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# Creating Environments for Working in a Knowledge Economy: Promoting Knowledge Diffusion through Area Based Development

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## 1. Introduction

The increasing knowledge intensity of the economy leads to changing demands for environments for working (VROM-counsel 2006). In many cities, we observe initiatives to create “knowledge intensive zones”, in a variety of disguises. Typically, the underlying philosophy is that co-location of knowledge intensive business and knowledge institutes will yield added value thanks to knowledge spill-overs, and may create effects for the urban economy as a whole.

In this paper we assume that co-location has certain advantages in terms of knowledge exchange, and explore the development of territorial concepts aimed at knowledge diffusion, focusing on the question how co-location at “knowledge parks” can be effectively organised. We are aware of reasonable doubts to added value of science parks as such. A comparative study into performances of firms “on” and “off” science parks for example shows, that returns to being located on a science park turn out to be negligible (Siegel et al. 2003). We conclude that there are reasons to believe that especially the quality of park concepts and measures for knowledge management (which are not taken into account in the former example) can make a difference in the performance of contemporary knowledge parks.

This paper contains a conceptual and an empirical part. The conceptual part of the paper reviews the literature on knowledge diffusion and the role of proximity in knowledge transfer. We present recent insights into the dynamics of pre-competitive networking, open innovation concepts and other interfirm co-operations. Based on this literature overview, we present a framework of analysis that helps to analyse knowledge transfer instruments in working environments in a knowledge economy. In the empirical part of the paper, we apply the framework to three major but very different “high-tech” park developments in the Netherlands: the High tech Campus in Eindhoven (in the south-east of the Netherlands), Knowledge Park Twente in Enschede (in the east) and Technopolis Innovation Park in Delft (in the west). Based on the conceptual and empirical part we derive conclusions upon the development of environments for working in a knowledge economy and suggest an agenda for further research.

## 2. Theoretical Key Notions on the Knowledge Economy.

In the late 50’s, the term “knowledge economy” was first used by Peter Drucker (Micklethwait and Wooldridge 1997). Nowadays, it’s an often used concept. Dahlman and Andersson (2000) define the knowledge economy as “one that encourages its organizations and people to acquire, create, disseminate and use (codified and tacit) knowledge more effectively for greater economic and social development”. Florida stresses the changed role of “human capital” in the knowledge economy. He argues that knowledge has replaced natural resources and physical labour as the main source of prosperity and economic growth, and hence, talent has become the key factor of production (Florida 2000, 2002). Although this “theory of human capital” by Richard Florida is praised as well as discarded in literature and the public debate (Glaeser 2004; Malanga 2005; Nathan 2005; Weterings and Stam 2006), it has a big influence in current (political) choices on urban development.

Many contributions on the emerging knowledge economy explore the process of knowledge creation, dissemination and valorisation. In business studies, there has been a surge of interest into knowledge management. Initially, during much of the 1990s, the focus was on managing knowledge production, diffusion and valorisation within larger organisations. Recently there is a shift towards “open innovation” approaches, referring to strategic co-operation between organisations. This reflects the transition towards a network economy in which firms need to tap from various knowledge sources in order to remain competitive. The concept of open innovation is based on the experience that the outside world always knows more and is smarter than an individual or a single company or unit. Innovative capacity hence critically

depends on the ability to recombine a firm's competence with knowledge and competences of others (Chesbrough 2003). This has a fundamental influence on the strategy of a company, since it means that there's no direct control over the knowledge development. Organisations have to learn how ideas and knowledge of others can be uncovered and gathered (Kennisalliantie 2006).

Innovation, knowledge creation and learning occur in interactive processes, in which actors possess different types of knowledge. In these processes, several competences come together to exchange information with the purpose of solving certain (technical, organisational, commercial or intellectual) problems (Bathelt et al. 2004). In the literature on the knowledge economy, we find a distinction between different types of knowledge and information. Important for our purposes is the distinction between codified knowledge and tacit knowledge (Polanyi 1983). Codified knowledge is information which is widely available through information- and communication technologies and other media. Tacit knowledge, on the contrary, "is under the surface of conscious thoughts and is gathered through experience, experiment, perception and learning by doing. It's rooted in personal experience and often filtered through someone's perspective, belief and value system" (Mascitelli 2000). It's hard to grasp and difficult to transmit because it's only shared with consent and co-operation of the individual who possesses it. Summarized, the exchange of tacit knowledge is dependent on (physical) relations and communication between individuals. Especially "face-to-face" contacts turn out to be an important source of (technological) information and in the exchange of tacit knowledge (Castells, 2000; van den Berg et al. 2003).

## 2.1 Knowledge Diffusion

Knowledge production and diffusion mechanisms are generally considered as key factors for economic development on micro, meso and macro levels. Chances of discovery and innovation increase when knowledge diffusion is stimulated (Atzema and Visser 2006). The chances of finding something unexpected, but useable while searching for something completely different increases. In literature this phenomenon is termed "serendipity". In the 2007 edition of dictionary "van Dale" this is described as "the talent to make an unsearched find, based on coincidence and intelligence".

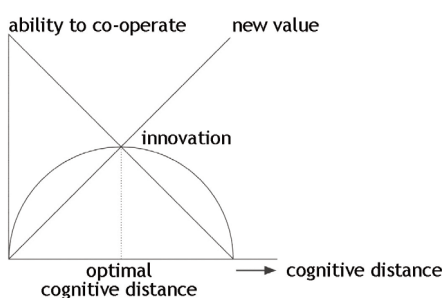


Figure 1, The optimal cognitive distance

Some stress the inherently social nature of knowledge diffusion. Learning and exchange is not an isolated process but always takes place in a social context, and hence the nature of this context affects the learning process. In this vein, Nooteboom argues that knowledge diffusion is restrained by the "cognitive distance" between actors (Nooteboom 2004). To generate unconventional, new ideas and innovations, it helps when co-operating partners are different with respect to the knowledge they have and the way they think. In other words, there should be a certain cognitive distance. However, the distance cannot be too big: people still have to understand each other to collaborate. From this perspective, Nooteboom defines the "optimal cognitive distance" as a mutual distance big enough to create new ideas and small enough not to oppose the capacity to collaborate (Nooteboom 2006).

In a knowledge exchange process between organisations, there is an inherent tension between competition and co-operation. On the one hand, companies may gain if they share or exchange knowledge: it may lead to new ideas or innovations of which both can benefit. On the other, there is a risk that the knowledge partner runs away with valuable new knowledge and appropriates it. In other words: there are relational risks. Managing this tension is a great challenge for knowledge-based firms.

Following March (1991), Nooteboom makes a distinction between exploration networks (aimed at discovering new things) and exploitation networks (aimed to commercialise "dominant designs", and produce or market them on a larger scale). The success of companies depends on their ability to strike the right balance between exploration and exploitation. However, both types of activities require different types of networks. Exploration requires innovative networks between different firms with substantial cognitive distance (Nooteboom, 1992). This will generate new ideas and produce innovation. Exploitation, however, requires a more stable organisational structure, a narrow focus and clear standards. Unit production costs are to be minimized; quality control and logistics are important issues.

Networks for exploration (aimed towards innovation, to discover new products or processes) operate in a context of uncertainty of outcomes. The type of knowledge that is exchanged is tacit, the process is creative. Firms prefer to have many (and frequently changing) knowledge partners: you don't know beforehand what the most useful contact will be. Levels of strategic interaction will be high. Levels of trust are typically high. To limit the relational risk, firms will invest in mutual understanding.

Exploration also often needs disintegration, which enables to create or absorb new elements which don't fit within existing structures. To improve their exploration power, large companies may create small, new organisations or units, or allow ventures in the vicinity which are not caught in existing corporate structures and interests.

In the exploitation stage, conditions are different. Uncertainty is less of an issue (a "dominant design" has emerged); the focus of activity shifts towards cost-efficient production and distribution. This requires the utilisation of scale economies and the search for cheap supply sources. These changing conditions have implications for the network. The number and scope of "ties" in the network can be reduced. Strategic interaction is less needed (specifications are clearly set), and relations shift from developmental to transactional. The increased division of labour leads to more specialisation in the networks, with each tie focussing on specific knowledge within a narrow scope of issues. Control becomes more formal (contracts, monitoring of compliance), and trust is less important.

Managing the relational risk is important in exploration and exploitation networks, but both types require a different approach. During exploration it's about the use of each others competences. During exploitation the governance of differences becomes important (Nooteboom 2004). Generally the focus lies in managing the competences, although the effects of managing relational risks can be far greater. The governance of "co-opetition" is about managing "lock-in" and "spill-overs". Lock-in means building sustainable relationships between organisations by collectively make investments, which creates a certain mutual trust and keep from opportunistic behaviour. Spill-overs occur when knowledge which is created by one actor is used by another actor without compensation, or with compensation less than the value of this knowledge (Jaffe 1996). Or, in other words, if knowledge is exchanged with the intended people or organizations, it is called knowledge transfer (or diffusion), and knowledge that is exchanged outside the intended boundary is spill-over (Fallah and Ibrahim, 2004).

Risks of undesired spill-overs (knowledge which leaks to a competitor) strongly depends on the speed of knowledge development. The risks decline, when knowledge is already outdated within the time period competitors can absorb and imitate it. This for example is the case in some sectors with rapid technological advancement, or in creative industries where fashions change fast. Copying makes little sense in these situations.

## 2.2 Knowledge Diffusion and the Role of Spatial Proximity

So far we have discussed knowledge creation and diffusion without referring to the role of regions, clusters, or working locations. In our paper however, we are particularly interested in the role and significance of spatial proximity as "enabler" (or disabler) of knowledge diffusion processes, in particular between organisations. Ultimately, we aim to explore how to create working locations that are conducive to inter-organisational knowledge exchange.

Does physical proximity enhance the process of knowledge creation and diffusion? To answer this question, different levels may be discerned: the regional/metropolitan level, the cluster level, and the level of a particular business location/park.

### The regional level

Jane Jacobs has made a famous contribution on the importance of urban diversity as driver for innovation. Diverse cities are contributing to unexpected encounters between people, which are a prime source of innovation. Jacobs argues that especially densely built, diverse urban environments (like as New York City, her prime case study) are therefore seedbeds of innovation and renewal, culturally as well as economically (Jacobs 1961). Some decades later, Richard Florida (2002) draws a similar conclusion. He argues that urban diversity and "cultural openness" attracts talented people, who are the prime generators of urban economic wealth. A recent study (van Winden et al. 2007) analyses the success factors of urban regions in the knowledge economy, integrating recent insights from the urban economic literature. They conclude that fruitful knowledge exchange works best when the economic base of the city is well aligned with the knowledge base. In that case, business life and academia can reinforce each other. Also, they stress the importance of accessibility (as facilitator for networks) and quality of life (to attract skilled staff).

### The Cluster Level

The literature on innovative clusters is another rich source of inspiration: it pays ample attention to the process of knowledge creation and diffusion in a localised setting (Baptista and Swann, 1998). The unit of analysis is not the entire city but rather the concentration of similar firms in one area or region. It is recognized that

the co-location of similar firms in one region (the textbook example is Silicon Valley in California) can enhance knowledge diffusion in several ways. A first “transmission mechanism” is the regional labour market. When people change jobs, they take knowledge from the one firm to the other, and hence “good practise” is diffused. Second, regional clusters may be conducive to mutual trust between firms and people. They see and meet each other not only in a professional setting, but share the same social and cultural background, speak the same language, share the same norms and values, and meet each other informally in churches, sports clubs or cultural events. This common background helps knowledge diffusion because it reduces the relational risk, as well as the cognitive distance. Also, a strong common regional culture makes interfirm networks more flexible, as detailed contracts are not needed. Third, in clusters, there may be reputation mechanisms at work that restrain “free rider” behaviour. When one cluster firm “cheats” a partner, his reputation is damaged and he may be expelled by others. Fourth, the co-location of similar firms in one region can promote competition, which gives individual firms an incentive to become more smart and innovative. Somewhat paradoxically, this can give incentives for innovative forms of co-operation (Feldman and Audretsch 1999).

Recent literature suggests that knowledge-intensive companies explicitly and increasingly consider “cluster benefits” in their location decisions. Doz et al. (2001) introduces the notion of “meta-national” companies: these are firms that scan the globe for localised knowledge concentrations (knowledge clusters) and select an environment where they can tap from these sources. Nokia, for instance, prefers to establish its foreign R&D facilities and factories in regions with strong high-tech clusters and technical universities. Porter, in this vein, describes this phenomenon as the contemporary paradox of economic geography: despite that the globalizing economy made organisations more footloose, they more than ever tend to be tied to a location (Porter 2000).

It should be noted that clusters can also hamper innovation, in particular when cluster actors become “inward looking” and neglect signals from the outside world. Grabher (1993) for example describes how the self-contained business elite in the German Ruhr Area failed to notice gradual changes in the world market, with dramatic consequences for the regional coal and steel cluster. Recent Dutch research shows clusters are not necessary to stimulate innovation. Innovation is a process which consists of three spatial scales; “global pipeline”, “local buzz” and “stand alone” (Bathelt et al. 2004). Local buzz refers to the communication derived from face-to-face contacts, co-presence or co-location of people and organisations within a certain branch and place. Co-location within the same economic and social context generates various chances for personal encounter and communication (Bathelt et al. 2004).

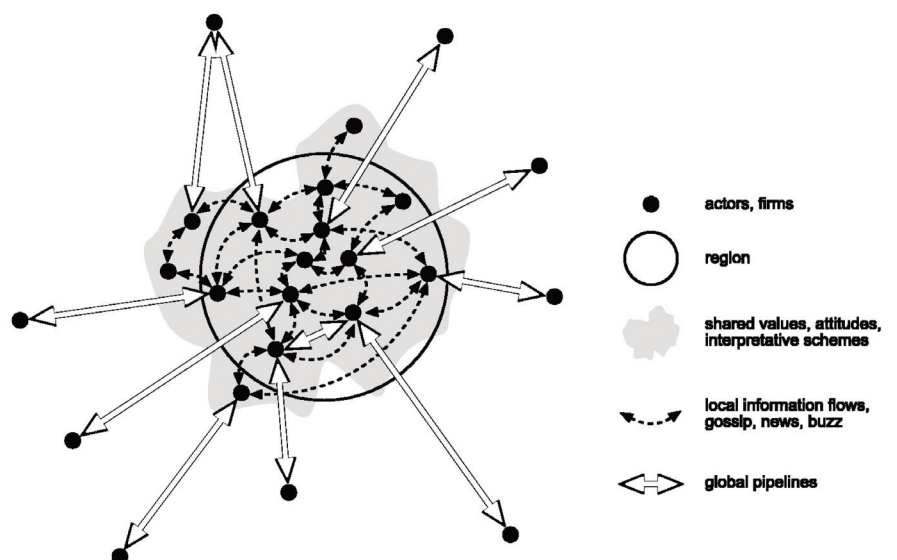


Figure 2, The process of innovation on three spatial scales

The cluster literature teaches us a lot on the mechanisms of innovation and knowledge diffusion in a regional economic context, and thus gives some clues for our central research question. The problem is that we cannot equal a cluster with a territorial business location. Knowledge transfer takes place in clusters, but clusters operate on a regional level. Cluster actors in one region are typically (though not necessarily) spread over several locations, and cluster effects described above do not



critically depend on the co-location of cluster firms on the same premises. Nevertheless, some knowledge-diffusion mechanisms may be very localised, even at the level of a business location. We will elaborate on this in our framework of analysis.

#### The level of the business location

A third strand of literature takes its starting point not at the meso level (region, cluster) but at the level of the individual firm. There are several conceptual studies that focus on the question how the design of offices or business premises affects knowledge diffusion and learning within organisations, and, alternatively, how the shift towards a knowledge based economy could or should be reflected in the design of working environments (Becker and Sims, 2001).

The development towards a knowledge economy and the recognition of the importance of knowledge diffusion has changed ideas about how to design appropriate environments for working. In the development of corporate real estate, there has been a proliferation of non-dedicated workplace (“flex work”) and transparent office concepts (Veldhoen 2005). These are based on the thought that communication (and the diffusion of knowledge) improve when employees perform their tasks flexible and on different locations. More and more organisations already transformed part of their corporate real estate into special places, designed to stimulate serendipity in social-professional encounters. Paradoxically though, some studies show that besides the increasing significance of human interaction in the workplace, there’s also a huge increase of work which needs a high degree of concentration (CABE 2005).

To our knowledge, there are no empirical studies that analyse how the design of business locations affects the innovative performance of a company, or, to what extent it is conducive to knowledge transmission mechanisms. There’s no systematic framework to understand successful connections between the workplace and performance, let alone when the workplace is envisioned beyond the corporate real estate.

### 3. Analysing Knowledge Locations: Towards an Analytical Framework

In the last two decades, we have seen a proliferation of area-based concepts for knowledge-based development: science parks, technology parks, all types of technological “valleys”, open innovation campuses, etc. Some parks focus on one specific branch or technology (i. e. bio science parks), others are more diversified. Some parks are built around a university, others are dominated by firms.

The creation of such parks has a number of well-documented advantages. First, co-location opens opportunities for facility sharing (i. e. the joint use of expensive facilities such as laboratories and cleanrooms), which helps to cut costs, and enables small firms to use state-of-the-art facilities that they otherwise could not afford. Science parks can help to bring university researchers and companies together, with benefits for both sides. Knowledge-based parks are also good locations for incubators: start-up firms have greater chances if they “grow up” in a knowledge-rich environment. And knowledge parks can help to foster the identity of a city as progressive knowledge-based city: they give the local knowledge economy a face and an “address”.

Finally, and here we come closer to our topic, co-location may enhance knowledge diffusion. It can make face-to-face interaction easier, and it may promote unexpected encounters between persons or companies. It is widely recognized, as we have seen in the literature review, that this may have a positive impact on innovation, which – in the end – should lead to a better economic performance. Consequently, in many science parks and other knowledge-based business locations, measures are taken to actively foster knowledge exchange among the tenants.

In our study, we intend to further explore this issue, and focus on the management of knowledge diffusion in these types of locations (i. e. managed multi-tenant locations with a strong knowledge component). In an explorative study, we intend to describe and analyse the “management” of knowledge diffusion in three knowledge parks in The Netherlands. We analyse each case study along three lines. First, for each case, we describe the regional-economic context in which the location is situated, assuming that knowledge diffusion in a park does not work in isolation. We describe the regional-economic context along the lines as provided by van Winden et al. (2007). Based on the literature, they identify a number of “foundations” that underpin the success of the regional knowledge economy: the economic base (sector mix, knowledge intensity of economic activity), knowledge base (quality of R&D institutes, education institutes, and skills of workforce), accessibility, quality of life, scale (needed to support amenities) and social equity. It seems reasonable to assume

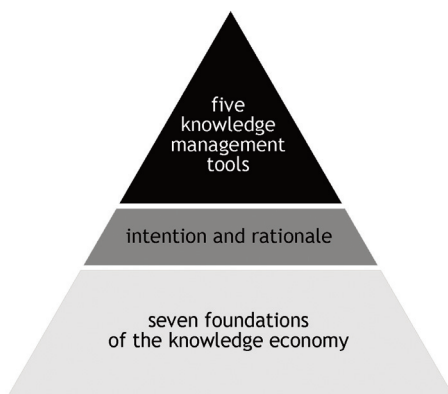


Figure 3. The framework of analysis

hat these seven foundations set the margin for successful locations, and as such they are able to validate the wider urban economic context in which locations are developed. This is relevant for the more specific issue that we address in this paper: how to create environments for working in a knowledge economy?

Second, for each case, we will describe the intention and rationale behind the development of the location: who took the initiative, who is the leading partner, and what is the key idea or purpose of the concept? Some parks/concepts may be driven by “political” objectives, or by the desire to increase the economic spin-offs of universities. Others may be more business-driven, with the ultimate aim to improve corporate innovativeness and profitability. But also, there may be cost or real estate considerations. We assume that the park concept has an impact on the way knowledge diffusion is managed at the location.

Third, for each case, we analyse knowledge management tools that are applied at the park. Based on the literature, we explore the following interrelated aspects:

The optimization of cognitive distance. Assuming that an optimal cognitive distance between park tenants is conducive to effective and fruitful knowledge diffusion, we explore to which extent measures are in place to manage this factor. Is there an admission policy? Does the park focus on one sector or “community of practise”? Are zoning or cluster policies in place to co-locate similar types of business?

The management of co-opetition. To what extent is pre-competitive co-operation and knowledge exchange between knowledge partners promoted? What measures are in place? Is there a policy to link stages in the value chain? And how is dealt with intellectual property.

The organisation of spill-overs. To what extent does the park facilitate the creation of spin-off and spin-out firms from a mother company or university? We assume that, if the “mother and the child” are located at the same spot, knowledge synergies can be expected.

The active promotion of knowledge diffusion. To what extent are policies in place to enhance knowledge sharing and exchange in the park? A way to increase the possibility of innovation, is simply to enhance encounters between people. Examples could be networking events, joint seminars, etc.

The passive promotion of knowledge diffusion. Knowledge exchange can be promoted in a passive way as well. For instance, the availability of common facilities (like cleanrooms or expensive machinery) may enhance contacts among people and firms, and lead to new forms of co-operation and exchange.

## Methodology

We analyse three cases of recently planned Dutch examples of environments for working: the High Tech Campus in Eindhoven, Knowledge Park Twente in Enschede and Technopolis Innovation Park in Delft. The parks are similar in the sense that each focuses on an area based development for high-tech industries. The selected cases also explicitly mention creating value through knowledge diffusion (High Tech Campus) or knowledge valorisation (Knowledge Park Twente, Technopolis Innovation Park) as a main theme for the area based development. But, there are also some clear differences. For example if the primary initiative is private (High Tech Campus), a public-private partnership (Technopolis Innovation Park) or public (Knowledge Park Twente). Also the regional contexts differ widely.

To analyse our cases, we conducted desk and field research. We analysed available policy documents and studies in order to assess the regional context conditions as well as the background and history of each park. In each case, we conducted 5 semi-structured, in depth expert interviews, with a variety of stakeholders: park tenants, project developers, researchers, and policymakers.

## 4. Case studies

### 4.1 High Tech Campus, Eindhoven



Figure 4, Impression of the High Tech Campus

#### 4.1.1 General Description

The High Tech Campus is a science park situated at the edge of Eindhoven, south of the city centre. It covers approximately 103 hectares and is adjacent to the highway A2 with a direct turnoff into the area. It is well reached by car, public transport and by bike. At approximately 15 kilometres there's Eindhoven Airport. The Eindhoven University of Technology is situated within 6 kilometres.

Parts of the area were already in use as a business area before it was transformed into a campus. The first phases of development are finished and about 174.000 m<sup>2</sup> of floorspace has been built or revitalized and is in use. At the moment approximately 5.300 people are working on the campus of an estimated ultimate population of 8.000 to 9.000 people. Fully realised, the total amount of floorspace will add up to 283.000 m<sup>2</sup>, which creates an average density of build space ("fsi" = 2,75). The functional program consists of 8.000 m<sup>2</sup> cleanrooms, 50.000 m<sup>2</sup> laboratories, 100.000 m<sup>2</sup> office space, 125.000 m<sup>2</sup> of additional development space and 10.000 m<sup>2</sup> of collective spaces in "The Strip". The investments in the area based development cover approximately 506 million euro (van de Klundert 2008).

#### 4.1.2 Knowledge Foundations of the Eindhoven Region

The knowledge foundations of the Eindhoven region are strong: the regional economy is dominated by high-tech business, and there is a renowned technical university. Approximately 50% of the total Dutch expenses on research and development happens in this region, in which Royal Philips takes a large share. The economic base is strong, but specialized in high tech manufacturing and therefore vulnerable. Quality of life in the region can be seen as average, while accessibility is troublesome: the city has no big international airport nor connection to HST systems. The urban diversity of the region is average, partially related to the limited scale. An advantage though is, that there's generally a positive atmosphere of collaboration. Key actors know each other well, and in a mutual solidarity there's readiness to stimulate initiatives (van Winden and van den Berg 2004).

#### 4.1.3 Intention and Rationale of the High Tech Campus

The High Tech Campus is a private development, initiated by Royal Philips Electronics as the owner of the property. The Philips Research division is one of the mayor tenants (1.800 employees and 125.000 m<sup>2</sup> floorspace) and the "launching costumer". Philips Research has much influence on the development [7] and plays an active role as "enabler" for open innovation [6]. Other anchor tenants like NXP semi-conductors (2.500 employees and 46.000 m<sup>2</sup> floorspace) or Atos Origin profit of this vision. Although creating real estate value is certainly a feature in the development, the primary choices are business driven [6; 10]. Therefore the development keeps a very strong focus on knowledge diffusion.

An important goal of the High Tech Campus is creating an environment for open innovation [6]. Culture and facilities on the campus connect to the quest for boundaries of knowledge, within the framework of commercial use. Collaboration, seen as formal innovation networks and informal value chains, is integrally connected to these goals, as well as healthy competition and mutual trust (High Tech Campus 2007). In open innovation, stimulating knowledge transfer is essential. Seeking for synergy between people involved in research and development is an important asset, as well as shortening the "time to market" [8].



The concept of the High Tech Campus can be characterized as an area based campus development where a network of meeting places on different levels is created. Open, transparent buildings as well as centralized amenities are organized as pavilions in a continuous landscape with many opportunities for social activities, sports and recreation.

#### 4.1.4 Knowledge Management Tools on the High Tech Campus

##### Optimization of cognitive distance

The High Tech Campus has a selective acquisition/admission strategy, which defines three types of potential tenants. So-called “Triple-A-Tenants” (for which the brand of the location is an important location-factor), small tenants (for which the accessibility of external, specialized facilities is an important location-factor) and techno-starters (for which the entrepreneurial advantages are an important location-factor). All potential tenants have to be R&D intensive organizations, which are related to (one of) the five main technological domains on the campus: microsystems, life-tech, high-tech systems, infotainment and embedded systems. Admission of end-users is an integral decision by the campus management, which strongly relates to the concept-value of the park and the mix of users as a whole (Westerveld 2006). The position of the different types of end-users within the campus lay-out is related to their primary location demands (i. e. sight, quality, scale and costs).

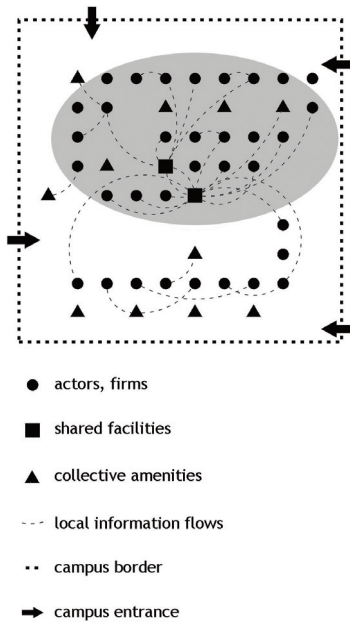


Figure 5, Spatial organisation of the High Tech Campus

##### Management of co-opetition

Management of co-opetition is organised by focussing on company segments within the exploration process. Company divisions and organisations on the High Tech Campus are mainly concerned with basic research. The only division which is close to production (and the process of exploitation) is Philips Applied Technologies, which “translates” innovative ideas into production solutions. Most of the work on the campus is limited to the pre-competitive phase.

Also, there is a keen and quick process of knowledge validation. On the one hand the “Technology Liaisons Office” maintains close contact with tenants and creates potentially valuable connections between them. On the other the “Intellectual Property & Standards-office” is permanently patenting innovations [6].

##### Organisation of spill-over

The campus organisation pays attention to company spin-outs and external start-ups in several ways. There’s a special fund for new technological entrepreneurs named Technostar. Apart from financial means, the management of this fund helps start-ups with their company development, networking and coaching. In the past three years fifteen spin-outs have started [6]. In a physical sense the start-ups are accommodated through a technology- and business accelerator: a multi-tenant building with reduced rents and dedicated spaces.

##### Active promotion of knowledge diffusion

The earlier mentioned Technology Liaisons Office functions as an intermediary for technology sharing and the management of spill-overs between tenants. It organises workshops, business meetings and network happenings to enhance knowledge diffusion. It has also initiated the “Campus Technology Liaisons Club”, which is a network organisation of decision-makers and “influentials” on the campus. The office essentially tries to build and maintain a community of practice. “In the end the purpose of this community is, to have the feeling you work on the campus instead of with an individual company” [6].

##### Passive promotion of knowledge diffusion

To promote knowledge diffusion, a series of specific physical measures are taken. The spatial organisation of the campus is dominated by the centralized position of collectively used facilities with a concentric zoning of different functions around it. In the heart of the campus, collective functions (like a restaurant, shops and meeting rooms) are organized in one building called “The Strip”. Next door, there are shared facilities like “MiPlaza”, “The Holst Centre” and the “Centre for Molecular Medicine”: buildings containing clean rooms, laboratories and specialized spaces. More toward the edges of the campus, there are a several collective parking buildings in between buildings with mixed functions and users. In the periphery the facilities for sports, children’s day-care and the technology- and business accelerator are situated. Related to highway A2 the “Triple-A-Tenants” are concentrated. The maximum walking distance between the centralized shared facilities and other functions on the campus is approximately 8 minutes.

The interior zone is inaccessible by car and the quality of the unbuilt space is high (landscaped). Employees and visitors are encouraged to walk to their destinations on the campus, enlarging the chance of casual encounters in a nice environment. Within the individual buildings there are no meeting rooms allowed beyond 8

persons. Instead, these facilities are collectively offered within “The Strip”. It’s also not allowed to have lunchrooms or café’s within the individual buildings. Again, these are offered collectively. Even the collective sporting facilities focus on team sports, in favour of individual workouts.

#### 4.1.5 Evaluation of the High Tech Campus

Within public media (BOM 2006, Elba 2006, Etin 2004, Saris 2003) and the interviews, the High Tech Campus is generally considered to be an excellent example of an area based development for a working environment in the knowledge economy.

Especially the strong focus on concept value and the involvement in development on the highest management level of key tenants are crucial in this respect. Noticeable are the good relationship with authorities and external actors.

Real weaknesses are not mentioned, although there are two main points of attention related to the purpose of this survey. Firstly the project sometimes tends to become too real estate driven, when striving for additional property value instead of creating value for companies on the campus. Secondary the open innovation concept would be really complete, if apart from the two anchor tenants (Philips and nxp) a third substantial corporation would concentrate R&D on the campus [6].

#### 4.2 Knowledge Park Twente, Enschede

##### 4.2.1 General description

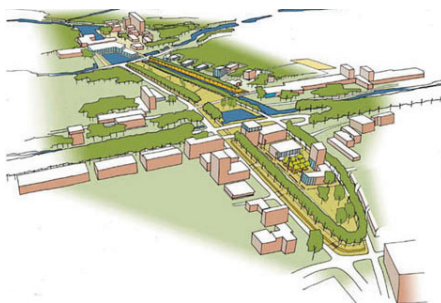


Figure 6, Impression of Knowledge Park Twente

Knowledge Park Twente is a university related science park at the edge of Enschede, north of the inner city. It consists of the campus of the University of Technology Twente (UT), as well as the Business and Science Park Enschede (BSP). The campus part is bordered by public streets and covers approximately 120 hectares, the BSP covers approximately 40 hectares. Both areas are adjacent to the “Hengelosestraat”, 2 kilometres from highway A35. The area is accessible by car, public transport and bike, and Enschede Airport Twente is situated within 10 kilometres.

The campus is an existing university domain, with facilities for education, research, living and sport. About 150.000 m<sup>2</sup> of program will be added to the existing functions, of which 60.000 m<sup>2</sup> consists of redeveloping the building “Langezijds”. The BSP offers space for the development of 50.000 to 100.000 m<sup>2</sup> floorspace for offices. Upon realization the amount of people working in the area will increase by approximately 10.000. The expected urban density of build space is average (fsi = 2,85). The initiative and planning phase have been completed, and realization is about to begin. Investments in the area based development cover approximately 140 million euro (van de Klundert 2008).

##### 4.2.2 Knowledge Foundations of the Twente Region

A recent Euricur survey shows that in the Twente region (“Networkcity Twente”) the knowledge base is reasonable, especially due to the technical university and the growth of the technological sector. The economic base is poor: the region is still in transition from an industrial past (textile industries) toward a service and knowledge economy; there are no large technology firms (like Philips in Eindhoven). The region is very “green”, which makes (the potential) quality of life high. Weak points are a poor (international) access and lack of scale. In order to increase scale advantages, there’s a very active policy focussing on regional (cross-border) co-operation in which the University Twente plays an important part. There are a lot of investments in technological start-ups, collaboration between corporations and university and creating the right conditions for high-tech development (van Winden and van den Berg 2004).

##### 4.2.3 Intention and Rationale of Knowledge Park Twente

The purpose of Knowledge Park Twente is creating a meeting point of European stature, where knowledge organisations and innovative corporations make use of each others knowledge and facilities. Knowledge valorisation, or turning academic research findings into commercial use, is an important feature. The challenge for the area based development, is building a meeting place for creative researchers and entrepreneurs on site of the university campus and the adjacent Business and Science Park (Kennispark Twente 2007).

Knowledge development and – diffusion works best in an inspiring, creative environment. It’s considered essential that the physical centre of the Knowledge Park is adapted to create an inspiring, creative, green environment [14]. The concept of the park intensifies certain areas within the existing university campus.

The initiative is a collaboration between three public partners. The University of Technology Twente, the municipality of Enschede and the province of Overijssel. The university is the anchor tenant and main owner. Mainly due to the phase in development, there are no known end-users at the moment.

The rate of success is measured in terms of knowledge valorisation or economic surplus. Especially in the amount of spin-off companies, increased employment rates and the amount of realised floorspace on and adjacent to the campus. We conclude that the development is mainly driven by political objectives.

#### 4.2.4 Knowledge Management Tools on Knowledge Park Twente

##### Optimization of cognitive distance

The Knowledge Park Twente focuses on seven target groups (Stec Groep 2006): start-ups, “restarts” and “returns” to the University Twente (spin-outs), R&D intensive organizations (smaller satellites of big technological firms), high-end production companies (with relatively complex and innovative production processes), offices (suppliers or technology related), knowledge institutes and training centres. The target groups have to be R&D intensive organizations within five specific technological domains (ICT, (bio-)medical technology, nano- and process-technology). Because the market dynamics in the region are not high, the admission of potential tenants is organized by means of “positive discouraging” [13]. A relatively wide target group is welcome, which are to be located in several dedicated zones. This implies the risk of fragmentation and not reaching a certain critical mass [15].

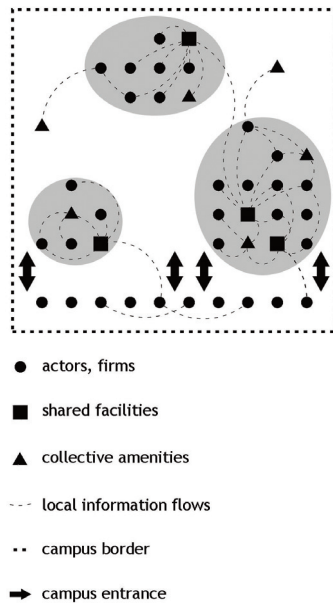


Figure 7, Spatial organisation of Knowledge Park Twente

##### Management of co-opetition

Knowledge exchange between (potential) tenants on the park strongly depends on “knowledge valorisation”, or encouraging co-operation and knowledge diffusion between market and university. This knowledge valorisation is organized by the “Innovation Lab”, which doesn’t make rigid distinction between processes of exploration or exploitation but does focus on specific business segments. To help firms with aspects of intellectual property, there’s an advisory board for patents together with a patent fund, which secures knowledge protection and organizes possibilities for exploitation (vsNU 2005).

##### Organisation of spill-overs

Exchanging knowledge and stimulating young entrepreneurs is considered highly valuable to the university. An active and successful policy for spin-offs is accompanied by business accelerators. The “top-program” (a program for temporary research positions) is an example in which recently graduated people get the opportunity to start a new business based on the knowledge generated within the university. Also external organisations are collaborating with the UT in developing a technological incubator (Business Technology Centre) (vsNU 2005). Furthermore, there’s a well funded start-up and spin-off program which organises facility sharing, coaching and finance. In the past 20 years this has led to 250 start-ups (Eijkel 2002).

##### Active promotion of knowledge diffusion

Knowledge Park Twente has no dedicated organisation yet which especially focuses on the management of knowledge networks within the area based development, although several programs and collaborations within certain segments are already active within the university. The park organisation experiences the difficulty of having several frames of reference between campus residents which not yet interfere [12]. Creating more mutual understanding in the near future is to be found in organizing congresses and events (Stec Groep 2006).

##### Passive promotion of knowledge diffusion

Knowledge Park Twente can be seen as a community, consisting of people with different lifestyles [12]. These different lifestyles are translated into multiple physical environments based on labelling certain zones [15]. These zones are organised in a poly-nuclear position of collectively used facilities, related to already existing buildings. The Business and Science Park is labelled with “offices” (Stec Groep 2006). Maximum walking distance between the centres of the zones is 8 minutes, while the maximum distance between functions within the area is over 20 minutes (!) walk.

Facility sharing is explicitly mentioned in the policy documents as a way to promote knowledge diffusion between knowledge institutes and commercial businesses. Knowledge Park Twente strives for opening up or creating new collective facilities, which lowers the threshold for applying new technologies. Examples of shared facilities are the planned collective functions in “Langezijds” like a restaurant, meeting rooms, hotel accommodation and sports facilities (BGSV 2007). The idea is to get liveliness by situating a hotel, restaurant, cafes, leisure and short-stay facilities between offices and research facilities [11].

#### 4.2.5 Evaluation of Knowledge Park Twente

Knowledge Park Twente is considered to have two crucial potentials. These are to be found in an entrepreneurial university and the quality of location. Especially the young, institutional dynamic which wrestles to create a “niche” is considered to be an advantage in that respect (Rip and Eijkel 2004). Due to the phase of development these potentials are only partially measurable.

There's a clear awareness of certain weaknesses in the development. The area is quite huge and therefore (to be) built in a relatively low density. Adding up limited market dynamics in the region, the question rises if enough critical mass will be reached. And, if the concept of poly-nuclear zoning doesn't further undermine potential advantages of co-location through the dispersion of functions in the vast area. Another weakness is the difficulty to organise the development due to differences in focus of involved actors. The lacking ability to think beyond the own organisation is negatively influencing the development and leads to time-delays (the original letter of intent was already signed in 1999, while first physical developments are only now starting).

#### 4.3 Technopolis Innovation Park, Delft

##### 4.3.1 General Description



Figure 8, Impression of Technopolis Innovation Park

Technopolis Innovation Park is a university related science park, situated south of the inner city of Delft. The area covers approximately 120 hectares and is directly adjacent to the Delft University of Technology. It's connected to highway A13, and is (or will be) well reached by car, public transport and bike. The nearest airport is Rotterdam regional airport, at 10 kilometres.

Approximately 50 hectares is already built and in use. Fully realised, the total amount of floorspace will add up to 600.000 m<sup>2</sup>, which creates a relatively high density of build space (fsi = 5,0). The expected number of workers in the area is about 10,000. The functional program consists of high quality business spaces, survey facilities, dwellings, a hotel, conference rooms and leisure. The initiative and planning phase have been completed and the development phase is starting. The amount of investments in the area based development is confidential (van de Klundert 2008).

##### 4.3.2 Knowledge Foundations of the Delft Region

A study by Nyfer shows that the knowledge base in the Delft region is strong (especially due to the scale and good contacts between the Delft University of Technology, TNO and several other knowledge partners). The economic base is poor and strongly focussed on the brand of Delft as “city of technology” since the 1990s. Though actual results of this policy, measured in employment rates or economic prosperity are weak. As for the quality of life, Delft should make more use of it's opportunities. Urban diversity is mediocre (Nyfer 2005). A policy shift from the local toward a regional scale could enforce the knowledge foundations further. It's import to note that Delft is functionally part of the Randstad area, with its strong economic base and labour force.

##### 4.3.3 Intention and Rationale of Technopolis Innovation Park

The main purpose of Technopolis Innovation Park is strengthening the economic structure of Delft. Also deepening the relationships between corporations and R&D is of great value to the Delft University of Technology (Gemeente Delft 2004). Keywords for Technopolis are innovation and entrepreneurship. University and business live together in “synergy”. The university profits from its neighbors, by the practical knowledge diffusion through tutorship or advisory. Companies on the other hand, profit from the brand and facilities of the university. Within these innovative milieus the exchange of knowledge is important. It's not only about pre-fixed interaction but also about casual contacts. Opportunities for personal (tête-à-tête) contacts are important [19].

The concept of Technopolis Innovation Park can be characterized as an area based campus development with a distinction in three zones; “clusters”, “rooms” and the “centre”. Especially the ground floors of the centre contains collective facilities and public services (VHP 2007).

The initiative is a public-private partnership between Delft University of Technology, municipality of Delft, ING real estate and Bouwfonds MAB. Approximately 85 % of the area is owned by the university, 15 % is municipality property. Although the university will be one of the mayor tenants, the search for important launching costumers turns out to be quite difficult [19]. Investing in external real estate and



acquisition of companies is not a core business of the university, therefore two real estate developers were added to the project [17]. We conclude that the development is partly politically driven (the city wants to promote the local economy), partly real estate driven (the university wants to make more out of its premises).

#### 4.3.4 Knowledge Management Tools on Technopolis Innovation Park

##### Optimization of cognitive distance

The acquisition strategy for Technopolis Innovation Park is based on connecting the (international) networks of the four participating “developers”, and focuses on a wide range of technological sectors [17]. National as well as international companies with R&D activity are welcome, if they intend to cooperate with Delft University (Technopolis 2007). The university offers a wide range of technological specialisations, and hence, the group of potential costumers of Technopolis is big. It concerns R&D intensive organisations in 13 (!) technical domains (Earth, ICT, life science, mechatronics, mobility, nanotechnology, water, infrastructures, sustainable energy, sustainable industrial processes, aerospace, computational science and material science). In marketing the development, a smaller profile of the strongest points is being elaborated [18]. The admission criterion for end-users is their intended interaction with the university. The different types of end-users are located into three different zones, related to their primary location demands (i. e. sight, building typology, quality and costs).

##### Management of co-opetition

The management of co-opetition on Technopolis Innovation Park is based on the viewpoint of knowledge valorisation. It occurs in the collaboration between university and business, between education and research. Concentrating R&D and the university faculties is therefore the first condition [19]. At the moment the valorisation of knowledge is organised centrally by the TU Innovation Lab. Furthermore, “valorisation managers” are active, and some faculties have special business managers (vsnu 2005).

##### Organisation of spill-overs

Delft University of Technology intends to generate 250 (!) start-ups each year. These start-ups vary from young design offices, ICT companies, architectural offices, firms for technological services to techno-starters (which launch new products). An organisation called YES!Delft (which is founded by the Delft University of Technology in collaboration with the municipality of Delft and the Dutch ministry of Economic Affairs) supports these start-ups with floor space, legal advice, and coaching by experienced businessmen or relevant networks (TU Delft 2007). In a physical sense, also several “incubator buildings” (breeding places) are planned within the park.

##### Active promotion of knowledge diffusion

Within the development area, the management of knowledge networks and promotion of knowledge diffusion is considered important. Only in this way “closed knowledge” can be opened up [18]. Apart from the existing valorisation efforts, there’s no dedicated organisation yet which focuses on the active promotion of knowledge diffusion within the area based development. Within the current discussion about acquiring new companies the tendency is, to even limit the tasks of a future park management organisation in order to reduce costs for future tenants [17].

##### Passive promotion of knowledge diffusion

The lay-out of Technopolis is characterized by a centralized position of collectively used facilities and a concentric zoning of different functions around it. Within the zones there’s a distinction between the so-called “centre”, “clusters” (near to the highway) and “rooms” (near the edge). In the “centre”, there will be a concentration of functions, including shops, restaurants, a hotel and a business centre. Adjacent to the “centre”, a series of parking buildings will be build. Within “the clusters”, functions with a high office component are planned in solitary buildings. Functions with less office floors and a higher business component are situated in “the rooms”. Maximum walking distance between the central functions and other buildings is 8 minutes.

The centre of Technopolis concentrates collective facilities (like survey facilities, conference rooms, leisure, reproduction service, hair salon, etc.) and hence creates a place for meeting and knowledge exchange [17]. Furthermore, the chances of casual encounters are enhanced by reducing the distinction between public and private space, and by investing in the quality of the unbuilt area (VHP 2007).

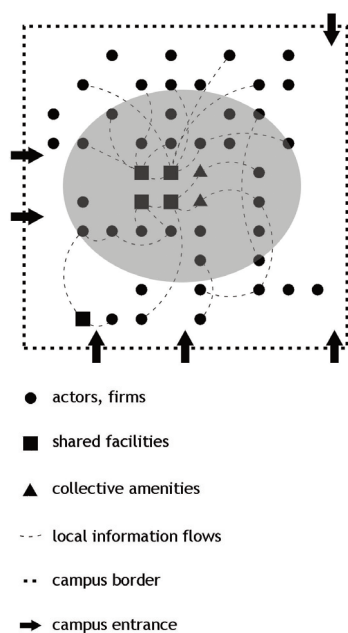


Figure 9. Spatial organisation of Technopolis Innovation Park



#### 4.3.5 Evaluation of Technopolis Innovation Park

Technopolis Innovation Park is considered to have a huge potential in becoming a successful area based development for a working environment in the knowledge economy. Especially the location in the heart of the Randstad, adjacent to a big university with long, historical knowledge competences are noticeable in this respect. Again, due to the phase of development these potentials are only partially measurable.

A main weakness in the development has an organizational character. Unequal division of responsibilities between the public and private partners is considered to be a danger to the project. This, as well as the difficulty in attracting launching business customers leads to an increase of the time span of development, which has lead to the nickname “the sleeping giant”. Also the park lacks focus: it targets a very wide range of companies.

#### 4.4 Comparison of the Cases

A common feature of the three cases is the area based character of the development, specifically designed for R&D in the high tech sector. The analysis of the cases shows that despite the programmatic similarities, each development has unique features, which makes comparison difficult. However, several conditions appear in each development, and there are parallels in the development processes. Also differences appear as a result of different pre-conditions and intentions of the development. Below we summarize the main characteristics of each development in a matrix, along the lines of the framework of analysis.

	High Tech Campus	Knowledge Park	Technopolis
knowledge foundations	Good, but small and little diverse.	Reasonable, with potential strengthening.	Strong, but regional co-operation should improve.
intention or rationale	Business driven development.	Politically driven development.	On the verge of a politically driven and a real estate driven development
cognitive distance	Very strong focus on branding and knowledge based zoning.	Limited key target groups, but many possibilities for indirect functions. Poly-nuclear zoning.	Very wide range of technological sectors and zoning based on the functional program.
co-opetition	Limiting exploitation and pro-active patenting.	Dedicated business accelerators and patent advisory and funding.	Central knowledge valorisation.
spill-overs	Dedicated spaces, funding and coaching of start-ups and spin-outs.	Successful technological incubators for start-ups and restarts.	Incubator policy for start-ups.
knowledge diffusion (A)	Area based network events.	Business related networking.	Knowledge network management (planned).
knowledge diffusion (P)	Maximized facility sharing and intelligent campus lay-out.	Sharing (existing and new) collective facilities (planned).	Accessibility of centralized facilities (planned).

### 5. Main Findings of the Analysis

Knowledge foundations set the margin  
 The framework of analysis argues that the (regional) economic context determines the potentials of an area based development of an environment for working in a knowledge economy. The case studies show, that neither a strong knowledge foundation automatically leads to a successful area based development (Technopolis). Nor does a good, but small knowledge foundation limits the outcome of an area based development (High Tech Campus).

Intentions and rationale  
 The development of the knowledge park is strongly contingent upon the roles and incentives of the actors involved (like university, companies and municipality). Our study suggests that parks mainly driven by the public sector or university

(Knowledge Park and Technopolis) have more difficulty in maintaining focus and defining clear strategies for the area-based concept. The number for actors involved is higher, decision making is more blurry, and whimsical political considerations play a role. A business driven intention (as at the High Tech Campus) scores better in these respects. Choices are made on the basis of business considerations rather than political processes. It also helps when one dominant private actor (Philips, in this case) takes the lead, in particular when it has good working relations with regional authorities and other external actors.

We conclude that there are different types of “beneficiaries” to successful knowledge environments. End-users can profit directly from added value of knowledge diffusion. Other actors within the development process may benefit indirectly (landowners through rising real estate value, politicians through political impacts). Apart from knowledge and facility sharing, locating in a knowledge park may have other advantages for firms. One is recruitment. In tight labour market, it is easier to get staff when you can offer an attractive working environment (Philips experienced this: it became easier to attract staff since the firm created the campus). Second, firms may prefer the knowledge park for accessibility reasons (if situated well in terms of highway and public transport access) rather than for the knowledge transfer effects. Thus, even if we would measure above-average rent rises in knowledge parks, it may not be because firms want to pay more to benefit from local access to knowledge.

#### Cognitive distance

An optimal cognitive distance is defined as one big enough to create new ideas, but small enough not to oppose the capacity to collaborate. In all three cases, branding and zoning are used as instruments to manage this aspect. Branding is used in determining “target groups” for the park, in order to generate a certain critical mass. Eindhoven translates this into very strict admission criteria for tenants; Twente and Delft are much less strict, and consequently face the risk of losing focus and creating fragmentation. We conclude, cautiously, that knowledge diffusion is enhanced if the park has a certain critical mass of tenants within fruitful cognitive distance from each other. But more research is needed to ground and quantify this conclusion.

In all parks, zoning is used to organize different functions and qualities within one area development scheme. The layout of concentric organisation is based on a central position of shared facilities, surrounded by functions and amenities in a variety of appearances (Eindhoven and Delft). The layout of poly-nuclear organisation is based on a diversified position of shared facilities, surrounded by functions within the same “theme” (Twente). This “physical clustering” of related activity is believed to enhance knowledge transfer through encounter, but there is no hard evidence. Again, further research is needed to assess whether this is the case.

#### Co-opetition

Knowledge parks are believed to be excellent “catalysts” of pre-competitive co-operation between firms. In the inherent tension between co-operation and competition it is argued that the distinction between exploration and exploitation is a valuable tool in understanding the management of relational risks. Within the case studies the relational risks are limited in two ways. On the one hand by concentrating on the exploration phase through segmenting on research and (a bit of) development. On the other by securing intellectual property through pro-active patenting.

#### Spill-overs

Without exception the cases show a lot of interest in managing spill-overs by stimulating start-ups through incubator strategies. It is argued that spill-overs become unwanted from the point of view of corporations in the phase of exploitation. In that sense there seems to be a difference between management of university spin-offs and company spin-outs. Where company spin-outs are strongly related to development of an existing value chain, university spin-offs cover a far wider scope of interest. This reflects in a significant difference in the average amount of (expected) start-ups each year in the cases; approximately 5 in Eindhoven, versus approximately 12,5 in Twente up to an intended 250 in Delft.

#### Knowledge diffusion (active)

It is argued that creating the right atmosphere for non-threatening casual encounters between people is crucial. In a variety of methods the cases use network management to create it, by organizing business meetings, conferences and gatherings. Again, differences are found in respect to the critical mass of participants within an optimal cognitive distance. Within “communities of practice” the focus lies in network management of content (High Tech Campus). It brings parties together on a specific topic. In a wider sense network management is in the process. It organizes parties around certain generic topics.

### Knowledge diffusion (passive)

Stimulating knowledge diffusion between organizations at a park can generate competitive advantages for tenants, but cannot be guaranteed through physical development only. Passive measures of knowledge diffusion (like facility sharing and zoning) is only “the stage” for interaction. However, there seems to be a relation between intention, critical mass and the spatial concept of the campus. It’s more likely to create local buzz in a concentric layout (Eindhoven and Delft) than in a more scattered, poly-nuclear layout (Twente). Also, further research is needed to measure differences due to the typology of campus scheme.

## 6. Some Final Remarks

Within the typical Dutch planning tradition of separating functions, knowledge parks tend to be poorly integrated within the urban fabric, spatially and functionally. This has disadvantages in terms of potential “new combinations” with other sectors, and prohibits optimized urban interaction. The three knowledge parks are created as a “city within a city”. Strictly bordered at the city edge, with dedicated amenities and leisure facilities, but without inhabitants (except for Twente where some housing is situated). This reduces the basis for services and amenities, and after working hours these areas are empty and deserted. Furthermore, unintended, they create not only a physical but also a socio-psychological barrier between the knowledge economy and other parts of the urban economy. More “inclusive” concepts, integrated within the urban fabric, could be better in these respects.

Park design concepts typically tend to overestimate the importance of spatial proximity. Proximity is not a sufficient nor a necessary condition for tacit knowledge exchange. Other forms of proximity (organisational, social) are good complements or even substitutes.

This paper hopes to give an understanding concerning area based developments for environments for working in a knowledge economy. It offers a practical tool, which can act as a checklist for professionals and may yield successful environments. It also makes clear, that developing locations requires caution but that private companies are capable of shaping their business environments and thus their success in global markets. Based on the main findings we will conduct further (international) comparative research, which will be reported in the future.

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## Interviews (Reports)

### General

- |                              |   |
|------------------------------|---|
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| [3.] Maas, dr. ir. P. C. M.  | director RDN architects and planners, Breda           |
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### High Tech Campus

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| [8.] Nagelsmit, ir. E.        | development supervisor Philips High Tech Campus            |
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Knowledge Park Twente

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- [12.] Eijkel, dr. C. J. M.
- [13.] Gude, E.
- [14.] Koopman, drs. B.
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- [17.] Canter Visscher Msc, R.
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