitate the link between the technological needs and services generated by the university through transferring technology and knowledge, managing industrial and intellectual property, providing technological supervision, fostering entrepreneurship and offering testing facilities (business incubators).

The office "Tarragona, Region of Knowledge" aims to provide to the industry and business sector of the Province of Tarragona access to funds for research, development and innovation at regional, state and European level. Its aim is to stimulate the research and innovation capacity of the territory's business sector, based on the knowledge society, and to involve a growing number of companies and institutions in R&D. Importantly, another instrument to foster university-business cooperation is the 'University – Company Chairs', created in collaboration with one or several companies or public institutions to promote knowledge transfer or enhance a specific sector activity.

Region

The socio-economic characteristics of the Tarragona Region are rather similar to those of other European regions, such as Tampere in Finland or Shannon in Ireland. Its strategic position at the intersection of the Mediterranean Axis and the Ebro Axis, and its important infrastructure of international communications (port, airport, high speed train), significantly reinforces the role of the Barcelona node in the new "network economy".

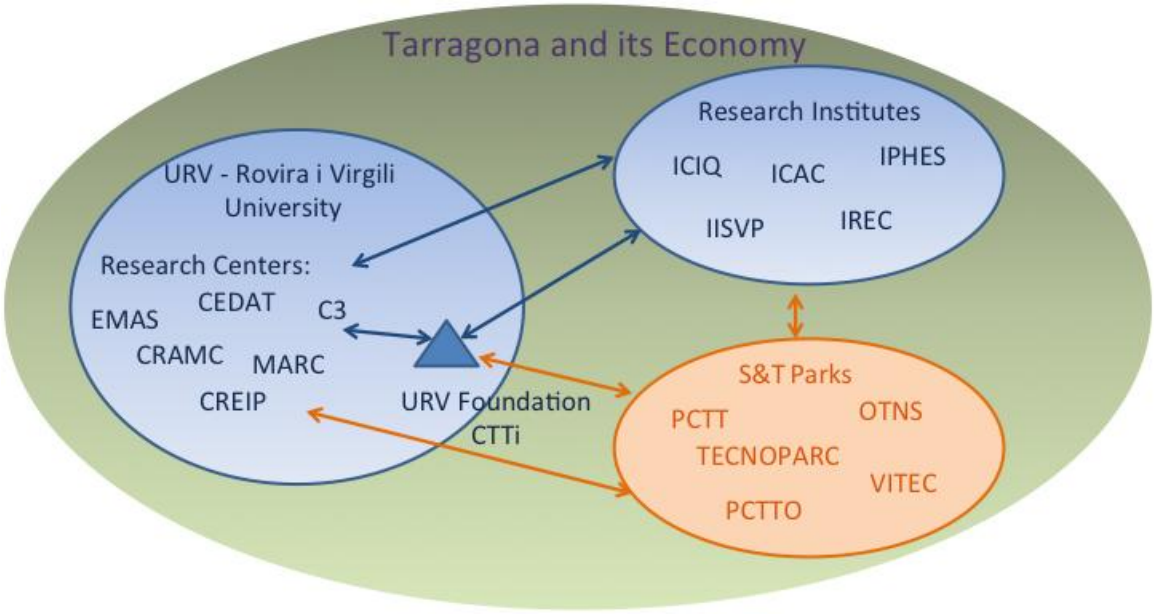
Industrial base

The Tarragona industrial parks are well connected, equipped with modern services, and there is space available to accommodate new businesses. In these industrial areas companies enjoy, in addition, excellent communications. Companies include well established organisations such as Repsol, Iberia BIC SA, BASF, Bayer, Dow Chemical Iberica, Clariant, E.ON Generation, Carburos Messer, CLH, TPS Tarragona Port Services SL, Cementos SA Branch, Prime Steel AG, Carbonell Figueras SA, DHU Ibérica, Pompeyo Ormos and Aarus Maritime.

The Port of Tarragona and its development as a logistics hub has become a vital driving force for the industry of Tarragona, managed by the Intermodal Centre ”del Camp” and the Area of Logistics Activities (ZAL) in the port. Synergies between the port and the regional chemical industry are good. The enlargement of the Chemical Pier at the Port of Tarragona will lead to a growth in trade of chemicals. The Port of Tarragona is positioned as “the gateway to the Mediterranean bringing the chemical industry to the world”. The recent creation of the ChemMed Cluster in March 2014 reinforces this strategy. The Port of Tarragona has intensified its position as a hub port for agricultural goods, energy products, and pulp trade. From the strategic view of traffic diversification, the new container terminal located at Andalusia docks will be ready to handle 1.5 million containers annually.

A vital element for the region is its chemical cluster, the largest in southern Europe, which accounts for 25% of the activity of this sector in Spain. According to estimations made by the Chemical Business Association of Tarragona (AEQT), the chemical park in Tarragona generates up to 40,000 jobs and has an output of 15,000 million euros. In addition, the energy sector generates over 60% of electric power in the region of Catalonia.

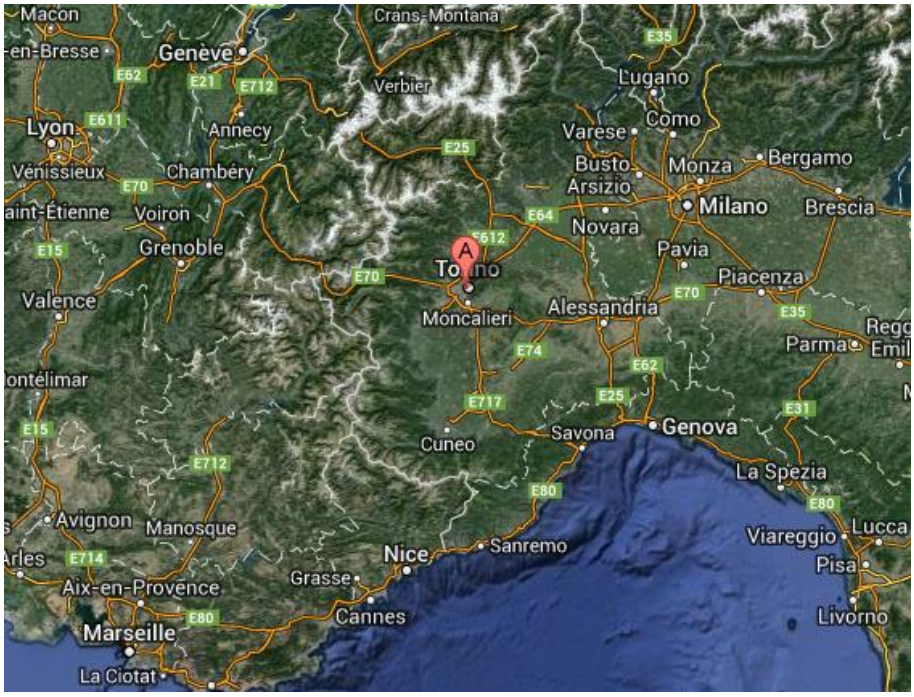
The URV innovation ecosystem



The regional innovation strategy in Tarragona was based on its long-standing industrial tissue. The strategy involved the creation of the university and then numerous highly specialised centres and institutes with precise missions. The university strategy was then built on and integrated in the regional development framework. URV is a co-owner in the research institutes and is involved in the management of the science and technology parks, with its own research centres well integrated into the regional knowledge transfer network.

URV started with its own Technology Transfer Office which later was split up into a research management office and the URV Foundation in the specific form of the CTTi: Centre for the Transfer of Technology and Innovation. URV's efforts in creating and structuring the local innovation ecosystem have just started to be fruitful. However, fostering the further engagement of non-academic institutions and private sector partners will be crucial to the success and continuity of their innovation ecosystem.

Politecnico di Torino (Turin Polytechnic)[17]



Map data © 2014 GeoBasis-DE/BKG (© 2009), Google

The Politecnico di Torino, founded in 1906 from the original Technical School for Engineers created in 1859, has a long-standing tradition of leadership in engineering and architecture studies and is strongly committed to collaboration with industry. The Politecnico di Torino promotes the ability to carry out theoretical or applied research and also the capacity to achieve concrete and reliable productive processes, or organise services and facilities.

There are around 32,000 students in Politecnico di Torino, of which approximately 18% are international students coming from 120 different countries. In recent years, the Politecnico has notably increased its international activities and, in collaboration with its partners, it has initiated several projects supporting the international mobility of foreign students.

[17] Sources:

- EUIMA case study – Politecnico di Torino, GM case (case study submitted between 2011 and 2012)
- Politecnico di Torino website: www.polito.it
- Wikipedia entries: “Polytechnic University of Turin”, “Turin”, “Province of Turin”, “University of Turin”, “Piedmont”, “GM Powertrain Torino”
- Città di Torino website: www.comune.torino.it/en
- University of Turin website: www.unito.it/unitoWAR/appmanager/unito/home_en?_nfpb=true
- I3P Incubatore di Imprese Innovative del Politecnico di Torino website: www.i3p.it
- ISMB Istituto Superiore Mario Boella website: www.ismb.it
- Fondazione Torino Wireless website: www.torinowireless.it
- Turin Province: www.provincia.torino.gov.it/welcome/inglese.htm

The range of studies in Politecnico di Torino is broad and spans space, environment and land, telecommunications, information, energy, mechanics, electronics, chemistry, automation, electrical engineering, industrial design, architecture and building.

The Politecnico di Torino provides scientific skills, research and consultancy services with a multidisciplinary, multiservice and customer-oriented approach in order to meet the needs of companies to solve complex issues. Companies are encouraged to collaborate with the Politecnico through research grants. The University also provides research, development and consultancy services, and support for tests, trials and analysis. In 11 multidisciplinary departments, 2 500 people carry out R&D activities in all fields of engineering, architecture and design.

The Politecnico di Torino provides several frameworks for businesses:

- the opportunity to share working space in the Cittadella Politecnica, the campus where research, business and finance work together;
- support to patenting and valorisation of research results;
- joint participation in research projects at international, European, national or regional level;
- an industrial PhD programme, a period of training for research through the development of projects carried out jointly with companies;
- high-level apprenticeship programmes including university courses, specific training courses and in-company internships, to support companies in recruiting highly specialised staff.

Within the Research Support and Technology Transfer Area (SARTT), the Technology Transfer and Industrial Liaison Division coordinates and supports technology transfer activities and is responsible for managing all aspects relating to IPR.

The Politecnico di Torino also promotes Innovation and Technological Transfer through:

- the Innovation Front End (IFE), launched in 2010 within the SaRTT Area. The project is mainly aimed at identifying, understanding and interpreting the research and innovation needs of enterprises. The IFE is a single reference point – a sort of entry point – for enterprises and public and private bodies which are the beneficiary of research and innovation activities carried out within the university.
- the Incubator for Innovative Enterprises I3P of Politecnico di Torino (I3P) is aimed at promoting the creation and spin-off of new enterprises. It provides equipped premises reserved for newly-established companies that are developing knowledge-based projects. Since 1999 it has hosted 159 start-ups. In 2004 the i3P won the 3rd Edition of the “Best Science-Based Incubator Award” and, in 2013, I3P ranked first in Italy, fourth in Europe and eleventh in the world-ranking UBI (University Business Incubator), the Global Benchmark Report annual ranking of the best academic incubators.

Region

In the territory of the Italian Region of Piedmont, where the Politecnico di Torino is located, the creation of productive synergy between local institutions has been an important goal. In the recent years, public policies have defined a cooperative development model, with a particular focus on the necessity of investing in human resources training, research and innovation.

A major policy instrument addressing this issue is the regional law (2006) entitled “Regional system for research and innovation” which promotes and supports research activities in universities, enterprises and public and private research centres in Piedmont. Piedmont’s regional research system has been provided therefore with a single policy framework which defines its objectives and main actions, in order to implement development policies for a knowledge-based society, and to boost the system’s growth by increasing funds and identifying common and consistent evaluation criteria.

A further element in the context of research development in Piedmont is the agreement between the regional authorities and the four Piedmont universities, which was signed in July 2007 for the creation of a Piedmont university system. The aim of the agreement is to identify strategies and objectives of growth, internationalisation, technology transfer and shared and coordinated local services.

In view of the world economic crisis and its impact on the territory of Piedmont, in 2010 the region launched its special employment programme in order to recover a competitive edge in employment through corrective measures aimed at giving new impetus to the system. In the context of this programme, calls for proposals have been promoted to finance projects whose objectives were to contribute to address the difficulties in the production system by enhancing its potential in science and technology sectors, which are crucial for sustainable development. Furthermore, the regional government has promoted a long-term competitiveness programme, with research, university and innovation as its main fields of action.

The actions which will be implemented by the new regional government are aimed at sustaining the university system through a regional university law whose objective should be to define a permanent support framework for the Piedmont universities. The support by the regional government will consist in financing research projects, the construction or upgrade of universities, and internationalisation.

The regional innovation/ecosystem

Taking into account the changes that have been occurring in Politecnico di Torino over the years, regional development programmes have increasingly played a crucial role. The project of expansion of the Politecnico beyond its historic locations has been realised with the “Cittadella Politecnica (Politecnico campus)”, which is to be found in the area next to the central location. The structure, which was erected in the area of the old “Major Repair Workshops of the Italian railways (Officine Grandi Riparazioni)”, is nowadays a modern complex with further spaces for students, research activities, technology transfer and services for the community. The new campus is placed in an area of 170,000m² and it is a strategic investment both for teaching and research and for industrial partners that are attracted by this major investment.

Politecnico di Torino periodically receives expressions of interest from Italian and foreign bodies/enterprises that want to join the university and present research, education and training projects to be developed in collaboration with the business research centre of the university. Following the evaluation of the projects presented, the university signs specific academic partnership agreements on research, education and training with the selected partners.

Further integration between university and enterprises is also achieved through other actors, such as:

- I3P (Incubator for Innovative Enterprises of the Politecnico di Torino), described above;
- ISMB (Istituto Superiore Mario Boella), which includes the Politecnico di Torino and the Compagnia di San Paolo, which is a centre for excellence in Information and Communication Technologies, with 120 researchers working in 8 different departments and research laboratories;
- SITI (Higher Institute on Territorial Systems for Innovation), which includes the Politecnico di Torino and the Compagnia di San Paolo, to develop research and higher education in the sectors of architecture and heritage, city and territory, environment and landscape, innovation and local development, and their areas of implementation;
- Fondazione Torino Wireless, whose mission is to support regional ICT companies in order to innovate, compete and sustain economic growth. The foundation brings together a complete range of all the major industrial, institutional and academic/research players, including the Piedmont Region, the province and town of Turin, the Politecnico di Torino and Turin University.

Industrial base

Turin is a major manufacturing centre and the home of the Fiat automotive company. It is also an important centre for editing, telecommunications, cinema, publicity, wine and food, design and sport. In 2010 the city generated a GDP of USD 58 billion, ranking as the world's 78th richest city by purchasing power. Turin is also well known for its aerospace industry (Alenia) and General Motors. The General Motors case study analysed in the EUIMA Collaborative Research project provides a good example of successful regional university-business collaboration.

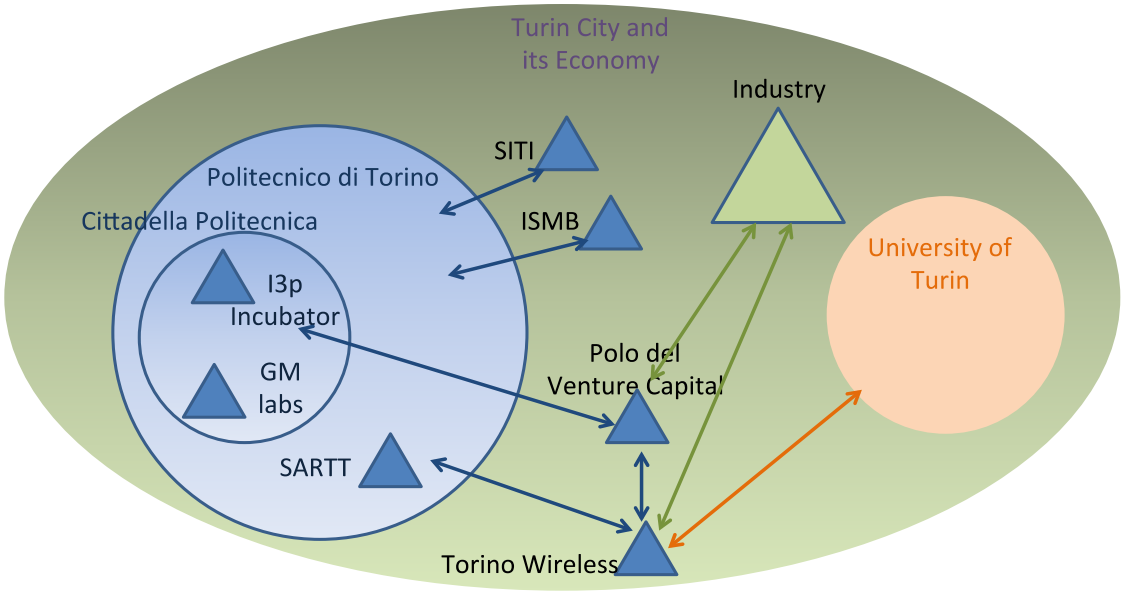
The beginning of this collaboration dates back to spring 2005 when the separation of GM from Fiat took place. The top management of the new GM Powertrain Europe, based in Turin, wished to build upon the years of cooperation between Fiat and the university in terms of expertise in diesel motor technology. With the intervention of the local authorities, a recently built building in the western suburbs of Turin was selected. GM Powertrain had already announced the launch of an ambitious growth plan, which would require large areas for workshops, engine test benches and offices. In the same period, the top management of GM Powertrain visited the Politecnico and learnt about the university's new development project.

By the end of November 2005, the foundations for the collaboration were laid and, at the end of March 2006, an agreement was reached. GM was ready to invest 25 million euros and hire up to 300 engineers; for their part, the Politecnico and the local authorities (municipality, province, region) were to be responsible for the construction of facilities and spaces. In the framework of the academic partnership research

agreement and of the academic partnership agreement on education and training signed in March 2006, GM has established its research centre on diesel engines – in which research activities for the development of all small automotive diesel engines of the GM global portfolio are carried out – on the Politecnico di Torino campus. The Politecnico and GM have also started a number of joint research projects aimed at the development of innovative, efficient and environmentally friendly powertrain technologies for automotive application, as well as education activities such as a Masters on "Innovative Diesel Engines".

The GM research centre was opened in June 2009 at the centre of the newly erected buildings of the "Cittadella Politecnica". Despite the crisis in the automotive industry, from initially 300 employees the number has risen to 500, 60% of whom graduated from the Politecnico di Torino.

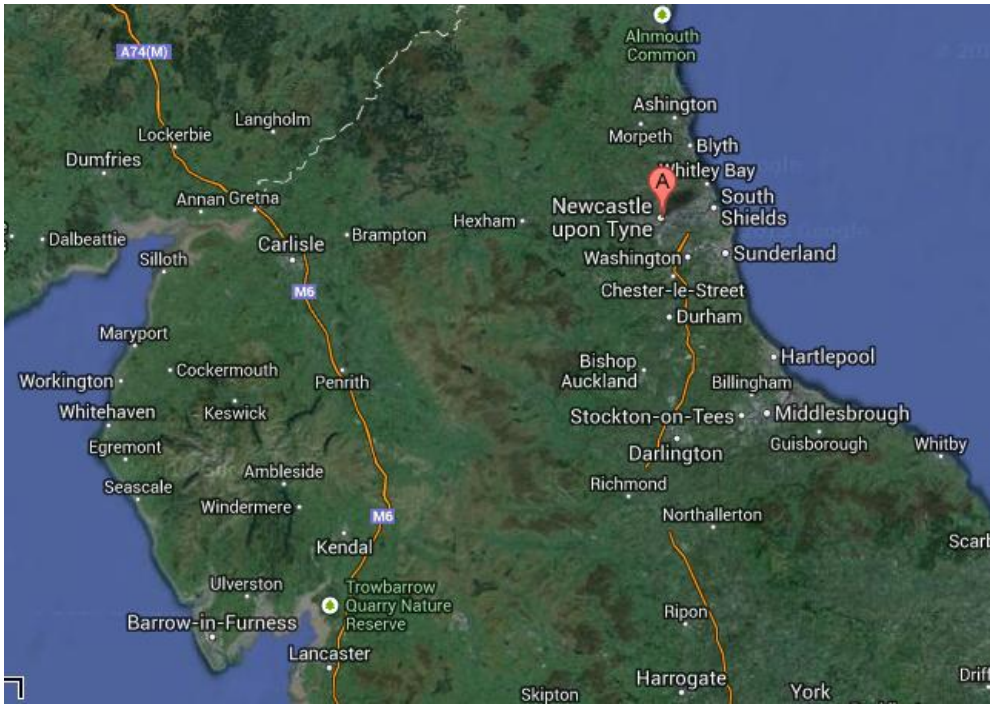
The Politecnico di Torino innovation ecosystem



This innovation ecosystem features quite clearly an example of a strong regional policy framework, in which the Politecnico has been able to acquire a key role. The Politecnico has clearly been capable of participating pro-actively in developing the regional development strategy and in establishing knowledge transfer relations with industry.

The relationship with GM Powertrain is an important model demonstrating the synergy to be achieved when a university is integrated into the innovation ecosystem through its knowledge transfer activities and when a company reaches out to a university to engage and collaborate with its researchers and graduate students.

Newcastle University[18]



Map data © 2014 Google

Newcastle University is based in the North East of England, in what was the "cradle of the industrial revolution", and has a strong tradition for industries such as coal mining and shipbuilding. In more recent years these activities have, for the most part, ceased and the region has looked to other sources of prosperity. The region has some of the most deprived areas in the UK, according to the 2010 English Indices of Deprivation.

The university was established as a School of Medicine and Surgery in 1834 and became the University of Newcastle upon Tyne by an Act of Parliament in August 1963. It has 19,700 students relative to a population in Newcastle of 189,863, but in the Tyneside conurbation, which is more reasonably the university's area of reference, there is a population of some 880,000.

[18] Sources:

- EUIMA case study – Newcastle University (case study submitted between 2011 and 2012)
- Newcastle University website: www.ncl.ac.uk
- Wikipedia entries: "Newcastle University", "Newcastle upon Tyne", "North East England", "Northumbria University", "Newcastle Science City"
- Newcastle City Council website: www.newcastle.gov.uk
- Northumbria University website: www.northumbria.ac.uk
- Newcastle Science City website: www.newcastlesciencecity.com
- One North East website: www.onenortheastlegacy.co.uk
- North East of England (NEPIC) website: www.nepic.co.uk
- Russell Group website: www.russellgroup.ac.uk

The city is also the home of Northumbria University, which until 1992 was Newcastle Polytechnic. Northumbria University has almost 30,000 students with four faculties; Arts, Design and Social Sciences; Business and Law; Engineering and Environment; Health and Life Sciences. Newcastle Business School has some 4 000 students.

Newcastle University undertook a major review in 2009-2010 and concluded that it wished to maintain a single university-wide service for both research and enterprise activities, with strong faculty footprints. This is a single service designed to provide coherent support for researchers across both the research and innovation agendas. Each of the three faculties: Humanities and Sciences; Medical Sciences; and Science, Agriculture and Engineering, has a Dean or Deans with responsibilities for research and/or innovation, and they are supported by the Director of Research and Enterprise Services, thus combining academic line management and service provision. In addition to the faculty-based teams, there is a legal team and a venture unit (providing support for spin-off companies).

Research support is provided by the University Research Office and the Joint Research Office (the Joint Research Office looks after both the Medical Sciences Faculty and the Newcastle NHS Hospital Foundation Trust research activity), comprising 45 staff members responsible for contributing to and implementing research policy and strategy, the costing and pricing of research proposals, negotiating research contracts and agreements, providing and analysing internal and external management information, providing research funding intelligence, opportunities and targeted support to faculties and support for strategic bids and initiatives, managing and supporting internal and external reviews of research including the national Research Excellence Framework, and the development and management of research systems to support researchers. Their mission is to develop and support research which is relevant to the university's research objectives and to work in partnership with local research administrators in faculties, schools, institutes and other research units as well as other professional service units, in particular with Finance and Planning, HR and the Library. The Joint Research Office is a "one-stop shop" providing an efficient, effective and streamlined service to support researchers in Newcastle upon Tyne Hospitals NHS Foundation Trust and Newcastle University in securing external research funding, whilst still protecting the university and trust in their legislative requirements.

Newcastle has invested in increased support for researchers over the last five years, further strengthening the support for Framework Programmes and initiating support for EU teaching and learning programmes. The EU Office, being well embedded in the university and its value recognised across the institution, has been instrumental in increasing research income from EU sources.

Region

The region where Newcastle University is located has been undergoing major change. The Regional Development Agency (RDA) structure is being dismantled under the present government and a Local Economic Partnership (LEP) structure is currently being implemented. There are consequences from these changes; two LEPs now cover an area previously covered by one RDA. The LEPs have very limited financial strengths where, as the RDA, there was a budget in excess of 300 million euros.

In the North East of England, there are currently a number of initiatives of which the university is a part. The first and most significant is that of Newcastle Science City. The university was designated a Science City in

2006, and since then a company called Newcastle Science City has been created. Newcastle Science City is a partnership of the City Council and the university (previously also the RDA). The purpose of Science City is to raise the profile of science and to help create prosperity for the city and wider region through the creation of new jobs and businesses, as well as to assist companies to innovate and grow. As part of this initiative, the local population can become involved in the city's continued scientific achievement. In physical terms, Science City is based on three themes in three places: Ageing, based at the Campus for Ageing and Vitality at the Newcastle General Hospital site (bringing together the largest interdisciplinary concentration of researchers in Ageing in Europe), and Regenerative Medicine at the Centre for Life. The third theme is based around Sustainability and is based at the Science Central site in the heart of the city. The university and City Council own 20 acres of the former Newcastle Brown Brewery site adjacent to the University's new Business School. The university and the city have invested significantly in the site and will continue to do so. Regional growth funding has just been secured for its development. The site now has planning consent for a multi-use development (university, retail, science, business and residential).

Industrial base

Newcastle played a major role during the 19th century Industrial Revolution, and was a leading centre for coal mining and manufacturing. Heavy industries in Newcastle declined in the second half of the 20th century; office, service and retail employment are now the city's staples. The city is also recognised today for its commitment to environmental issues, with a programme planned for Newcastle to become "the first Carbon Neutral town".

Newcastle is the commercial, educational and, in partnership with nearby Gateshead, the cultural focus for North East England. As part of Tyneside, Newcastle's economy contributes around GBP 13 billion to the UK Gross Value Added. The Central Business District is in the centre of the city, bounded by Haymarket, Central Station and the Quayside areas. The university is located at its edge.

The regional innovation ecosystem

Newcastle University is a member of N8, which brings together the eight northern research-intensive universities (Manchester, Durham, Liverpool, Leeds, Sheffield, York, Lancaster and Newcastle). Similarly, the Angel Alliance is collaboration between the universities of Newcastle and Durham, and Universities for the NE brings together the North East universities of Northumbria, Durham, Sunderland, Teesside and Newcastle.

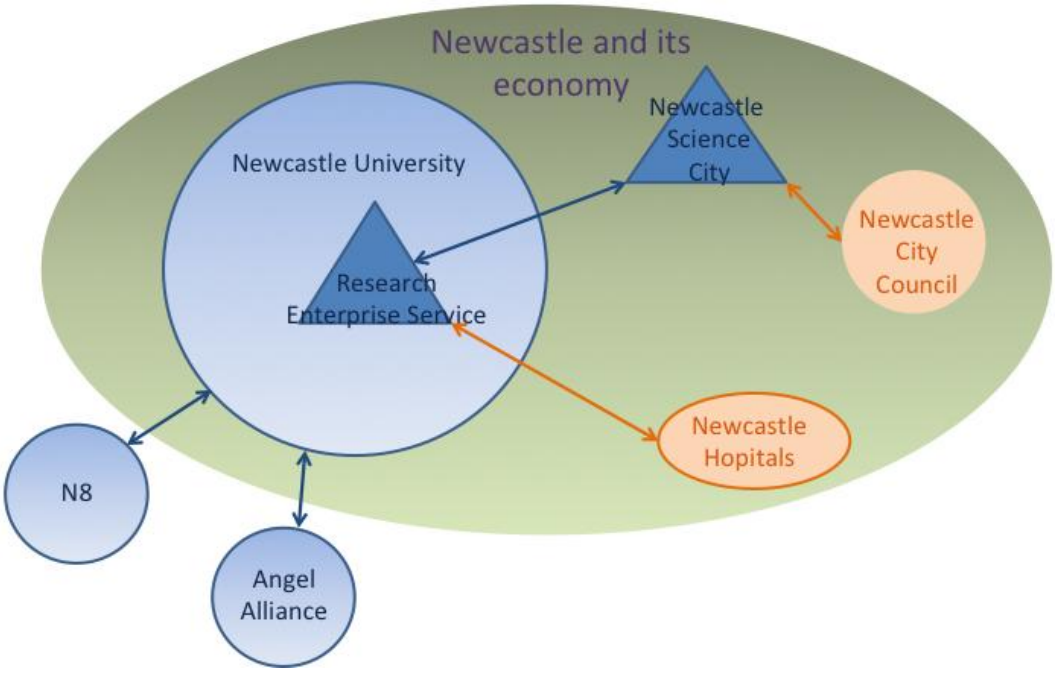
Newcastle had close links with One North East (ONE), the regional development agency, and has secured a number of ONE-funded projects looking at issues specific to the region. There are no science parks in the Newcastle area; spin-off companies tend to be housed within the university in their early years, and the university has a number of small distributed incubators on campus which accommodate companies at various stages of development, such as RedHat and Arjuna Technologies. The university is planning a wet-lab incubator in a converted space on campus and the City Council is presently building a new facility on Science Central to open in 2014.

There are a number of industry-led initiatives in the North East of England: North East Process Industry Cluster (NEPIC) represents in excess of 500 pharmaceutical, biotechnology, speciality polymer and rubber, petrochemical and commodity chemical companies based in the North East and it supports research which

encourages the sustainability and improved competitiveness of those industries. The Technology Strategy Board in the UK is developing a series of Catapult centres to strengthen demand-led innovation. The region will house parts of the first two Catapults in High Value Manufacturing (CPI) and Renewable Energy (NAREC). The university has strong connections with both organisations and the national and supra-regional networks are growing in importance.

The region is fortunate to have a network of venture funds supported under the JEREMIE programme by the European Structural Funds, which have reinforced university technology businesses. The region is the only one in England where public sector investment in R&D is dominated by the universities and it is the only one without any major government research institute, and in which private sector investment in R&D is lower than public sector investment. This environment creates a significant challenge for the region.

The Newcastle innovation ecosystem



This ecosystem depicts a strong city development policy framework, in which the university has been able to insert itself. There are also close relationships with the city hospitals, as seen by the combined development of the “Newcastle University Ventures Unit”, clearly derived from the origins of the university itself. This relationship with the city has led to the joint development of the Newcastle Science City as a major knowledge transfer initiative into the social reality of the town.

Ruhr University Bochum[19]

Map data © 2014 GeoBasis-DE/BKG (© 2009), Google

Ruhr University Bochum (RUB) is one of Germany's leading research universities with an acknowledged reputation for excellence in interdisciplinary research, for the advancement of early-career researchers, and for its ability to implement change. It was established in 1965 as the first new university in the Federal Republic of Germany (i.e. after World War II) with the specific objective to catalyse structural change in the – at the time – heavily industrial coal and steel region of the Ruhr. RUB is now host to more than 41,000 students and 5 000 academic and non-academic staff and draws its scholarly strengths from both the breadth and proximity of scientific disciplines on a single coherent campus, covering all three areas of knowledge: (i) Science, Engineering and Technology, (ii), Biotechnology, Medical and Life Sciences, and (iii) Economics, Social Sciences and Humanities. This highly dynamic setting enables students and teachers,

[19] Sources:

- EUIMA case study – Ruhr University Bochum (case study submitted between 2011 and 2012)
- Ruhr University Bochum website: www.ruhr-uni-bochum.de/index_en.htm
- Wikipedia entries: "Ruhr University Bochum", "Bochum", "North Rhine-Westphalia", "Max Planck institute for Iron Research"
- Bochum City: www.bochum.de/C125708500379A31/Docname/HomeEN
- North Rhine-Westphalia website: www.nrw.de/en
- ICAMS website: www.icams.de/content/icams_start.html
- UAMR website: www.uamr.de/index_en.php
- Rubitec website: www.rubitec.de

early-career and established researchers, domestic and international academics, to collaborate across traditional boundaries of academic subjects and faculties. RUB is part of the University Alliance Ruhr (UARuhr), the consortium of three universities in the Ruhr area: RUB, the Technical University of Dortmund and the University of Duisburg-Essen.

RUB is organised in six research departments and internationally competitive research areas have been developed in materials science, interfacial systems chemistry, plasma science and technology, protein science, neuroscience and religious studies. These have evolved by taking advantage of RUB's particular campus characteristics, which foster research excellence, primarily at disciplinary interfaces. Research departments are flexible matrix structures for excellent interdisciplinary research and are designed to build bridges across traditional faculty borders, to pool existing research collaborations, and to initiate new externally funded projects, such as Collaborative Research Centres or even larger Clusters of Excellence, which also collaborate closely with non-university research institutions.

RUB actively fosters close ties with research and technology organisations (RTOs), as well as with industry both within the region and beyond. The primary objective of these collaborations, in particular those involving RTOs, is to increase research capacity. In 2010, RUB signed a comprehensive framework contract with the Max Planck Society to enable new and highly efficient formats of collaboration, joint appointments, and the advancement of early-career researchers. Currently, ten full professorships are jointly appointed with RTOs, such as the Max Planck Society and the Helmholtz, Fraunhofer, and Leibniz Associations.

Large-scale research collaborations with industrial partners are usually initiated at faculty level. Strategic partnerships currently exist between, for example, ThyssenKrupp and the Faculty of Mechanical Engineering and the Faculty of Economics, E.ON and the Faculty of Mechanical Engineering, as well as Research in Motion and the Faculty of Electrical Engineering and Information Technology. Both ThyssenKrupp and E.ON are headquartered in Essen, only 20 km away and, in 2010, the company Research in Motion (Blackberry) established its European research centre next to the RUB campus because of the existing research capacity at the university.

One of the biggest collaborative research projects initiated in this context in recent years is the Interdisciplinary Centre for Advanced Materials Simulation (ICAMS), which is located on the RUB Campus and supported by matching start-up funds (24 million euros in total) from the state of North Rhine-Westphalia and a multi-partner industrial consortium led by ThyssenKrupp. The sustainability of three newly created professorships at ICAMS is guaranteed by RUB. The research centre focuses on the development and application of a new generation of simulation tools for multi-scale materials modelling, with the aim of reducing development costs and development time for new materials – one of industry's important requirements.

Region

Bochum, a university city with 370,000 inhabitants, is situated in the heart of the Ruhr area. With 5 million inhabitants, this area is the largest economic region in Europe. Where coal industry once dominated, the service and education sector have long since taken over.

Since the 1960s, with fourteen universities and over 150 other non-university education, research and

development facilities, the Ruhr area has become one of the most important scientific landscapes in Europe.

Industrial base

The city of Bochum – once renowned for its coal and steel industry – has experienced fundamental structural changes. Nowadays, many of the companies are active in the service sector or play an important role in developing innovative technologies. Today, Bochum is a central business location in the restructured Ruhr area, where medium-sized enterprises have become the driving force for economic upturn and progress.

Of course, Bochum also gains a lot from the economic capacity of the state of North Rhine-Westphalia (NRW). Here, almost 18 million inhabitants produce a quarter of Germany's gross domestic product and spend about 220 billion euros each year.

The regional innovation ecosystem

The RUB campus is sandwiched between two science parks, the Technology Park and the Biomedical Park, which provide developed land for SMEs to build new property in the direct vicinity of the university. Companies can also rent space or facilities at the Biomedical Centre on campus. Technology transfer services at RUB were first established in 1975 as part of the administrative office UniContact and then professionalised in 1998 with the foundation of a dedicated research and marketing association: Rubitec – Association for Innovation and Technology at Ruhr University. Rubitec markets technological services and oversees the patenting and licensing of RUB ideas, inventions and products. The existence of many contacts with companies and cooperation with other marketing partners enables effective technology marketing. Rubitec also offers targeted services such as consulting, technology transfer seminars and business idea competitions and is host to patent scouts. Sponsored by the North Rhine-Westphalian Ministry of Innovation, patent scouting aims to acquire marketable ideas, evaluate inventions, advise academics and monitor the patenting process in order to increase the number of inventions registered by the universities.

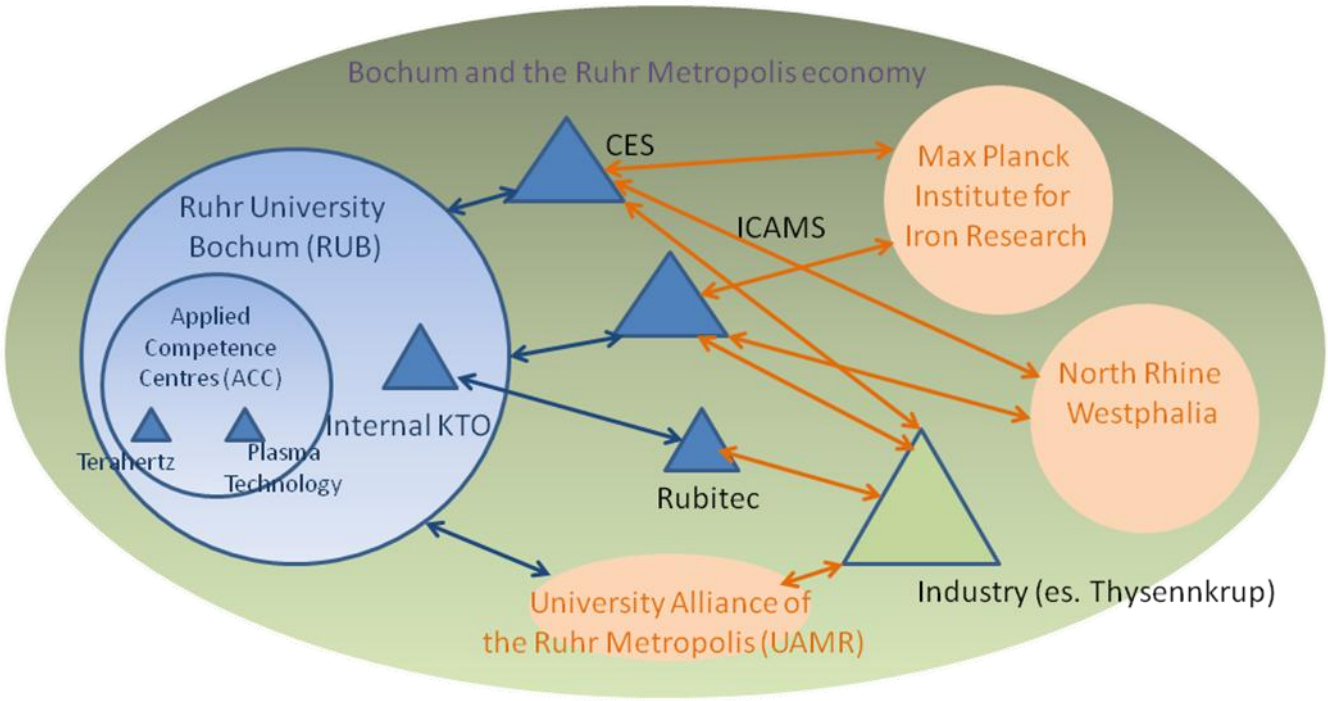
Rubitec, RUB's technology transfer company, provides the following services:

- facilitates the transfers of R&D results into practice;
- initiates and manage R&D projects between the university and the private sector;
- assists on patenting and licensing university ideas and developments;
- develops ideas and R&D results into marketable products and processes;
- supports the development of new fields of technology;
- negotiates strategic partnerships for marketing innovative products and support entry into new markets;
- supports spin-off companies out of the university.

In addition, RUB itself provides a range of in-house services to support Rubitec's activities, as well as

external research collaborations: (i) legal advice regarding collaboration contracts and IPR issues, (ii) financial advice, e.g. regarding taxation or full financial costing, (iii) platforms to disseminate results via press releases and web pages, as well as (iv) the necessary political and financial support by university management if strategic issues are concerned. Bochum's Chamber of Commerce and Industry (IHK), the Ruhr Health Management Network (MedEcon) and the Ruhr Development Company (EGR) are also important local and regional players, involved in issues regarding technology transfer and regional development.

The RUB innovation ecosystem



The RUB innovation ecosystem is a well-developed and interconnected one. The process of expanding from an internal knowledge transfer office by creating an external organisation (Rubitec) is a process that is now mature.

The internal Applied Competence Centres (ACCs) and the external joint centres are developments that add knowledge transfer competences to the university as a whole. The collaboration with the Max Planck Institute provides a strong regional base in research competencies.

The setting of the highly industrialised Ruhr area and its wealth are clearly important drivers that also increase demand for graduates with specific knowledge and skills which RUB is well able to provide.

Norwegian University of Science and Technology[20]

Map data © 2014 Google

The Norwegian University of Science and Technology (NTNU), is the result of a merger in 1996 between the Norwegian Institute of Technology, which had its first intake of students in 1910, the University in Trondheim which was based on the Teachers' University College established in Trondheim in 1922 and the Faculty of Medicine at the Regional Hospital, which had its first student intake in 1975. Included in the merger was also the oldest academic institution in Trondheim, the Museum of Natural History and Archaeology, with a history that dates back to the Royal Norwegian Society of Sciences, which was established in Trondheim in 1760.

The university has 22,000 students and 5 000 employees.

NTNU is organised in seven faculties:

- Faculty of Engineering Science and Technology;
- Faculty of Natural Sciences and Technology;

[20] Sources:

- EUIMA case study – the Norwegian University of Science and Technology (NTNU) (case study submitted between 2011 and 2012)
- NTNU-Trondheim Norwegian University of Science and Technology website: www.ntnu.edu
- Wikipedia entries: "Norwegian University of Science and Technology", "Trondheim", "Norway", "SINTEF", "Trondelag"
- SINTEF website: www.sintef.no/home
- Trondelag website: http://en.trondelag.com/
- City of Trondheim website: www.trondheim.no/engelsk
- SIVA website: www.siva.no/sivabas/nyheter.nsf/nysivano/english%20summary
- www.ntnu.no/bridge/

- Faculty of Information Technology, Mathematics and Electrical Engineering;
- Faculty of Architecture and Fine Art;
- Faculty of Medicine;
- Faculty of Social Science and Technology Management;
- Faculty of Humanities;

plus the Museum of Natural History and Archaeology.

Hence the university comprises a broad range of university disciplines, from the humanities and the social sciences, medicine, architecture and fine arts to engineering and natural sciences. However, as the name indicates, the main profile of the Norwegian University of Science and Technology is within engineering and natural sciences. NTNU was given a mandate with a national scope and is the primary institution for the education of engineers and scientists in Norway.

NTNU lives in a symbiotic partnership with SINTEF, a foundation for applied research mainly within the fields of technology and engineering, which was established in 1950 by professors at the Norwegian Institute of Technology (now part of NTNU), and which is now Scandinavia's largest independent research organisation. SINTEF has 2 100 employees, the majority located on or close to the university campus. NTNU and SINTEF share laboratories, professors participate in and supervise SINTEF research projects, SINTEF researchers supervise university candidates and give lectures at NTNU. Together, NTNU and SINTEF represent the main base for research and research-based education in science and technology in Norway.

Region and industrial base

The Trøndelag region, consisting of the two Trøndelag counties with some 425,000 inhabitants, has traditionally not been linked to the predominant sectors of industrial activity in the region, traditionally run by small and medium-sized enterprises, including agriculture, forestry, fishing, trade and small and medium-sized enterprises. The regional and local interplay with NTNU has increased significantly during the last decade.

Technology-dependent companies have set up offices in Trondheim to ease and facilitate their cooperation with NTNU and SINTEF, and also to achieve a competitive edge in the recruitment of highly qualified personnel.

Also, the increased focus on the commercialisation of research-based innovations has brought the local academic institutions into closer collaboration with venture funds, new technology enterprises established in the region, and local government institutions. Collaboration with NTNU and SINTEF has become high on the political agenda at the level of municipalities and counties, as well as regional banks. Today, NTNU is participating in several local and regional forums for innovation and industrial development. The coordinator for the newly established regional strategic board for industrial development was recruited from the staff of the Vice-Rector for Innovation and External Relations.

The regional innovation ecosystem

The NTNU Technology Transfer office (NTNU TTO Ltd), primary owned by NTNU was established in 2003 as the commercialisation arm of NTNU. The company's mandate is to commercialise results from research, to secure, refine, manage, market and sell the rights to use and own ideas and inventions developed at NTNU and the Central Norway Regional Health Authority. NTNU TTO Ltd may hold shares in other companies, and may also establish wholly -or partly- owned daughter companies. The track record of this office to date is one of the best in the Norwegian context. Previously, an innovation centre had been established as the first on-campus incubator for small companies commercialising research results from NTNU and SINTEF. Recently, NTNU Discovery has been set up, which is a fund targeting the very early stages from idea to commercialisation.

SINTEF has also established a technology transfer office under the name of SINVENT. The NTNU School of Entrepreneurship should also be noted. It runs a two-year Masters programme aimed at future entrepreneurs.

Several private and public venture funds are located in Trondheim. The most important for NTNU and SINTEF in the 1980s and 1990s was Leif Erikson Nyskaping AS, which was important as an incubator and counsellor before becoming a venture fund. Now the government-initiated venture fund Investinor has its head office in Trondheim, as has the private Viking Venture and the jointly created fund Proventure.

Collaboration with external partners has a long and well rooted tradition in all fields studied at NTNU, and in particular in science and technology, as the partnership with SINTEF promoted external collaboration. In its earlier years of existence, SINTEF provided support in terms of financial control and legal services. Largely due to the increased importance of the EU Framework Programmes, in recent years NTNU has invested heavily in strengthening its own institutional capacity in project management and human resources both, at the level of central management and in the faculties. Thus, each faculty employs staff responsible for the administrative management of external projects, while legal and financial expertise is located in the rector's office and in the central administration.

Contract research and other collaborations with external partners are recognised at all levels in NTNU as vital for the quality and relevance of research and education. External partners are also important supporters of scientific equipment and laboratories and provide a significant part of the income at department level. Hence, external collaboration is encouraged at all levels of the university.

An innovation centre was established in 2000 as the first on-campus incubator for small start-up companies commercialising research results at NTNU and SINTEF. Also behind the centre is SIVA – the Industrial Development Corporation of Norway, a government corporation and national instrument founded in 1968. SIVA aims to develop strong regional and local industrial clusters through ownership in infrastructure, investment and knowledge networks, as well as innovation centres.

Recently NTNU Discovery has been set up, which is a fund targeting the very early stages from idea to commercialisation. It is financed by NTNU, regional governments and a regional bank. It offers up to 125,000 euros for technology development, quality assurance and verification in order to reduce technological and commercial risks, thereby bridging the gap between an idea and a bankable project. Eligible applicants are NTNU employees and students, and members of NTNU TTO Ltd.

Specifically targeting students, NTNU Bridge was established as a non-profit, national initiative where businesses and institutions are invited to present project ideas and the tasks they propose students to address. These may be specific projects in which students can use their Bachelor's or Master's degree competencies, and/or professional practice through relevant part-time and summer jobs.

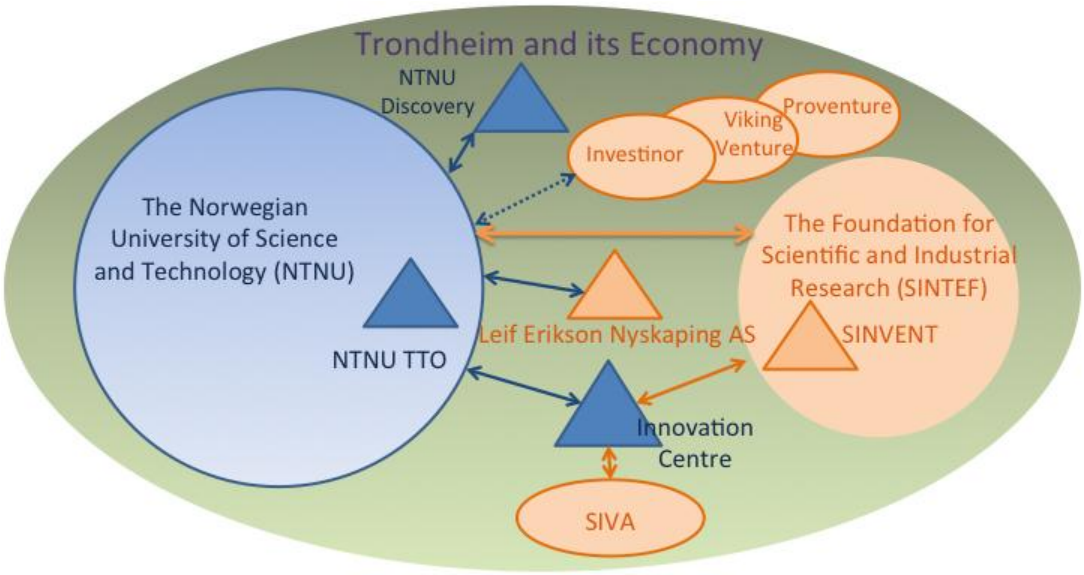
The purpose of NTNU Bridge is to:

- strengthen corporate innovation and competitiveness through increased opportunities for recruitment and innovation;
- give students practical experience in applying their knowledge and assessment skills to real problems;
- strengthen education and its cooperation with community and industries.

Expertise in teamwork is a compulsory course in all Master programmes at NTNU where students learn to work in interdisciplinary teams to solve different tasks/projects. Five groups of five students each are organised in a Village headed by a Faculty member. The students learn both to work together and to solve complex problems together. The problem provider (often a Mentor) often comes from industry, private or public organisations.

Finally, groups of departments have established permanent networks relevant to companies in the form of industrial forums. Such forums are governed by a joint board of directors, and include activities such as workshops, seminars and conferences. The activities are funded through membership fees. The motivation for companies to engage in the industrial forums is twofold: to keep up-to-date on recent developments of relevant research, and to maximise the relevance of education and training for their future key personnel.

The Trondheim innovation ecosystem



NTNU, SINTEF and St. Olav's University Hospital activities play a prominent role in Trondheim today. This innovation model is based on a strong collaboration between a university and a research centre, which have their own significant national standing. For example, NTNU provides 80% of Norway's civil engineers.

The regional strategy around this innovation ecosystem continues to develop systematically, building on technological expertise over time, which clearly supports its development.

These organisations have become a significant economic driver of the region which, combined with the knowledge transfer ecosystem, has built up a significant new economy composed of high-tech innovative companies who have chosen Trondheim as their base.

Conclusions

Our conclusions, based on the analysis of the EUIMA Collaborative Research case studies, are aimed at university management and policy makers with a view to assisting their decision-making processes in the area of innovation and knowledge transfer. They focus on the development of university activities in support of the local economy and look for ways to develop the knowledge transfer ecosystem, either individually or in collaboration with other public or private institutions. To a large extent, the EUIMA Collaborative Research case studies by themselves are useful, as a suitable wide range of examples from which decision makers can extract their own conclusions. The discussion that follows, however, is intended to provide a common conceptual framework to assist this task. We extrapolate here some general considerations from the case studies, which will give us a baseline on which a strategic framework could be built. Let us consider some general parameters arising from the analysis of the case studies:

- **Scope of the university**

From our analysis we can see a constant indication that universities which have a more technological academic profile are, by their very nature, more active in the development of knowledge transfer ecosystems (Chalmers University of Technology, Hamburg University of Technology, Politecnico di Torino and NTNU – Norwegian University of Science and Technology, are good examples of this). The concentration of technological academic profiles clearly generates, at the level of institutional governance, a stronger interest in proactive approaches to interaction and knowledge transfer with the local environment, and thus universities to become important strategic players in the development of the regional knowledge transfer ecosystem itself.

The implication for university management and policy makers is that consideration should be paid to bring together colleagues from a wide range of disciplines to develop a suitable strategy and to set adequate goals for collaboration, as well as to deal with the challenges arising in this process. In particular, interdisciplinary research involving the social sciences and humanities are increasingly in demand to tackle societal challenges in fields of energy, health, climate change, etc.

- **Size of the university**

The size of a university (or of any organisation) has an impact on the effectiveness of its decision-making processes and the way power is distributed across the organisation. The EUIMA Collaborative Research case studies show how small to medium universities can be very pro-active in their specific research and innovation activities.

Let us take this a little further in order to understand the mechanisms at hand, as these are critical aspects for a university in developing its knowledge transfer strategy. In larger universities, power structures tend to be decentralised and they are typically concentrated around their faculties or departments, depending on national legislation. This tends to make the development and application of centralised university strategies difficult to carry forward whilst constantly having to negotiate support from the decentralised power structures.

Clearly, this has no reflection on the quality of the competencies in a larger university, or in the range of knowledge transfer activities actually being carried out by that university. It simply helps us to understand the challenges, and consequently define suitable strategies, for becoming effective institutional players in a local ecosystem. The implications in the case of a large university may be those of considering more externalised or decentralised actions that find a strong ownership with the central administration.

- **Presence of other universities**

In larger towns or cities we often find more than one university for various historical reasons, and the institutions are often differentiated by size or scope. The EUIMA Collaborative Research case studies have shown the importance of analysing the local variables and developing realistic strategies taking into consideration the profile of the other local universities.

For example, considering the first two parameters, the Politecnico di Torino's scope (technological), and its university size (small-medium), are key advantages for its position in the innovation ecosystem. The presence of the larger Turin University provides for the mainstream academic requirements and plays a complementary role in the region. Both organisations benefit from building on their respective areas of expertise.

The case of TuTech Innovation is also relevant here. Considering the first two parameters, scope and size, Hamburg University of Technology established TuTech Innovation, which over time has demonstrated its effectiveness. The University of Hamburg, much larger and covering all academic disciplines, proposed the establishment of Hamburg Innovation based on TuTech's model. This is not a question of a smaller university being able to "do things better", but simply that of acknowledging the advantages and flexibility of smaller size universities with a clear technological focus that have been able to use these characteristics as a springboard to enhance their knowledge transfer activities.

- **Size and population of the town/city**

The EUIMA Collaborative Research case studies included a variety of cities, characterized by different population sizes, ranging from Hamburg (1.8 million inhabitants) to Leuven (98,000 inhabitants). Therefore, the size of the town itself is not an indication of success, but these two case studies are excellent to emphasise that the size of the population may be a useful factor to take into account when defining a suitable approach for the development of the knowledge transfer ecosystem.

In some ways, the same considerations that we made above on the size of universities are valid here. Smaller towns usually have a stronger centralised political power structure and, depending on the availability of suitable finances, may develop local strategies for the innovation and knowledge transfer ecosystem more easily. For example, success in Leuven is clearly the result of a strong relationship between the town and the university and the existence and implementation of an effective regional strategy.

The larger the town or city, the greater the difficulty in maintaining local or regional authorities' support for long-term strategies, and often this is simply not possible. In the case of Hamburg this has been left to the universities themselves, who have taken the challenge on board.

The implication here is rather general, but it is important to be aware that the clarity of the local strategy will be strongly linked to the level of political unity or division, which is often connected to the size of the town/city. Merely being aware of this fact, as a condition rather than a problem, will help in defining a suitable strategy for the development of the knowledge transfer ecosystem.

- **Presence of strong and relevant industry**

Clearly, if the final objective is to transfer knowledge, then suitable "customers" for that knowledge are important. Our intention here is to gather information from the EUIMA Collaborative Research case studies on how the presence of these "customers" (e.g. industry, business) in the local ecosystem can be relevant for the innovation and KT ecosystem itself and for its strategic development. The presence of relevant industry in the local ecosystem is indeed important for a university looking to gain support for its own knowledge transfer strategy.

The Rovira i Virgili University is an example of where a regional strategy, based on industrial needs, has been the driver for the creation of the whole university as part of a much wider and more complex ecosystem. Politecnico di Torino has incorporated GM Powertrain into its ecosystem by bringing the company into its own labs. Ruhr University Bochum has involved ThyssenKrupp in supporting its ecosystem development.

On the other hand, we also have the example of NTNU, whose strong ecosystem has over time provided the foundations for innovative companies, even though this ecosystem was not developed based on a strong and relevant local industry.

The message here is to be aware of the important potential advantages arising from industries or single companies situated in the region, and to involve them from the beginning in the knowledge transfer strategy, and to develop such strategy based on these industries' characteristics. Clearly, where industry is weak, fragmented or simply absent, the innovation plan needs to take this into account and aim at building new structures and districts.

- **Presence of a strong and supportive regional strategy**

In the EUIMA Collaborative Research case studies, we have many examples of strong regional strategies, and just how effective they can be in the long-term. In these cases, we can also see that universities have a fundamental role in their development. Where joint initiatives between region, university and industry have been established we can see university experts actively participating in the respective governing structures.

Regional strategies usually develop from a strong and effective dialogue with the universities, which, as we have noted above, can be easier in smaller populations. Clearly a university will have a "feel" for the possibilities of engaging its support in regional development strategies, but due to the complexity of local politics this may not always be feasible. It is definitely worthwhile for universities to invest time in building multiple relationships with local decision makers and proposing development strategies, as the capacity for development with suitable regional support can be far superior to that of an individual institutional effort.

Relationships with industry, in particular with regard to supporting the development of an innovation ecosystem, may be facilitated through regional support. The case of Newcastle University is a good example of the effects of a clear regional strategy for rebuilding the local economy, through the joint venture with

Newcastle City Council to build the Newcastle Science City.

- **Presence of research centres and/or science parks**

IMEC in Leuven, Max Planck Institute for Iron Research in Bochum, SINTEF in Trondheim, and the more decentralised system in Tarragona system are examples of how suitable relations between universities and research centres can be strategic to developing innovation ecosystems.

The advantages, and therefore the value, of these relationships are derived from the diverse nature of the organisations. Universities educate, carry out research and, as a third mission, transfer knowledge. In research centres, research activities tend to be more applied and knowledge transfer as a core mission is usually more explicit.

Strengthened collaboration will bring closer industrial ties to the university through the research centre and, vice versa, will enrich the scientific activities of the research centres by incorporating basic research developed in the university. The involvement of staff from the company research centres in university courses also has an inestimable value in their motivation.

Final Remarks

It is unlikely that any two universities share the exact same environmental conditions, even if we consider the fairly simple set of general parameters presented above (scope of the university; size of the university; presence of other universities; size and population of the town/city; presence of a strong and relevant industry; presence of a strong and supportive regional strategy; and presence of research centres and/or science parks). Therefore, it is unlikely that any one university can simply reproduce the actions carried out by another with the same success.

Nevertheless we hope that it will be useful for universities to study these case studies, particularly based on the general parameters we have analysed. This can lead to a valuable exchange of ideas with other universities with similar characteristics through visits, discussions and the sharing of experience and advice.

We would recommend that any university interested in applying our analysis to their own innovation ecosystem should proceed by studying and considering the relevance each parameter individually. This will reduce the risk of under-evaluating the potential significance of each parameter and lead to the formulation of a more robust innovation and knowledge transfer strategy. This strategy will then need to be shared and agreed upon by the widest possible range of local stakeholders before proceeding to its implementation.