Silicon Valley in the Polder? Entrepreneurial Dynamics, Virtuous Clusters and Vicious Firms in the Netherlands and Flanders

Willem Hulsink, Harry Bouwman and Tom Elfring

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SILICON VALLEY IN THE POLDER?

ENTREPRENEURIAL DYNAMICS, VIRTUOUS CLUSTERS AND VICIOUS FIRMS IN THE NETHERLANDS AND FLANDERS

Willem Hulsink
Erasmus Universiteit Rotterdam, PO Box 1738,
3000 DR Rotterdam, whulsink@rsm.nl

Harry Bouwman
Delft University of technology, PO. Box 5015,
2600 GA Delft, e-mail: h.bouwman@tbm.tudelft.nl

Tom Elfring
Vrije Universiteit Amsterdam, De Boelelaan 1081c,
1081HV Amsterdam, e-mail: t.elfring@fsw.vu.nl

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Abstract

High-technology starters do not operate in a vacuum and innovation is not a solitary activity. The activities of technology-based firms are embedded in socio-economic networks with other companies, investors, universities, vocational institutions, etc. The geographical proximity of those institutions and infrastructural hubs will partly play a role in determine the location of ICT firms decision. Furthermore, many high-tech companies shape clusters around areas where their major customers are located. The topic of this paper is regional clustering Enright, 1992; Rosenfeld, 1997within the context of Internet and ICT technology. A dynamic model previously developed for the analysis of ICT-entrepreneurship and networking will be applied to make a critical analysis of five ICT-clusters in the Netherlands and Flanders (Northern part of Belgium): the Louvain Technology Corridor, Flanders Language Valley, Amsterdam Alley, Dommel Valley, and Twente.

INTRODUCTION

The inspiring examples for promoting successful technology clusters are often found in the small business districts of Italy and Germany, and in Silicon Valley, where shared identity, craft-based skills, regional specialisation and networks of local sourcing, have produced a dynamic and flexible ecology (Best, 1990; Grabher 1993a; Saxenian, 1994). Those techno-industrial districts have a well-developed infrastructure of supportive institutions, promoting variety among capabilities, firms and organisational forms (Van de Ven, 1993). As convincingly argued by Grabher (1993b; 1993c), the institutional embeddedness of those business districts, however, has to be moderate (social ties should bind, not blind) and dynamic (avoiding rigid specialisation and functional and socio-political lock-ins or chaos from arising). For instance, Glasmeier (1994) discusses the example of the traditional Swiss watch industry which proved vulnerable to severely external shocks in the 1970s and early 1980s. The advent of quartz technology, the subsequent introduction of new production systems, and global competition replaced its tradition of precision manufacturing, mechanical craft skills and indigenous collaboration. The arrival of the electronic watch, associated with far-reaching automation and the global search for economies of scale, forced the gates of the then complacent and relatively inert Swiss watch cluster to open.

There is a large number of analyses that looks at why certain regions are successful in creating an innovative technology cluster (e.g. Rosenberg, 2002; Castells & Hall, 1994; Lee et al., 2000, Kenney, 2000). In some cases it is an internationally renowned university that inspires engineers and scientists to become entrepreneurs (e.g. Cambridge University), in others it is a large core company outsourcing many activities to smaller companies that together can serve as a region's catalyst (Fairchild Semiconductor and Intel in Silicon Valley). Also an active government can stimulate indigenous clusters by making local resources and funds available (e.g. risk capital, high-quality infrastructure), attracting foreign firms to invest, and building ties with Silicon Valley (e.g. Hsinchu Taiwan) (Mathews, 1997.

In the documents of governments on innovation policy, increasing attention is paid to the (potentially) dynamic role to be played by thriving high technology firms and entrepreneurial universities and research institutions and the dynamic growth patterns they (can) bring about (CEC 1995; 1997; 1998; Van den Brande 1995; Ministerie van Economische Zaken, 1999). The academic literature, more interested in the causes of the outstanding performance of some

of those emerging *high technology* regions, refers to the successful collaboration between local universities and research laboratories and established high-technology companies and a large number of new firms in so-called *innovative milieux* (Castells & Hall 1994).' This process of collaboration, including spontaneous cross-fertilisation, local/regional spin-offs and spill-overs, outsourcing and strategic partnering, may ultimately lead towards constant innovation and an ongoing knowledge transfer between the major public and private stakeholders in the region.

We will describe a cluster as a geographical concentration of mutually dependent companies with vertical as well as horizontal and cooperative as well as competitive relational patterns, with companies often operating within the same industry or on the basis of the same basic technology (Jacobs & De Man 1996). When the clustering of companies takes place within high-tech sectors (e.g. biotechnology, new materials, ICT) terms like *technopole* and *technopolis* are also used (Castells & Hall 1994). Besides looking at (the potential of) spill-overs in a dynamic network of larger companies and new start-up firms, attention is also given to the importance geographical concentration and proximity of technology firms, investors, universities, and other supportive institutions, leading to local networking and clustering. Porter (1998) has argued that those *clusters* of geographically proximate group of interconnected companies and associated institutions in a particular field are important to stimulate competition, growth and innovation. As argued by Jacobs (1984) and Glaeser et al. (1992), both technological specialization and competition at the regional level may simply not be good enough, instead intra- and inter-industry variety and diversity may ultimately be more productive in accomplishing and sustaining growth. In this respect, large diversified cities, with their intrinsic multitude of opportunity structures stimulating the cross-fertilisation of ideas and technological spill-overs, are more successful in speeding up innovation and being conducive to an economic take-off, than small and/or specialized technology districts.

Policy makers and entrepreneurs in Western Europe and elsewhere have come up with plans and measures to promote start-up firms and techno-industrial districts in newly emerging industries, such as Information and Communication Technologies (ICT), biotechnology and new materials. For instance, politicians, civil servants, entrepreneurs and investors who concern themselves with the significance of ICT with regards to regional economic development, are primarily interested in the possibilities for growth of the local economy and in positive effects on employment. The increasing relevance of the ICT and multimedia

sectors for the regional and national economy, is illustrated in several studies (e.g. Braczyk, 1999; Cooke 2002; Larosse et al. 2001; Den Hartog & Maltha (1998). Together with other European and South-East Asian states, the Netherlands and Flanders (the northern, Dutch-speaking part of Belgium), together known as the Low Countries, seem to be fascinated by the success of high-technology districts and the prevailing 'entrepreneurial spirit' in the United States (US). Inspired by the vision and experiences with dynamic entrepreneurship and cluster formation across the Atlantic, they have come up with suggestions to promote innovation and new business formation, and create fast growing firms and successful techno-industrial networks in the field of Information and Communication Technologies (ICT) and biotechnology. With the example of Silicon Valley, the Dutch and the Flemish seek to emulate their structures, cultures and networking dynamic. The inspiration and imitation goes so far that the names given for these new ICT-districts in the Low Countries refer to either *Silicon* or *Valley*: Silicon Polder (the Netherlands in general), Amsterdam Alley, Dommel Valley, DSP Valley and Flanders Language Valley. The only high-technology region in the Netherlands and Flanders yet without a *valley* or *silicon* in its name is the Twente region in the Eastern part of the Netherlands.

In this contribution we will focus on the process of regional clustering in the Netherlands and Flanders around the exploration and exploitation of Internet and ICT. Key questions for policy-makers and captains of industry in those countries in this respect are:

- is it possible to emulate the success of Silicon Valley?
- and what are the preconditions for growing another Silicon Valley in the Netherlands and Flanders?

In *Silicon Valley in de Polder: ICT-clusters in the Low Countries* (Bouwman & Hulsink 2000a), the analysis of Silicon Valley has lead to a dynamic model for the analysis of ICT-clustering. In this respect we introduce a number of criteria that are relevant to the success of technology-clusters, namely a knowledge/technology core, a pool of trained professionals and (nascent) entrepreneurs, a sophisticated supporting infrastructure, and network dynamics (e.g. creation of spin-offs, job hopping, subcontracting, knowledge transfer). We want to use this model to make a critical analysis of five (emerging) ICT-clusters in the Netherlands (NL) and the Flanders region in Belgium (FL): Dommel Valley Eindhoven (NL), Amsterdam Alley (NL), Flanders Language Valley – Ypres (FL), Twente – Enschede (NL) and the Louvain Technology Corridor (FL) (see figure 1). Before comparing these regions with one another,

we will first give a brief introduction to the particularities of high-technology entrepreneurship and clustering in Western Europe

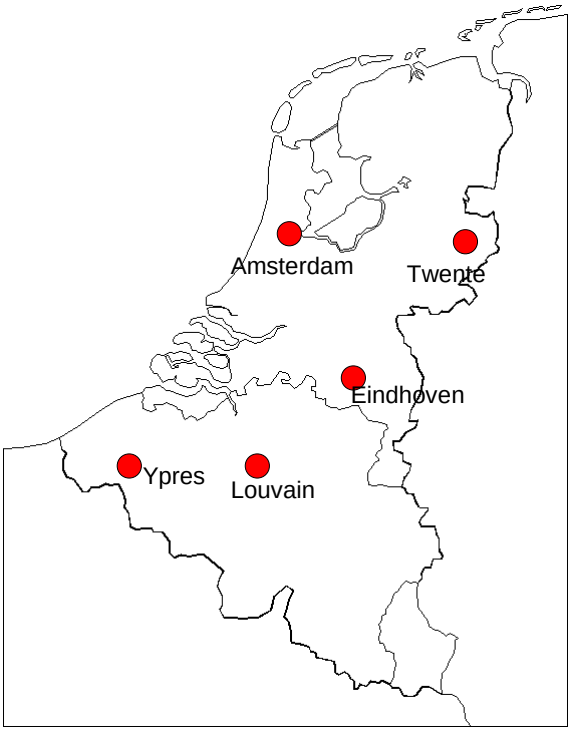

figure 1: Silicon Polders in the Netherlands and Flanders

HIGH-TECHNOLOGY ENTREPRENEURSHIP AND CLUSTERING IN EUROPE

In order to stimulate economic growth and employment and strengthen the competitiveness of European high-technology industries, authorities have recently sought to improve entrepreneurship, market dynamism and the institutional environment for their small and medium-sized businesses. The background for these plans is Europe's poor record on innovation and entrepreneurship in general, and a lagging rate of new enterprise formation and fast growth companies, especially when compared with the USA. Comparisons of the level of entrepreneurship between the USA and Western Europe should be made with great care, given the difference in terms of the size of the national economies (e.g. large (USA, medium-sized (Germany) and small (The Netherlands and Belgium) and the definitions used in measuring the phenomenon. On the basis of an operationalisation of the level of entrepreneurship in terms of self-employment as share in the nation's labour force, Audretsch et al.(2002) have found that from the early 1990s, when the difference between the USA and the West European countries was at its maximum (i.e. level of entrepreneurship being higher in the USA than in Europe). From that moment on, The Netherlands, Belgium and Germany

among others have started to narrow the gap and were almost level at the turn of the century. For instance, while in the USA, a large minority of the people have participated in business start-ups (8,5 % of the adults), in Europe there is a small minority involved in setting up their own business (2,4%) (GEM, 2001). When comparing the USA and the European Union in terms of the availability of dynamic companies (i.e. fast growth companies as a percentage of all mid-sized companies), the rates are 19 % and 4 %, respectively (UNICE, 1999). In short, attitudes towards entrepreneurship differ: while in the USA entrepreneurs are worshipped (e.g. 'the pioneering spirits'), entrepreneurs in Europe are treated indifferently (almost like second-class citizens); instead most attention is given to large corporations and public employment (Muzyka et al., 2000). In the annual benchmark on conditions for entrepreneurship conducted by Andersen & Growth Plus (2000), the USA and the United Kingdom stand out, in terms of access to finance, incentive structures (e.g. remuneration, stock options), a favourable business environment (e.g. tax levels), clearly ahead of the Continental European countries, such as the Netherlands, Belgium, France or Germany.

The reasons for Europe's under-performing economy mentioned in official policy documents are (CEC 1998, 1997, 1995; Ministerie van Economische Zaken, 1999):

- heavy administrative burden on business in general and SMEs in particular and rigid government regulations: cost and bureaucracy involved in registering, starting-up and ceasing a business; high taxes (e.g. corporation tax, tax on dividends, levying of wage tax and payment of social premiums); inflexible labour legislation, and protected and oversubsidised product markets;
- the high economic and socials costs of failure: while in the USA bankruptcy is part of a learning-by-doing exercise in setting up a business, entrepreneurs in Europe are more worried about a loss in their social security provisions and the social stigma of being a 'loser' in case of a commercial failure;
- an underdeveloped enterprise culture in Europe with a poor commercial exploitation of existing knowledge with a low level of (high-technology) start-ups, and low numbers of management buy-outs and university spin-offs;
- bottlenecks in obtaining finance for new venture and sustainable growth: strong dependence on bank lending (in stead of equity financing), and a reluctance of many founder-entrepreneurs to dilute ownership, which equity financing requires.

To improve Europe's economic performance and to encourage a thriving enterprise culture, the Commission, for instance, suggested a number of measures (CEC 1998). At first, the European Commission strongly recommended to simplify the administrative environment by streamlining legislation (e.g. registration, bankruptcy laws) and reduce the number of compulsory procedures. Secondly, the Commission sought to make taxation systems more business friendly: e.g tax relief for new businesses, tax incentives for business angels and fiscal promotion of managed buy-outs. Thirdly, the Commission suggested to improve access to finance through fiscal measures aimed at the promotion of loan guarantee schemes, the encouragement of venture capitalists, private investors and pension funds providing risk capital or capital matching requirements, and the creation of second-tier stock markets (e.g. Neuer Markt, EASDAQ, etc.). Finally, the Commission advocated a major upgrade of Europe's knowledge and skill base by fostering 'entrepreneurialism' and creativity in schools, promoting training schemes, and facilitating participation of small businesses in the R&D programmes of the European Union.

The fact that (Continental) Europe has a lower rate of business creation than the US (and the UK) is often explained by referring to the highly dynamic and transparent capital market that has become extremely efficient at channelling capital at low cost and quickly to ambitious start-up businesses (Cowie, 1999). In other words, the availability of venture capital provides US high technology entrepreneurs with superior access to equity and debt finance.[1] Furthermore, US venture capital funds have stronger capabilities in assessing ICT and biotechnology start-ups: many of those funds are run by experienced (former) entrepreneurs and industrialists (Gupta 2000). Besides giving the financing of start-up companies no priority and lacking the skills to evaluate new technology-based firms, Continental European venture capitalists invest in foreign high-technology and bio-technology stock.[2] Compared with the US where there is a tradition of equity financing in the high technology industries, European small and medium sized firms are reluctant to dilute ownership to allow for sharing equity in order to enable growth and long-term viability (ENSR/EIM 1995). While in the US, informal investors and venture capitalist play a prominent role in the seed and early growth phase of

[1] While in the mid-1990s the US venture capital industry invested on average 35% of its funds in early stage business formation, the bulk of European venture capital was invested in sunset industries and in deals to facilitate corporate and/or industrial restructuring in later stages (*Financial Times 25 November 1997*).

[2] For instance, major Dutch venture capitalists invested in the mid-1990s on average 70 per cent of their ICT money outside the Netherlands and only 16% of their ICT is allocated to seed and start-up companies (Booz-Allen & Hamilton 1998).

the start-up company, in Europe the majority of external financing for small and medium-sized firms is provided by banks, who tend to favour secured lending and other risk-averse investments (Bouwman 1999).

A DYNAMIC MODEL FOR ICT CLUSTERING

The geographical structure of high technology industries is often very concentrated, with a multitude of linkages between core firms, their spin-offs and local subcontractors, top-class universities and major research centres, and local/regional authorities and with extra-firm institutions providing collective goods (Roberts 1991. To describe the growth of a successful techno-industrial-scientific complex (e.g. technology parks, science cities, and techno-industrial districts) such as Route 128 or Silicon Valley, Castells & Hall (1994) have introduced the concepts of *milieux of innovation* and *technopoles.* The first has been defined as 'social, institutional, organisational, economic and territorial structures that create the conditions for the continuous generation of synergy, (..) both for the units of production that are part of the milieu and for the milieu as a whole (p.9).' The second, refers to 'various deliberate attempts to plan and promote within one concentrated area, technologically innovative, industrial-related production (p.8).' There have been various attempts to create and develop *technopoles* (or science & technology cities and business parks) all around the world, in which technologically innovative, industrial-related production is planned and promoted within one concentrated area. According to Castells & Hall, such a technopole policy serves three purposes: to develop new industries as a national policy (re-industrialisation: attracting investment), to regenerate a declining or stagnant region (regional development), and to develop a milieu of innovation (scienctific & technological excellence). Those goals are sought to be achieved by furthering collaboration between leading research universities, corporate laboratories, core firms with their subcontractors and spin-offs, and venture capitalists.

Probably the most inspirational and well-known *milieux of innovation* is Silicon Valley, Northern California; other illustrations are Route 128 (Massachusetts) and Silicon Alley (New York) (Rosegrant & Lampe 1992; Saxenian 1994; Bouwman & Hulsink 2000a: Ch.2; Braczyk et al. 1999: Chs. 2,4 & 5). Silicon Valley, located in between San Francisco and San José, has Stanford and Berkeley as its most important universities and Hewlett & Packard,

Intel, Apple, SUN, Oracle and Yahoo! as its indigenous key players (Lee et al., 2000; Kenney 2000). Through the active encouragement of 'academic entrepreneurs' such as Frederick Terman (former Dean of Engineering at Stanford University), William Shockley (Nobel Prize winner, who set up a business to commercialise the transistor), and the tandem Gordon Moore & Robert Noyce (together with venture capitalist Arthur Rock co-founders of Fairchild Semiconductor and Intel), a dynamic techno-industrial setting of excellence took shape in Silicon Valley, where knowledge, people and funds were constantly transferred from one firm to another. The availability of large cost-plus research contracts with the Department of Defence and NASA in the 1960s and 1970s, the establishment of the Stanford Industrial Park hosting several privileged firms and R&D establishments, further contributed to the success of Silicon Valley.

Leading companies from the West Coast that have contributed to American leadership include among others Hewlett-Packard (HP), Apple, Intel, SUN, Cisco, Netscape, and Silicon Graphics. While HP, Varian Associates (and to a certain extent Shockley) were spin-offs from Stanford University, the first generation of Silicon Valley companies gave way to a next generation of spin-offs, including Fairchild Semiconductor, and eventually to another wave of spin-offs, including Intel, National Semiconductors, AMD. Later, the fist waves of spin-offs, were followed by a new generations of spin-off companies and start-ups working in personal and desktop computing (e.g. Apple and SUN), networking (Cisco) and Internet technology (Netscape, Yahoo and Google). Before setting up their own business, most of the leading 'entrepreneurial' scientists and engineers from Silicon Valley have had their education at Stanford University and have worked in a corporate R&D Lab (e.g. the almost legendary Palo Alto Reserch Center (PARC) of Rank Xerox and/or in a senior management position in an established company (e.g. HP, Intel).

Route 128 is named after the highway near Boston along which the main companies (e.g. Raytheon, DEC, Wang, Data General) and knowledge institutions (Massachusetts Institute of Technology (MIT) and Harvard University), are located. Silicon Alley is the area of Manhattan (New York) where many dynamic Internet and electronic commerce companies are concentrated. All of the three regions discussed above are based on the spontaneous cross-fertilisation between local universities and research laboratories and established high-technology companies through dominant practices such as subcontracting research and product development, churning out of new firms, permanent intra- and entrepreneurship, and

practising cross-fertilisation and knowledge diffusion by job hopping and spin-offs (Saxenian 1994; Kenney & Von Burg 1999; Kenney, 2000; Lee et al., 2000).

As shown in several studies (e.g. Castells & Hall 1994), those deliberate strategies to plan and promote local/regional techno-poles, shows at its best, mixed results. As shown by the success stories of Silicon Valley and the Route 128/MIT area, successful technopoles can come about, due to an emergent strategy, instead of central and/or regional planning. In setting up those effective public-private networks and ties between entrepreneurs, technologists and business angels, leading universities play a pivotal role by not only generating new basic and applied knowledge and producing a well-trained workforce of engineers and managers, but also act as a catalyst by actively supporting the process of spinning-off its research into a network of industrial firms and business ventures. Successful companies are spinning a web of affiliates, including business/technology partners and dedicated subcontractors, around a shared value platform or industry standard in order to promote continuous innovation and seek leverage of the 'strategic network' as such. For instance, Apple's network consists of specialised suppliers that produce, for example, only switches, software, disk drives, microprocessors or keyboards. Apple itself is responsible for design and marketing, and for the production of core components and the assembly of the computers. Small and medium-sized enterprises (SMEs) in the high technology industries (ICT, new materials and bio-technology) are a breeding ground for innovation, job creation and economic growth. Much of the development, implementation and diffusion of these knowledge-intensive goods and services is carried out by small enterprises, who either act as local subcontractors to major internationally active companies or are independent in serving international niche markets.

In the creation of a lasting concentration of economic activity in a specific geographical area a number of aspects play a role. Important parts of such a high-tech cluster are (Van de Ven 1993; Elfring, 1999; Kenney, 2000; Lee et al., 2000):

- universities and the R&D departments of large companies (for the churning out of scientific research findings and knowledge which can be applied commercially);
- a pool of of competent human resources (highly trained entrepreneurs and professionals);
- a sophisticated supporting infrastructure (e.g. a variety of financing mechanisms, incubators and investors);
- network dynamics (e.g. the reclycing of ideas, firms, moneys and human capital: technology transfer, job hopping, subcontracting, spinning out & spinning in).

University and research laboratories

If a region wishes to profile itself as a high-tech region, there has to be attention for a specific technology. An important element in the development of successful clusters is, therefore, the presence of knowledge institutions that are part of the national and international elite. Starting entrepreneurs are usually educated at universities that play an important role in prominent fundamental and applied research. Academic entrepreneurs appropriate basic knowledge from the public domain and transform it into proprietary knowledge through applied R&D work in areas related to a technological innovation (Van de Ven 1993; Roberts 1991). Also important is the role that is played by central core companies that appropriate, propagate and use technological innovations (e.g. new products, prototypes, applications etc.). Large vertically integrated companies, however, do not always succeed in accurately assessing and marketing their technological advantage, examples of which are Xerox and Philips (Hiltzik 2000; Metze 1991). Although these companies can take credit for a large number of innovations (for example, the computer mouse, graphic interface, VCR-technology, CD-I technology, HDTV), they have not been able to translate them into market success. Young companies, on the other hand, are more capable of playing an innovative and catalysing role within ICT-clusters.

Highly trained professionals

In Silicon Valley, Stanford is one of the leading universities attracting studens from the United States and the rest of the world. Stanford, UC Berkeley and the other universities in the region produce a continuous flow of highly educated professionals in various fields. Some of the graduates start their own companies, but the majority finds a job at one of the many companies in the region. The influx of new talent is important, as newcomers will bring with them unorthodox views and other contacts. The international background of many students increases the diversity and opens up new networks in unexpected ways. Asian students, for example, established renewed contacts with the low wage countries in Asia when they started working in the high-tech companies in Silicon Valley. This process has partly resulted in a brainflow towards Silicon Valley, but is has also started inverse processes. Not only does knowledge find its way back to South-east Asia, but there is also a growing stream of venture capital from Asian entrepreneurs that are successful in Silicon Valley, available for native starters in places like Bangalore Plateau (India), Singapore and Taiwan.

A sophisticated supporting infrastructure

ICT-starters do not operate in a vacuum. The economic activities of technological companies are embedded in socio-economic networks and in more or less formal structures (Grabher 1993). Successful start-ups usually participate in more or less decentralised production networks, within which lasting and mutual transactions take place between specialised and complementary companies. These decentralised production networks can also be found in Silicon Valley (e.g. Apple and Cisco). Within the (emerging) ICT-cluster, venture capitalists play an important role. In the early stages, new companies are usually financed in a haphazard and opportunistic way. Depending on their need for capital, starting entrepreneurs usually bring in their own savings and house(s) (i.e. mortgages), funds provided by friends and relatives and/or a loan from the bank. The need for capital in the ICT-sector is enormous, especially due to the high costs involved in writing software, acquiring advanced machinery and organising content. A starting company will usually not be able to survive and it will have to look for additional investments, for example from informal investors and venture capitalists. Whereas informal investors tend to invest in starting companies (the bambi's), venture capitalists favour fast-growing companies (the gazelles) on their way to maturity. In a possible floatation phase or private sale enterprising pioneers and investors step back to make place for new management and other stockholders. In addition to capital, their input consists of technology and market expertise, experience with the management of starting technology companies and participation in a larger partner-network. Venture capitalists are network brokers *par excellence* (Gupta, 2000): they provide the missing links in the early growth of starting companies. By establishing new contacts with customers, distributors and new management they provide the young and vulnerable company with a broader techno-economic foundation and thus increase its social legitimacy.

The Dutch Ministry of Economic Affairs has set up a web of start-up ICT companies grouped around distinct market opportunities and with close ties to the academic world. The strategic goal of this so-called Twinning project was to stimulate new ICT companies in the Netherlands and stimulate domestic venture capital industry in general, and attack the 'funding and marketing gap' as experienced by starters and initial growth companies (Booz-Allen & Hamilton, 1998). The leading concept is 'twinning', referring to the promotion of collaboration between incubators and linking Dutch ICT companies to American - often

Silicon Valley-based- firms to support joint research & development, production and trade. The Twinning Framework is based on the following elements: Twinning Centres offering coaching, accommodation and financing (i.e. Amsterdam, Dommel Valley Eindhoven and Twente Enschede have recently been appointed because of science parks and large ICT companies in their region), the Twinning Start Fund (government-sponsored seed/start-up fund for ICT entrepreneurs), and Twinning Growth Fund (a government-sponsored co-investment fund allowing for equity financing). Roughly similar to the Dutch plans for setting up Twinning Centers to promote the development and exploitation of ICT are the initiatives of the Flemish government to establish science/technology parks in Louvain, (Flanders Digital Signal Processing (DSP) Valley), Ghent (Flanders Biotechnology Valley) and elsewhere (Van den Brande, 1995). The pivot in the first Louvain-based venture is IMEC, a leading inter-university R&D centre in the field of semiconductor technology, and in the second Ghent-based platform, the Flanders Interuniversity Biotechnology Platform (VIB) acts as a spider in the web of biotechnology research and an incubator of start-ups.

Network dynamics

Together, all the wheeling and dealing of venture capitalists, the continuous creation of start-ups and the high level of workforce mobility, produce a rich network containing a large and varied number of actors. Within that network there is a process at work of increasing returns, a continuous growth of capital, information, creativity and entrepreneurial talent that is available for reinvestment (Krugman 1991; Arthur 1994; Shapiro & Varian 1999). Important parts of the process are talent recruitment, workforce mobility and spin-off creation. The floatation of Lernout & Hauspie (L&H) and the FLV Fund meant that successful entrepreneurship and popular capitalism in the Flemish Westhoek (the triangle Kortrijk-Lille-Bruges) was rewarded and that, in addition, the proceeds are being reinvested in the region (e.g. expansion of the technology park and participation in young local companies).

New technologies and (nascent) entrepreneurs meet when employees (alone or with others) leave a large company or university to start their own company. This kind of spin-offs usually is about further developing and marketing new technologies, for which the organisation they have left gave them insufficient room. The large majority of starters in Silicon Valley are spin-offs, and that process feeds and rejuvenates the high-tech cluster. *Social capital* plays an important role in dynamic processes such as the realisation of high-tech entrepreneurship

through spin-offs. Social capital refers to the complex of local institutions, relations based on trust and information flows between economic actors in a region that are based on the historically determined culture (Cohen & Fields 1999). The horizontal networks between individuals, companies, collective organisations and institutions within and between which information is exchanged and resources shared, and the trust on which the relationships are based, are a regions social capital. An example of such a successful integrative platform in a dynamic environment is *Joint Venture: Silicon Valley Network* (www.jointventure.org).

AN EVALUATION OF ICT-CLUSTERS IN THE LOW COUNTRIES

The extent to which Dutch and Flemish ICT-clusters will be able to emulate the success of Silicon Valley and other regions can be assessed on the basis of the above-mentioned criteria. If we use these criteria to arrive at a preliminary qualitative assessment with regards to a number of existing local ICT-establishements and recent initiatives in the Low Countries, five regions stand out (Bouwman & Hulsink 2000b):

- Amsterdam Alley, running from Hoofddorp, through the centre of Amsterdam, via the science and technology park Watergraafsmeer, to Hilversum, and containing a large variety of multimedia companies;
- Dommel Valley Eindhoven, home of powerhouse Philips and a small number of spin-offs (e.g. ASML, Simac), that have by now achieved international success as well;
- Twente, a rising, but vulnerable ICT-region, characterised by an entrepreneurial university, a number of large public research establishments institutions and company R&D centres, heavily subsidised by local/regional, national and European governments;
- the Louvain Technology Corridor, in which a central role is played by the Interuniversity Centre for Micro Electronics (IMEC) and an entrepreneurial university (Catholic University of Louvain: KU Leuven);
- Flanders Language Valley (FLV) Ypres: also a prominent cluster (both for positive and negative reasons), around the speech and language technology company of L&H in Western Flanders (Ypres, Belgium).

Although those five regions are well-known and established in the Low Countries, but internationally, they lack a reputation and a track record. Certain elements of those ICT clusters are unique and worth investigating, such as Dommel Valley Eindhoven, being the

home base of Philips Electronics and its R&D centres, Amsterdam as pan-European Internethub and an international multimedia & publishing stronghold, and Leuven/Louvain as the Flemish equivalent to Cambridge UK. The other two, Twente Enschede and Flanders language Valley Ypres, are specialised either in a regional sense (the East of the Netherlands) and in a technological sense (namely speech and language technology). Besides in terms of familiarity, the five regions also differ in terms of their geographical, technological and functional built-up and in their growth dynamics. The Amsterdam region is a relatively large, multi-technological and diverse agglomeration and Dommel Valley Eindhoven is a medium-sized cluster with a clear focus on ICT, electronics and software and a dedicated support framework. Louvain and Twente Enschede could be described as dynamic and compact mini-clusters, where spin-off processes, innovation and growth take place, but at a smaller scale and at a slower pace. The FLV Ypres cluster, specialised on speech and language technology and built around the local high-flyer from the region, Lernout & Hauspie (L&H), with its R&D partners, software developers, distributors and other business partners on the corporate campus. With the downfall of L&H and the crisis in the ICT and speech & language sectors, the FLV technology park was hit hard and spatial concentration became replaced by co-location, closures and divestments.

The data of our five case studies were collected on the basis of desk research (government reports, policy papers, etc.), statistics and databases from the national and functional statistical offices (CBS, NIS, RSZ) and trade associations (e.g. Agoria). Also interviews with a small group of stakeholders, normally including representatives from a flagship companies and smaller more specialised firms, local government officials, and spokespeople of knowledge centres and chambers of commerce, provided valuable information.

Table 1: Key data	**Amsterdam region**	**Eindhoven region**	**Enschede region**	**Louvain region**	**Ypres region**
Population	1.200.000	500.000	300.000	100.000	50.000
Number of ICT firms (CBS, NIS, SZ)	6.000	1.100	750	150	40

Amsterdam Alley

The Amsterdam-based ICT-cluster is characterised by the unique combination of elements that can be found in Silicon Valley and New York's Silicon Alley. Like Silicon Valley,

Amsterdam Alley is technology-oriented. This holds true both for the knowledge infrastructure, which is centred around the government-funded Centre for Mathematics and Information (CWI) and the National Institute for Nuclear Physics and High Energy Physics (NIKHEF). Both institutes, together with the city's two universities' computer centre SARA, have been involved almost from the outset in the developments concerning the Internet. It is hardly surprising, then, that the link-up to the Internet's backbone (the Amsterdam Internet eXchange or AMSIX) is located on the premises of SARA and NIKHEF (physically speaking there are two collocation points). In due course a third collocation point will be opened. The two research centres CWI and NIKHEF have their premises at the Amsterdam Science Park (Watergraafsmeer); another relevant organisation located at the Science Park is the aforementioned Twinning, an incubator that is partly funded by the national government. Around 100 start-ups have already used the services of the Science Park.

An important spin-off of CWI-NIKHEF was NLnet, the first commercial Internet Service Provider (ISP) that started in the early 1980s. By now, NLnet has become a part of MCI/Worldcom. In the early 1990s other ISPs like XS4ALL (set up by hackers) and Planet Internet (set up by graduates from the University of Amsterdam) followed in its footsteps. Since the liberalisation of the telecommunications market a number of large (among others MCI WorlCom, Telfort/BT, Equant) and small (among others Versatel, Colt Telecom, UPC) have opted in favour of locating themselves in the vicinity of the financial district and the media and advertising cluster in and near Amsterdam. The telecommunications companies in turn attract other players. In 1999, Cisco has chosen Amsterdam for establishing its European headquarters because it wanted to be near one of its largest customers, namely WorldCom (apparently the former number one Internet company was also lured to Amsterdam by an attractive fiscal package). Less than two years later, the situation is completely different for the two companies. Cisco is using less than a third of its office premises; instead of preparing space for 5000 employees, Cisco still has less than 1500 workers in Amsterdam. As a consequence of the ICT-crisis of 2001 and after, also Worldcom had to scale back its growth activities.

Amsterdam has also several things in common with the multimedia and software cluster in downtown Manhattan, New York. In addition to the telecommunications infrastructure, Amsterdam and its immediate environment houses such companies as Adobe, Nortel, PeopleSoft, and @Home. According to the Amsterdam Chamber of Commerce, the total

number of companies in the ICT-cluster in 1999 was 3705. At the more creative end, especially projects like the Digital City and activities surrounding the community centres De Balie (culture & theatre) and De Waag, where the Society for New and Old Media is located, have contributed to the familiarity and acceptance of the Internet in the early 1990s. All kinds of activities in the fields of culture and advertising have contributed to the creation of a whole new industry in Amsterdam: the multimedia sector. The presence of the Amsterdam New Media Association (www.anma.org), bringing together parties that are active in the area of new media and ICT in the Amsterdam region, stimulates the formation of a network of companies.

The sector is still young, and it is as yet hard to say anything about the number of companies, the number of employees or turnover statistics. There are indications, based on research conducted in 1998, that around 1,300 companies are in some way active in the field of multimedia content production and distribution. The majority of the companies is also active in other areas. The number of 'pure' multimedia companies is limited. Turnover figures indicate that the Amsterdam multimedia sector has a large number of small companies. Just over a quarter of the companies has a turnover (both from multimedia and other activities) of less than 70.000 Euro. The business model of these companies can be compared to the one used by dot.com companies in Silicon Valley. Larger companies are predominantly concerned with content and publishing. To provide an indication of the total multimedia turnover with regard to multimedia products and services, we have multiplied the average turnover by the number of companies in the multimedia sector. The result is a total turnover of over 450 mEuro. Almost 40% of that turnover is realised in the content phase, one sixth in the publishing phase, one seventh in the distribution phase and over one tenth in the phase of user support. The remainder is related to research and consultancy.

Dommel Valley

The medium-sized city of Eindhoven likes to call itself *the* Technopolis of the Netherlands. The reason for this is the presence of many international companies (Philips, ASML, Océ, DAF and NedCar), the high level of education among the professional population and the presence of knowledge institutions like the Technical University of Eindhoven, Fontys Polytechnics, Philips NatLabs, Microcentrum Nederland, TNO Industries, The design Academy and the European Design Centre. It is the region with the highest technological

potential where a great deal of attention is paid to product innovation. Of the total national budget for R&D, 50% is said to go to this region (www.rede.nl). In international terms the region is very significant as well. The electro-technical industry is strongly represented in Dommel Vally Eindhoven and the surrounding area: it is the (*de facto)* home base of global market leaders Philips and ASML. High-tech companies are also strongly respresented: 25% of the regions companies fall within this category, compared to a national average of 12%.

If we see Dommel Valley Eindhoven as an ICT-cluster, we must recognise that Dommel Valley Eindhoven is dominated by a few large vertically integrated organisations. These organisations are inter-related. ASML Lithography and Simac have been churned out by Philips. Apart from these three companies, Philips hardly produces any spin-offs at all. Philips is especially internally oriented and, as a consequence, its knowledge/technology transfer programme is limited: research activities and business development are concentrated on the Philips high-tech campus or carried out within the company and its many divisions. In Dommel Valley Eindhoven, there are a few interesting multimedia companies such as Calibre, active in the field of interactive visualisation and simulation, Ilse, the Dutch search engine, currently owned by Amsterdam-based publisher VNU, and Turpin Vision and Codim. The latter two are active in the area of digital animation production for CD-ROM and the Internet. In all, some 1,200 companies are said to be active in the ICT domain. The majority of these companies, however, has a traditional profile and has emerged from the automation, graphic or marketing communication sectors. There is hardly a dynamic to speak of that has to do with starting companies around the Eindhoven-based ICT-cluster. For instance, the Twinning subsidiary, located at the campus of the Technical University, has great difficulties finding companies that are interested.

The question is what may be expected from Philips' high-tech campus, centred around its famous NatLabs, as a catalyst for the local economy. At first sight, it seems to be first and foremost an impulse for the internal R&D-activities of Philips itself. Cooperation with the Technical University of Eindhoven, the concentration of the number of employees and the influx of (international) talent means that one of the conditions for the creation of a successful cluster is apparently met. However, the other two aspects, a supporting infrastructure and network dynamics, are less evident. There is no highly developed network in which start-ups can participate. Existing networks are being dominated too much by the region's key player Philips. Although there are investors and investment companies active in the region, and both

the local investment company NV Rede and the incubator Twinning have a venture capital fund, these opportunities are hardly used by starting companies.

Twente Enschede

Twente's ICT-cluster can be especially characterised as an R&D-cluster. The number of companies and public organisations for which ICT is an important part of business is around 200. In 1997, around 6,000 people were employed in Twente's ICT-sector (including the knowledge institutions). Around 40% of these are working at a limited number of institutions, namely at (parts of) Signaal, Ericsson and knowledge institutions (Twente Polytechnic, the Telematics Institute, a public-private partnership between government, universities and businesses, and the University of Twente). The ICT value chain is fairly balanced. It contains network owners (for example, the national telecom operator KPN and the regional cable company CasTel), hardware manufacturers (for example Fluke Industrial BV) developers of telecommunications equipment (for example Ericsson and De Haar Telecom) and software producers (for example V&L, Matrix and Origin). Many small ICT-companies that have emerged from the knowledge infrastructure, are growing very rapidly. The role played by the knowledge infrastructure is a large one, not only because of the presence of the knowledge institutions mentioned earlier. There is also a large number of companies that have opened an R&D subsidiary in the vicinity of the University of Twente (close to Enschede); examples of this are CMG-Telecommunications, Lucent Technologies, TNO-FEL and KPN-Research. The emphasis, therefore, is on research, design and development. This cluster is rather vulnerable due to cyclical influences when R&D organisations cut in R&D. Actually, during the recent downturn (2002), Ericsson stopped all its R&D activities in Twente.

There is no clearly defined user community in Twente, although organisations like the Foundation Teleport Twente, the Technology Circle Twente and the Twinning Centre (their 3rd subsidiary) do play a modest role. The engines behind developments in the area of ICT are especially the university, the Overijssel Development and Investment company (OOM), the municipality of Enschede and the Province of Overijssel. Some of these parties are involved, for example, in the development of NDIX, the Dutch-German Internet Exchange. Other relevant initiatives are:

- the Temporary Entrepreneur Places scheme, aimed at helping starting entrepreneurs to build their company. 1999, 35 to 40 companies started with the help of this scheme.

Around 40% of the companies was active in the field of ICT. Knowledge diffusion from science to the business community is an important objective.

- the Technological Spearheads project, aimed at attractive high-quality technological companies, a project that fits in with the university's technological spearheads. The companies are being located in the 'Business & Science Park', or in the immediate vicinity of the university. One of the spearheads is telematics (next to laser technology, biomedical technology and microsystems technology).
- the *Palo Alto project* is aimed at matching companies from Twente with companies from Palo Alto (Twente's Californian twin town) to exchange knowledge and technologies and to do business (e.g. thanks to this project cooperation takes place between the Twente-based OVSoftware and the American Hansen Information Technologies).

Although there is a wide variety of activities to stimulate ICT in Twente, there is no coherent vision to connect the various initiatives. It is true that a large number of parties are taking part, but there is hardly any cooperation between them. Furthermore, the availability of venture capital and experienced (general) managers is also a bottleneck for the Twente Enschede region. The main focus is still on R&D what makes the region vulnerable to economic turbulences.

Louvain Technology Corridor

The pivot in the Louvain innovation network is the Catholic University of Louvain (KU Leuven) and IMEC, the Interuniversity Centre of Micro-Electronics linked to the university. In addition to being an internationally renowned knowledge centre, KU Leuven has also become known for its active policy with regards to academic entrepreneurship and the transfer of knowledge. Tangible examples of this are the creation and exploitation of a large science park, several innovation and incubation centres and a subsidiary for licensing and contract research. The Louvain region is a furtile breeding ground for young and innovative companies: in the course of time KU Leuven has produced nearly 40 spin-offs, a number of which have entered the stock-market (for example ICOS Vision Systems, LMS International, Netvision/Ubizen), and all of which are located on campus. In the commercialisation of knowledge through spin-offs and important role is played by two venture capital funds that KU Leuven has established with, among others, private financial investors Fortis Bank, GIMV and KBC: the ICT venture fund IT-Partners and the generic Gemma Frisius Fund.

Finally, also active within this techno-academic region is the L.Inc platform (Louvain Innovation Networking Circle), which aims at building a bridge between innovative entrepreneurs, consultants, financiers and various intermediary organisations (e.g. accountancy & consultancy firms) in Flemish Brabant. Apart from KU Leuven and IMEC, there are a number of commercial parties, the City of Louvain, the regional Chamber of Commerce and the local utilities company that are involved in expanding the L.Inc project.

Since its foundation in 1984, IMEC has built its own impressive technology portfolio and, in addition, has attracted a close group of leading research organisations and international contract partners in the field of micro-electronics. In 1999, IMEC's total budget was 80 mEuro (a third of which was provided by the Flemish government), with contract research reaching 40 mEuro. In close cooperation with large ICT-companies and organisations such as Philips, Alcatel, Agfa, ASML and Sematech, IMEC has established a variety of specific research and training programmes. The presence of these multinational companies has to compensate for the lack of a local core company. The other conditions for a successful high-tech cluster have been met reasonably well. KU Leuven, the intellectual powerhouse with its large educational variety, produces highly trained people; as a consequence the supporting network can be characterised as adequate. A significant contribution to the necessary network dynamics has been made by the creation of the Digital Signal Processing Valley (DSP) in 1994. DSP was established by IMEC and a number of its partners and spin-offs to create a catalyst for the use of digital signal processing technology in new applications, and the creation of a new generation of start-ups. In addition to creating spin-offs (some 20 companies that are still in business), IMEC's activities are aimed at attracting foreign expertise and investments in the field of micro-electronics in the Louvain region. Since it was founded, DSP Valley has grown considerably: the number of participating companies has risen enormously and the number of DSP experts in the region went up from 350 in 1994 to around 1200 in 2000.

Flanders Language Valley Ypres

In November 1999, the technology park of the *Flanders Language Valley* (FLV) was officially opened. This centre, situated in a rural environment near Ypres in the Western Corner of Belgium, was established to attract and combine knowledge, talent and investment in the field of speech and language technology. The FLV campus, designed in the shape of a

human ear (the symbol for communication), houses and education centre, auditoriums, offices and laboratories for starting and established companies and a service zone with, among other things, supporting knowledge institutions (of local universities and polytechnics) and a large number of service companies (among other things, a bank, an employment agency, restaurant and a child day-care centre). At the centre of this extensive network is one of the world's leading companies in the field of speech and language technology, L&H Speech Products. This company, originally founded by two entrepreneurs from the Western Corner of Flanders, Jo Lernout and Pol Hauspie, experienced a difficult pioneering phase between 1987 and 1994, but has grown into a 'high-tech flyer' listed at the New York (NASDAQ) and Brussels (EASDAQ) stock exchange. At the end of 2000, the company employed around 5000 people and had offices in a number of European and Asian countries as well as the USA. L&H, with a market capitalisation of around $2 billion, in 1998 realised a turnover of $ 212 million, at a profit of $38 million. L&H develops a range of products for speech and language technology in several languages and for all types of processor. Their products include automatic translation devices, dictation systems, various speech control applications, advanced applications for browsing the Internet and software designed to compress speech. L&H is one of the few long-term success-stories in the European ICT-industry. Since 1994, the company has continually doubled its yearly turnover (after a spate of aggressive acquisitions), and it is in business with both Microsoft and Intel (both companies hold minority stakes in L&H).

L&H is strongly rooted in its region of birth, and its headquarters and extensive R&D-activities are located there. In addition, L&H is the core company of the Flanders Language Valley (FLV), where at the end of 1999 nearly 20 specialised suppliers, distributors and customers of L&H's technologies, have established themselves. A number of other partners have promised to move into the FLV business park in the foreseeable future. An important role in attracting investments to the technology park and promoting local knowledge transfer and technological dynamics is played by the FLV Fund, which specialises in investments in speech and language technologies. In addition to the presences of L&H as a technology developer, the expected synergy between L&H and its business partners in the development of new applications and the availability of business support and incubation services (as provided by the FLV Foundation), this FLV Fund, as the provider of venture capital, is the fourth leg of the regional innovation system of speech and language technology. In addtion to all this, Jo Lernout and Pol Hauspie then became actively involved in the exportation of the FLV concept. In November 1999, it was anounced that an international network of nine

centres of excellence would be constructed around Flanders Language Valley (by now renamed SAIL Port Flanders), designed to stimulate worldwide technologies in the field of *Speech, Artificial Intelligence & Language* (SAIL) technologies.

Until recently the pride of 'High-tech Flanders', L&H has recently become the 'paria' of the international stock markets.[3] The two entrepreneurs from Western Flanders have succeeded in building a local clusters of partner companies and knowledge institutions around the company in Ypres. In addition, the company was in the process of building an international network of local clusters. However, recent problems with foreign investors since the Fall of 2000 are extremely unwelcome. It is not unthinkable that (parts of) L&H will be taken over by large international competitors such as IBM, Oracle or Philips, or that its non-exclusive partner Microsoft will take the company under its wings (or even worse, that the company will go bust). If that should happen it remains to be seen whether the intended campus around L&H and the industrial area attached to it will ever be completely filled. Partly as a result of imploded stock prices, commitment among L&H's employees will decrease (share options have lost their value already) and people will start to vote with their feet (thus rendering the company's recovery process *de facto* impossible). The high-tech flyer from the Low Countries was expecting to be for a rough ride, but now founds itself in a case of emergence, preparing for a rough landing.

COMPARISON AND CONCLUSION

We have briefly described a model with which we can describe and evaluate the dynamics of ICT-cluster formation. Based on the principle elements from that model we have assessed five clusters, namely Amsterdam Alley, Dommel Valley Eindhoven, Twente Enschede, the Louvain Technology Corridor, and Flanders Language Valley. In our view, Dommel Valley Eindhoven, Louvain and Amsterdam have a better starting position than Twente and Flanders

[3] Between August and October 2000, the L&H came under attack from business journalists (especially the Wall Street Journal Europe!), quickly followed by auditors, and institutional investors and other shareholders about allegedly creative bookkeeping. After a thorough investigation by the SEC/NASDAQ, EASDAQ and an internal audit by KPMG in November, the company admitted severe accounting irregularities and is now facing threats of litigation from disgruntled shareholders. After a boardroom shuffle and a profits warning, together with the pending investigations, the future of the once leading and independent provider of voice and language technology is looking bleak with the company facing a bankruptcy. As a consequence of L&H's being the only catalyst for the region, the company's strategic partners, the FLV Fund and Flanders Language Valley, are also in crisis.

Language Valley. The lack of large dynamic domestic companies that can serve as a region's catalyst (Twente), and the dependence on Lernout & Hauspie, a company that has recently made less than favourable headlines (e.g. accounting irregularities, threat of litigation from disgruntled shareholders, a dramatic corporate restructuring facing bankruptcy) together with the lack of a central knowledge institution (Flanders Language Valley), give us reasons to believe these regions face a less certain future than the other three, i.e. Dommel Valley Eindhoven, Louvain and Amsterdam.

Table 2: Evaluation of High tech-clusters in the Netherlands and Flanders

	Amsterdam Alley	**Dommel Valley Eindhoven**	**Twente Enschede**	**Louvain Technology Corridor**	**Flanders Language Valley**
Core of knowledge: **- universities** **- flagship companies**	sufficient/good (universities), many start-ups, foreign subsidiaries	good: Philips NatLab & TU Eindhoven	sufficient/good: Uni Twente, public/private R&D Labs	Sufficient: KU Leuven, no core company few foreign companies	good but very specialised (L&H, no university)
Pool of Professionals	high variety of professionals	some variety (no life sciences)	skewed towards engineers, few marketing & sales people	high variety (all disciplines available)	skewed: medium- level locally available, high-level recruited elsewhere
Support infrastructure	sufficient: several incubators, science park, little venture capital, presence of leading users	limited: little venture capital available	Moderate incubators, science park, no venture capital, dependence on subsidies	solid: fully developed & thick network	targeted towards one company & one technology
Network dynamics	good (mixture of indigenous forces & foreign inputs	limited (no spin-offs & foreign investments)	confined to regional dynamics	good (spin-offs + foreign establishments)	volatile & vulnerable to success & failure

On the basis of an initial qualitative assessment (see table 2) we have to conclude that the (further) growth potential of Twente is as yet unclear. Twente is a developing region where R&D and innovation play an important role, above all stimulated by a promising knowledge infrastructure (a number of large technology institutes and companies' research laboratories), but which is presently handicapped by its peripheral location and a conservative local culture. The lack of a number of important core companies and key venture capital firms that could serve as a catalyst to the region, are also notably absent.

Dommel Valley Eindhoven and Amsterdam would appear to have better chances of becoming successful high-tech clusters. Dommel Valley Eindhoven is dominated by one large and vertically integrated company (Philips), which may have at its disposal high-quality expertise, but which does not sufficiently market its technology. In addition, regional-economic dynamics are limited, and there is relatively little outsourcing taking place within the ICT-domain, there is little cooperation with suppliers, and the number of spin-offs from the mother company is low. The spin-offs that do take place are very successful. Based on our initial assessment we must conclude that Amsterdam has a good chance of becoming a successful high-tech cluster, especially thanks to the strong emphasis on innovation (both in terms of technology and services), the presence of (highly) educated professionals, an advanced supporting infrastructure and the presence of large foreign ICT-players in the region. With the exception of venture capital, which has hardly found its way to Amsterdam and the availability of successful entrepreneurs that can serve as role models and informal investors to the new generation, Amsterdam Alley faces an optimistic future.

Two years ago, the two high-tech clusters in Flanders had great potential to develop into international specialised technology regions. After the collapse of L&H and the Flanders Language Fund, the momentum of the Flanders Language Valley has subsided, leaving a question mark over the future of the core company of L&H, the local speech and language technology-cluster and the dynamic Flemish Western Corner region. The evolution of the core company L&H in the Flanders Language Valley offers a perfect illustration of the law of increasing returns: while the company in its successful growth and expansion period benefited from a 'virtuous circle' (*success breeds its own success*), in its current crisis the company seems to be faced with a 'vicious circle' (*if things go wrong they really go wrong*). For the region as such the slimming down of L&H does not necessarily have to be a bad thing: the failure of Shockley and Fairchild in the 1950s and 1960s helped create a new generation of core companies in Silicon Valley (a.o. Intel and National Semiconductor). For the Flemish region it might even turn out to be a blessing in disguise, if former L&H employees move to smaller local partner companies or even start their own companies. This way, the region would be less dependent on a single large company. The Louvain Technology Corridor has a number of interesting elements that make the region 'promising': an innovative university, that is not only part of the European knowledge elite in a number of areas, but that also actively promotes entrepreneurship and the transfer of knowledge. However, the Louvain Technology Corridor lacks a certain balance. Whereas IMEC, with its international and local

research partners, has developed a successful mini-cluster around microchip technology (i.e. DSP Valley), specialised around other technologies are as yet insufficiently developed.

If we look at the lessons learned from the case studies on those clusters than a couple of things stand out: the extreme vulnerability of an emerging technologically specialised cluster, being too dependent on one leading company and on the business cycles in the larger industy. As the cases of the mini-clusters of Louvain and Twente Enschede illustrate, small scale is not a disadvantage provided if there is an active and dynamic university and associated R&D centres supporting academic entrepreneurship, local knowledge transfer and regional development. Amsterdam Alley, and to a certain extent Dommel Valley Eindhoven, indicate the importance of Jacobs & Glaeser's argument (discussed in the beginning of this chapter) that local competition and techno-industrial variety matter (more than technological specialisation). The diversified city region of Amsterdam and the diversified power house of Philips provide ample opportunities of intra- and inter-industry learning, cross-fertilisation and all kind of spillover and network effects. These diversified regional systems with a broad portfolio of (potential) activities) are conducive to innovation and growth in a positive scenario, or, in the case of a negative scenario, may act as slack and easily provide alternatives. Furthermore, there appears to be a gap between the technological potential and the realization of that potential. The key building blocks of a cluster are a necessary condition, but not sufficient to realize its potential. Particular networking characteristics and capabilities need to be present to get the interactions between the building blocks going. These virtuous circles seem to be based on entrepreneurial exploration, which is facilitated by brokers and networks with structural holes. These variation creating mechanisms within a cluster with strong building blocks appears to be crucial in living up to its potential.

An interesting new combination could be the transborder cluster of Louvain and Dommel Valley Eindhoven. These two regions, that are already connected with regards the area of micro-electronics and digital signal processing technology through Philips, ASML and IMEC, offer a greater potential for synergy (among other things, a favourable business climate for starters and a leading core company that can serve as incubator and as leading edge customer). It would, therefore, be interesting to map further the current state of affairs with regards to the interwovenness between Eindhoven and Louvain and to analyse the synergetic potential that exists between the Netherlands and Flemish Brabant. Together, these two regions have the potential to evolve into a transborder and internationally successful cluster.

Will the Low Countries, with the relative success of Amsterdam and the potential of Eindhoven and Louvain, see the dawning of another Golden Age?

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