CHAPTER 5

CREATING THE DYNAMIC TECHNOLOGY REGION

The knowledge pearl Leuven – Flanders[1]

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INTRODUCTION

During the 'March 2000 Summit' in Lisbon, the European Heads of State and Government leaders gave themselves the challenge of turning Europe into the world's leading knowledge economy by 2010. That is easier said than done, as today – seven years after the summit and with only five years left before the target year has been reached – there is little or no indication that Europe will be able to make good on its promise (Hinoul 2006). Indeed, several reports point to the fact that the knowledge gap between Europe and the United States is not closing, but has a tendency to widen even further. A recent article in the *Financial Times* – 30 October 2006 – again shows that the US are widening the gap with Europe when it comes to R&D. Corporate R&D spending in the US rose by 8.2% over the past year, compared to 5.8% in Europe, according to the international R&D Scoreboard published by the UK Department of Trade and Industry. The gap is more striking when viewed over the longer term. Strangely enough, Germany appears to be the worst performer among the larger European countries, with an R&D increase of only 2% in 2005-2006. The most spectacular growth is seen in Asia. The 44 Taiwanese companies in the R&D Scoreboard last year increased their R&D spending by 30%. The 17 South-Korean companies that are included increased their R&D spending by more than 12%. These results clearly indicate that Europe is not catching up at all, and that the continent is still far away from reaching the 'Lisbon 2010' target of 3% GDP spent on R&D.

The knowledge economy is still largely an American phenomenon, a place where it all started in the shadow of the Second World War. It is across the Atlantic

W. Hulsink and H. Dons (eds.), Pathways to High-tech Valleys and Research Triangles: Innovative Entrepreneurship, Knowledge Transfer and Cluster Formation in Europe and the United States, 99-116.

that the two legendary knowledge regions developed that today are still the model for what moves the world: Route 128 around the much famed Massachusetts Institute of Technology (MIT) on the East Coast and the equally renowned Silicon Valley around Stanford University on the West Coast (Saxenian 1996). In both cases, indivual people took the lead – Professor Fred Terman in Stanford and Professor Vannevar Bush in Boston. The two regions formed the basis for the current knowledge economy because it was here that, for the first time in history, scientific knowledge was valued and commercialized professionally and systematically. The phenomenon of these knowledge regions did not limit itself to these two technopoles. Other parts of the United States followed, with new high-tech valleys and corridors, such as North Carolina Research Triangle, the San Diego Golden Biotech Triangle, the Silicon Desert, and the Silicon Hills, to name a few. These new 'knowledge regions' also were to play an important role in the growth of the American economy in the second half of the twentieth century, and in the creation of millions of new high-level added-value jobs. In the 21st century, this development is continuing unabatedly – with companies like Google, Amazon.com and eBay as excellent examples.

As far as Europe is concerned, the idea of becoming the strongest knowledge economy by 2010 appears to be even further away. Europe, the historical cradle of modern science, was to follow the developments in the United States with some delays, initially with hesitation, but later with knowledge regions that to a certain degree matched their American forerunners. It all started in Cambridge, one of the oldest universities in the world, which will celebrate its 800th anniversary in 2009. Thus far, Cambridge University received 81 Nobel prizes, more than any other university in the world. Cambridge started thinking about a 'science-based industry' with the Mott Report presented in 1969. One of the first results from this report was the establishment of the Cambridge Science Park, the fist park in England to be founded under the guidance of Trinity College's Senior Bursar, Dr John Bradfield. From then on, Cambridge began to attract high-tech companies (Ablett et al. 1998). The university created 51 spin-off companies, while many entrepreneurs outside the university started their own company in the vicinity of the university. Cambridge was also able to attract top companies from abroad, a good example of which is the establishment of the Microsoft research centre on the Science Park. Today, the greater Cambridge is host to more than 3,000 companies, more than 1,000 of which are pure innovative companies.

Other European examples are the Sophia Antipolis (Côte d'Azur, France) high-tech park, which was started in the mid-sixties with the idea of senator Pierre Laffitte, who thought that high-tech companies could bring much additional wealth to the Côte d'Azur, besides tourism and real estate. Sophia Antipolis witnessed the arrival of many high-tech companies such as IBM, Texas Instruments, Alcatel Space and Philips, to name a few. At the time Pierre Laffitte started his Sophia Antipolis high-tech park, there was no university in this area. Later on, the university of Nice was founded. Other interesting examples are the Munich area, well-known for the development of medical technology, and Finland, with the Oulu and Tampere regions, which specialize in the area of ICT but are also very strong in mechatronics, life sciences and opto-electronics. Finland spends more than 3.5% of the GDP in

research and development, which is much more than the European average of 2%. We need to bear in mind that Lisbon 2010 demands that Europe spends 3% of its GDP on R&D.

Knowledge regions have also been developed around growth poles in Asia, for example the high-tech regions in China, India, South Korea, Singapore and Japan. Japan and South Korea are already well-known for their high-tech activities. Although China and India are new to this area, there is no doubt that they will play a major role in the new knowledge economy. Today, there are more than 400 regions in over 80 countries that have the ambition to remain or become a 'region of excellence'. In most cases, these regions have the following key factors:

- *Excellent knowledge centres (universities, technical colleges and research centres)*
- *A developed entrepreneurial culture and role models*
- *The necessary physical structures (incubators, research parks, industrial parks)*
- *A technology transfer cell*
- *Financial instruments (seed capital and venture capital)*
- *Capital market (stock exchange)*
- *Presence of international companies*
- *Government support*
- *Sustained quality of life.*

THE LEUVEN REGION: DYNAMICS IN KNOWLEDGE CREATION

Knowledge is clearly the driving force behind prosperity and well-being in the new millennium. The speed and intensity with which new scientific and technological knowledge is transformed into socially and economically relevant activities is well-known. The Leuven (Louvain) region clearly demonstrates its ambition to play a dynamic and leading role in the European knowledge economy in the 21st century (Hinoul 2006). The region has a long tradition in knowledge creation (Debackere and De Bondt 2002; Van Looy et al. 2003; Debackere et al. 2004). The University of Leuven dates back to 1425, when the City Council, supported by the Chapter of St. Peter, took the initiative to build a university in Leuven. The Bull of foundation was issued by Pope Martin V on 9 December 1425.

The K.U. Leuven (Catholic University of Leuven), together with the University Hospital 'Gasthuisberg', has a leading position among the 25 most renowned European academic research centres, and it is determined to expand and reinforce this position. In addition to the university, there is the Interuniversity MicroElectronics centre (IMEC), Europe's largest independent research centre in the field of microelectronics and increasingly active in nano-electronics. The city of Leuven plays a key role in developing the region into a real knowledge-economy region. Furthermore, there is 'Charter 2020', which plays a significant role as 'think tank' and acts as a structural forum, a regular place for leading figures from the knowledge organizations, the private enterprises, the city and the regional development societies. 'Charter 2020' is one of the cornerstones of the dynamism leading to the innovation and viable growth that have become characteristic for the

region in the past 10 years. We will take a closer look at the knowledge region around Leuven with the aim of seeing whether this region has the necessary ingredients and, more importantly, whether it has a recipe for further success.

The Leuven region is a knowledge centre

The scientific output of the Leuven knowledge institutes is a clear demonstration of their contribution to knowledge creation (Debackere and De Bondt 2002). International publications are an important criterion, as they are the primary instruments for dispersing new knowledge to an international platform. Annually, more than 3,000 international publications in fundamental science journals are published. As far as IMEC is concerned more than 1,200 publications are published each year. An important indicator of the quality of these papers is the position Leuven occupies within Europe in the 'citation index', i.e. a frequency numbering the times that publications are cited by other researchers.

The quality of knowledge creation can be refined further by focusing on the so-called top publications. Publications are considered excellent if they appear in journals with a high impact factor. The 'impact factor' of a specific journal shows the average number of times a publication in this specific journal is cited. The higher the impact factor of the journal is, the higher the prestige is of the publications that appear in the journal. About one fourth of the publications of the K.U. Leuven appear in so-called 10% top journals, which means that today the K.U. Leuven ranks among the top 15 research organizations in a few dozen future-oriented research domains, in particular in the areas of biochemistry, biomedical sciences, engineering and new materials. The IMEC is a leader when it comes to microelectronics and nano-electronics process technology.

Next to publication output, an analysis of patent data is a common way of assessing the innovative character of the technological performance of a region. Leuven delivers around 200 patents per year, or 11% of all applications in Belgium. K.U. Leuven plays an important role in the League of European Research Universities (LERU). Other universities in this league are Cambridge, Oxford, Edinburgh, Munich, Heidelberg, Leiden, Karolinska, etc. Leuven also belongs to the Coimbra Group of European universities, gathering 38 universities, some of which are among the oldest and most prestigious in Europe. The region's concentration of researchers is thus quite high: 3,400 researches at the K.U. Leuven, 1,300 at Leuven Gasthuisberg and 1,400 at IMEC.

A dynamic entrepreneurial culture and role models

Leuven has a long history in entrepreneurship, dating back to names like Mercator, Justus Lipsius, Gemma Frisius and Vesalius – who were each world leaders in their fields. In the 20th century, Leuven continues that tradition, with Pieter De Somer, Jacques Vander Eecken and Roger Van Overstraeten.

- Pieter De Somer developed a fascination for microbiology and immunology. He conducted research on penicillin and new types of antibiotics. He realized the

cooperation between industry and the university that later would lead to the establishment of the Rega Institute, which developed the polio vaccine and later became famous for its research on interferon. He later became the first rector of the K.U. Leuven, a position he held until his death in 1985. De Somer has put the K.U. Leuven on the international map.

- In 1982, Jacques Van der Eecken became the Dean of the Faculty of Economic and Applied Economic Science. In 1984, he became the president of K.U. Leuven Research and Development – the interface cell between university and business. Vander Eecken gave LRD, which was founded in 1972, new fervour and became one of the central figures in the contacts between the K.U. Leuven and the business community. He was certainly one of the first professor-managers at the university.
- Roger Van Overstraeten studied at Stanford, where he met the Silicon Valley pioneers. On his return to Leuven, he was convinced of the potential impact of the 'microchip' on the economy. He started a small laboratory called ESAT, a lab for electronics, systems, automation and technology. In 1984, he started the IMEC labs with a staff of 70 people and an initial investment of € 62 million. Under his guidance and leadership, IMEC turned into the most renowned microelectronics centre in Europe. Today, the lab employs 1,400 people and has a budget of € 250 million.

Today, Leuven has a large number of entrepreneurs and role models:

- *Former rector Andre Oosterlinck, who did an outstanding job as rector of the university for eight years. He was also a brilliant engineer, which resulted in the creation of several spin-offs of the university. Icos Vision Systems, one of the companies he set up, is still one of Flanders' leading companies in the area of microelectronics. Oosterlinck is also on the board of various other Leuven high-tech companies.*
- *Urbain Van Deurzen, who as a young doctor engineer started a new spin-off company called LMS or Leuven Measurement Systems, a software company that is active in the field of noise and vibration measurements. LMS became quite successful worldwide.*
- *Jan Callewaert started the successful company Option International, which is active in the field of wireless communications and one of the fastest growing companies in Leuven. In 2005, he became manager of the year in Belgium, while his company Option International was pronounced company of the year.*
- *Dr Jos Peeters, who has a PhD in physics, was one of the first venture capitalist in Flanders. He worked for Benevent, a venture company of KBC bank. Later, he started his own venture fund Capricorn Ventures in Leuven. He also stood at the basis of the European stock exchange for high-tech companies Easdaq.*
- *Professor Koen Debackere became head of the K.U. Leuven transfer cell LRD in 1998. Under his leadership more than 40 spin-offs were created, mainly with the help of the university venture funds: Gemma Frisius I and Gemma Frisius II. Each fund has € 12.5 million and has been set up by K.U. Leuven, KBC Bank and Fortis Bank. Professor Debackere also set up a successful patent fund at the university.*

- *Professor Frank Luyten, who worked for a number of years at the NIH (National Institutes of Health) in the United States and later set up his own company in Leuven in the area of skeletal tissue engineering (Tigenix).*
- *In the 1980s, Professor Desiré Collen cloned t-PA or tissue plasminogen activator, a technology that he patented. Later, the patent was transferred to the Californian company Genentech, where it was transformed into a blockbuster new drug. Professor Collen set up his own spin-off Thromb-X, and later Thrombogenics, which he brought to the stock market.*
- *And finally, Professor Declerck, who did excellent work in the field of HIV at the Rega Institute. He worked with Gillead Sciences, also in the United States.*

To summarize, in Leuven there are dozens of entrepreneurs who are still active and have their own companies or who are exploiting their own patents. This represents a relatively high concentration of entrepreneurs in such a small town, which is certainly at the basis of several other successful start-ups in the Leuven region.

Money for research, money to build companies

To build such a critical mass of high-quality research one needs money. The K.U. Leuven spends around € 250 million each year on research. A similar amount is spent by IMEC. This brings the Leuven research budget to € 500 million. Although it is more difficult to estimate the expenditure of the technology companies, it is fair to assume that the 300 technology companies in the Leuven region spend another few hundred million Euros on research and development of their products and services. Furthermore, Leuven spin-offs can rely on a solid financial structure, thanks to a sufficient amount of investment capital to support and stimulate the process of innovative entrepreneurship. Belgian and foreign venture capital groups have invested in excess of € 500 million in Leuven-based start-ups in the past four years alone.

In 1997, the K.U. Leuven founded its own venture fund, called ‘Gemma Frisius’. The university and the venture capital divisions of Fortis and KBC bank provided a capital of € 12.5 million. The Gemma Frisius Fund offers seed and start-up capital and in this way supports the K.U. Leuven spin-offs that want to commercialize the results of the research further. Due to the success of the initial fund, a second Gemma Frisius Fund, also with a capital of € 12.5 million, was set up in 2002. IMEC also established its own incubation fund.

In addition to these university seed and start-up capital funds, Leuven has various private venture capital investors, such as Capricorn Ventures Partners, Quest Management, Software Holding & Finance, Beluga, Stonefund and Servifund, which together provide another € 300 million to Leuven-based entrepreneurs. Finally, there are several Flemish and Belgian venture capital investors with close links to the region.

The K.U. Leuven Technology Transfer cell – K.U. Leuven R&D

K.U. Leuven Research & Development was founded in 1972 as a separate entity within the university. Its mission is to promote and support the transfer of knowledge and technology from the university to the business world. To achieve that goal, LRD, with its more than 40 employees, offers professional legal, technical and business advice. First there is contract research, which over the last 30 years has represented a substantial part of the university's R&D portfolio. In 2005, about € 70 million, almost 25% of the total direct research spending at the K.U. Leuven, which has risen to € 250 million per year, was spent on contract research. Secondly, LRD focuses on the efficient management of the university's intellectual property. The Knowledge Management cell in LRD deals with this aspect. Its main task is to pursue the most successful commercialization of the intellectual property. This means generating income from the commercial use of the university's protected technology. The K.U. Leuven belongs to the European top 3 when it comes to income from licence fees. The Rega research institute, the Centre for Human

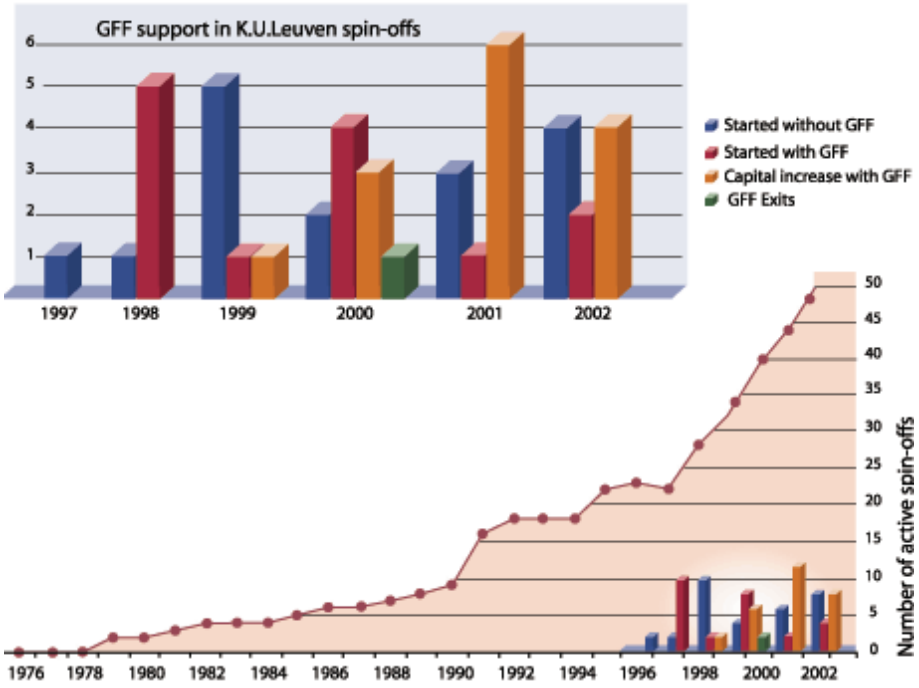

Figure 1. *The Oosterlinck-Gemma Frisius Fund (GFF) effect. At the moment, 65 spin-off companies (exploiting university research results) are active, with a total turnover of 600 million EUR and more than 2500 employees*

Genetics, the Collen research foundation and the Centre for Molecular and Vascular Biology play a leading role in this respect. In addition, K.U. Leuven has its own patent fund. A third core activity of LRD is founding spin-offs. The creation of these high-tech enterprises that originate from the exploitation of the university's research results is an ever more important mechanism for the transfer of knowledge.

The foundation of the K.U. Leuven Gemma Frisius Funds (Fund I and Fund II) was very crucial in this field. The first fund was set up late 1997, and since then there has been an exponential growth of spin-off companies from K.U. Leuven. It was former Rector Oosterlinck who took the initiative to set up this fund, together with Fortis Bank and KBC Bank. The number of spin-offs in Leuven rose from 22 in 1998 to more than 67 today. Not many universities in Europe can show these kinds of results (see Figure 1). In addition to creating spin-off companies, K.U. Leuven R&D is quite active in contract research. What started as a minimal fraction of the R&D activities, over the past 30 years has grown to be a very substantial part of the university's R&D portfolio. Today, it represents some € 70 million, nearly 30% of the total university's direct research spending. Thirdly, there is LRD's focus on the efficient management of the university's intellectual property, not only by filing patents but also by generating a substantial income through the commercialization of this intellectual property.

Infrastructure development: Incubators and Research Parks

In 1998, it became clear that a state-of-the-art infrastructure was needed to follow the explosive growth of the Leuven technology region. At the time, there was an incubator with 3,000 square metres of office and laboratory space (The I&I or Innovatie- & Incubatiecentrum) with an average occupation of around 6 to 10 new companies at any given time. The incubator was recently upgraded to 5,000 square metres, and it currently houses 15 new companies. In 2004, it also became clear that K.U. Leuven was spinning off more and more life-science companies. The region was also able to attract several biotech companies from abroad. Therefore, in 2005 a decision was made to build a new state-of-the-art incubator for life-science companies. The first companies were planned to move in at the beginning of 2007. This incubator, which is located on the site of the new Arenberg Research Park, has twelve modern biotech laboratories and a state-of-the-art technical infrastructure, and the necessary services required by young start-ups. At the Arenberg Research Park there is space to build two more of the bio incubators.

Leuven has three research parks, located in the South of Leuven: the Haasrode Research Park, the Arenberg Research Park and the Termunck Research Park. Combined, which together are known as the 'Leuven High-technology Corridor' (see Figure 2). The research parks date back to the early 1970s. At that time, Leuven made a decision to build its first research park in Haasrode. 'Haasrode Research Park' is situated south of Leuven, near the E40 freeway connecting Ostend-Brussels-Aachen. This park is located at 25 kilometres from Brussels International Airport. The park occupies 136 hectares and is exploited by Interleuven (a local/regional development agency). Today, Haasrode Research Park is nearly full. There are at

least 150 technology companies, and around 5,000 high added-value jobs were created here. The campus contains some of the leading spin-off companies from K.U. Leuven and IMEC, such as Leuven Measurement Systems, Icos Vision,

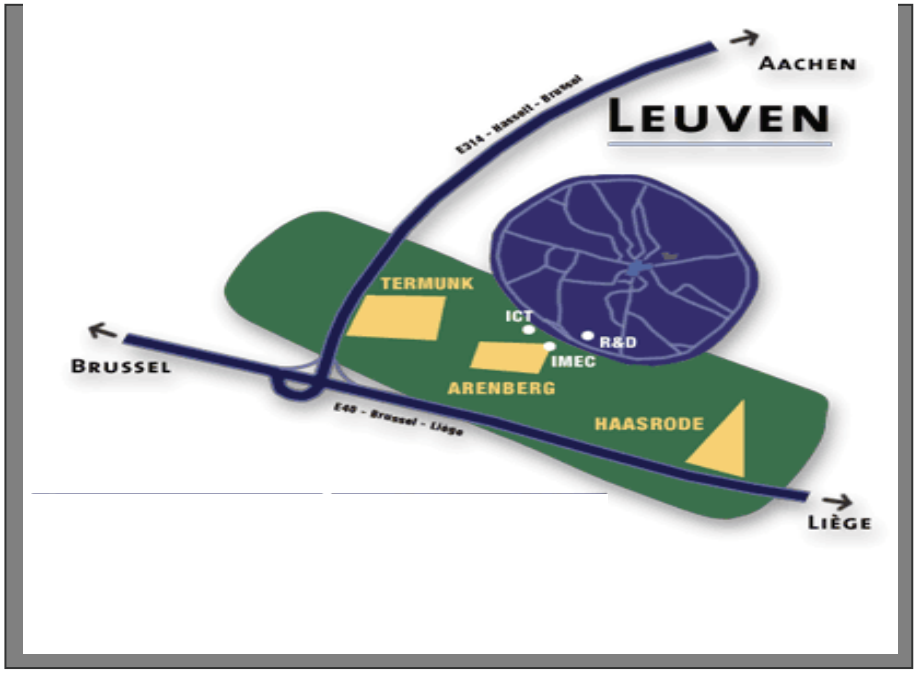

Figure 2. *The Leuven Technology Corridor*

Materialise, Tigenix, Ansem and Metris. Many European, American and Asian companies were also attracted to these research parks, for instance Philips, Terumo, Junghans and J.S.R. Electronics, as well as a host of technology companies from the Flanders Region, such as Telindus.

At this very moment, Leuven is building its second Research Park, called the Arenberg Research Park, which is situated next to the IMEC research centre and close to the K.U. Leuven Science campus. The park occupies thirteen hectares and is located near the city and only 15 kilometres from Brussels International Airport. The park will have five clusters, each with 25,000 square metres in office and laboratory space, with a total park infrastructure of 125,000 square metres. Three clusters have been reserved for ICT companies, and two will be dedicated to life-science research. Today, around 18,000 square metres (13,000 for ICT and 5,000 for life sciences) are operational, with companies such as Option International, Easics, Luciad, the Digital Signal Processing (DSP) valley, etc. Once the bio-incubator has opened (in the beginning of 2007), around eight modules will be taken by K.U. Leuven life-science companies and some international life-science companies. This Arenberg Research Park can be completed in 2012 and will eventually host around 100 companies,

employing around 4,000 people. A third research Park, the Termunck Research Park, which will be 36 hectare in size, is planned for 2012. In the coming years the master plan for this park will be worked out. Leuven also built two other state-of-the-art high-technology campuses: the Remy campus and the Ubisite campus. On both sites several high-tech companies are located, such as Ubizen and Septentrio.

Further growth of the Leuven High-technology Region

As is the case in many other knowledge economy regions in the world, further growth not only occurs in the vicinity of a university, as we can see, for example, at Silicon Valley, where it all started around the Stanford Campus (Hinoul 1999). Today, we see that Silicon Valley is spread out over several thousand square kilometres. This is also applies to Cambridge, where the companies are spread over a wide area around the science parks. In the case of Leuven, there is a similar growth towards the east. We see the first nucleus in Tienen, a small city twenty kilometres east of Leuven. The Tienen region has a long tradition in the food industry. Today, there are plans to develop a cluster around 'feed–food–health' or 'functional food' here. Further to the east, there is the city of Genk at 70 kilometres from Leuven. Today, Genk has one of the largest Ford assembly plants in the world; however, one would also expect more innovative companies to set up in the Genk area. A plan is made up to build a research park on 20 hectares of land, with the help of the University of Leuven and the University of Hasselt.

It is also important to mention here that Leuven is involved in the new European knowledge region ELAT, better known under the name: Eindhoven–Leuven–Aachen triangle. This triangle in the heart of Europe could become one of the most promising knowledge regions in Europe. Several strong sectors are emerging, such as medical technology, mechatronics and precision technology, automotive and digital signal processing. In this triangle, there are several excellent universities and technical colleges, as well as excellent research centres, multinational companies like Philips, and thousands of small and medium-sized enterprises. The potential power of this triangle lies in the synergies and complementarities of its research centres and companies.

The Leuven clusters

Thus far, the K.U. Leuven research laboratories and IMEC have produced a total of 90 spin-offs: 65 from K.U. Leuven and 25 from the IMEC institute. Also, many Flemish, Belgian and international companies have set up in Leuven, and there are currently more than 300 technology companies in the region. Most of these companies belong to one of the five clusters active in very specific niches.

We think that a cluster can be described as representing the driving force behind economic development in a region. Clusters are concentrations of innovative interdependent enterprises (co-competitors), operating in the same field, localized in a specific geographic area, in close proximity to centres for research and development. This is indeed what we find in the Leuven clusters. In the nucleus we

see top research centres from the K.U. Leuven and IMEC. In the next circle we clearly see the creation of pure R&D companies, surrounded by a group of innovative companies. This will be clearly shown in the next figures.

The life-science cluster

A first cluster in Leuven revolves around life sciences. The fundamental research in this area is concentrated in the group Biomedical Sciences of the K.U. Leuven. The UZLeuven (University Hospital) and the various research groups of the Faculty of Medicine support this research. There is the research group for molecular and cardiovascular medicine, with more than 20 years of experience in heart and artery diseases. The recombinant t-PA (tissue plasminogen activator) that has been developed by this group is annually administered to hundreds of thousands of patients around the world. Other research groups are: the Leuven Clinical Coordination Centre, the Centre for Human Genetics and the Centre for Experimental Surgery. Also, at the IMEC centre, increasing research in this field is performed – namely in biosensors, biochips, lab on a chip, etc. Indeed, the convergence of life sciences and nano-electonics opens a completely new area of medicine: the bio-silicon field. Furthermore, significant work is going on in bio-informatics. Over the years, in Leuven a series of interesting biotech companies

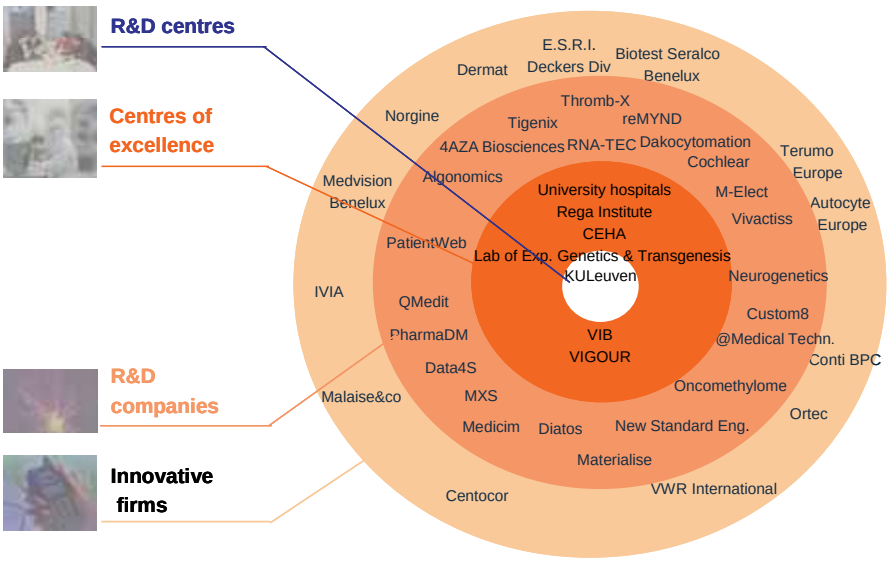

***Figure 3**. Life sciences*

have formed from classical companies to bio-silicon to bio-informatics, such as Throm-X, Tigenix, 4 AZA, Diatos, reMYND, RNA-tech, Thrombogenics, Vivactiss, Pharma DM and Algonomix, to mention a few. Leuven has also managed to attract

biotech companies from abroad, such as Diatos, Onco Methylome Sciences, IDT (Integrated DNA Technologies Inc.), Torrey Pines, etc. (see Figure 3).

The feed–food–health cluster

A second cluster is built up around feed–food–health. There is a tremendous amount of knowledge in the field of molecular and cardiovascular medicine and that of immunology around the Leuven University Hospital (UZLeuven). Also, K.U. Leuven is quite strong in the area of applied bioscience and engineering and, last but not least, there much is done in the area of biosensors and biochips at IMEC. There is a strong belief in Leuven that to develop new products in the food sector (functional food or nutraceuticals), this multidisciplinary approach is needed. Also, this sector of functional food is one of the strongest growing sectors. Leuven certainly has a tradition in this sector, and the nearby Tienen region also wants to play a major role in this new type of development (see Figure 4).

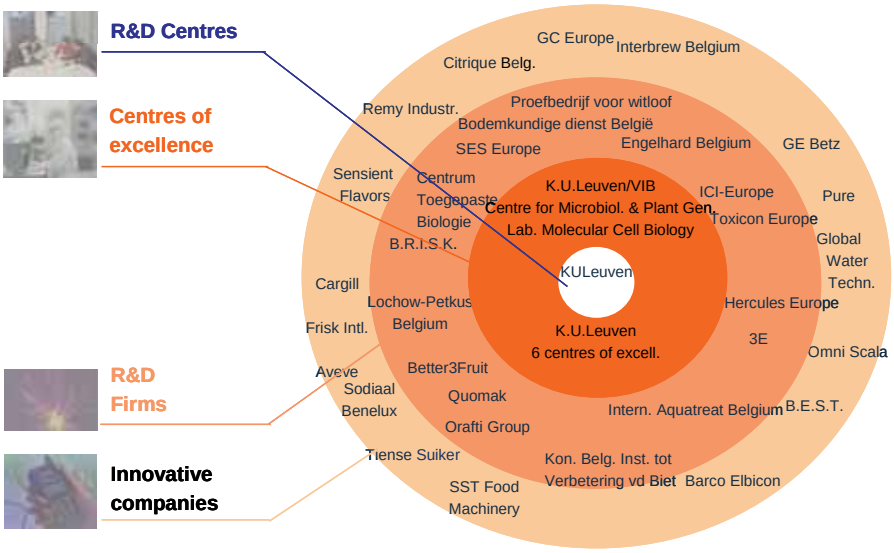

Figure 4. *Feed–food–health*

The mechatronics cluster

The mechantronics cluster encompasses the domain of mechanics, robotics and electronics. K.U. Leuven has a longstanding tradition in these areas, with its Mechanical Engineering, Materials Engineering, and Electrotechnics departments. These research departments have generated a number of top spin-offs, such as Leuven Measurement Systems (LMS), one of the university's first spin-offs and still one of the leading Leuven-based high-tech companies. Other spin-offs are Materialise in fast prototyping, Krypton and Metris (companies merged recently) in

the field of dimensional metrology and movement control. Metris was Belgium's 'Company of the year' in 2006. Figure 5 presents the centres of excellence, the innovative companies in this field and the mixed innovative companies.

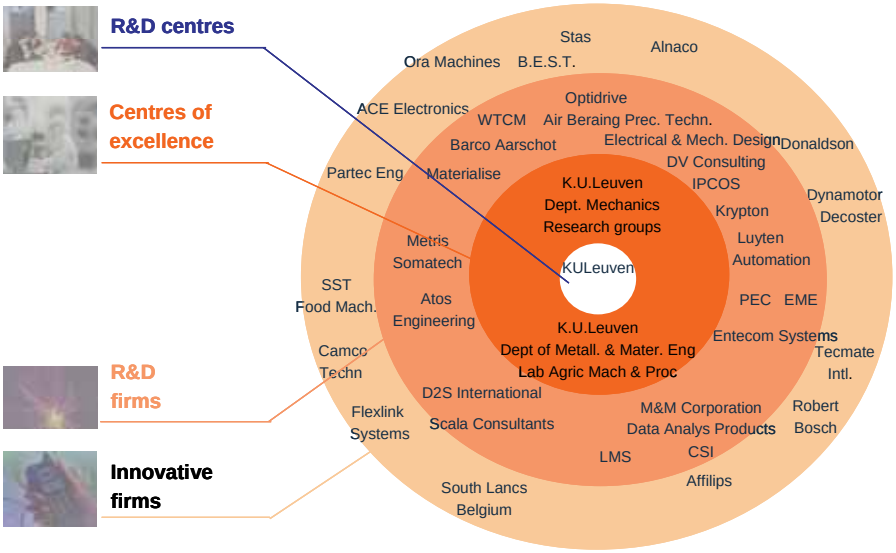

Figure 5. *Mechatronics*

The cluster for telematics and communications

It is clear that IMEC, Europe's largest independent research centre for microelectronics and nanotechnology, plays a crucial role in the development of this cluster. The Design technologies for integrated Information and Communication Systems (DESICS) division possesses the expertise needed for designing chips and systems for intelligent environments. Also important is the K.U. Leuven department for Electrotechnics (ESAT), which has several centres of excellence, such as the Centre for Speech and Image Processing and the TELEMIC research group, which focuses on telecommunication and microwaves. This resulted in spin-offs such as Eyetronics, MEAC, Data4S and others. The presence of Belgian ICT company Telindus and the American multinational company Tyco is a further asset to this growth sector (see Figure 6).

The Microelectronics and Nanotechnology cluster

The fifth cluster, which involves microelectronics and nanotechnology, is concentrated at IMEC and K.U. Leuven. IMEC conducts research into process technologies for the next generation of computer chips, for intelligent environments and for nanotechnology. K.U. Leuven is active in several centres of excellence, with

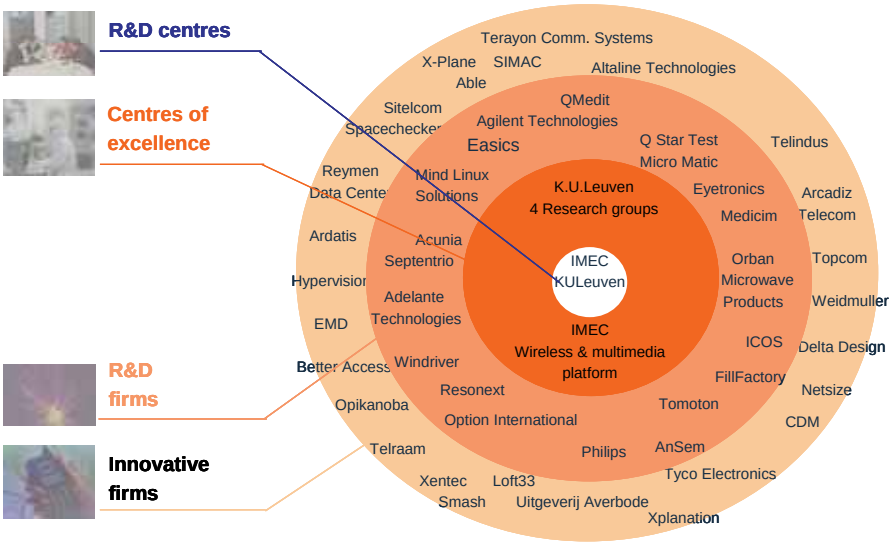

***Figure 6**. Telematics – communication*

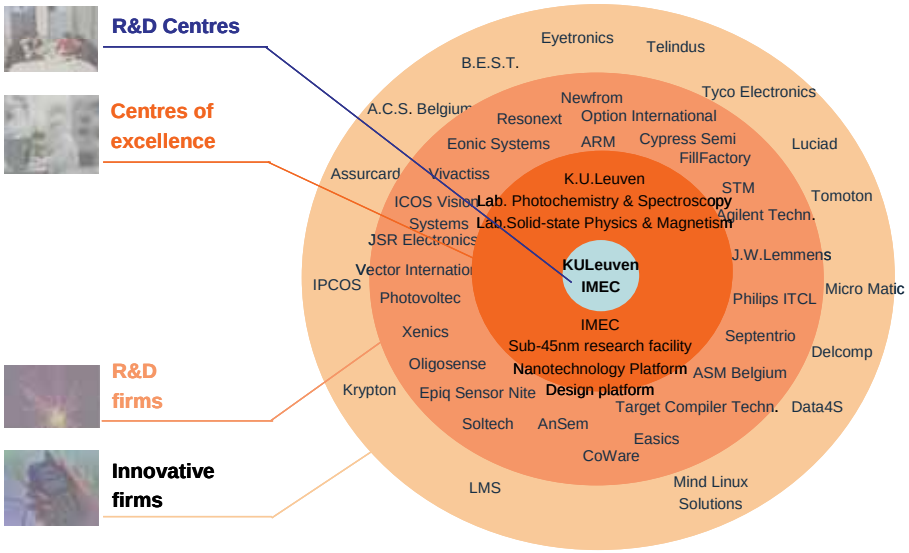

***Figure 7.** Microelectronics and nanotechnology*

the Laboratory for Solid-state Physics and Magnetism, the Laboratory for Photochemistry and Spectroscopy and the department Interface Chemistry, and the Laboratory for Experimental Genetics and Transgenesis. Further work in this field is

carried out in ESAT. Several Leuven high-tech companies active in this field are ICOS Vision Systems, JSR Electronics, Ansem and Photovoltec (see Figure 7).

The e-security cluster

Since the end of the 1970s, the Leuven and Brussels regions have become important players in the field of e-security. Leuven was one of the first regions in the world to concentrate research for e-security geographically, and the university faculties of Applied Sciences (department ESAT and Computer Science) and Natural Sciences (departments Informatics and Mathematics) were at the forefront of this evolution. One of the leading centres of excellence is the COSIC research group (within ESAT), which focuses on cryptographic algorithms and the development of security architectures for computer systems and telecom networks. In 1999, a COSIC researcher developed the C++PEC programme, a world first. The 'Rijndael algorithm' was another international success for this research group. This algorithm was selected by the National Institute for Standardisation and Technology (NIST). A series of innovative companies that are active in this field have established themselves in the region, such as Ubizen, Utimaco, Safeware, Data4S, Hypertrust, Risc Technology, Telindus, etc. (see Figure 8).

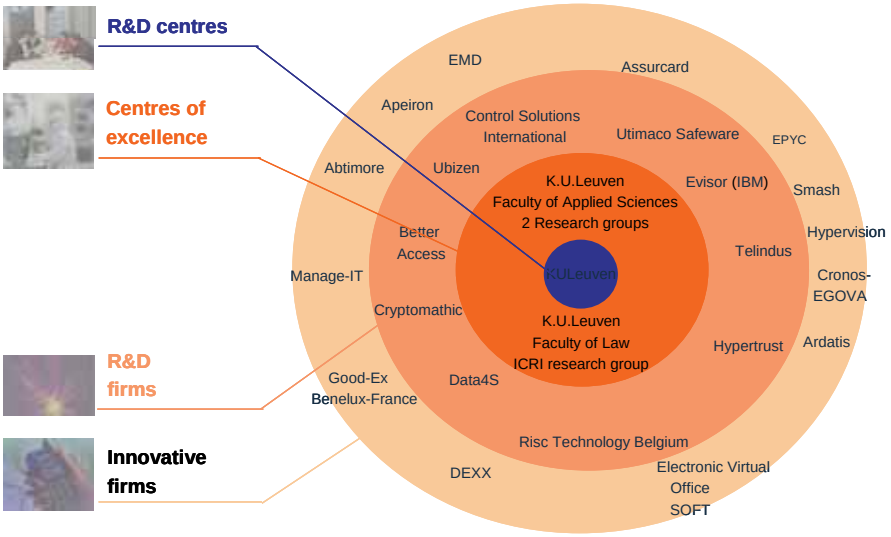

***Figure 8**. E-security*

THE LEUVEN NETWORKS

Leuven recognizes the power of networks with the existence of a 'horizontal' network (Leuven Inc.) and several 'vertical' networks (such as L-Sec and DSP Valley).

Leuven Inc (Leuven Innovation Networking Circle)

This network was set up in November 1999, based on the experience of the Cambridge Network, with a mission to bring like-minded people together. It was founded by IMEC, K.U. Leuven R&D, Deloitte & Touche, Fortis Bank and KBC-Investco, with active support from seven founding members: LMS, Icos, Krypton, Option International, Materialise, Easics and Capricorn Ventures. Leuven Inc is a horizontal or multidisciplinary network for knowledge-intensive entrepreneurship and constitutes a constant bridge between knowledge institutes, high-tech entrepreneurs, service enterprises and established enterprises. The network currently has more than 500 members and on a regular basis organizes the Entrepreneur Café, round-table conferences and visionary workshops and seminars.

DSP Valley

In 1998, DSP Valley was founded as an innovation network for digital signal processing, and it was Leuven's first technology network organization. It promotes the Leuven Region as a centre of excellence for the development of electronic systems for digital signal processing. The DSP valley is now also active in the ELAT (Eindhoven–Leuven–Aachen triangle) knowledge region, and last year it opened an office in Eindhoven.

L-Sec E-Security Innovation Network

The geographic concentration of the research centres in the field of e-security led to the founding of the Leuven Security Excellence Consortium in January 2002. The K.U. Leuven and eight companies were at the basis of this consortium, which promotes Leuven and Belgium as a knowledge and expertise centre in the field of e-security.

The Leuven Chamber of Commerce

The Leuven Chamber of Commerce is the oldest network organization in Leuven, dating back more than 210 years. Currently, it has 2,000 members; it offers a variety of services to enterprises and entrepreneurs, and is structurally a part of 'VOKA', the Flemish network of enterprises. The Leuven Chamber is also member of the worldwide network of Chambers of Commerce.

CONCLUSIONS

The Leuven success story can be summarized in twelve points:

1. *The basis is certainly the critical mass of high-quality research at the K.U. Leuven research centres and IMEC.*
2. *The creation of an appropriate entrepreneurial climate in a university environment.*
3. *The creation of a legal framework for the exploitation of academic research.*
4. *Clear incentives and policies to encourage research groups to actively seek knowledge transfer opportunities.*
5. *The creation of a professional interface unit allowing for an integrated approach to valorize research.*
6. *The creation of a seed-capital fund.*
7. *The fostering of spin-offs.*
8. *Clear ownership of intellectual property.*
9. *Improved awareness among the different shareholders ('triple helix', i.e. the public–private partnership between university, government and business).*
10. *The creation of professional networks.*
11. *Enthusiasm.*
12. *The high quality of life in the region.*

Over the past ten years, the 'Leuven Pearl' certainly has become a successful knowledge region – serving as an excellent example for the Flanders region and Europe as a whole. It is clear that Leuven not only has the ingredients needed to build such a successful knowledge region, but that it also has the recipe and people.

NOTES

[1] As a member of the Leuven Charter 2020, I would like to thank the Charter for the very interesting discussions we have had on the Knowledge Region Leuven. These discussions were collected in the booklet 'Leuven, Knowledge Pearl' (more information at www.leuvenknowledgepearl.com). At an International Expert Meeting of 'Strike – Strategies for towns and regions in the knowledge economy, cities as engines of the knowledge economy (Amsterdam, 21 September 2004), Dr Willem van Winden (Euricur – Erasmus University Rotterdam) described Leuven as a 'Knowledge Pearl' – a city in which knowledge is not only passed on, but also produced and applied (see Leuven Charter 2004: 2). For the Leuven Charter 2010 (now renamed as Charter 2020), a think tank discussing Leuven's future, this was considered an appropriate name for a booklet describing Leuven's past, present and plans for 2010 and beyond (Leuven Charter 2005).

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