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Knowledge sharing within open innovation networks
an analysis of the High Tech Campus Eindhoven ecosystem

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An analysis of the High Tech Campus Eindhoven Ecosystem

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This report was written in the context of the graduation project which concludes the Master Program in Innovation Management at the Technical University of Eindhoven. The project was carried out during a period from April to December 2006. It investigated the knowledge sharing practices of the High Tech Campus Eindhoven (HTCE). I experienced the project as an interesting and pleasant period. Interesting, because Knowledge Management and Open Innovation are challenging topics. Pleasant, since the working process at the University and the HTCE was open and friendly. Moreover, the HTCE and the TU/e are dynamic and complex environments currently involved with these concepts.

It has been an enormous challenge to approach the daily effort to manage knowledge on the HTCE from a scientific point of view. The many developments and changes in the Campus structure, members and policies make a careful and detailed analysis of the situation a difficult task. Having to conduct the project in such a context has enabled me to develop my scientific as well as my practical skills.

I would like to thank several persons who helped me with the realization of this report. First of all, I want to thank my university supervisors – Hans Berends and Sjoerd Romme – for their valuable advices and the enthusiasm with which they supported me during the project. Of equal importance for the result of this project were my contacts within the HTCE. I would like to thank them for their time and interest, and for the opportunities they gave me to experience the daily business routines and challenges in a large and influential environment such as the High Tech Campus Eindhoven. Last, I’m grateful to the colleagues at the Open Innovation project for their friendly cooperation.

My family also has played an important role. Lia, my wife, I’m glad for all her help and support during the period of my studies and on this project. For my parents, I express gratitude for the trust and motivation. My brother and sister were essential, always inspiring and giving me the example to be followed.

I had a fantastic time during the years living in The Netherlands and the study period at TU/e. It was only possible due to this community’s continuous motivation.

Eindhoven, December 2006

Gaus Azeredo

Epigraph

If I have been able to see further, it was only because I stood on the shoulders of giants.

Isaac Newton

It is not knowledge, but the act of learning, not possession but the act of getting there, which grants the greatest enjoyment.

Carl Gauss
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1. Introduction

Many authors have argued that significant changes are occurring within the economy and society. These changes have been described as a transition to a knowledge economy and knowledge society (Hislop, 2005). The main challenge in this knowledge economy is the production of innovative and personalized products. These new products are expected to be technologically innovative as well as valuable to the market. This innovativeness requires much more than new products. It concerns reinventing business processes and building entirely new markets that meet untapped customer needs. Services, businesses and the market itself demand that the creation and production of such innovations occurs at an ever increasing intensity.

Today's business practices also require collaboration in order to drive growth. The exchange of information, knowledge, and technology become crucial to firms to achieve the necessary competitive advantage. Practitioners and academics recognize that interorganizational and intraorganizational knowledge sharing are crucial for achieving collective outcomes. Therefore, knowledge sharing should be an essential part of the daily routines of employees. Nevertheless, many companies have experienced that knowledge sharing does not always happen in practice, and requires management attention.

Within this perspective, this graduation project addresses the topics of Open Innovation and Knowledge Management. In an exploratory study, the emerging ecosystem of the High Tech Campus Eindhoven (HTCE) is investigated. At the HTCE, high-tech businesses are being created to stimulate technological excellence. Its culture and policy are geared towards pushing the boundaries of knowledge within the framework of commercial viability. Cooperation, through formal and informal networks, as well as healthy competition and confidentiality appear to be part of the Open Innovation policy of the HTCE.

This graduation project examines how residents of the HTCE share their knowledge and how effective the Campus' deliberate and emergent design characteristics (e.g. shared facilities and informal networks) and channels of communication are. By recognizing the Campus as a privately owned science park, emerging from the Open Innovation strategy of its Anchor firm (Philips), we have been able to accomplish a unique study. This distinctive research happens because existing literature on the field (e.g. Cooke, 2004) is restricted to the discussion of developed clusters and science parks which appear to be merely incorporating the Open Innovation paradigm. Moreover, the specific issue regarding Open Innovation in interorganizational level that has not yet being adopted under a design oriented perspective.

This graduation project is structured as follows. In the initial chapter a discussion about Open Innovation and Knowledge Management concepts is provided. Special attention is given to literature on organizational networks, clusters and science parks. Supported by current literature, a research framework is introduced. The methodology applied is then presented, followed by the empirical analysis of the HTCE. Finally, the discussion section elaborates on the acquired findings and insights. Conclusions are then developed toward design principles and design propositions for the management team of the Campus.
1.1 – Research Problems

Three research problems, identified from gaps in the literature are the focus of the investigation. Initially we observe that Open Innovation emerged as a concept defined by Chesbrough (2003) at the firm level. However, Vanhaverbeke (2006) distinguishes alternative levels for the analysis of Open Innovation: a. intraorganizational networks; b. firm level; c. dyad level, i.e. the interest of two or more companies tied to each other through equity or non-equity alliances or corporate venturing investments; d. interorganizational networks; e. regional or national innovation systems. In addition, within the value network level numerous firms join the creation and sharing of knowledge and technology. As a consequence, an efficient tool is needed in order to lead the process of adding value to these exchanged knowledge and technologies. In this graduation project the use of the Open Innovation concept is extended to its effect on the multi-firm level of clusters and science parks.

Within this multi firm level, it has been noticed that although a large pool of knowledge exists on how to manage single and multiple partners, little information is available on how to design and organize a large number of partners (both firms and individuals). Therefore, the specific issue of managing cluster and science parks under a design oriented perspective is addressed. Below this central research problem is highlighted.

- The design of clusters and science parks from a knowledge sharing and Open Innovation perspective has not yet been explored.

As a last issue, this graduation project pays attention to the relevance of an Anchor firm on privately owned clusters and science parks. The study of Cooke (2001) on private funded clusters is used to support the HTCE as a privately owned institution. Feldman (2003) also argues for considerations on how Anchor firms influence clusters and science parks. The author claims that a large innovator firm causes not only an average increase in the observed patenting level by other local smaller companies, but also enables a higher sensitivity of such firms to the research conducted within the region.

1.2 – Research Question

This graduation project focuses on investigating the knowledge management policies of the Campus. Its objective is to understand the influence of emergent and deliberate design characteristics on knowledge sharing of residents of the Campus. Deliberate design characteristics are previously planned and directly manipulated according to the strategy, while emergent characteristics, although predicted, are not consciously structured.

Thus, the central question of the study is how resident firms of the High Tech Campus Eindhoven share their knowledge and what is the importance (relevance) and effectiveness of the available design characteristics of the Campus. More precisely, throughout the empirical research we address:

(i) What design characteristics (emergent and deliberate) enable, or constrain, knowledge sharing in the interorganizational network of the HTCE?

(ii) How is the influence of design characteristics affected by different types of relationships and by the Anchor firm of the HTCE?

(iii) Which design principles and design propositions are applicable to the Open Innovation ecosystem of the HTCE?

Design rules and design propositions are defined in section 3.2.
2. Theoretical Background

One of the pillars of this study is the concept of Open Innovation. This is a new way of looking at innovation processes that considers the outside-in flow of knowledge as crucial as, or even more important than, the inside-out flow. Another pillar is the literature on knowledge management. Furthermore, literature on clusters and science parks was also incorporated.

2.1 – Open Innovation

The term Open Innovation was coined by Henry Chesbrough in his 2003 book by the same name. Chesbrough (2003) defines the concept as a paradigm that assumes firms can and should use external ideas as well as internal ideas, and internal and external paths to market, to advance their technology. The external component may include formal forms of collaboration such as alliances and spin-in’s, but also informal networking around new ideas, perspectives and technologies. According to Chesbrough, the main idea of this concept is to accelerate the internal innovation of organizations and at the same time expand the market for the external use of it.

However, to allow a correct understanding of the topic, it is first necessary to understand the innovation process of the previous 'closed innovation' model. Within this model, the process is called ‘closed’ because projects can only enter in one way, at the beginning, and can only exit in one way, by going into the market, all within the same organization. Although this approach constrains much of the potentialities of the external environment, we can still find studies on ‘radical innovation’ supporting such ideas (e.g. Leifer et al., 2000).

Open Innovation, on the other hand, involves a new way of looking at innovation. It argues that the decline in innovation capabilities of many major corporations starts in the way these companies treat the innovation process; therefore the necessity to redesign organizations from a closed innovation structure towards an open model exists. This will allow fundamental results coming from external factors to emerge. Examples of these external factors are the increasing amount of highly educated people, the growing mobility of these professionals and the increasing access to private venture capital.

Chesbrough describes Open Innovation, from the perspective of a single firm, in terms of the following principles:

- Not all of the smart people work for us, so we must find and tap into the knowledge and expertise of bright individuals outside our company.
- External R&D can create significant value, but internal R&D is needed to claim a portion of it.
- In order to profit from research, it does not need to be originated internally.
- Building a better business model is better than getting to market first.
- If we make the best use of internal and external ideas, we will win.
- One should profit from others' use of his intellectual property, and buy others' whenever it advances one's own business model.

Open Innovation involves the exchange of innovation, knowledge and technology between firms. Within this model, companies are more dependent on the exchange of innovative knowledge and technology between firms in order to remain competitive. According to Chesbrough, firms can, and should, use external ideas as well as internal ideas in order to commercialize its concepts. At the end, by adopting an Open Innovation policy companies will obtain a more permeable boundary that nurtures a greater flow of ideas. However, it is not clear how to determine a feasible way to share knowledge and
information. And, whereas the literature focuses on the bright side of knowledge sharing, it is clear that this also presents dangers.

Regarding the further discussed topic of clusters and science parks, the relationship with Open Innovation can be noticed in the three kinds of networks proposed by De Man (2005). These three networks help to see how network embeddedness might emerge among organizations.

- Current literature of study on clusters and science parks - Ego-centric (connected with a single object).
- Practice among studied clusters - Socio-centric (partial network).
- Proposed perspective - Open-system networks (no clear boundary).

Research on intraorganizational communication documented the importance of interunit interaction to diffuse new ideas within multiunit organizations (Ghoshal et al., 1994). Interunit social interactions blur the boundaries between organizational units and stimulate the formation of common interests that, in turn, supports the building of new exchange or cooperative relationships (Tsai and Ghoshal, 1998).

However, networks are not per definition innovative, and with time, they can even loose their acquired ability to innovate. Sternberg (2000) concludes that a network has to renew itself continuously. To achieve this, the integration of the network into international and global networks is necessary.

2.2 - Knowledge Management

Complementary to the notion of Open Innovation, in the past decades the concept of knowledge management has emerged. In our study it becomes important due to its close relation with Open Innovation. Most significantly, within an Open Innovation policy, useful knowledge is generally believed to be widely distributed and of high quality. This characteristic makes knowledge management an essential element of this concept.

Knowledge management has received support and attention from both researchers and industrial practitioners (Kim et al., 2003). There is an increase in the amount of books and articles on this topic, and numerous organizations have embarked upon their own knowledge management programs (Scarbrough and Swan, 2001). The growing emphasis on knowledge management is a direct effect of its importance for both organizational and social areas. Information and knowledge intensive industries have become more dominant since the mid-1970. The number of knowledge workers and knowledge-intensive organizations has grown substantially in the last decades and has made knowledge one of the most important assets of a company (Hislop, 2005). At the societal level, a proposal from the European Commission emphasizes many challenges to be faced to boost knowledge, research and innovation. To the Commission, the challenge of investing in knowledge is “the best and maybe the only way for the EU to foster economic growth and create more and better jobs, while at the same time ensuring social progress and environmental sustainability.” (EU’s communication COM 2005 - 6 April - pg. 118).

Much research supports the attention that knowledge creation and sharing is receiving. Osterloh (2000) argues that knowledge creation and sharing are essential for organizations to sustain a competitive advantage by improving its performance. Polanyi (1966) introduced the distinction between explicit and tacit knowledge. Polanyi said that “We can know more then we can tell” (pg. 4), meaning that knowledge can best be described as an iceberg; some of it shows itself above the surface, but most of it lies beneath
the surface. In this analogy, the visible part of the iceberg is referred as explicit knowledge, while the immerse fraction is denominated tacit knowledge. Explicit knowledge is described as knowledge that can be codified and is therefore communicable in a formal language. Tacit knowledge is highly personalized knowledge, which makes it hard to communicate (Nonaka, 1994). Mascitelli (2000) illustrates that tacit knowledge creation and sharing within, and between, organizations are fundamental for the creation of successful innovations. Unlike explicit knowledge that can be recorded (Stewart 1998), tacit knowledge can often be transmitted much more comprehensively through narrative. In fact, the more complex the knowledge, the less effectively it can be codified.

Additionally, social groups and organizations can merge tacit knowledge into a powerful source of breakthrough innovation. The ability to form and nurture these groups may be even more important to the long-term competitive advantage of organizations than just the transitory benefits of even the most commercially successful innovation (Mascitelli, 2000). One of the reasons is that it is almost impossible for competitors to copy such tacit knowledge. Grant (1996) proposes a theory which centers on the idea that the prime role of the firm, and the essence of organizational capability, is the integration of knowledge. Moreover, according to the case study of Kim, Suh and Hwang (2003), organizations leverage knowledge both within themselves and externally to their stakeholders and customers.

The main objectives of knowledge management are to contribute to organizational development and to create competitive advantage through the management of its intellectual resources. An empirical study involving NPD-projects of US companies by Patti et al. (1997), investigated the impacts of knowledge sharing. Knowledge sharing positively affected budget performance, schedule performance and final product quality.

Knowledge management can be founded on two contrasting epistemologies: the objectivist and practice based. The objectivist perspective treats knowledge as an object. It is founded on the distinction and separation between tacit and explicit knowledge, being codification and collection of knowledge the main elements of study. Within this perspective knowledge needs to be accessible and, consequently, mechanisms to foster it are elaborated. On the other hand, the practice-based epistemology bases itself on the concept of embeddedness and inseparability of knowledge from practice. This perspective emphasizes diverse forms of interaction and communication to enable knowledge sharing (Hislop, 2005, pp39).

The effects of these two different knowledge management strategies are discussed by Hansen et al. (1999). Their claim is that effective firms focus on either the codification (objectivist perspective) or personalization approach (practice-based perspective) when implementing a strategy. The final conclusions of their article is that knowledge management strategy should, on top of everything, reflect a company’s competitive strategy.

Although innumerable advantages may emerge from knowledge management practices, it should be clear that barriers to knowledge sharing and dissemination still exist. Organizational structure and culture often act as major inhibitors. Furthermore, reward systems that do not match the type of relationships between employees appear as a frequent threat. Trust and reputation also seem to play an important role in the motivations for sharing knowledge (Inkpen and Tsang 2005).
2.3 – Clusters and Science Parks

The world has seen an increasing number of clusters and science parks since the 1980s, and nowadays an increasing accumulation of knowledge about the subject is taking place. As cited by Vanhaverbeke (2006), Porter (1998) defines clusters as the geographical concentration of interconnected companies and institutions in a particular field. Science Parks, in contrast, are property developments designed for a concentration of high-tech or science related businesses (Cabral and Dahab, 1993). In our study, we apply the findings related to both concepts in a complementary way.

Science Parks were primarily university owned. Later, as this concept matured, a transition started to occur. Zhang (2005) exposes the increasing functions that science parks have been expected to perform due to the change from universities to governments as major promoters. The most recent change within the topic is the emergence of private-owned science parks such as the High Tech Campus Eindhoven.

Looking at the broader perspective, three major categories by which cluster's characteristics can be classified have been identified: (i) infrastructure, (ii) social capital and (iii) knowledge ecosystem. These are introduced below.

Infrastructure characteristics were the first to attract the attention. Besides shared facilities and services, infrastructure also involves indirect assets of clusters and science parks. Such assets have a relation with geographical proximity, allowing roads, rail, airport and telecommunication to perform an important role, especially the linkages a region has with the global world (Cooke 2001, Cooke 2002, Becheikh et al. 2006).

Jonsson (2002) analyzes the importance of geographical proximity regarding the type of knowledge and the collaborative arrangements of clusters. Jonsson further investigates the existent untreated interdependencies and the possible ICT impacts occurring at clusters and science parks. His findings suggest that, even when 'local embeddedness' is a prevalent phenomenon, firms within a regional proximity are at the same time connected to national and transnational networks. Jonsson's article supports the findings of Breschi and Malerba (1998) that the more knowledge is ever-changing, tacit, complex and a part of the system, the more relevant are informal means of knowledge transmission. As consequence face-to-face contacts, personnel training and mobility of personnel becomes highly important. On the other hand, when knowledge is more standardized, codified, simplified and independent, ICT plays a stronger role, making the dependency on the physical proximity weaker. Conclusions are that the reasons firms agglomerate is not always related to the proximity of other firms and the possibility of establishing networks. Instead they are connected to the availability of resources found within particular regional contexts, such as the availability of highly qualified labour force. Nevertheless, the geographical concentration of firms with similar knowledge requirements constitutes the prerequisite driving the occurrence of such grouping of knowledgeable labour. Jonsson suggests that the advantages available to firms joining the researched cluster are, in great part, originated from the unique and prestigious environment that was created at IDEON (cluster in Lund, Sweden). This environment provides firms a positive image to the outside world and an IDEON identity that facilitates contacts in the financial and marketing settings. As a final conclusion, Jonsson states that non-formalized, non-priced and socially constructed relations have a limited impact on the innovation process of IDEON firms. This happens because very soon these relations tend to be formalized in different kinds of contract. In this specific cluster, the importance of such relations existed mainly in the initial phase, a finding aligned with literature on geographical localized knowledge spillovers (Zucker et al. 1998).
The second category with potentialities is the knowledge ecosystem. Both the homogeneity and diversity of knowledge within clusters and science parks are relevant. Overall, the notion of knowledge ecosystem refers to the number of institutional partners and their variety of knowledge. Homogeneity provides clusters with a similar knowledge base guiding to specialization of labour, research and sharing of costs. Calderini and Scellato (2005) conclude from their research in the wireless sector that specialization is also positively correlated with innovation. Homogeneity further facilitates the development on project base and scientific research involving academic interaction (Cooke, 2004). Moreover, the literature suggests that clusters and science parks better disseminate their embedded knowledge if member firms possess a common prior knowledge. Diversity, in contrast, allows contact with different institutional frameworks which may support different types of innovation (Whitley, 2002). The presence of innovation support organizations like venture capitalists, patent lawyers, merchant banks and consultants is necessary to exploit and commercialize scientific findings (Cooke, 2001). Diversity also allows the coverage of complementary points of the value chain.

Tallman et al. (2004) investigate the role of knowledge stocks and knowledge flows in clusters concluding that through constant interaction the firms in a regional cluster will develop an inter-firm or cluster-specific stock of architectural knowledge. This stock of knowledge ultimately becomes part of the body of common knowledge of those inside the regional cluster. This public good available within the limits of the clusters distinguishes them from the rest of the industry, in the same way that stocks of firm-specific architectural knowledge justify differences between firms within the same industry. The knowledge that is public only within a cluster provides competitive advantage to the cluster as a whole. It also benefits the firm that once had it exclusively, since it provides a unique common base of know-how for applying the technology. As a result, interpretations and applications of cluster-level knowledge remain unique for extended periods of time. In comparing Nordic clusters Asheim and Coenen (2005) identify localized learning processes on it, concluding that the 'sticky' knowledge belonging to a cluster should be considered as grounded in social interactions.

Other identified category of design characteristics was social capital. Social capital, by definition, involves a variety of inter-related definitions based on the value of social networks. In clusters and science parks, the mechanism leveraging social capital involves networks of relationships, reciprocity, trust, and social norms. Such a mechanism may take the form of shared identity, informal networks and social meetings.

The literature supports social interaction as an important element of social capital that facilitate knowledge transfer among different units of an organization (Coleman, 1990). Through social interaction, organizational units gain more opportunities to share their resources and ideas, and thus increase knowledge flows within the organization. In a more general perspective the network theory claims for the establishment of social embeddedness, i.e. stable relationships between social actors shaping expectations and behavior (Granovetter, 1985), and the influence of social conditions and networks in the firm behavior and performance. These interactions help firms to bridge gaps in its information, scientific knowledge, resources and competencies. Cooke (2002) argues that especially small and medium-sized enterprises (SMEs) profit from vertical and horizontal networks for collective learning and innovation. Within networks, trust and soft relations are important agents (Sternberg, 2000 and Vanhaverbeke, 2006).

Dahl and Petersen (2004) researched informal contacts and networks in industrial clusters. Their study on a cluster of wireless communication firms in Northern Denmark (NorCOM) revealed that engineers do share valuable knowledge through informal contacts. Regarding the genesis of these informal contacts, the
authors suggest a correlation with the categories to which such contacts belong (e.g. former colleges, former classmates or private friends), the mobility of the engineers between firms, their years of experience, their function and previous opportunity in formal joint projects. Moreover, even specific knowledge about new products, which is likely to be very firm-specific and which firms are likely to protect from competitors, is shared via informal networks.

A specific perspective, the debate on the importance of an Anchor firm for clusters is added to the research. A pertinent question is how an Anchor firm differentiates the cluster’s capabilities and opportunities regarding knowledge sharing. Feldman (2003) incorporates the perspective of Anchor firm in his study while investigating clusters and science parks at the US Biotech industry. The author defines Anchor firm as an agglomerative force with strong influence in the formation and growth of new dedicated firms and the overall technical specialization of clusters. Feldman suggests that Anchor firms are important factors on the formation of competitive clusters, which positively affects the specialized development of the industry within a region. Anchor firms benefit new technology intensive firms located in the same region by attracting skilled labour pools and specialized intermediate industries, and further developing knowledge spillovers. In the long run, Feldman justifies, once the technology is established additional firms may provide expertise and knowledge about specific applications, product markets, and technical development trajectories. Since such expertise is capable to move generic scientific innovations in specific directions, it might also distinguish the specialization of the clusters.

Finally, the existing framework regarding clusters and science parks might not always be as beneficial as it seems. For instance, Hislop (2005) describes that individuals must also be willing to share knowledge. Another issue is the absorptive capacity described by Cohen and Levinthal (1990), which implies that prior related knowledge is needed to assimilate and use new knowledge. Although the environment of clusters and science parks facilitates knowledge sharing, if employees are not willing to share or are not capable of absorbing knowledge, the stimulus provided by such environment may become worthless. Cohen and Levinthal support this line of thought by evidencing that if employees are not capable of absorbing the knowledge provided, co-location becomes a useless notion. Therefore, if organizations joining clusters and science parks are not capable of absorbing the available knowledge, the presence at such environment may be of no use.

Although it is known what type of factors are important to the successful development of clusters and science parks, the manner in which to design specific networks within these environments still not clear. Therefore, this graduation project objective is to understand how resident firms of clusters and science parks craft their network and share knowledge. More precisely, throughout the empirical research we address how to design clusters and science parks from a knowledge sharing and Open Innovation perspective, which has not yet been explored.
3. Research Framework

3.1 – High Tech Campus Eindhoven

The High Tech Campus Eindhoven (HTCE) is the empirical object of this study. This opportunity came from the close cooperation between the Technische Universiteit Eindhoven (TU/e) and the HTCE. The Campus is currently implementing a policy towards Open Innovation and apparently provides an ideal setting for studying knowledge management and sharing. In line with increasing necessity of cooperation among industries, universities, research centers and public institutions, the HTCE plays an important role by sponsoring knowledge flows within the region of Eindhoven. It also supports spinoffs and new technology related entrants of the region.

The HTCE started when, in the late 1990s, Royal Philips Electronics initiated the construction of a High Tech Campus in the city of Eindhoven, the Netherlands. In the process of becoming a major private Science Park in Europe, its location in a knowledge and technology intensive region helped the Campus to evolve into a technology centre with global reputation. As such, the label of ‘Open Innovation’ has been adopted to define its emerging strategy. Nowadays, Philips acts as the Anchor firm trying to negotiate and motivate knowledge flows among the Campus residents.

The Campus’ objective is to generate opportunities for co-operation and joint ventures, creating valuable partnerships and turning ideas into business ventures. The Campus’ infrastructure provides adequate setting for such cooperation. Its environment, also known as an ecosystem, includes several companies living together which facilitates the development of new strategies towards a new way of doing businesses at the value network level. The Campus’ corporate brochure presents its strategy as “… the unique ‘Tri-part’ benefits of High Tech Campus Eindhoven through shared facilities, value network and R&D programs”. The Campus focuses on high technological areas such as microsystems devices, embedded systems, signal processing and nanotechnology, offering opportunity for research through formal partnerships and consortiums. In a closer analysis, it is evident that the HTCE depends on its member firms to achieve successful results, but at the same time its companies also rely on the Campus. Such a context enables a self-contained environment with major opportunities.

3.2 – Design Oriented Approach

This graduation project follows the science-based design oriented approach (Romme and Endenburg, 2006). This approach distinguishes between science and design methods. Romme and Endenburg argue that science develops knowledge about what already is; whereas design involves human beings using knowledge to create what should be, things that do not yet exist. Science-based design is further defined as the entire body of intellectual though, analytic, partly formal, and partly empirical knowledge for design processes. Many academic researchers focus on explaining what is, but just a few consider a design oriented approach, i.e., the generation of knowledge to improve organizations. In a design oriented research, the acquired knowledge can be later codified onto design rules. The research model of a science-based design oriented approach consists of 5 steps: organization science, construction principles, design rules, organization design and implementation & experimentation (Romme and Endenburg, 2006). In this graduation project, construction principles and design rules are considered together to simplify the framework of study. This set is labeled design principles.
Romme and Endenburg describe organization science as the cumulative body of key concepts, theories, and experimentally verified relationships useful for explaining organizational processes and outcomes. Therefore the place of our theoretical review is between Organization Science and Construction Principles. After carrying out the empirical research, rules are to be formulated in terms of "to achieve A in situation S, do D" (Romme 2003). In our study, D will involve the design characteristics of the HTCE. Design principles and design propositions in this graduation project should facilitate the learning and the knowledge transfer between firms and knowledge workers. Design principles should be validated by the empirical research. Design propositions emerge as insights from the analysis and related design principles.

Among the Construction Principles, or design characteristics in case of this graduation project, two movements were noticed to exist: deliberate and emergent design characteristics. These movements are classified according to their origin. Deliberate design characteristics are the ones previously studied and premeditated planned to perform a role within the strategy. Emergent characteristics, although predicted to be influential in the process, were not deliberated structured to work as they do. Nevertheless, emergent characteristics are also susceptible to manipulation and guidance to excel in important roles.

3.3 – Analytical Framework

The framework is elaborated to identify critical relations necessary for the long-term sustainability and growth of the HTCE ecosystem. The factors comprising the analytical framework were developed from the previously presented theoretical background and discussed research problems. These factors were incorporated in the study’s framework due to their known influence on knowledge sharing and Open Innovation practices of the HTCE. Therefore, their occurrence within clusters and science parks is an assumption. Figure 2 shows the general framework of research.

Design characteristics are identified and investigated throughout the project, becoming a support to the recognized design principles. Due to the scope of this graduation project, generative mechanisms and innovation and organizational performance are not individually discussed. Nevertheless, reference to it exists throughout the graduation project. In the following sections, knowledge sharing, design characteristics and the contingency variables of the research are discussed.
3.3.1 – Knowledge Sharing

Knowledge sharing consists of three phases (Hansen et al., 2005): deciding to seek knowledge, searching for knowledge and transferring knowledge. Deciding to seek knowledge is a decision making process which involves motivational stage of workers. Searching for knowledge is a phase to look and identify useful knowledge. Transferring knowledge is moving and incorporating knowledge. Additional issues regarding these knowledge sharing phases are the benefits of weak ties in searching non-redundant information, the problems of willingness and ability to share knowledge, and the distinction between transferring codified and tacit knowledge (Hansen, 1999).

Borgatti and Cross (2003) also pay attention to the phase of seeking knowledge. The authors propose a formal model of information seeking, where the probability of seeking information from another person is a function of (i) knowing what the person knows; (ii) valuing what that person knows; (iii) being able to gain timely access to that person’s thinking and (iv) perceiving that seeking information from that person would not be too costly. They also suggest that the knowing (i), gaining access (iii) and cost variables (iv) mediate the relationship between physical proximity and information seeking. Literature review supports that the amount a person seeks for knowledge of others is positively related to what this person knows about the others, i.e., their awareness of the knowledge of others. Regarding transferring knowledge, to maximize this phase potentialities, the knowledge transfer should involve exchange of pertinent knowledge. In addition, the usefulness and effectiveness of the information shared is of great concern.

Knowledge sharing can be formal or informal. Formal knowledge sharing are the ones occurring as fruit of formal contracts and partnerships. Among firms, these can assume the form of alliances or joint ventures. A joint venture is a legal entity formed between two or more parties to undertake economic activity together. The parties agree to create a new entity by both contributing equity, and then they share in the revenues, expenses and control of the enterprise. The venture can be for one specific project or a continuing business relationship. In contrast, a strategic alliance, although also a formal partnership, involves no equity stake by the participants and it is a much less rigid arrangement. Grant (1996) refers to it as partnerships involving market contracts, which he argues to be a “typically inefficient mean for transferring knowledge”. Spin-ins and spin-offs are also considered as a source of formal knowledge sharing. Formal sharing of knowledge tends to engage hierarchical structures, generally leading to a centralization process.

Informal knowledge sharing, on the other hand, can be seen as the sharing of knowledge independently of formal contracts and formalities. These are spontaneous and autonomous, being strongly based in social interaction. Grant refers to it as relational contracts, either in individual strategic alliances or broader interfirm networks. Grand argues that such relational contracts provide the “reputational assets and repeated-game characteristics necessary to avoid the inefficiencies associated to knowledge sharing”.

3.3.2 – Design Characteristics

Based upon literature on cluster and science parks (see chapter 2.3) the design characteristics were classified into distinct groups, according to their founding principles. The first category of design characteristics is discussed under the label of infrastructure. The second set of characteristics is supported by literature on intellectual capital. As a result, social capital was identified as a pillar of this pool of characteristics. The other identified groups were knowledge ecosystem and rules & agreements. Below is an overview of the design characteristics.
Infrastructure Characteristics

Infrastructure characteristics involve direct and indirect assets of clusters and science parks. Such assets have a relation with physical proximity, allowing shared facilities and services to become essential. This set of design characteristics is related to a knowledge that is institutionalized within the cluster. Youndt et al. (2004) defines this institutionalized knowledge as residing in, and utilized through, data-bases, patents, manuals, structures, and processes. Important considerations regarding these characteristics are:

- Intranet, e-mail, telephone and face-to-face meetings represent different infrastructure outcomes.
- There are important differences between ICT and co-location, such as easiness and spontaneity of knowledge and capacity to overcome time and space.
- Do infrastructure characteristics stimulate each other or do they make each other superfluous?

(i) Physical Proximity & Co-location

Close geographic location has been shown to result in knowledge spillovers from firms and from university research in many industries, especially high-tech (Porter, 1990). Van der Bij et al. (2003) found evidence that firms consider physical co-location an important factor enhancing knowledge dissemination. Although co-location is not required for the transfer of explicit knowledge, the codification process of tacit-to-explicit knowledge, as described by Hislop (2005), is made much more efficient by co-locating professionals. Hislop argues that co-located employees are no longer required to carefully codify their tacit knowledge to transferable explicit knowledge. This happens because knowledge can be shared in a tacit-to-tacit (face-to-face) manner. At the interorganizational level, the effects of co-location can be noticed on the discussion of clusters and science parks. Several articles draw on the common rationale that territorial agglomeration provides the best context for an innovation-based globalizing economy. Asheim (2002) and Asheim and Isaksen (2002) show that this happens mainly because of localized learning processes and 'sticky' knowledge, grounded in social interactions.
(ii) Shared Facilities and Services

At clusters and science parks, a variety of facilities and services are available to save on capital investments. These shared facilities and services provide opportunity to share ideas and experiences. At leading clusters, a complete package of professional services, from logistics and organizational support till ICT and communication services are available. In addition, the sponsorship of networks having experts of various disciplines is another goal of this design characteristic. Such objective is achieved by people meeting people, whereby the direct contact with knowledge, skills and questions generated by others stimulates new contacts. Shared services may help researchers to find the right people and channels for technology development and business financing. It might put researchers in touch with the right technologies available at the market or even leverage rich discussions on innovative programs.

(iii) ICT

Van der Bij et al. (2003) define ICT as a medium that supports and enhances the communication-related activities of organizations. The argument is that ICT helps to overcome space and time constrains in communication, to increase the range and depth of information access, to target groups more precisely and to enable knowledge to be shared more rapidly, more conveniently and less expensively. Song, Berends, Van der Bij and Weggeman (forthcoming) propose a moderation of co-location on the possible effects of ICT. In their study, the effects of ICT on knowledge dissemination are higher if employees are co-located (as opposed to a dispersed work force). At clusters and science parks, a portfolio of ICT services is available, including IT infrastructure, applications, business information systems, library and on-line documentation. ICT also includes the related infrastructure on shared facilities.

According to the media richness theory (Daft and Lengel, 1986), a fit must exist between the type of information being shared and the communication channel chosen to transmit this information. To reduce the ambiguity in certain settings, the chosen information system needs to be a rich communication channel, such as face-to-face meetings. The media richness theory defends that, in an ambiguous and uncertain setting, as the development of a radical new product or the start-up of a new enterprise, both rich and lean ways of communicating are needed for processing information. When the purpose is more of an incremental nature, and hence the ambiguity is lower, a shift towards the use of lean media such as ICT can occur. According to Daft and Lengel (1986), ICT is a relatively lean medium through which it is difficult to transfer rich information, i.e. information regarding ambiguous issues stemming from different frames of relevance.

Social Capital Characteristics

Social capital refers to the collective value of all ‘social networks’ and the inclinations that arise from these networks to do things for each other (Putnam, 2000). However, the concept underlying social capital is much older. The first cohesive exposition of the term was done by Pierre Bourdieu in 1972. Bourdieu places the source of social capital not only in social structure but also in social connections. Therefore social capital can be seen as the aggregate of actual or potential resources which are linked to the possession of membership in a group (Everingham, 2001). Subramanian and Youndt (2005) present two arguments that further support this set of design characteristics. Initially, human capital in organizations is inevitably tied to social capital. As consequence, it may be imperative for organizations to invest on the development of social capital in order to provide to their knowledge workers the necessary conduits to network and share their expertise. Secondly, social capital appears to be the bedrock of innovative
capabilities. Subramanian and Youndt argue that communication is the "fluid diffusion" of information and knowledge sharing, which are vital elements of innovative capabilities. The authors argue that investments in social capital are fundamental for developing a range of innovative capabilities and acquire the flexibility to use them to meet market and competitive exigencies.

(iv) Informal Networks

A basic social capital characteristic to be included in the study is the informal network of employees. Dahl and Petersen (2004) report a positive effect of these networks. In their study, informal networks increased on knowledge sharing and employee's knowledge acquisition. Their findings confirm that employees do share valuable knowledge with informal contacts. Tallman (2004) also reaches a similar conclusion through the study of untraded interdependencies, i.e., the knowledge exchanged informally and without explicit compensation. These informal networks may emerge as the result of the cultural environment of clusters and science parks. They can be stimulated by the interaction of workers, social events and formal routines.

(v & vi) Meetings

Frequent meetings in an interorganizational network enable and improve knowledge sharing because of the opportunity of frequent communication and interaction through face-to-face contact. These frequent face-to-face interactions create a social community, thus generating a network identity (Dyer and Nobeoka, 2000). Dyer and Nobeoka exemplify it by referring to Toyota and its monthly supplier meetings, in which associations of suppliers are able to disperse knowledge and information. Meetings support knowledge sharing by sponsoring storytelling and sensemaking. As individuals share what they have learned, say Boyce and Franklin (1996), shared mental models emerge which determine what is remembered. People tend to remember better the knowledge that is shared through stories, since they can easily reproduce it when a similar subject occurs. As evidenced by Abma (2003), storytelling is vital to facilitate knowledge management within organizations. Abma's case studies indicate that storytelling workshops foster organizational learning, by enabling participants to exchange stories and to talk genuinely about their experiences and concerns. Ultimately, storytelling allows individuals to ask questions, a fundamental process of organizations that learn.

Formal Meetings: Colloquiums, Seminars and Workshops

Formal meetings include a vast diversity on educational background, personnel interest and motivational forces of individuals. These formal meetings vary from technical workshops, seminars and fairs, to more specific debates in symposiums, conferences and colloquiums. Dyer and Nobeoka (2000) report the example of Toyota as a success story of formal meeting. At these meetings, Toyota employees are co-located with its suppliers, with the goal to report results and share information. Toyota benefits with quality improvements and problem solving successes.

Informal Meetings and Social Events

Informal meetings and social events have been proposed as additional variables occurring to leverage the social capital at clusters and science parks. The main purpose of such events is to be as "generic" as possible, giving opportunity to different knowledge workers and specialists to participate in the same experience. Examples of such events are happy hours, sport related events and celebration meetings. On informal meetings, groups develop norms that reduce uncertainties which later provide a clearer course of action to the whole group (Feldman, 1984).
(vii) Knowledge Brokers

According to Brown and Duguid (1998), knowledge brokers are primarily individuals who participate in different communities. Since knowledge brokers participate in several communities, they function as a 'bridge' between those communities. This bridge position allows them to exchange information between different parties. Cillo (2005) argues that knowledge brokers act as third parties who connect, recombine and transfer knowledge to companies in order to facilitate innovation. Cillo also recognizes a new type of knowledge broker: the internal broker. Internal brokers are "individuals or teams who manipulate knowledge to facilitate the process of internal transfer between different groups or communities" (pp. 405). Some authors classify these resources as gatekeepers (Allen, 1977). Harada (2003) defines gatekeeper as "individuals who are capable of understanding and translating contrasting coding schemes" (pp. 1739). For Spencer (2003), gatekeepers are conceptualized as "firm-level constructs that absorb knowledge from other (foreign) firms and convey it to their domestic firm" (pp. 432).

(viii) Shared Identity

At clusters and science parks, a base for a common shared identity is noticed to exist. Thompson (2005) evidences that, while working within project teams, a common feature of the staffs' daily activities involves a considerable amount of interaction at the group level in the form of ongoing activities. Much of a group's sense of cohesion appears to derive from this interaction. In such scenarios, group members have to develop their own strong sense of collective identity, which appears to be rooted in these vigorous daily activities. Boer (2004) refers to a communal sharing relationship which occurs within bounded group of people as equivalent and undifferentiated. According to Boer "people in a communal sharing relationship often think of themselves as sharing some common substance, and hence think that it is natural to be relatively kind and altruistic to people of their own kind".

Rules and Agreements

Rules and agreements emphasize the parties' underlying interests and responsibilities, and emerge to regulate exchange activities. They may include the trade of goods, materials, documents or simply knowledge between the parties. Clear rules can reduce mistrust among members and increase the efficiency of processes, however when agreements are not clear or not beneficial for both parties, the development of trust can be a challenge (Newell and Swan, 2000). Three subgroups form this category.

(ix) Intellectual Property Rights

Intellectual property rights are the rights given to persons over the creations of their minds. They usually give the creator an exclusive right over the use of his/her creation for a certain period of time. Intellectual property rights are customarily divided into two main areas: copyright and industrial property. This graduation project focuses on industrial property, which can be further divided into two areas: the protection of distinctive signs (in particular trademarks) and the protection of the primary stimulus toward innovation and creation of new technologies. It is within this latter category that inventions (protected by patents), industrial designs and trade secrets fall. On this category, the social purpose is to provide protection for the results of investments made in the development of new technology, thus giving the incentive and means to finance research and development activities. A functioning intellectual property regime should facilitate the transfer of technology in the form of foreign direct investment, joint ventures and licensing.
(x) Regulations and Practices

This set refers to practices, regulations and administrative procedures which determine the "dos" and "don'ts" of members of clusters and science parks. These agreements aim to constitute commitment in the organization by demonstrating the formal reciprocal attitude (Muthusamy and White, 2005). At clusters, such regulations vary according to national and regional norms and the general strategy of institutions. Practices and regulations are treated through formal contracts, usually established at the beginning of the membership, or via informal agreements built throughout the development of the partnership. By making agreements and establishing contracts, the mutual benefits and efforts of the relationships are defined (Newell and Swan, 2000).

(xi) Financial compensations

At clusters and science parks, costs emerge as the result of benefits acquired by the resident companies. Benefits vary from physical facilities and infrastructure, to assistance on services, environmental and legal matters. Some costs are implicit on the regular fees charged on members, while others are directly linked with the service or product provided. Costs are often described based on the timing or applicability of the service or product granted.

Knowledge Ecosystem

At this set of design characteristics, attention is given to the homogeneity and diversity of the firms residing at clusters and science parks. Special concern involves the decision if the competences and capabilities of companies joining clusters and science parks should be aligned with the business model of the Anchor firm, in order to reach maximum value of the combined (technological) capabilities of the partnerships in the ecosystem. In contrast, the decision could be to involve companies that have a differentiated base of expertise. In this study, the distinction on homogeneity and diversity of knowledge is based on two different areas: functional expertise (similarity of the activities being performed) and organizational context (similarity of the organizational context in which knowledge is being shared). Examples of similar functional expertise include knowledge sharing between researchers of the same department about how to perform a scientific research. Examples of similar organizational contexts involve small and medium-sized enterprises (SMEs) who want to share knowledge in a particular field of innovation or want to combine their forces in fields like standardization or market information.

(xii) Homogeneity

Homogeneity helps to overcome the lack of a common language. It provides clusters with a similar knowledge base guiding to specialization of labour and research. Calderini and Scellato (2005) argue that specialization is positively correlated with innovation. Homogeneity further facilitates the development on project base and scientific research involving academic interaction (Cooke, 2004). Homogeneity suggests that future interactions will be free of conflict. Actors with a similar shared background are likely to trust each other more than partners with a different background (Nooteboom, 2000). However, contradictory findings also exist on what regards the influence of similarity on functional background. Hislop et al. (2000) claim that these contradictions concern mainly the motivational and relational dimension of knowledge sharing, demanding that an integrative framework is applied for understanding knowledge sharing in such organizational context.
(xiii) Diversity

Diversity allows contact with different institutional frameworks which may support different types of innovation (Whitley, 2002). The presence of innovation support organizations like venture capitalists, patent lawyers, merchant banks and consultants that are necessary to exploit and commercialize scientific findings (Cooke, 2001). Due to the division of labor and consequent fragmentation, specialization and distribution of knowledge, it becomes a requisite to integrate a diversity of complementary knowledge in order to achieve the collective outcomes (Grant, 1996). At the end, this diversity of collective outcomes will result in a diversity of different organizational settings, in which knowledge is being shared differently. Such organizational settings are implemented, or emerge, since none of the actors involved can produce the collective outcome individually. In this respect, knowledge sharing becomes the main driver of clusters with a diversity of knowledge. The diversity of knowledge within clusters helps new and existing enterprises around the region to improve customer relationships, enhance partner collaboration and create efficiency across their supply chains and business operations.

3.3.3 – Contingency Variables

In the next paragraphs, the contingency variables used in the study are discussed. Adding these variables to the research framework supports to identify to what extend knowledge sharing differs on distinct knowledge flows. To conduct such analysis, it is first necessary to understand what variables may affect knowledge sharing at the HTCE. Supported by the Open Innovation and knowledge management background, the chosen variables were: intra & extra HTCE knowledge flows, new & existing relationships and intra Philips Research, inter Philips business units & extra Philips knowledge flows. Each of these contingency variables moderates the sharing of knowledge and can contribute to the amplification, or reduction, of the influence of a particular design characteristic.

Intra & Extra HTCE knowledge flow

A priority is to understand if knowledge sharing within and across the boundaries of the Campus occurs in the same manner and generates the same outcomes. Because resident companies participate on the Open Innovation policy of the Campus, relevant flows of knowledge are predicted to exist in both, intra and extra Campus contexts. Knowledge sharing and existing networks within and across the boundaries of the Campus, may present differences in the type of assumptions made and partnership agreements between the parties. Expectations, and the consequent level of satisfaction regarding knowledge sharing and networking, may as well be affected by this contingency variable.

New & Existing Relationships

The classification of relationships in new or existing supports the distinction between partnerships that previously existed, either in a high frequency or in a sporadic way, from the ones that have been just initiated. This differentiation is relevant because knowledge sharing is strongly affected by the existence of previous interaction. The 'Drexler/Sibbet team performance model' (Patti et al., 1997) describes seven stages that new teams go through: orientation, trust building, goal/role clarification, commitment, implementation, high performance and renewal. According to this model, same-time/same-place communication is needed in the first two and in the last stage (when ambiguity is high). During goal/role clarification only same-time communication, e.g. telephone, is needed (trying the reduction of uncertainty). During the implementation and high performance stages, the communication can occur at different times (written document and alike). Thus, it is expected that a positive moderation of existing
relationships, on which trust is high, may be particularly important to social capital design characteristics by fostering new contacts and relationships. In addition, critical periods such as ambiguity and uncertainties phases, may be reduced due to previous interactions, which comprise previous knowledge about team work process and performance, and individuals and team behaviour.

**Intra Philips Research, Inter Philips Units & Extra Philips Knowledge Flows**

With this distinction, the aim is to capture similar influences as discussed in the first contingency variable (intra额外 HTCE). However, within this differentiation, boundaries are set around Philips Research and other Philips business units, taking into consideration their role as part of the Anchor firm of the Campus. As argued by Feldman (2003), when the analysis of clusters and science parks is done from an Anchor firm perspective, innumerable opportunities on knowledge sharing emerge. One such is to perceive how the Anchor firm influences the residents by attracting skilled labour and specialized industries possessing similar knowledge base. The dependence between the Anchor firm and the new entrepreneurial start-ups of the cluster might influence the success of knowledge sharing among the partners. Thus, the characteristics of the HTCE may influence both internal and external Philips knowledge flows in different ways (intra & extra Philips).

By adding the perspective of Philips as an Anchor firm, and the distinction between its product divisions, it is possible to better evaluate the knowledge flows occurring at the Campus. The fact that the Anchor firm co-exists with small firms often imply the existence of different advantages and expectations regarding knowledge sharing.

In the figure below the design characteristics, contingency variables and knowledge sharing phases are developed into the research framework.

### Design Characteristics

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**Figure 4 - Detailed Research Framework**
4. Methodology

This chapter discusses the research strategy, the investigated subjects (unit of analysis) and the procedures for collecting the data. The discussion on data analysis is the closure of the section. The recommendations by Yin (1994) were used as general base-line. The books from Miles and Huberman (1994) and Strauss and Corbin (1998) were also used.

4.1 – Research Strategy

In general the study applies an exploratory perspective based in a qualitative and design oriented approach. Following the design oriented approach (Romme and Endenburg 2006) will allow us to formulate design principles after the empirical research. Through this approach the goal is to understand how principles and mechanisms of the emerging policy of the HTCE affect its success factors. In this way, we aim to contribute to the overall design of the HTCE by developing design principles related to the existing knowledge base and characteristics of the Campus, which should facilitate learning and transfer of knowledge between different projects, firms and knowledge workers.

A qualitative approach is applicable to the graduation project because the questions at hand, and the related design principles and design propositions are not easily codified. Since the study’s aim is to explore and understand the mechanisms of emerging characteristics of the Campus, a quantitative research is not suitable; instead qualitative types of data collection are more appropriate (Yin 1994, Miles and Huberman 1994).

Over the past decades, more systematic procedures have been developed (Yin, Strauss and Corbin, Miles and Huberman). This study particularly follows the matrix-base approach of Miles and Huberman. An explicit and systematic method supporting the qualitative analysis is performed on a computer program (NVivo). Besides assisting the researcher, this software is expected to minimize the effects of ‘self-delusion’ barriers. This strategy is also in line with the recommendations from Miles and Huberman.

Regarding the strengths of qualitative studies, one is that it focuses on naturally occurring, ordinary events in natural settings, so that it is possible to capture what real life is. The fact that data is collected over a period of time makes it adequate for studying desired processes and relationships. With a qualitative approach it is possible to go beyond the ‘snapshots’ of only measuring ‘what’ and ‘how many’. The inherent flexibility of qualitative studies (data collection, analyses and findings) give us further confidence that we will understand what is necessary for answering the proposed research questions.

Unit of Analysis

The unit of analysis was chosen after close examination of the available possibilities within the literature. Van Aken, Berends and Van der Bij (2006) identify four objects that can be used as unit of analysis to investigate knowledge sharing: orders and projects, events and incidents, organizational units, and business process or organizational systems. The chosen unit of analysis should be strongly related to the problem at hand.

This study focuses on events and incidents. The decision was also supported by Hoopes and Postrel (1999). In their study, a new technique of measurement is developed. It is based on the analysis of ‘glitches’, which is argued to be easier to operate than other methods for studying knowledge. The authors define glitches as “a costly error possible only because knowledge was not shared”. Glitches were measured from the analysis of events that were useful to their research, which ultimately offered a more practical way of measuring the importance of shared knowledge. While the application in their paper is
related to product development, the analyses of specific incidents is also useful in studying how shared knowledge affects other decisions crafted collectively by differentiated specialists, such as business and research programs. Furthermore, we do not focus on negative incidents but positive ones, not on absence but presence of knowledge sharing.

The graduation project addresses knowledge sharing between organizations working closely together within an Open Innovation environment. Therefore, the focus of our analysis becomes knowledge sharing events (episodes/experiences) that occurs in the process of transferring an innovation, idea or knowledge to other firms, always considering an technological background. The selection criteria of these events, as well as of the participants, are discussed in the following sections.

Selection of Events

Theoretical sampling was used to support the selection criteria. According to Strauss & Corbin (1998), theoretical sampling involves data gathering driven by concepts derived from the evolving theory and based on the concept of making comparisons, whose purpose is to go to places, people, or events that will maximize opportunities to discover variations among concepts and to densify categories in terms of their property and dimensions. By using theoretical sampling, we intend to increase the potential of analyses regarding the comparison of events, allowing the assessment of how a category varies in terms of its main characteristics. Because of our objective to compare different knowledge flows, the goal is to select events of knowledge sharing among actors that fill the criteria of the previously discussed contingency variables. Below a review of these variables, as well as an overview of the model containing targeted events and related knowledge flows are presented.

- Knowledge sharing within the Campus and/or knowledge sharing with parties outside.
- Knowledge sharing within Philips Research, between Philips units and with partners from outside.
- Knowledge sharing within a longstanding relationship and/or knowledge sharing with new partners.

Figure 5 - Model representing the targeted events of knowledge sharing

In order to reach representative events, two distinct selection procedures were used. The first method, a top-down approach was based on indications from mentors within the Open Innovation project. Such method aimed to achieve access to crucial and strategic events. The second method, a bottom-up approach, involved the selection of episodes through the accomplishment, and latter analysis, of informal interviews. These informal interviews were performed with randomly selected employees of the Campus. These individuals were reached during seminars, colloquiums, workshops and social events occurring at the Campus. Contacting workers in social areas and shared facilities of the Campus was also a strategy.
4.2 – Gathering Data

Yin (1994) further suggests three principles of data collection for case studies: use of multiple sources of data, creation of a database, and maintenance of a minimum chain of evidence. These were also adopted throughout our descriptive research. Yin proposes the use of multiple sources of evidence as a way to ensure construct validity and reliability. As a result, this graduation project uses interviews, direct observation and documents as multiple sources of evidence (triangulation approach).

Among the sources of data collection, semi-structured interviews were the main provider of information. The choice is supported by Berends (2006), where the interviewing of individual persons is argued to be sufficient to "uncover individual factors influencing knowledge processes". Additionally, such approach gives the researcher the opportunity to gain direct interaction with professionals of the innovation area. The semi-structured interviews were conducted with researchers, managers and other employees, both within and outside the Campus. To achieve a consistent series of interviews, a specially designed interview guide was used. This guide was used to direct the researcher, with supporting data being acquired through preliminary searches on the web (intra and internet), available documents and review of interviews already performed (triangulation platform). Some strategic interviews were also recorded allowing the researcher to freely scan its content. Additionally, this strategy aimed to support future researchers working in the 'Open Innovation project High Tech Campus - TU/e'.

Important stages of the data collection occurred during the meetings of the Open Innovation project, where multiple researchers from Philips, HTCE and TU/e have participated. On these meetings, literature review and research proposals were discussed to uncover potential issues and opportunities. Directions for the study design were also discussed, as well as emerging findings and insights. In additions, interviews were conducted with members and coordinators of the Open Innovation project to ensure commitment to the project and get an overview of the Campus and events that could be investigated. In parallel to the semi-structured interviews on knowledge events, further interviews were carried out to support the considerations of the Campus overall ecosystem and related design characteristics. These were performed through quick-interviews planned with members and users of shared facilities and services of the Campus. In order to remain on the track of the theoretical model of the study, these quick-interviews were based on the same guide developed for the semi-structured interviews. Interviews were later extended to reach coordinators of these units, who supplied additional data for the research. The list of identified organization of supporting services, as well as its location at the HTCE follows in the Appendix.

Besides interviews, information was also gathered by direct observation of the related design characteristics, such as the environment at shared facilities and the knowledge flows occurring during colloquiums and seminars. By directly observing how employees go about sharing knowledge and asking questions regarding the selected events, it was possible to get a better insight of the problems and opportunities arising during the processes of knowledge sharing. It was evident that within the Campus the necessary knowledge to be transferred is, to some extent, contextual and tacit.

The observations of knowledge sharing episodes also included the presence on formal and informal meetings. Formal meetings included colloquiums, sponsored by and restricted to Philips Research, and the Campus Technology Seminar which was an open event to all Campus Residents. Informal meetings varied from cultural experiences such as the lunch concerts to specific meeting such as better-2-getter, a get together event dedicated to international workers which occur every third Thursday of the month.

In addition to interviews and observation, archival data was also investigated. The event's notes and information, e-mails and other formal documents were inspected, and all possible relevant data codified in
the research dataset in NVivo. This was also considered as vital to the exploratory phase. During the phase of data collection, the researcher followed the daily routine on the Campus. All observations were recorded in a personal logbook during a period of six months. These observations were then analyzed and codified. The research database was stored on NVivo software.

During the data collection process, the use of memos was crucial to the development of the research. By memos, we mean written records of analyses that may vary in a wide range of types and forms. These were intended to be analytical and conceptual, rather than descriptive. The memos were elaborated in two ways: the old-fashioned way, i.e. by hand and the more up-to-date technique using NVivo. The aim of using both procedures was to allow a more structured form of research without restricting the researcher’s creativity and momentary insights.

4.3 – Analyzing the data

At the HTCE, it was possible to successfully identify, and explore, innumerable flows of knowledge. On the Appendix the summary of the relevant events collected during the empirical research is available. The classification of these according to the predefined contingency variables is also included on the table.

During the interviews and meetings with researchers and knowledge workers of the Campus, an alternative to this unit of analysis was identified. This alternative was labeled as routines. These routines, differently from the previous referred events, had the counterpart of the knowledge exchange either not identified by name, or considered as the average outcome with the specific department of firm referred. The emergence of this alternative object of data analysis was found to have two origins. One was due to the manner interviews were conducted. It was either not possible to extend the queries in a deeper detail to all events, or the interviewee could not record (remember) the names and particularities of the several experience he/she had regarding these specific experience on knowledge sharing. As consequence, we understood this as an involuntary reason for not explicating the actors involved. On the other hand, the other cause of capturing routines instead of specific events was considered to have a voluntary reason. Simply saying, actors were concerned whether they were allowed to share the related knowledge, and as consequence, there was a protection of the actors and knowledge involved on the event. This topic is later discussed in chapter 6. It is important to remark that the majority of the interviews were recorded as part of the methodology of the study. This contributed to the occurrence of this second origin of routines. The Appendix presents an overview of the identified routines, as well as its categorization according with the contingency variables.

The investigation of selected episodes and routines formed a map that allowed the evaluation of knowledge sharing at the HTCE. It also let specific considerations about the design characteristics to be formed. It was possible to understand the context on with companies joining the Campus were involved, and to identify design characteristics related to effective knowledge sharing events. The recognition of which design characteristic best fit the different knowledge sharing phases (deciding, searching and transferring) was also achieved. Based on emerging findings from the analysis, the proposed theoretical model was evaluated and, in some extent, adjusted. Then, supported by up-and-coming insights regarding the analytical framework, design principles were explored with the aim to improve knowledge management at the Campus.

Throughout the research, coding was used to support the collection and latter analysis of the data. As defined by Miles and Huberman (1994), codes were used as tags or labels for assigning units of meaning to the descriptive or inferential information compiled during a study. In this research, we applied three
distinct types of coding: descriptive, interpretative and pattern codes. By employing descriptive codes, the purpose was to entail little interpretation and only attribute a class of phenomena to a segment of the text. Interpretative codes were used as result of interpretation of interviews' segments and other supporting documents. Pattern codes allowed more inferential and explanatory analyses. These pattern codes were used later in the course of data analysis. As guideline to create codes, a provisional start-list of codes was elaborated prior to the field work. This list emerged from the previous discussed theoretical background, conceptual framework and research questions. By systematic coding in NVivo the chain of evidence was maintained.

To analyze the data, the grouping and predictor-outcome matrix methods proposed by Miles & Huberman were considered. On this study, the predictor was interpreted as the design characteristics of the Campus and the outcome as the defined categories of knowledge sharing (phases and formal/informal). The comprehension of how the proposed contingency variables influence the relationships between design characteristic and knowledge sharing was also a method used during the analysis. The outcomes of grouping and matrices is presented, and then discussed in the next sections.

By adopting the two principal methods proposed by Eisenhardt (1989), the risk of improperly interpreting atypical events was minimized. The first method involved arranging the interview transcripts and notes into chronological order. Transcripts and notes were then juxtaposed and common and unique perceptions of events identified. This process highlighted areas where further investigation was required. The second method required reorganizing the original transcripts and notes around key identified constructs.

Theoretical comparisons composed the core of the analysis. They were derived from experience acquired during interviews and initial data analysis. As referred by Strauss and Corbin (1998), each incident was compared at the property level for similarities and differences, and then grouped into specific categories. According to the outcome of interviews, direct observations and document reviews, conclusions were developed using contingency variables as groups of comparison. In the figure below a graphical representation of the groups is shown. Deeper analysis of eventual discrepancies and similarities was performed, as for example, in matching the events occurring on new relationships within (intra) the HTCE with knowledge flows occurring in existing relationships with partners from outside (extra) the Campus.

![Figure 6 - Example of guide for systematic comparison of different phenomena](image)

Keeping a record during coding was also important. Strauss and Corbin refer to the use of mini-frameworks designed to show relationships between concepts. They define it as small diagrammatic theoretical structures that arise as result of coding around a concept. In this study, mini-frameworks were used to get insights on relationships between categories. Additionally, evaluation of the usefulness of the knowledge shared was also carried out. This analysis investigated how participants of knowledge sharing
episodes experienced the benefits, and limitations, of the knowledge exchanged. The evaluation also incorporated the distinction on different knowledge sharing phases, since each phase generates a particular expectation, and effect, on workers. A comparison with predicted objectives and interests was also performed.

By applying such a research method, it was possible to find out how the Campus' design characteristics influence the knowledge sharing of its residents. Furthermore, this method allowed identifying whether employees, firms and the whole ecosystem of the Campus were able to profit from these design characteristics. Lastly, through the comparison of different events, we have obtained an important idea about the knowledge sharing occurring within the HTCE and compared success and failure stories.

4.4 – Limits

Some barriers associated to the chosen research approach are: (i) perceptions of interviewees were also used to uncover causes and consequences and (ii) the study was not longitudinal, which prevents uncovering changes in the situation. Another barrier is that knowledge sharing events and routines left room for further investigation. To get better insight into a broader set of employees, different kinds of data sources were used. An efficient way was to have employees participating in at least short interviews (the previously referred 'quick-interviews'). Additionally, the first mentioned barrier urged for inclusion of observation sources complementing interviews. The second barrier, non-longitudinal study, demands a more complex approach. It was partially overcome by gaining new information from the data sources, and by reconsidering the findings, after a short period of time, regarding a selected number of events and routines.
5. Analysis

The analysis section begins with the description of a number of knowledge sharing events. These provide evidence on opportunities and threats related to the design characteristics of the HTCE. Next, cross-analyses of events and routines regarding knowledge sharing at the Campus are presented. Such events and routines, and the knowledge exchanged during these opportunities, are also an advantage of the HTCE. Later, the design characteristics are individually discussed, leading to the identification of design principles. Lastly, an analysis regarding the contingency variables and the knowledge sharing phases is presented.

5.1 – Events and Routines

(i) Simulation Tool

The first event concerns the search and acquisition of knowledge via informal networks and knowledge brokers of the Campus. At the time of the event, Timo Roermund had been working at NXP, former Philips Semiconductors, for about 3 weeks (started on September 1st 2006). Within his initial activities at the company, he had to collect information on how to obtain the correct output from a specific simulation tool. This search and acquisition of knowledge is here used as a knowledge sharing event.

Initially, the worker searched for the knowledge within his network of colleagues, mostly from his department. However, no immediate success was obtained.

T. Roermund: “After asking several persons at the department no one could help me.”

Although the specific knowledge was not available, this network guided him to Kees van Berkel, a senior researcher of NXP and a former employee of Philips Research. It was Kees who directed Timo to the source of knowledge at HandShake Solutions, a company located at building 12 of the Campus. Handshake is a line of business of Philips dedicated to developing innovative IC design solutions.

Interviewer: “And HandShake Solution just helped you like that? I mean, you just knocked on their door and asked for help and they gave it?”

T. Roermund: “No ... it was Mr. Berkel that phoned them introducing me, and then Mr. Berkel gave me some directions.”

Kees van Berkel has a strong network within HandShake Solution. In the past, he was involved with the initial researches that culminated in the emergence of this Business Unit. Through his network, Kees van Berkel was able to identify the knowledge holder, Mark de-Wit, and introduce Timo to him. Timo was then able to reach Mark via face-to-face meetings, on which he acquired the necessary knowledge on the simulation tool.

Interviewer: “But still, I wonder why HandShake Solution helped him (K. van Berkel). Perhaps the Campus shared identity, or he had some informal contact with them (HandShake) ... do you imagine why?

T. Roermund: “This is easy...he (K. van Berkel) was the one who started with the project at Philips Research that has originated HandShake Solution.”

Figure 7 - Model representing the simulation tool event and its knowledge flows
Through this event, we observed the support of several design characteristics. The informal network of both, Timo and Kees, were fundamental to the process. The role of Kees as a knowledge broker mentoring and acting as bridge between Timo and HandShake Solution was of great importance. There was also physical proximity allowing the decisions involved on the phase of searching for knowledge to be easily taken. The phase of transferring the tacit knowledge regarding the simulation tool was also supported by face-to-face meetings frequently performed by the professionals (co-location). An unexpected finding was that the successfulness of the knowledge sharing process was highly dependable on the complementary work of a number of design characteristics. In other words, in eliminating or misplacing one of them, the final outcome of the event would be different.

Other findings emerging from this event were:

- Although this was an event with knowledge flows crossing the boundaries of Philips (under the contingency variable 'extra Philips'), the fact that NXP was the former Philips Semiconductors (a Business Unit of the Anchor firm) has supported the observed informal network.
- Informal networks were used with the perception of cost avoidance. The inknowledge gathered by Timo Roermund could have been obtained via a consultant (additional cost) or had taken longer to be obtained (generating indirect costs on the project due to time delay).
- At the event, the 'strength' and importance of the knowledge broker were noticed. His network and shared identity around the Anchor firm appeared to facilitate the broker function.

(ii) SME Routines

Now we focus our attention to routines of SMEs residing within the Campus\(^2\). We specifically refer to a problem solving routine involving a SME and some units of the Anchor firm. The interviewee was introduced by a knowledge worker involved in this graduation project. With this worker acting as a broker, a certain level of trust (in reference to the information being shared) was noticed during the interview. The meeting with the Manager of the SME was more open since the beginning and, at the end of the interview some usually unanswered questions were replied. It is important to say that besides the trust originally 'borrowed' from the sponsor of the meeting, the previous one hour of interview together with the agreement that some information would not be explicitly presented, helped to enhance the trust level among the actors.

The routines are at first simple, involving several problem solving situations. On these, the SME gathered useful knowledge that it effectively applied on its processes and products. The different units of Philips, which assisted the SME, did so through its researchers and shared services (Miplaza and ICT). Overall, a dependence of this SME on the achievements (solutions) obtained by its employees via their informal network was observed.

In addition to the recognition by the interviewee of the valuable knowledge acquired by the SME, another pattern was noticed. The perception was that those benefits originated from the informal

\(^{2}\) A few names and references are omitted upon request from the participants. More information on chapter 6.1 (hidden informal networks).
networks available at the Campus were not openly discussed. Such conduct restricts the development of the networks itself, once the knowledge holder or broker is not openly recognized. It also undermines the marketing of the Campus and compromise current efforts to leverage its visibility.

To provide the reader an idea of how important these informal networks used in problem solving situations are, we refer to the recently renegotiated contract between this SME and the Campus. Although the facilities, cleanrooms and related services were recognized as an important feature in favor of the Campus, the reason to stay within its boundaries, instead of moving to a cheaper location in Veldhoven, was entirely based on the existing informal networks that this SME has with researchers and knowledge employees of the several Business Units and spinoffs of the Anchor firm. In this sense, physical proximity and the access to the Anchor firm buildings and offices acted as facilitator for the excellence of the existing informal networks.

(iii) Cross-analyses

Search Engine - Liquavista and Bosch

Ruud Nagelkerke is responsible for the search engine tool, a service provided by the Library of the Campus. The interview with Ruud gave understanding of the ‘search engine’ and provided information about the usage of the tool by several Philips units (Philips Research, Applied Technologies, Semiconductors) and other companies within and outside the boundaries of the Campus. This tool allows researchers to search for articles, journals and people that have the relevant information they need. The search runs on several journals and databases, some being available only under subscription. The tool works with keywords and allows researchers to search and download articles, from both technical and business databases. The search engine does not only save time but also allows a more efficient search.

Ruud also works as a ‘filter’ while performing the search for the information requested and evaluating its results, as evidenced by the quotation below.

R. Nagelkerke: “It is amazing how you can lose a lot of information if you just google the subjects.”

(in reference to the non-identification of relevant information when simple search engines are performed outside the formal network of Philips Research).

The cross-analysis involves two events captured during the interview. One included Bosch Security Systems, an external company who possessed a previous relationship with Ruud. The other refers to Liquavista, a recent spinoff from Philips, located inside the Campus. The basic structure of the events consists of researchers from both Bosch and Liquavista running the search engine tool with Ruud.

Although the events differ with regards to being on the Campus or not, both faced similar issues while sharing knowledge: the necessity to deal with financial compensations and to manage one way through the boundary that exists around the Anchor firm and Philips Research. The financial compensations and barriers can be visualized through the necessity of approved purchase orders. These issues support the finding that the presence, or absence, of a company on the Campus does not completely support the exchange of information within the event. This gap in overcoming the barriers within the Campus was not initially predicted due to the idea of a Campus environment sponsoring

Figure 9 - Model representing the search engine routine and its knowledge
knowledge sharing. Moreover, the existing physical proximity appeared to not influence the experience with Liquavista, since the barrier encountered by the actors avoided that such characteristic became noticeable (it has higher relevance when the 'search engine' service is performed).

It is interesting to remark that, in both events, the lack of success towards the execution of the search engine had the same cause: the absence of a formal contract. In the case of Bosch, the new purchase order did not exist, although Bosch knew about its necessity. On the other hand, in the case of Liquavista, even being a existing relationship the researchers simply didn’t know about the necessity of such formal agreement after ‘spiningout’ of the Anchor firm of the Campus (Philips).

From the events, findings evidenced that for transferring knowledge (final knowledge sharing phases) happen successfully, formal agreements were necessary. From the interview supporting the events:

R. Nagelkerke: "...useful knowledge sharing will demand formal agreements."

On the other hand, the phases of deciding to seek and searching for knowledge appear to be positively influenced by the Campus design characteristics, in special by existing informal networks. It was through informal networks that researchers from Liquavista were able to avoid formalities and financial compensations by identifying fellow researchers that could run the search engine for them. These knowledge sharing phases were also influenced by the physical co-location of actors. For instance, the near access to the Library and other units of the Anchor firm gave Liquavista certain benefits not available to Bosch (as the easiness to arrange meetings and appointments to discuss the occurring issues).

Although Philips Research in Leuven, Aachen and Eindhoven belong to the same Business Unit, Leuven and Aachen are considered as external clients. Both, Philips Research in Leuven and Aachen have to pay, via purchase order, in order to use the services related to the search engine. Besides the additional costs, Leuven and Aachen have to cope with, these rules and policies imply the establishment of formal agreements and contracts. Relevant to the routine, is the fact that Philips Research Leuven and Aachen have the interest in the search engine tool. They are also willing to pay for it. However, the rules and agreements involved with the usage of the tool still work as a barrier. These limitations may also be restricting the utilization of potential knowledge brokers within the Campus Library. Reference to training sections given in Leuven, regarding the possibilities and opportunities within the search engine, was also gathered. The occurrence of these trainings (formal meetings) evidences that, although the group involved with the search engine tool is acting in a pro-active manner, the previously referred limitations constrains the existing efforts.
5.2 – Design Characteristics

In this section, design characteristics are individually analyzed. Besides the events and routines, the daily work at the HTCE gave further opportunity to join and explore formal and informal events. These experiences provided opportunity to investigate the integration of the different design characteristics of the Campus (e.g. shared facilities, meetings, informal network and extra cost). Some of these meetings and other events are later presented in this section. Below the analysis of the events and routines is summarized. Such summaries provided guidance to confirm perceptions gathered during the empirical research and to direct the project toward emerging insights.

<table>
<thead>
<tr>
<th>Event</th>
<th>Company Variables</th>
<th>Design Characteristics</th>
<th>Knowledge Creation</th>
<th>Tasks and Agreements</th>
<th>Appropriate Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simulation Tool</td>
<td>Philips</td>
<td>new</td>
<td>present</td>
<td>imp</td>
<td>present</td>
</tr>
<tr>
<td>CTT Trainings w/ Consultant</td>
<td>Philips</td>
<td>new</td>
<td>present</td>
<td>imp</td>
<td>present</td>
</tr>
<tr>
<td>CTT Trainings w/ Philips Lecturer</td>
<td>Philips</td>
<td>new</td>
<td>present</td>
<td>imp</td>
<td>present</td>
</tr>
<tr>
<td>SME - Silicon Valley</td>
<td>Philips</td>
<td>new</td>
<td>present</td>
<td>imp</td>
<td>fund</td>
</tr>
<tr>
<td>SE - Research</td>
<td>Philips</td>
<td>new</td>
<td>present</td>
<td>present</td>
<td>imp</td>
</tr>
<tr>
<td>SE - Laboratory</td>
<td>Philips</td>
<td>new</td>
<td>present</td>
<td>present</td>
<td>imp</td>
</tr>
<tr>
<td>GE - Phys Appl Tech Campus</td>
<td>Philips</td>
<td>new</td>
<td>present</td>
<td>present</td>
<td>imp</td>
</tr>
<tr>
<td>SE - Phys Appl Tech Sigma</td>
<td>Philips</td>
<td>new</td>
<td>present</td>
<td>present</td>
<td>imp</td>
</tr>
<tr>
<td>GE - Research &amp; Development</td>
<td>Philips</td>
<td>new</td>
<td>present</td>
<td>present</td>
<td>imp</td>
</tr>
<tr>
<td>EPO</td>
<td>Philips</td>
<td>new</td>
<td>present</td>
<td>present</td>
<td>imp</td>
</tr>
<tr>
<td>University</td>
<td>Philips</td>
<td>new</td>
<td>present</td>
<td>present</td>
<td>imp</td>
</tr>
</tbody>
</table>

| Examples of qualitative matrix on events and routines |

To guide the reader through this analysis section, some preliminary conclusions on the table below are now given. The frequent occurrence of some design characteristics was the first pattern to be noticed. Informal networks, knowledge brokers and physical proximity are some of them. Shared facilities and ICT, although frequently coded throughout the events and routines, were found to influence knowledge sharing only indirectly. These design characteristics were identified as important support to knowledge sharing, but not sufficient on its own. Other, such as informal meetings, diversity and shared identity were observed to have minor contribution to the current knowledge flows of the Campus. In the following paragraphs these design characteristics are discussed in detail.

As result of the analysis design characteristics were identified as deliberate or emergent. Such a distinction was based on the reasoning that deliberate design characteristics were directly managed to perform a role within the strategy, while emergent characteristics were only indirectly influenced. Findings indicate that the management team of the Campus is, in some aspects, guiding emergent design characteristics to influence knowledge sharing. Because in the following sections the distinction on these two different categories is used, an overview of this grouping is available next.
Table 2 - Grouping in deliberate and emergent design characteristics

<table>
<thead>
<tr>
<th>Infrastructure Characteristics</th>
<th>Deliberate</th>
<th>Emergent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Proximity and Co-location</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Several events show that physical proximity is fundamental to the existence of a cluster, however these events also evidence that this design characteristic is not sufficient to leverage knowledge sharing among residents. The arguments are highlighted in the paragraphs below. To start with, the findings of a cross-analysis of routines are used. It involves routines around the search engine tool and Philips Applied Technologies. The episodes refer to two distinct moments. The first goes back to the time Applied Technologies was located at the Strijp (neighborhood in Eindhoven). The second routine refers to the exchange of knowledge after Applied Technologies had moved to the HTCE. In the cross-analysis, physical proximity was captured as a core distinction among the routines. An initial finding was that, on the phase of seeking and searching for knowledge, physical proximity was noticed to support knowledge sharing.

R. Nagelkerke: “When Applied Technologies was located in the city (center of Eindhoven) the initial contact was made through e-mail or via phone, and then an appointment was set since a face-to-face meeting was necessary.”

Although the Campus contributed to increase the visibility of the search engine tool, the Library was not allowed to perform this service to the researchers from Applied Technologies without a purchase order (P.O.). Thus, even though workers from Applied Technologies started to know about the search engine tool via their informal network with researchers co-located at the Campus, when they requested a similar 'knowledge sharing experience', the Library was not allowed to perform it. To overcome this barrier, the formalities around a P.O. were required. Therefore, on the phase of transferring knowledge, rules & agreements and additional costs appeared to cancel the benefits generated by physical proximity and co-location of professionals.

The cross-analysis also provides evidence of the success of the creation of new informal networks. The researchers that personally interacted, and the ones having training sections at the library, increased after Applied Technologies joined the Campus. These were similar findings from routines of CTT. Here, the establishment of new informal contacts, besides the facility to search for knowledge, was observed to occur together with the co-location on the Campus. However, it was also noticed that physical proximity, by itself, is not sufficient to sponsor new informal contacts. The influence of knowledge brokers and formal meetings, for example, was a constant reference whenever physical proximity played a role on leveraging knowledge sharing.

Finally, the effects of physical proximity and co-location appeared to be strongly moderated by the Anchor firm. It is the Anchor firm who grants, or restricts, the access to several buildings and facilities of the Campus.
The identified design principles are:

- Use physical proximity to sponsor knowledge sharing, by stimulating the persons involved to have frequent personal (face-to-face) contact.
- Take advantage of the physical proximity of employees freely on the knowledge sharing phases of deciding to seek and searching for knowledge. To exploit the transferring phase make use of meetings, manipulate regulations & practices or adequate financial compensation.
- To leverage new networks, physical proximity and co-location of professionals are not sufficient.

(ii) Shared Facilities and Services

At the Campus a variety of facilities are available which provide opportunities to share ideas and experiences. The mostly apparent examples were MiPlaza and The Strip. Other references are the HomeLab and the Wellness Center. The Appendix provides an overview of these facilities and services.

Shared facilities were observed to be an important feature of the Campus, allowing costs sharing and knowledge sharing. There was also proof that common testing facilities, such as MiPlaza, support the formal flow of knowledge, further assisting SME’s by enhancing freedom on knowledge creation.

M. Verregt: "...the whole idea behind the Campus is to indeed share some facilities and to split the financial costs of laboratories located here. Originally it was a consequence of migrating all the research facilities to the same location and making available the space on the center of the city that have a higher financial value. This was on the late 90's." (Researcher from Semiconductors).

Regarding the SME’s it is possible to perceive another advantage next to the split of costs and knowledge sharing opportunities.

M. Verregt: "For the small companies it is beneficial because they can sell that they have access to high tech facilities and, if they need, they can perform the tests. Of course they have to pay for it"

Such perception corresponds to literature arguing that the advantages available to firms joining clusters are, in great part, originated from the unique and prestigious environment created at these enterprises (Jonsson 2002). This environment provides firms a positive image to the outside world and a cluster identity that facilitates contacts in the financial and marketing settings.

Shared facilities and services also represent a beneficial infrastructure of the Campus. They enhance the development of new products and technologies by allowing easy access to top level equipments and experts.

M. Verregt: "...and this (availability of shared chemical vapor deposition equipments) changed the way of thinking. Now you have the facilities and start asking if someone has a use for it. Such offer stimulates the thinking. This caused some ideas to emerge. Of course, as it was, people would have the same ideas, but imagine you as a researcher asking for a few million USD to run some tests on some developing ideas. So now they had the equipment available. In this sense, the availability of such equipment and facilities stimulates experiments."

Throughout the interviews references to shared facilities and services initially appeared favorable towards the Campus’ infrastructure. However, after carefully analyzing the data, shared facilities were noticed to have no direct contribution to the knowledge flows. Instead, the references to shared facilities were restricted to its contribution on supporting tests.

R. Aarts: "We use the laboratories and facilities to do the tests. But mainly within Philips Research. The contacts with Hamburg are mainly done via e-mail." (in reference to the BaryTube events)
Findings were not always positive. For instance, shared facilities were also seen by employees as having limited support. Examples involve the use of conference rooms and Intellectual Property rights.

M. Vertregt: "...if you ask for a lecture-room to do an event, you of course don't want others to have access, or be walking around. So you share the cost of the infrastructure but you don’t use it. You just use it if you have formal agreements and deals."

J. Fellius: "...some lecturers ask that their training sections are performed outside the Campus. Here, the participants have access to wireless connection and they keep the notebook online during the trainings or during the breaks, they go back to their desks and don’t interact at all.”

Another finding involves the informal networks of the Campus. The single moderation of shared facilities appeared to not stimulate new networks. In general, just by placing workers together at common facilities did not make them to interact. Not even with the support of social events, as later discussed.

Bert-Jan Voertman: “At the moment I still don’t see enough of a community. We all share something, that’s obvious. We are all high-tech researchers. But I still see too few people spontaneously engaging with one another. Co-workers tend to stick together in set groups at lunchtime and rarely meet new people’. (Manager of The Strip on interview to e-magazine)

Still, shared facilities and services appeared to support existing networks and knowledge brokers. It was observed that once the contact already exists, shared facilities have the capability to preserve these social capital design characteristics.

H. Vink: “I usually meet lecturers at the restaurant. Or people see you and remember that they need to talk you about something and then we can easily set an appointment.”

Just the availability of shared facilities & services was observed to be insufficient to sponsor knowledge sharing. Shared facilities & services have some effect on the knowledge sharing phases of deciding to seek and searching for knowledge, but no stimulus was found on the knowledge transferring phase. Thus, this graduation project aims to evidence that by applying strategic and specific design propositions related to this design characteristic, great potential to exploit knowledge sharing opportunities exist.

The identified design principles are:

- Use shared facilities to support knowledge sharing in existing informal networks, but not to support new relationships.
- Exploit shared facilities and services as a basis for social capital design characteristics (informal network, meetings, shared identity).
- Use the access to equipments and services of shared facilities to control intellectual property.

(iii) ICT

The ICT services were noticed to provide valuable support to knowledge sharing within the Campus’ boundaries. Frequent reference occurred to the knowledge sharing phases of deciding to seek and searching for knowledge. It was at these phases of knowledge sharing that the contributions of ICT were mostly noticed. For instance, on several opportunities, it was possible to observe the assistance provided by the intranet of the Anchor firm on the search for employees. Via this ICT support, one can easily obtain the employees’ role within the company, its e-mail and telephone number. These are important data supporting the development of networks.

A routine gave an interesting idea of emerging roles of ICT was the one involving a recent SME and new generation of workers. The findings regard the relationship between the media used on the process of
knowledge sharing, and the ‘value’ of exchanged knowledge. Michael de Nil currently works at Silicon Hive, a business line of Philips. While sharing low protected (valuable) knowledge, ICT provided De Nil the frequently used media (e.g. blogs and virtual communities). On this media, no formality was necessary allowing the exchange of knowledge to happen in an informal way. However, as soon as the need of face-to-face meetings emerged, it also meant that the knowledge shared was somehow under the influence of Intellectual Property rights and the partnership was assuming a stage of higher commitment and dependency. At that moment, some kind of formal agreement was needed, either to justify ‘work hours’ of the involved researcher or to comply with Intellectual Property rights.

Additionally, formal and informal meetings count on ICT to market their happening. Examples are the e-magazine and the TV screens located on shared facilities. The E-magazine is a monthly digital newsletter of the Campus, also referred to on a few events. Employees and external workers can subscribe to the e-magazine and receive the newsletter via e-mail, which is an active way of marketing the Campus. Other benefits associated with this ICT service involve the creation of awareness of formal and informal events, special activities, latest innovations and general news of the Campus. The influence of ICT is also available on the discussion about the formalities and informalities regarding knowledge sharing (section 4.4). The effects of the business dynamics that the Campus is passing through can be noticed on the emergence of new programs such as the new intranet (launched on October 2nd).

Negative aspects of the Campus IT network and its related services were also captured during interviews. One limitation was observed during an interview with an EMC consultant. Once a member of the Campus IT network, it is not possible to consultants to access the external network from Philips Applied Technologies. On the case described by the consultant, constant necessity exists to “input on the system work hours” into the database of Applied Technologies. However, the consultant cannot proceed with such a task because he is already a member of the Campus network, which restricts his access to other networks. The ICT services of the Campus mentioned that such limitation was not under the Campus IT services responsibilities. The same answer was provided by the ICT services from Applied Technologies. Months later, the EMC researcher still has no answer on the matter. This lack of solution culminated on the process of having a single computer that does not belong to the Campus IT network and that is used exclusively to report the hours of researchers. This improvised solution leads to several problems and by the end of the month there is always a busy schedule for using the computer with the unique connection. Overall, on this event we perceive that ICT, if not properly developed, can also mitigate the exchange of knowledge (even codifiable) across the boundaries of the Campus.

Finally, it must be said that ICT of the Campus offers unique opportunities for knowledge sharing. One such is the C3ITS (www.c3its.nl), the environment in which services are provided to residents of the Campus and outside companies. The Collaboratory (www.collaboratory.nl) is also an example of how ICT can support knowledge sharing. Through this consortium, a virtual lab is available making use of the internet to enable a more interactive way of working between researchers and experts. Additionally, it enables more cost-effective use of expensive analytical tools combined with reduced response time.

The identified design principles are:

- Exploit ICT (Campus-wide) as channel for both formal and informal communication sponsoring knowledge sharing.
- Make use of the ICT of the Campus in line with regulations & practices and financial compensation design characteristics.
Social Capital

(iv) Informal Networks

Informal networks were identified at the Campus confirming that valuable knowledge is being shared between employees. This informal exchange of knowledge was observed to occur without explicit compensation. Among the origins of these informal networks could be the cultural environment of the Campus, the shared identity around the anchor firm, the interaction of workers at shared facilities or informal meetings and social events. Formal factors, such as colloquiums and seminars, should also sponsor these networks.

Different perceptions on this design characteristic were collected throughout the events. Some evidence a lack of belief toward the design characteristic, while others suggest a positive influence of it. The analysis of the data confirms that creation of new informal networks does occur, even transcending the boundaries of the Campus. However, these new contacts occurred only because of a pool of design characteristic acted together or because of the motivational aspect of individuals seeking for the benefits of these networks. In general, new informal networks within the boundaries of the Campus appeared to be not stimulated by the single occurrence of design characteristic such as co-location, homogeneity or by the availability of shared facilities.

For these new links to happen, additional design characteristics are required, such as the participation in formal meetings or trainings. The sponsorship of knowledge brokers, with their linkages and shared identity with members of the Anchor firm (Philips), can also be a complementary design characteristic.

H. Vink: "...but also to support and extend the network of contacts from the participants (regarding participation in trainings). After the course the participants can reach the other participants or the lecturer."

As experienced during the empirical study, informal networks were enhanced by formal meetings occurring at the shared facilities of the Campus. One example was the Campus Seminar occurred on 19 of September 2006. The subject of that month's Campus Technology Seminar was AFM/STM (electronic enhanced microscope). It was held in the auditorium at High Tech Campus 34. The speaker was Harry Nulens of Philips Research. After the meeting, the speaker was surrounded by researchers, around 5 individuals, and there they spent 20 to 30 minutes. Although a small group, these researchers were the ones most interested and who appeared to have a good understanding of the potential of the technology just presented. Another formal meeting experienced was the Open Innovation Day sponsored by Philips Research. On this event the participants, employees of the Anchor firm and of several knowledge institutions (TU/e, Radboud Universiteit Nijmegen, Imec, Brainport Horizon, Fontys Eindhoven among others), shared a similar interest on the topic of Open Innovation. This examples offer a glimpse on what is possible to be achieved with formal meetings, thus endorsing that informal networks were strongly supported by formal meetings.

Formal meetings as a design characteristic sponsoring informal network have also its limitations. SME's of the Campus evidenced unexpected reactions to this strategy when it was discussed with them. It is understood that formal meetings could lead to a 'formalization' of the knowledge sharing process. Their perception was that, by formalizing the environment and context on which knowledge is being shared, the knowledge itself will be considered more valuable and, as consequence, become more costly. Overall, we agree that knowledge may become more valuable as soon as the knowledge sharing process is mapped. Even more, with the knowledge sharing processes mapped, we argue that it will be possible to influence and somehow control the knowledge exchange itself. However, given the core policy of the Anchor firm
to support knowledge sharing among the residents of the Campus, SMEs should not be concerned with the existence of extra costs on knowledge exchange.

A further limitation of formal meetings with regard to informal networks is that these meetings (e.g. colloquiums and seminars) were held mostly within the boundaries of the Anchor firm's Business Units. For instance, trainings and colloquiums that could be a sponsor for new informal contacts were observed to be offered only for groups belonging to the same firm, Business Unit or Department. Such context limits the enhancement of this emergent design characteristic. Existing informal networks, on the other hand, are able to profit from the occurrence of a single design characteristic, from informal meetings or social events, till physical proximity of workers or the shared facilities available at the Campus.

Regarding the motivational aspects which influences the occurrence of informal networks, besides the previous referred events regarding CIT (section 5.1-v), an additional example was identified on the labeled University event. In this event it was noticed a personal interest from the researcher to expand its network towards new members of the university.

Interviewer: "... does your network include only professors or does it include students and PhDs as well?"
R. Aarts: "Nowadays it is mostly with professors and researchers. But with a more frequent presence at TU/e I hope to extend the network to 'fresh' PhDs."

In general, the boundaries around the Anchor firm of the Campus were found to set the limits of informal networks on the Campus. Within the business units of the Anchor firm, such as Philips Research or Philips Applied Technologies, informal networks were noticed to be a fundamental channel of knowledge flow. While investigating informal networks between other firms of the Campus, it was noticeable that they were highly dependable on current or former employees of Philips. It was interesting to notice that informal networks of former employees of the Anchor firm were also dependant on other design characteristics of the Campus (e.g. physical proximity).

These informal networks help former employees to identified problem solving knowledge and avoid eventual boundaries. These informal networks necessary for SMEs to transfer and acquire knowledge were noticed to be controlled in great part by the Anchor firm. It does so, by restricting or enhancing, the access to 'coffee places' and 'open doors' environments. The control also comes from its policy toward knowledge sharing and the consequent impact on its employee's behavior.

Workers with no previous experience at Philips had to count with an additional design characteristic such as knowledge brokers to gain access to the available networks of the Campus. Most importantly, the Anchor firm policies on Intellectual Property rights and financial compensations directly affect the creation of new informal contacts, especially to residents that do not belong to Philips.

Belo the identified design principles:

- The exchange of knowledge is not structured. It is an organic and complex process. Therefore a strong informal network to let it happen naturally is needed.
- Informal networks do not arise spontaneously. Use other design characteristics to stimulate it. ³
- To achieve effective knowledge sharing stimulate informal networks in accordance with the strategy and intellectual property rights of the Anchor firm

³ This topic is develop further in the next sections (e.g. to create new informal networks, stimulate formal meetings )
(v) Formal Meetings

Besides the data collected on episodes and routines, practical experiences with formal meetings at the Campus were also achieved. Design Your Own Future (April 26th), Science Café with Mark van Loosdrecht (June 20th), Open Innovation Day (Oct. 4th) and European Introduction Day (Nov. 10th), besides a few colloquiums, were some of the experiences. To start with the analysis of this design characteristic, the PD Perspective meeting is presented as introduction.

The PD Perspective meeting was held on 29th of August and presented the overview of Philips Lighting. The invited speaker was Theo van Deursen, the CEO of this Business Unit of the Anchor firm. During the event, and later by carrying out informal conversations with participants, perceptions and findings toward the study emerged. Some follow below:

- After brief chats with 15 persons, no employee from outside Philips Research was found.
- The advertisement of the meeting was done just on the screens located on the Philips Research buildings. At the screens located at the restaurant, the Strip and other Philips Buildings such as CIT, Semiconductors and Applied Technology no advertisement was found.
- Although some examples were given about partnerships and spin-offs no direct reference to Open Innovation existed.

Other examples of formal meetings available at the Campus are the frequent colloquiums and seminars sponsored by the Anchor firm. However, these colloquiums and seminars which appear to have a positive influence on the knowledge sharing of the Campus residents also possess a few limitations:

- Colloquiums were restricted to Philips Research employees. No outside worker was allowed to participate. This constrained the creation of informal networks across firms of the Campus.
- Open Seminars of the Campus, such as the Campus Technology Seminar, were not marketed in an active way to employees from outside Philips Research. Other residents, even the different units of the Anchor firm, only had the announcement on e-magazine available, while within Philips Research the event was intensively announced on TV screens at the corridors among other channels. The consequence is that, on this specific seminar of 19 of September, the great majority, if not the totality of the audience, was from Philips Research. This limited the expansion of networks crossing the boundaries of Philips Research.

Normally, participants are not beginners in the field under discussion. In colloquiums, the idea is to familiarize participants with a chosen subject and to allow the lecturer to interact with examples of the practical problems that always crop up during this type of knowledge sharing event. It is, essentially, a place where researches are discussed, questions raised and debates conducted. Workshops, alternatively, are a gathering or training session which emphasizes problem-solving, hands-on training, and requires the active involvement of the participants.

Formal meetings appeared to help to overcome barriers and allow better results on knowledge sharing. By co-locating workers having related or common knowledge, they could more effectively share their knowledge. This happened because the knowledge could be better understood (relation with absorptive capacity). Without formal meetings, the adequate audience for the knowledge holder and knowledge brokers would not be available.

Nevertheless, the efficiency on the formal component, which caters to strong linkages of employees and further stimulates informal networks, is not explored in all of its potentialities at the Campus. As a result, information dissemination, and acquisition by SME's are processes to be stimulated by using formal
meetings and other design characteristic. This dissemination of knowledge should include not only the latest developments on technology, but also in business and marketing.

The example of Toyota’s formal meeting with its suppliers (Dyer and Nobeoka 2000) provides guidance to perceive the opportunities within this design characteristic. On Toyota’s meeting, the exchange of knowledge is sponsored toward its suppliers. Toyota profits on the long term, via quality improvements and problem solving achievements of its suppliers. Nevertheless, as coordinator of the meeting, Toyota also markets its position, and policies, acquiring valuable knowledge that can be later used to develop internal innovations on products, processes and services. The formal aspect of the meeting is stimulated by presentations from previously chosen suppliers. Awareness of the meeting is created by invitation or pre-defined obligatory presence in case of specific suppliers. The meeting allows actors with the same interest, but different capabilities, to meet each other in a face-to-face manner. This enhances the suppliers’ network and helps them to identify problem solving knowledge which, without the meeting, could run unidentified.

The process of knowledge sharing through formal meetings and colloquiums was observed to be performed also with excellence within Philips Research. Our analysis leads us to the understanding that the Campus currently misses the opportunities leveraged by formal meetings with all residents. So far there is no institution that provides to all residents of the Campus the same service that CTT does to Philips Research. According to empirical data, CTT itself appears to be the organization to perform such role by expanding its activities and crossing the boundaries of the Anchor firm.

H. Vinks: “When we draw the conclusion that we (CTT) need to work together with the companies of the Campus we will go to them to discuss about it. We understand that we need to be proactive on it.”

H. Vinks: “…so our big question is how can we support not just Semiconductors but also other companies located in the Campus? Or the ones with, at least, a department here at the Campus.”

Through its formal trainings, CTT strongly supports the creations and expansion of informal networks within, and across the boundaries of Philips Research.

The identified design principles are:

- Use formal meetings (e.g. colloquiums and seminars) to stimulate knowledge sharing and support the development of informal relationships and new networks.
- Elaborate formal meetings to bring groups together, focusing on specific subjects and allowing face-to-face contact between individuals with a common knowledge base and similar interests.

(vi) Informal Meetings

Findings on informal meetings had also the support of observations and chats, which together with notes were later analyzed. The official reopening of High Tech Campus 34 (8 Sept.), Lunch-time concert (11 Sept.), Better-2-Gather (21 Sept.) and Campus Pop 29 Sept were some of the experienced events. Informal meetings and social events we noticed to have the potential to support existing informal networks and allow its growth. However, its effect in building new informal networks and sponsor the integration of new incomers to the complex network of the Campus is limited. A dependence on the action of other design characteristics, such as knowledge brokers or shared identity, was frequently observed.
Throughout the event, no reference existed to formal meetings and social events. A few quotations that present this design characteristic were because the interviewer was stimulating answers toward it. Below a few passages that show the limited performance of informal meetings.

**Interviewer:** "In your perception, if Campus wants to stimulate knowledge sharing and informal networks, how it should be done?"

**R. Aarts:** "You should do more social events. I guess you are the one that should respond that question."

**Interviewer:** "You are right! Do you participate in happy hours, lunch concerts or other informal meetings of the Campus?"

**R. Aarts:** No!

While investigating other sources of data, a questionnaire was obtained. On this, a specific question supports the generalization of the perception toward informal meetings, presenting that 75% of the respondents did not participate on such events.

*What do you think about the Happy Hour that is organized in the Grand Café every Thursday evening?*

- Good initiative, try to go there every week: 30 respondents (14.6%)
- Haven't been there yet, but am planning to go in the near future: 32 respondents (15.6%)
- Didn't know there was a happy hour until now: 27 respondents (13.2%)
- Don't think I will ever go there: 91 respondents (44.4%)
- No opinion: 25 respondents (12.2%)

Identified design principles related to this design characteristic are:

- Use informal meetings to create knowledge sharing opportunities.
- Explore informal meetings (at shared facilities) to sustain and grow existing networks, but do not expect the creation of new contacts without exploiting other design characteristic (e.g. mediation of knowledge brokers).

**(vii) Knowledge Brokers**

Knowledge brokers were noticed to be fundamental to the Campus because of their direct influence on knowledge sharing. They act as sponsors of knowledge flows not only due to their knowledge on the network of employees and available expertise within the Campus, but also because they act as bridge to new members to integrate themselves. Knowledge brokers introduce these new members in informal ways, personally or via e-mail and telephone, allowing new incomers to continue with the informal approach. These informalities may later avoid eventual formalities, which can lead to the necessity of agreements and financial compensations. In addition, there is a transferred feeling of trust from the knowledge broker to the employees he/she is guiding, which is a major benefit supporting the exchange of knowledge. Thus, knowledge brokers were noticed to be crucial to the creation and expansion of informal networks.

Knowledge brokers were found to be mostly employees, or former employees, of the Anchor firm of the Campus. Among these, there is some that still not aware of their potential as brokers. Others perform the broker function but not explicitly, unaware that such behaviour may be desired by their firm and the whole ecosystem of the Campus. Some knowledge brokers were found to be well explored, while others are not yet fully identified and others not even considered in the knowledge map and Open Innovation strategy of the Campus.
Throughout the study, knowledge brokers appeared as a constant integrant among the coded design characteristics. For instance, on the Simulation Tool event, without the broker to connect Timo to Mark (KXP to HandShake Solution) the knowledge could still be missing. The same happens at the Silicon Hive event, a knowledge sharing episode involving a SME of the Campus and NXP. The experience involving a consultant lecturer and training section of CIT also shows that opportunities exist for brokers to gain while performing their bridge function. In the case of this specific event, new contracts were achieved by the consultant.

Literature confirms that internal knowledge brokers, a recent label of gatekeepers (definition on chapter 3.5) are an important source of information toward the success of innovation. Hastbacka (2004) exemplifies:

- Procter & Gamble has put in place ‘Technology Entrepreneurs’ who search the internet, scientific literature and other sources for innovations of potential benefit to its businesses.
- Companies have also turned to ‘innovation agents’ who help companies spot, adapt and adopt technology across domains.

The considerations above indicate how researchers providing services, managing trainings or coordinating formal meetings could support their organization on the search for successful innovations. These are just a few that could be investigated. They are noticed to posses capabilities demanded by their daily routine that are related to the knowledge broker role. On truth, some already applied for tasks that go on the direction of an innovation agent defined by Hastbacka (2004), however with no success. Below follows a quotation evidencing the spotting of trends while performing routines.

R. Nagelkerke: “Chemical information from 30 years ago is still interesting but microprocessor information from 5 years ago is not interesting anymore”. (while discussing about the search engine routine)

Considering the business dynamics the Campus currently faces, to manage knowledge brokers became a task even more important. LG and Semiconductors (NXP) recently independency from Philips together with the fact that the Anchor firm of the Cluster shows no intention to continue providing the search engine service to then is of great concern. The continuity of this service can be interesting for Philips, especially Philips Research since it allows the company to keep track of the tendencies of the market. With the Anchor firm of the Campus possessing such expertise, it is a consequence that its overall ecosystem could profit from it (reference on chapter 2.4). However, the empirical study captured actions in the opposite direction. On such were the policies and regulations in relation to Bosch Security System and Liquavista (recent spinoff from Philips) as discussed previously (chapter 5.2-1,7).

It is also important to evidence that in some aspects the Campus is aware of the possibilities, and is searching for opportunities in areas such as trainings. The routines at CIT, in addition to collected information, lets us concludes that this Business Unit of the Anchor firm is currently modifying its policy to become an active service to all residents of the Campus. Below an quotation from Hans Vink

H. Vink: “We are feeling the change toward Open Innovation….it is a constant discussion within the CTT.”
H. Vink: “When we draw the conclusion that we need to work together with the companies of the Campus we will go to them to discuss about it. We understand that we need to be proactive on it … so our big question is how can we support not just Semiconductors, but also other companies located in the Campus? Or the ones that have at least a department here.”

In achieving its objectives, CIT will be in constant interaction with the residents of the Campus. This will not only support these organizations, but also provide the opportunity to the Anchor firm to map the existing knowledge at the Campus. Emerging areas of knowledge can be identified. Regarding the business
dynamics of the Campus, it was observed that CIT is aware of the treats and is already under negotiation to provide its services to NXP.

H. Vink: ‘We are discussing with the Innovation and Human Resource Department (from NXP) about it … they already know CIT, and are pleased with our service … together, we are changing our way of working, toward work with several companies. And if these companies want to keep their I.P. right that is fine with us (CIT). We are experts in knowledge transfer. It should be a win-win situation.”

Below the identified design principles related to knowledge brokers:

- Stimulate knowledge sharing by designing knowledge brokers to both formal and informal meetings.
- Support knowledge sharing crossing the boundaries of resident firms (in special the Anchor firm) by maintaining knowledge brokers within the Campus.

(viii) Shared Identity.

During the empirical research, a shared identity around the Campus was not found. Among the collected evidences, this section brings examples with researchers having a long history on the Campus. When discussing the BaryTube event, the existence of physical barriers within the Campus appeared to be harmful to a shared identity.

R. Aarts: “It could be better (interface with IP&S). For example it is easier to get to their building from outside the Campus than if you are going from inside. I don’t know if you notice but they have a fence around the building separating it from the rest of the Campus … (from outside) you can go directly to the main entrance. Of course you should also present yourself and register/ have access, but it is strange that you have a fence separating it from the Campus.”

The interaction between shared identity and physical access was also noticed on interviews with researchers from Semiconductors, now NXP. On these interviews the future limitations on access to buildings and facilities of the Campus, and of the Anchor firm, was a major concern.

M. Vertregt: “Yes. By first of October when we (Semiconductors) are not Philips anymore we will have no access to anything: intranet, offices and facilities. And we were the ones that build ourselves here, and by first of October we will be just cut off, from everybody. Extremely!” (former researcher from Semiconductors, now NXP)

In general, I observed a feeling that, although you belong to the Campus, physical barriers limit your access. Analyzed events evidenced no further reference to the existence of a shared identity of the HTCE.

On the other hand, a shared identity among the members of the Anchor firm, especially within the Product Divisions, was observed. The most evident example was within Philips Research. On the BaryTube, SME and Search Engine episodes, we noticed that the shared identity existing around the members and former members of Philips was fundamental to the experienced knowledge sharing.

In addition, through the information received from the participants of the PD perspective event, it was possible to identify that the enhancement of a shared identity around Philips. However, the same cannot be concluded about the sense of community on the Campus. Similar findings were achieved as result of the analysis of the Campus Technology Seminar, an open event of the Campus.

Participant: “I was proud to see Philips working hard to improve the environment by using light technology to purify water”
Interviewer: “Did the event increase our sense of union toward Philips?”
Participant: “Yes”
Interviewer: “And about the Campus, do you think the event stimulated a shared identity?”
Participant: “No”
Nevertheless, latter analysis evidenced one positive perception toward a Campus identity. It was a reference to The Strip during the presentation of van Deursen (about how Philips Lighting currently cooperates with The Strip to promote a better environment by using light technology). The quotation below, extracted from an interview after the presentation, gives us indication that the emergence of a sense of community and pride for the Campus is possible.

Participant: "Nice to see that the Strip was present on the slides and on the folder"

Throughout the graduation project, it was possible to observe that the management team of the Campus is aware of the necessity to develop a common shared identity.

Bert-Jan: "At the moment I still don't see enough of a community... but I hope the people here soon will be saying with a sense of pride: I work at High Tech Campus Eindhoven. That's the spirit I want to facilitate. I would like to hear from everyone with ideas on how we can strengthen the sense of community." (manager from The Strip).

Recently, on October 2006, the Campus launched a new initiative towards a shared identity by using the Campus badge as a sponsor. Such initiative was jointly introduced with the new website and intranet of the Campus. Altogether, this actions support a common identity of the HTCE. Below follows the announcement placed at the recent reformulated website of the Campus.

![Campus Badge](http://www.hightechcampus.nl/open_innovation/innov_value_network/campus_badge.html)

The identified design principles on shared identity are:

- Stimulate a shared identity, by removing physical barriers and allowing mobility within the Campus.
- Sponsor a shared identity by enhancing network level knowledge sharing among residents.
- Develop a shared identity of the Campus by managing the existing conflicts with rules & agreements and infrastructure characteristics.

Rules & Agreements

(ix) Intellectual Property Rights

It was noticed that, although Intellectual Property protection enhances the trust and supports knowledge transfer in the long run, it can also be harmful to the exchange of knowledge in the short term. One example as coded in NVivo under the code 'knowledge sharing limitations' during the analysis of the BaryTube event. Below follows part of the passage:

Interviewer: 

R. Aarts: "In theory, yes, we should first sign a confidentiality agreement. But in practice we have to be flexible and start transferring some information before these formal agreements are ready."
The influence of a shared identity around the Anchor firm was also noticed to exist when Intellectual Property was considered on the event. This makes us believe that such shared identity, and the consequent feeling of trust among the actors, was a necessary condition to allow the informal exchange of knowledge to happen. Through the quotation it is noticeable that, although the parties exchange knowledge previously to the formal agreement is established, the necessity of formalities is a must. In analyzing why these formalities impact on the flow of knowledge, the reason given by the interviewed was:

Interviewer: “Why (concerning the need to start transferring information before the formal agreements are ready)? It is a necessity of the project (to speed up) or do the formal agreements take to long?”
R. Aarts: “Both. But most of all the technology moves faster than the business.”

The business dynamics that the Campus is living can be once again observed. Here we see that even more complicated that the work of IP&S toward the separation from Philips of Semiconductors and SMEs, is the fact that the Department itself is under a period of changes.

Interviewer: “...so I suppose IP&S will have a lot of demand (concerning the independence of Semiconductors), what makes useful to have them here.”
M. Vertregt: “But also a part of IP&S will be separated. So now you will have a fence inside IP&S. Because it will became two different companies.”

During the PD Perspective meeting, a core message from the speaker, Theo van Deursen (CEO from Philips Lighting) was how important intellectual property is for Philips group. Among the given examples, follows a quotation evidencing how different levels of knowledge, and patents, can harm companies like Philips and G.E. The case involved an American company using an ‘application patent’ on lighting field.

Theo van Deursen: “By mixing the red, blue and green color you achieve white (in reference to the application patent), as consequence when Lighting was testing laser technology to achieve a white color it was faced with a patent suit....therefore we need to have a strong portfolio to be able to fight back.” (during presentation at PD Perspective meeting)

The identified design principles are:

- Use Intellectual Property rights to align regulations & practices and financial compensations design characteristics and to maximize their success on sponsoring knowledge sharing.
- Exploit infrastructure and social capital design characteristics only after considering the existing Intellectual Property rights, and the design characteristics it directly influences (regulations & practices and financial compensations).

(x) Regulations & Practices

Empirical data shows that some of the practices and regulations observed during the study were deliberately set in order to straighten the borders around its performers.

Interviewer: “I went to the seminar of Theo van Deursen (Philips Lighting CEO), but found just employees of Philips. Is that supposed to be that way or should it also involve other Campus members?”
R. Aarts: “No, only Philips Research. Also you were not supposed to join it.”

Others, although not intending to generate the same outcome, did it in a similar way, i.e., these practices culminate in excluding the presence of workers that do not belong to the Anchor firm of the Campus.

Interviewer: “I notice that although some events are open to everybody no advertisement is done outside Philips. This really restricts the participation of employees outside Philips!”
H. Vink: “Yes that is a correct observation. If you don’t take measures, development happens very slowly.”

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Different routines evidenced the same outcome regarding this design characteristic, as for example, the search engine episodes. Although the Campus contributes to increase the visibility of this tool, the Library is limited to perform the search only to researchers from Philips Research. Exceptions involve other Units that have a purchase order (P.O.) in place. To illustrate the above, the routine with Philips Applied Technologies, another recent resident of the Campus, is summarized. Researchers and knowledge workers from this Business Unit of the Anchor firm get to know about the search engine via informal contacts with employees from Philips Research. However, when they request a similar search, the Library is not allowed to run the search. To gain access to it, the researchers from Applied Technologies have to submit and get the approval on a purchase order.

At the example above, the existing practices and regulations of Philips Research appear to enhance boundaries around this unit of the Anchor firm. When using an available service of the Campus, Philips Applied Technologies is considered as an external client, and as a consequence, a P.O. is needed. Such formal procedure involves not only financial barriers, but also other bureaucracies such as the fulfillment of request forms and negotiation with the Purchase department. Most importantly, a P.O. demands time, effort and previous know-how on financial budgets and the policies around it.

Regulations and practices were observed to constrain even existing flows of knowledge. Once again we refer to the search engine routines, this time involving the Incubator of the Campus. This unit of the Anchor firm used to be a major client of the search engine in the past. The relationship had always worked via an informal contract, i.e., a "gentlemen agreement" (R. Nagelkerke). Nowadays, due to the business dynamics the Campus faces, the existing regulations between Philips Research and the Incubator restricts the later of using the search engine tool. Therefore, the Incubator had sharply decreased the usage of this service of the Library.

Taking the opportunity, the reasoning is briefly extended to the overall Library in order to evidence the influence of future regulations and practices. Nowadays, residents of the Campus can use the Library with no charge or restriction; however such policy is valid only until end of 2006. Additionally, even on this period of free access, residents of the Campus that do not belong to Philips Research can not loan books, articles or magazines. If they intend to do so, they have to face fees and additional costs.

Another example of regulations and practices affecting the daily routine of researchers, and appearing to enhance the barriers among the residents of the Campus, involves the recent disentanglement of Semiconductors, now NXP.

R. Aarts: "I don't think they (Semiconductors) will use my services anymore"

Current regulations and practices appear to be constraining the efficiency of informal networks. These act in parallel with the effects of intellectual property rights and financial compensations existing at knowledge sharing process. On the quotation below, a synthesis of the findings was noticed.

M. Vertregt: "...out of recorded yet (about the exchange of knowledge through informal networks). But if you want something more mature and tangible you will have to set agreements and formalities. It is heaven for all kind of consultancies, lawyers and accountancies."

Observed design principles are:

- Directly stimulate knowledge sharing at the Campus, by manipulating the regulations & practices of the Anchor firm (especially Philips Research).
- To support the Campus boundaries, use common regulations & practices with the residents.
- Through regulations & practices, facilitate the development of network and trust among the Campus residents.
(xi) Financial compensations

Financial compensations seemed to influence knowledge sharing at the Campus, partially via its *impact on informal networks* of employees. To illustrate this perception, we use the event described by the EMC consultant evidencing that, while informally sharing knowledge, he had to be careful because of potential costs related with this exchange of knowledge. Basically, if the consultant shares too much of his knowledge, there is a chance that this will reduce further costs/profits related to knowledge share via eventual formal agreements. At the same time, the consultant needs to evidence how much it can help the ‘customer’ in solving the problem. This duality is noticed to be in line with the arrow information paradox. This paradox refers to the seller’s need to disclose information about the technology to the buyer, to entice the buyer into acquiring the technology. The buyer needs to know exactly what the technology is, and what it can do. However, if the seller fully discloses all this information to the buyer during the negotiation, the buyer will have effectively acquired the technology without having to pay anything for it. The currently solution that EMC Managers are working on is to have an internal budget which allows the department to assume the risks of ‘hours of work’. By the end the idea is to sell to the client only the final solution to the problem, instead of selling the knowledge throughout hours of consultancy.

The above reasoning is not surprisingly related to the fact that informal networks became the way SMEs found to overcome financial compensations. Such costs may be related to shared services, such as download of papers from the Campus library, or to consultancies with researches and experts of the Anchor firm regarding problem solving issues. Examples of such approach can be seen on SME routines and on the Simulation Tool event. On these, the informal network existing among employees of the Anchor firm were a strategic and influential factor for SME companies, mainly the ones spinning-out of Philip, to acquire useful knowledge.

There was also an important interaction between financial compensations and shared facilities of the Campus. This interaction affected the ecosystem and the knowledge sharing of the Campus by influencing design characteristics such as shared identity and informal networks. Below follows some arguments supporting the perceived influence of financial compensations of shared facilities and services:

- There is no difference on the cost of several facilities and services on what regards the contingency variable *intra/extra HTCE*.
- Regarding knowledge flows transcending the boundaries of Philips Research, and Philips as a group, differences exist. Although justifiable, these differences do not take into account the fact that the firm is, or is not, a resident of the Campus.

The identified design principles are:

- Avoid that financial compensations become a barrier for knowledge sharing, by mapping its influence on residents’ routines.
- Use financial compensation to directly influence knowledge sharing, either for more or for less.
Knowledge Ecosystem
(xii & xiii) Homogeneity and Diversity

The influence of the homogeneity of the Campus’ residents has a direct effect on the performance of the encountered knowledge sharing flows. Homogeneity also supported the networks of knowledge flow at the Campus. New informal contacts emerge from the common background available at the Campus. However the efficiency of homogeneity in leveraging new networks appeared to be dependable on other design characteristics, especially formal meetings and knowledge brokers of the Campus.

The influence of homogeneity was observed even on knowledge flows external to the Campus. Researchers and knowledge workers who seek for additional network usually end up concentrating on their own field of research. This focus on specific technical knowledge (supporting homogeneity) is, at the end, the factor driving researchers to exchange knowledge and expand their networks.

R. Aarts: "I just started this year as a part-time professor, but before I used to participate as a guest lecturer. I think it is useful to my network. Although I already have one and don’t think it will increase that much. But it is always interesting to participate on the programs. It is something that I enjoy doing."

Interviewer: "does your network is just with professors or with students and Phds also?"

R. Aarts: "Nowadays it is mostly with professors and researchers. But with an more frequent presence at TU/e I hope to extend the network to fresh Phds."

An important finding regarding the homogeneity of background within the Campus is that the great majority of resident employees is, or was, member of the Anchor firm. This homogeneity is identified as a great potential toward the sponsorship of a shared identity and the leverage of informal networks. Ultimately, this homogeneity around the Anchor firm may also sponsor knowledge sharing among the actors.

The diversity of knowledge was also observed to be fundamental to the Campus routines. It can be argued that the diversity within the boundaries of the Campus allows the coverage of complementary capabilities on the value chain. For instance, let’s observe the events and routines involving Intellectual Property rights. These included, in one way or another, the interference on layers and administrative consultants. The observed diversity of knowledge within the events and routines was the feature that allowed a positive outcome plus gave further agility to the developments.

To illustrate the influence of diversity of knowledge, the BaryTube event is briefly highlighted. At this event, the diversity of professional collocated at the Campus supported the formulation of the ‘confidentiality and non-agreement contract’. The actors on this event are a researcher from Philips Research and IP&S department. The event refers to the sharing of knowledge relevant to the BaryTube bass reproduction technology. This exchange of knowledge involves a partner at Philips Semiconductors GmbH, who works at the Home Innovation Center (HIC-H) in Hamburg, Germany. Currently, the project is at a phase of formalizing and establishing agreements to allow further development to continue. A ‘Confidentiality and Non-Disclosure Agreement’ is being developed by the parties, with support of the Intellectual Property and Standards Department (IP&S) of Philips.

![Figure 11 - Model representing the BaryTube event and its knowledge flows](image-url)
Other contribution from the Campus' design characteristics was the support that knowledge sharing received from the diversity allocated within the Campus. This diversity, associated with the physical proximity of the actors, facilitated the interaction between the researcher and the Intellectual Property and Standards department (IP&S). The fact that both the researcher and IP&S were co-located allowed frequent face-to-face meetings during the elaboration of the contract, which needed to be customized to specifications of the project. Thus, the knowledge sharing was facilitated by the physical proximity of a diversity of knowledge (researchers and layers) within the Campus. The fact that the project was managed with support of constant face-to-face coordination with IP&S reduced the ambiguities and uncertainties on the knowledge exchange also with the researcher in Hamburg. This provided to ICT the opportunities to perform with quality, since the communication between Eindhoven and Hamburg was done mainly through e-mail of telephone.

The identified design principles are:

- Creating a Campus around an Anchor firm stimulate the existence of an homogeneous background
- To influence the way people share knowledge, exploit the available common knowledge and background.
- Facilitate the management of innovation, by providing diversity of knowledge within the value chain (e.g. legal and financial know-how).
5.3 – Types of Knowledge Flows

On this section, a few more differences existing at knowledge flows of the distinct groups formed by the contingency variables are evidenced. Qualitative matrices on this analysis follow on the Appendix.

Intra & Extra HTCE

If you look at the HTCE as an enterprise, and how successful it is managing the available knowledge and interfering with the environment, perceptions are that boundaries exist within the Campus. These boundaries differentiate the ones who belong (or belonged) to the Anchor firm and new incomers and other residents. Nevertheless, informal networks, physical collocation, homogeneity of knowledge and background and shared facilities make the environment unique and valuable. The previous presented events (e.g. Silicon Hive, SME and Simulation Tool) evidence how important the ‘stocks’ of the Campus are for its residents. For instance, if one does not have access to the formal, and informal, networks of the Campus, the consequent non-identification of problem solving opportunities may not be acceptable. Lastly, the business dynamics the Campus currently lives is another issue that affects the value of the enterprise, and therefore should be carefully followed.

New & Existing Relationships

On the Campus new and existing relationships find support on the physical proximity of the workers and on the available shared facilities. However, new relationships do not emerge from the simple existence of such design characteristics. Below follows part of an interview which exemplifies how new relationships can benefit from the physical proximity and homogeneity of background available at the Campus.

R. Nagelkerke: “... yesterday I did a search for a person, it was the first time, and he was surprised what we achieve in less than a half hour. He had also tried a similar search with IP&S (to look for patents – mp3 related issue) but we got 3x more information than IP&S did. And you also have to pay for the service of IP&S.”

Interviewer: “why is that so?”

R. Nagelkerke: ‘IP&S works with ‘classification codes’ and I work with key words. And the researches that come to me are more familiar with searches trough key words. They cannot understand the classification codes’. Then the following contacts with this person were done via e-mail (exchange of key words) and new appointments were set.”

It is relevant to remark that IP&S Department is mostly formed by lawyers, therefore classified as part of the diversity of knowledge of the Campus. As such, it is assumed to not posses the same knowledge background and reasoning as researches.

Existing Relationships involving actors belonging, or that belonged to the Anchor firm, present a particular characteristic. On these relationships the strong bound of the informal networks, together with the existence of a shared identity, allows formalities to be avoided (support from SME’s event and routines and Simulation Tool event).

Intra Philips Research, Inter Philips Units & Extra Philips Knowledge Flows

Throughout the analysis of events and observations of the Campus’ routines, a strong boundary was noticed around Philips Research. Within this Business Unit of the Anchor firm of the Campus, knowledge sharing was found to occur intensively. A solid shared identity, the existence of a live informal network and the excellence on exploiting the benefits of physical proximity and the ‘open doors policy’ was constantly evident on the daily practices of researchers.

Regarding knowledge flows between Philips business units, a shared identity was noticed around the Anchor firm. This shared ID forms a boundary among members, and ex-members of Philips, that is fundamental to support the knowledge sharing between the employees of the Anchor firm. The informal network and the efficiency of knowledge brokers observed on the events Simulation Tool and Silicon Hive evidence how a similar background and trust feeling exiting at relationships is fundamental to the
development of effective knowledge flows. Finally, even on knowledge flows external to Philips, still a strong dependence on the Anchor firm exists (e.g. informal networks, knowledge brokers, shared services).

5.4 – Knowledge Sharing

Different organizations having employees with different backgrounds and interests are involved on the HTCE daily routines. As consequence, differences between perceptions and expectations on knowledge sharing exists, especially if one considerer the distinction between the Anchor firm and SME's.

By considering the pre-defined phases of knowledge sharing, this study found that different design characteristics influence in different ways the distinct phases of deciding to seek, searching for and transferring knowledge. In general, the phases of deciding to seek and searching for knowledge are the ones that profit the most from the available design characteristics of the Campus. Physical proximity, co-location and shared facilities were found to play an important role on these phases. Below we present some quotations exemplifying the findings from the empirical study.

H. Vink: “… the participants being located here (at the Campus) save then time. Also the lecturers, because we have constant contact with them to discuss the trainings … being located in the Campus is easier for us.” “I usually meet lecturers at the restaurant. Or people see you and remember that they need to talk you about something and then we can easily set an appointment.”

M. Venter: “… all of a sudden the researchers here (at the HTCE) were owner of some chemical vapor deposition pieces of equipments that had the value of a few million euros, but they bought for one million euros. So now you have such equipments available … and this changed the way of thinking. Now you have the facilities and start asking if someone has a use for it. Such offer stimulates the thinking. This made some ideas to emerge. Of course, as it was, people would have the same ideas, but imagine you as a researcher asking for a few million USD do run some tests in some developing ideas. Now they (researchers) had the equipments available. In this sense the availability of such equipments and facilities stimulates experiments.”

While for the phases of deciding to seek and searching for knowledge face-to-face contact was a major sponsor, at the phase of transferring knowledge it was also found that the ICT of the Campus have a great importance. Nevertheless, when the knowledge to be transferred is under more tacit levels, face-to-face meetings were found to be indispensable. Next, quotations on how co-location of professionals within the Campus enhanced the exchange of information.

H. Vink: “… also we receive more questions from outside Philips of persons that want to participate on the trainings.” (in reference to the advantages of CIT been located within the Campus boundaries)

The routine on the Flexible Display report can also be used to exemplify how the Campus, and its design characteristics, enhances the searching for knowledge. The report consists of a year round collection of articles and technical information available under request (its cost around 4.000 USD). Ruud Nagelkerke (responsible for the search engine tool) has no access to it, since it is not on current contracts Philips has with publishers. On the routine, a researcher from Philips Research asked Ruud about the report, but he was not able to help. Therefore, the researcher had to buy it by himself, for private use only (aware that it could not be shared with others). Later, Ruud received another request for the same report (also from a researcher from Philips Research). The answer he was able to provide was, once again, “I’m not allowed to download it”. However, this time he was able to refer to the previous researcher who had earlier downloaded the reported. Although not the optimum support, this reference was enough to guide, and satisfy, this latter coming researcher. This complementary occurrence of a knowledge broker (bridge function), physical proximity (face-to-face meetings), informal network (integration of knowledge) and shared identity (enhancement of trust between researchers, both of Philips Research) was a fundamental contribution from the design characteristics of the Campus.
6. Challenges in Open Innovation

The following discussion is based on the previous analysis and supported by the identified design principles (a summary is available on Appendix). It addresses existing challenges at the HTCE which the management team has to cope with. These challenges have to be faced to maximize opportunities for knowledge sharing and Open Innovation. At the end of the section, design propositions are introduced based on the empirical research and the literature review, with the objective of solving the revealed challenges. Design propositions, differently from the previous presented design principles, emerge as insights from the analysis and should be considered as suggestions for organizational design. Therefore, these design propositions still need to be validated by future implementation and experimentation.

Throughout the empirical research, no common knowledge on Open Innovation was identified among researchers of the Campus. It was noticed that the vision (toward Open Innovation) from the management team was not adequately aligned with the vision from researchers. Residents showed doubts and ambiguity on the meaning of Open Innovation, its benefits and its value.

This lack of common knowledge on Open Innovation can be traced to two challenges: communication and the tension between openness and protection. Intellectual property rights, regulations & practices and financial compensations are the design characteristics that are directly related to these challenges.

In the next sections (6.1 & 6.2) the discussion around the identified challenges are elaborated. The communication issues are presented as Deployment of Open Innovation, while the tension between openness and protection is discussed under the label of Open Innovation networks & Intellectual Property rights.

6.1 - Deployment of Open Innovation

Ambiguity exists regarding Open innovation at the Campus. This happens even though the policy of the Campus is clearly based on Open Innovation principles. This ambiguity was observed to challenge the implementation of Open Innovation, since it requires researchers who not only excel in their work, but are also able to work in such an open culture.

Knowledge incorporated in clusters and cooperative relations was considered to be not developed in great leaps, but incrementally, step-by-step. Therefore this ambiguity was noticed to be part of the natural process of implementing Open Innovation. To install Open Innovation within single firms is already a challenging task, but when the strategy is to leverage this new paradigm to an entire community, the demands are even higher.

M. Vertregt: "...in order to Open Innovation to settle (at the Campus), it will take some vision and time."

H. Vink: "The technical transitions are going much faster than this kind of changes (organizational) since it affects the way of working of people."

Moreover, the Campus itself is a dynamic and complex environment currently involved with these concepts. Such a scenario not only makes more difficult the existence of a common knowledge on Open Innovation but also make its settlement less trivial.

Interviewer: "Is this something that is happening or is still under planning?" (regarding how CIT deals with Open Innovation on its routines)

H. Vink: "We are still investigating it. It is not easy to do it since Philips is a large company. It takes time!"
Throughout the research period at the Campus, this ambiguity was noticed to influence knowledge sharing among residents of the Campus. It seems that the ‘gears’ of Open Innovation, the researchers and knowledge workers, are not yet fully embedded with this new paradigm.

“I see no structures enabling the development of Open Innovation. I can see the Strip with the restaurant and shops but I have no interaction with the other workers when using it”

“No shared vision or common direction exists. I don’t feel that I’m part of the Campus, just that I’m located here.”

The informal networks are evidence for the lack of common knowledge and ambiguity existing at the Campus. Findings suggest that ‘hidden’ informal networks exist within the Campus. As a result, informal networks are occurring under an unmapped condition (not evident/identifiable by the Anchor firm). In addition, the sponsorship and creation of new informal contacts does not occur as it could. Mostly important, these results occur at the same time that the management team of the Campus visibly tries to enhance the network of residents.

Simply saying, researchers and knowledge workers from SMEs do not want to explicitly evidence the benefits generated from their informal network. On the other hand, researchers from the Anchor firm do not know if they are allowed, or not, to share knowledge with their network. Still, they do exchange information since they have personal motivation to do so. Therefore, a duality was noticed. The management team is searching for knowledge sharing of the resident employees, knowing that the exchange of knowledge is not only allowed but also desired (although not all knowledge should be shared). In contrast, researchers and knowledge workers of the Campus are still not sure about which knowledge can be shared and which should remain strictly inside their organizations. Who is allowed to have access to certain knowledge is also not clear for them.

A mixed message was also observed to exist. It was experienced that representatives from the Legal and IP&S department are also involved in promoting Open Innovation at the Campus (e.g. European Introduction Day on November 10th - welcome event for new employees of Philips Research). Although these representatives support the deployment of the Open Innovation policy, many restrictions were perceived due to the emphasis on intellectual property rights. This mixed message also comes from the regulations & practices existing at the Campus (e.g. limited access to facilities and meetings, bureaucracies and formalities) and financial compensations required (e.g. cost of facilities services, lack of transparency).

One reason for the ambiguity is a lack of communication. Some researchers perceived that Philips is marketing one thing, but doing another. In other words it appears that, although Open Innovation is being marketed as a core policy of Philips, its employees don’t experience any involvement or benefit from it. Therefore, the deployment of Open Innovation to lower levels of the hierarchical chain is seen as a challenge to be overcome.

Several researchers and employees of the Campus mentioned that no attempt was made to ‘sell’ the Open Innovation idea. During interviews, no references to the reinforcement and institutionalization of changes toward Open Innovation were made. Researchers that were not involved in spinoffs or shared facilities and services of the Campus were frequently not aware of the new policies toward Open Innovation. As a consequence, although the ecosystem of the Campus influences researchers’ daily routines, no direct results toward knowledge sharing were observed. Some statements grounding these findings were:

“I perceive a lack of transparency regarding the implementation plan. If I knew the possibilities and advantages of this ‘Open Innovation’ policy perhaps I could profit more from it.”

“Management did not involve us (researchers) and they were not honest with the ‘marketing’ presented”
No successful deployment of Open Innovation occurred to the researchers of the Campus, at least outside Philips Research. It seems that the strategy has not been communicated, and the idea of a Campus practicing Open Innovation seems to some employees of the Campus as an 'ideology'. Empirical data indicates that, even when the management team had the chance to deploy this emerging policy, they either made "the same common speech that looks like a top-down deployment" (researcher from Philips Research) or they just ignored the topic.

Personal experiences also contributed to the perception of an incomplete deployment of Open Innovation. In a few opportunities (e.g. colloquiums, Design Your Own Future workshop -DYOF, PD Perspective) it was experienced that the achievement of an innovation was mostly, if no exclusively credited to Philips Research, being it used as a marketing tool for this part of the Anchor firm. In some cases these opportunities were oriented at Philips (Research) staff only, but in other occasions the message was addressed also to other residents of the Campus (e.g. DYOF workshop and Open Campus Seminar). As Open Innovation defines, no technology is useful if the possibility to market and to produce it does not exist. Instead of deploying such a thought, the noticed process throughout the experiences was the ‘selling’ of Philips and Philips Research as an ecosystem of potentialities.

Communication and deployment of Open Innovation could be done through the parallel use of some design characteristics for example. Through formal meetings (e.g. colloquiums) open to all residents and focused on Open Innovation, results can be achieved. One is the direct deployment of the Open Innovation concept, achieving a common knowledge on topic. Secondly, knowledge brokers could be mapped and sponsored to start informal networks involving employees interested or necessary on the topic. With share facilities and services (e.g. meeting rooms, cafes & restaurants and library) supporting this development, knowledge sharing about Open Innovation may became frequent within the Campus.

Researchers from Digital Signal Processing (DSP), a group of Philips Research, referred to the case of electronic-paper display as an example. This technological achievement was developed through an Open Innovation process. Therefore, an option for marketing Open Innovation is the case involving Philips’ technological contribution to the e-book described by Hastbacka (2004). This article reports how Open Innovation performed a crucial role on the birth of the e-book and the electronic paper and how important it was to bring these innovations to the market.

A second reason for the ambiguity regarding Open innovation at the Campus is a tension between openness and protection. This tension was also noticed to affect the deployment of Open Innovation to lower levels of hierarchy and the value chain at the Campus. This comes from the fact that the Open Innovation strategy of the Anchor firm is not yet completely defined. Such continuous development of Philips strategy is, in part, a consequence of Open Innovation itself being an ‘organic’ concept, i.e. a continuous evolution based on previous developments. This tension between openness and protection is discussed separately in the following section.

This discussion led to the investigation of propositions for the management team. An essential proposition to cope with this dilemma is to invest in more clarity with researchers (regarding existing policies) and to develop knowledge workers with higher autonomy. To further spread knowledge about Open Innovation to the Campus residents is also important. At the end, these researchers are the ones that can easily judge whether the reasons for the adoption of the Open Innovation strategy within a specific project will fit with the type of innovation applied. But now, with Philips not holding the majority of the investments of the Campus, how will the deployment be coordinated? In the following section such a concern is discussed and design proposition involving the studied design characteristics proposed.
6.2 - Open Innovation networks vs. protection of knowledge

It became clear that the tension between openness and protection exists on the intersection of Open Innovation and intellectual property rights. This tension is not new and, as a consequence, not easily solved. As a result, Intellectual Property rights were observed to create barriers to the implementation of Open Innovation at the Campus.

Intellectual property rights are a necessity in today’s global arena. Teece (1987) adds that the effectiveness of protective property rights (appropriability regime) strongly contributes to the value creation potential of innovations. In addition, intellectual property provides the rights that assure value for the owner. Nevertheless, the principle of valuing intellectual property is highly uncertain since it involves determining the future income associated with its ownership. Due to this uncertainties and overall dependence on the organizations strategies (which are also dynamic), the implicit discussion of protection vs. knowledge leakage becomes an even more challenging topic.

Knowledge protection occurs through different design characteristics of the Campus. On infrastructure set of design characteristics, the access or limitation to facilities, services and ICT (e.g. intranet) is an immediate concern. Regarding the rules & agreements set of characteristics, there are the direct and indirect effect of costs, formalities and intellectual property rights. Even on social capital group an influence is perceived, such as access to formal meetings, knowledge brokers and informal network.

This graduation project supports that a balance, not a tension, should exist between openness and protection issues on knowledge sharing, intellectual property rights, patents and others. Without this balance, the main support of knowledge sharing at the Campus - the residents’ informal networks - will not perform with excellence. Next the design propositions toward such a balance are presented. The first action is to maintain Intellectual Property policies as a high priority among the concerns of the management team of the Campus. This proposition is aligned with the findings of Davis (2006). In his study, several challenges to implement Open Innovation in organizations are evidenced. One in particular is that Intellectual Property issues should be considered a major area of concern in an Open Innovation program. Davis proposes the following queries for managers under the process of implementing an Open Innovation policy:

"Will information from external groups contaminate my IP and will the lawyers be following close behind?" Davis (2006).

"Will I inadvertently disclose IP by describing my needs and communicating them to the global research and innovation community?" Davis (2006).

Another proposition is to have Intellectual Property rights aligned with actions toward the sponsorship of knowledge sharing within the Campus. The integration of regulations & practices and formal meetings toward the deployment of Open Innovation can also be a possibility. This example is further discussed in this chapter.

The empirical research elucidated that the Anchor firm of the Campus is aware of the challenges and is taking actions. One example was to observe that in a welcome event for new employees of Philips Research the agenda gave priority not only to the discussion on Open Innovation, but also brought as speaker an employee from Legal department to develop on legal aspects, external relations and intellectual property rights. As a message from the event, it was experienced that although Open Innovation is clearly defined as a policy of the firm there is still a lack of clarity on its ‘grey’ areas (Open Innovation is not black and white, not open or closed, there is a mid-term). During the presentation of Legal aspects conflict appeared to exist with the just presented Open Innovation policies. The Legal representative seems more
concerned in transmit the message to avoid losing valuable knowledge by adopting clear action in line with Intellectual Property rights policy. Intellectual Property should not be given away! Although the message was necessary, no feedback on Open Innovation and how to benefit from the reciprocity on knowledge sharing by exchanging Intellectual Property that is not vulnerable was discussed.

A message that comes clear is that the field of intellectual property management is evolving in ways that could not have been predicted a few years ago and its influence is rapidly spreading from the legal department to the management positions. For small start-ups intellectual property rights were often the most important asset the company has. Therefore control and management is possible. But while dealing with (managing) the assets of small firms, and even medium-size firms, the Campus has to cope with large companies and the Anchor firm as well. For the Anchor firm, it is an entirely different matter. The intellectual property policies are not easy to be defined and are constantly being updated. Besides, its influence on the Campus ecosystem is an additional issue to be considered.

On the developments around intellectual property, the main argument it the new book of Chesbrough is that business models depend not only on their tics but also in their intellectual property strategy (example of Qualcomm). Thus, the use of Open Innovation may also depend on the available intellectual property regime. Overall, it is argued that prior research on Open Innovation has underemphasized the importance of maximizing returns from knowledge outflows and emphasized inflow over outflow of knowledge.

Chesbrough also argues that the “formal appropriability by large depends on intellectual property (IP) laws, and certain types of Open Innovation are only possible through such intellectual property protection”. Thus, this graduation project recognizes that the relationship between intellectual property policies at the organizational level and the practices of Open Innovation is under tension at the Campus. Chesbrough further exemplifies, from studies of biotechnology and information technology innovations, that too much appropriability is also bad for Open Innovation.

Chesbrough also presents the discussion of potential role of intellectual property. The arguments refer to the role of intellectual property on what regards generation of innovation. The idea is to avoid the problem of underinvestment in innovation that grants temporary monopoly through intellectual property rights, usually in favor of large companies (in detriment to SME). Chesbrough refers to Besen and Raskind, who observe:

"The objective of intellectual property protection is to create incentives that maximize the difference between the value of the intellectual property that is created and used and the social cost of its creation" (Besen and Raskind 1991)

Applying this argument to the Campus, the proposition is toward its Anchor firm. Philips, more than never, should provide the social ecosystem and deal with the incurring social costs in order to establish the incentives to the creation of innovation. Intellectual property rights should exist to preserve the value of the knowledge, but it must not restrict the influence of design characteristics on knowledge sharing.

It appears that the higher independence of the Campus from the Anchor firm (as noticed on the percentage of employees residents) is a positive step being taken toward Open Innovation. In the future, by marketing the Campus not only as responsible for infrastructure and services but also as the holder of knowledge and intellectual property (in great part controlled by Philips Research), knowledge sharing within the Campus might be directed affected. To add the characteristic of knowledge holder to the facilitator and enabler role the Campus currently has remains as design proposition for the management team of the Campus.
The management team already demands a more 'pro-active' way of working from knowledge brokers (consultants, CITT4 lectures and MiPlaza employees); however the knowledge brokers' work is still limited by current boundaries of Philips or even Philips Research (e.g. search engine tool and CIT trainings). Such barriers usually demand the establishment of formal agreements, which were observed to indirectly complicate (higher complexity) the exchange of knowledge between organizations. It was verified that knowledge institutes (e.g. Center for Translational Molecular Medicine – CTMM and Holst Center) are being created to overcome such barriers. These institutes will work as enabler of knowledge exchange and facilitator of formal procedures. In the future, the HTCE is expected to extract better results from its deliberate design characteristics by sponsoring knowledge brokers from such institutes to formal meetings and intellectual property rights discussions. These brokers should be the ones pushing the chain of events by sharing their network and turning it useful to other organizations of the Campus. At the end, these institutes should keep the Campus at the technological leading edge.

A further concern is how to manage the Campus design characteristics to enhance knowledge sharing and Open Innovation? The adoption of pilot sponsors and innovative services involving the design characteristics can provide the tools to encourage meaningful behaviors within the Campus. Additionally, the discussion on knowledge brokers, informal network, intellectual property rights and deployment of Open Innovation should be considered.

In his study, Davis (2006) argues that the adoption of a “structured transformation approach through a pilot program can significantly reduce the risk of introducing an open innovation program into the organization.” By pilot program Davis means “taking a group and looking for technology or innovation patterns globally to meet their projects demand”. As design proposition for the Campus management team, a suggestion is the adoption of such pilot programs approach. The first step is to identify areas, or departments of the Anchor firm, that can run as pilot program of innovative services aiming Open Innovation and knowledge sharing at the Campus (innovative services is discussed and exemplified on the next paragraph). These should be selected according to their strategic access to valuable information or their fundamental role to the Campus. Throughout the ‘snap shot’ captured in the empirical research, CITT was identified as possessing the necessary conditions and capabilities to be considered as an option to become a pilot sponsor of knowledge sharing.

The adoption of this approach should be linked with a stimulus to the management team toward the adoption of innovative services. In discussing Open Innovation, much attention is dedicated to profitable outcomes as result of innovative products that have a value to the market. However not much is argued about services that may be originated via the adoption of Open Innovation. These are services that can range from simple incremental enhancements to breakthrough opportunities. Gilsing (2005) presents that “the successful introduction of a novelty, which can be a new product or service in the market or a new internal process for producing products or services, is called an innovation.” (pp. 5). From the analysis of interviews and observation of routines, it was possible to codify the new strategy of CITT as the introduction of a novel service, providing novel outcomes to the Anchor firm and the entire HTCE. The search engine routine also falls under this classification, however actions toward its improvement were noticed to be necessary.

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4 Center for Technical Training, a department of Philips Research.
7. Conclusions

According to the analysis of literature and empirical data, both knowledge management and Open Innovation are suitable for companies residing within the High Tech Campus Eindhoven. Within the ecosystem of the Campus it was observed that knowledge sharing does take place. The different flows of knowledge existing at the Campus vary from informal to formal knowledge sharing. Informal knowledge flows crossing the boundaries of the Anchor firm to reach spinoffs, SMEs and recently disentangled Product Divisions represent a fundamental channel of communication. Formal exchange of knowledge was also seen as an integral part of the knowledge sharing at the Campus, especially when discussion about intellectual property rights is necessary. However, the evaluation of design characteristics also showed that challenges exist: ambiguity on Open Innovation and tension between openness and protection. Moreover, design characteristics are not fully explored. Overall, resident firms should give higher importance to assumptions about which workers are appropriate for which roles and rethinking the ways in which they protect and share their knowledge.

The effect of design characteristics on knowledge sharing was codified throughout the study into design principles and design propositions. Infrastructure characteristics work as a basis enabler. It is a necessary set of characteristics, but not sufficient to promote and sustain knowledge sharing. In addition, its effect on knowledge sharing depends on other design characteristics (e.g. rules & agreements and social capital). The findings suggest that infrastructure characteristics have a strong effect on existing relationships (e.g. access or limitation to facilities and services) and less impact on new connections. Social capital characteristics are recognized as a vital set of design characteristics to the Campus. Informal networks, which do share valuable knowledge, were found not to emerge spontaneously. It was found that formal meetings and knowledge brokers support the exchange of useful and effective knowledge within the Campus, in special when the characteristics overlap each other. In contrast, informal meetings were not sufficient to generate new informal relations. At the end, for the HTCE to continue on its successful path, out of all the activities, knowledge sharing through informal linkages and networking is central.

The project also highlighted the role of the Anchor firm. In a few words, the Anchor firms has responsibilities (e.g. environmental policies and infrastructure) and rights, such as mapping the available knowledge and taking advantage of knowledge opportunities (exchange, spinning-in/out, outsourcing). The process of knowledge sharing and the establishment of new networks within the Campus can receive great stimulus by letting the current policies of the Anchor firm, especially the Philips Research, to cross its boundaries and impregnate the overall behaviour of the Campus. Within the Anchor firm boundaries, the observed flows of knowledge were stimulated by the constant interaction of workers (formal and informal) and by formal factors, such as conferences and seminars. Overall, the informal networks of employees appeared as the fundamental channel of communication. Nevertheless, the management of knowledge sharing strategies in accordance with current intellectual property concerns of Philips deserves special attention and remains as a proposal for further investigation.

Another lesson learned was that an additional set of design characteristics was necessary to reflect the reality of the Campus. At the beginning of the study, the design characteristics were restricted to infrastructure, social capital and knowledge ecosystem (chapter 2). As a result of the empirical research, the new category of rules & agreements emerged, which was later investigated with support of a literature review and divided in intellectual property rights, regulations & practices and financial compensation. Such a development confirmed the transition from a positive perception toward the sponsorship of
knowledge sharing (possessed at the beginning of the graduation project) to a more sensible reflection about the challenges and difficulties involved on it.

Throughout the period of empirical research at the Campus, it was observed that the co-operation between resident companies and institutes is based on complementarities and mutual reinforcement instead of competition. As consequence, it is possible to affirm that a growing movement toward an Open Innovation ecosystem exists. Such a scenario creates a sustainable competitiveness on the Campus. However, it is necessary that the Anchor firm of the Campus not only punctually deploy such Open Innovation policy to the Campus’ residents, but also gain their trust on it. Philips should conquer the belief of its partners that such Open Innovation policy will be beneficial for all actors involved on the relationship. Financial compensations and intellectual property rights design characteristics should be managed in order to migrate these from being a barrier to become a sponsor of knowledge sharing. In addition, the external dimension of the Campus should also be addressed. The Campus should continue its path toward being a visible cluster acting on the political, economical and financial fields. Because of its pioneer role in such areas (e.g. environmental policies) the Campus also pushes innovation to a diversity of arenas.

During the graduation project, challenges were identified which need to be transposed to increase the opportunities for knowledge sharing and Open Innovation. Among these challenges, a major concern is how to overcome the existing doubts and ambiguity regarding Open Innovation. The deployment of Open Innovation policies, the balance between openness and protection and the clarity of these processes were the areas addressed in order to overcome these challenges.

Among the design propositions offered by this graduation project, a common attribute is the dependency on the integration of design characteristics. The core message is that an integrative approach regarding the management of design characteristics is not an option, but a necessity! Within this integrative approach, design characteristics should run in a parallel workflow, instead of working sequentially through the different phases of knowledge sharing. Although this parallel workflow does not necessarily reduce the amount of effort and costs for managing the knowledge, it does reduce time in building knowledge networks, and thus enhances efficiency of the available design characteristics. For instance, the integration of regulations & practices and formal meetings can be explored to facilitate the deployment of Open Innovation on the Campus. Besides providing clarity on the policy, this approach of deployment can also stimulate informal networks and knowledge brokers in the field of discussion of Open Innovation. These sponsored knowledge brokers and informal networks may then emerge as a valuable channel of deployment of the policy. Nevertheless, by dealing with Open Innovation as an organic paradigm it becomes evident that the management team has to simultaneously cope with the different axes existing within it (e.g. intellectual property, regional/national boundaries, human resource management, organizational culture and governmental policies).

As suggestion for further studies, the governance policies toward the ways by which the firms residing at the Campus hire, motivate, and retain employees should be investigated. Moreover, once aware of the business dynamics the Campus is currently living, it is necessary to continue with a more robust longitudinal study to completely evaluate the effects of the Open Innovation policies of the Campus and the maturity of its ecosystem. At this point, the generalizability of this study must be addressed. Since the project only focused on the High Tech Campus Eindhoven, its conclusion are only valid to this
ecosystem. Other studies comparing these findings with other clusters and science parks are therefore necessary.5

Within the conclusions, one should not forget the difficulties existing when trying to align the perceptions and expectations of all residents of a cluster. The challenges involving business dynamics the HTCE currently lives are just a few to be highlighted. Ultimately, these business dynamics can be seemed as a barrier or opportunity. Among the several business changes that occurred in the recent years, there were examples varying from new spinoffs joining the Campus (e.g. Liquavista and Silicon Hive) to the disentanglement of Semiconductors, a Product Division of Philips that represents approximately 40% of the Campus (including area, employees and activities). Other important topics are the environmental policies and other governmental interactions occurring at the Campus. For instance, the environmental policy management of Philips Research is currently being expanded to cross its boundaries and attend other residents of the Campus. Through this service, the Campus cooperates with local authorities on the environmental issues and innovates in terms of permit grating by the authority. The permits involved in this service are expected to receive the government approval in early 2007. In addition, the new manager for this function was still under definition at the time of the empirical research.

The management team of the Campus is undergoing changes, culminating in the recent nomination of a new director for the Campus and MiPlaza. CTT was noticed during the study to be changing its policy toward serving not only Philips, its customers and its suppliers, but all residents of the Campus. Additionally, CTT has also recently changed its management team. Below some other milestones:

- New intranet was launched on 2 of October 2006 with the slogan of "bringing Open Innovation to the middle of the table"
- New partnerships for MiPlaza are constantly occurring (refer to Appendix, section 9.2)
- The ELAt program started 4 years ago to stimulate politicians toward the unification of the region

By considering managing multigenerational workforces, the management team of the Campus also approaches a dynamic context. Young knowledge workers want to seek and acquire knowledge at the same time that the middle generation needs to believe in the knowledge sharing provided. Therefore, there should exist no feeling of ambivalence. In addition, the middle generation has to secure the knowledge involved. It was observed that some older employees of the Anchor firm draw closer to the age of retirement at the same time that other initiate new firms emerging as spin-offs from the Anchor firm. These researches and knowledge workers possess the informal network among the business units of the Anchor firm and also the ability to perform as knowledge brokers between the existing employees of the Campus. Through informal networks it is possible for these professionals to transfer their knowledge and for the new young workforce to acquire information and expand its own network.

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5 As part of the Open Innovation project, two other students are investigating clusters across Europe and North America.
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Appendix

9.1 – Shared Services and Facilities

Figure 12 – Marketing of the HTCE and its shared facilities and services

Below a collection of information extracted from the various media channels available at the Campus (web, printed press, visual displays among others). An important source was the e-magazine, an electronic publication of the HTCE available on the following link: www.hightechcampus.nl/news_events/emagine.html

(i) The Strip

At the center of the Campus lies The Strip, a building that houses several of the shared facilities of the Campus. This is where the Campus occupants can meet up in the restaurants, do their shopping or consult with each other in the conference rooms. This building is equipped with high-tech facilities. The Strip is also home to the Conference Center - the location for meetings, seminars or events. Bert-Jan Woertman is the manager of The Strip since April 1st. His challenge is managing the modern 400-meter-long building known as The Strip.

The Strip is intended to be the central meeting place for a Campus community for both business and pleasure. It is an important symbol of the Campus. It is where researchers and technicians meet each other
in restaurants, meeting halls, shops, the Conference Center and the Campus Wellness Center. At the end of the day, it's all about people. Bert-Jan reinforces: 'The Strip plays a central role in the community. That's why I want to offer first-class facilities, food & drink. But I like looking beyond that. This is the hub of the Campus community and needs to be a place of relaxation, inspiration and creation. This is where that chance meeting can happen, the meeting that leads to ideas. That is open innovation.'

It is with this thought that the Campus facilitates and organizes numerous events in The Strip for Campus residents and other interested parties. Specialist seminars, network events, lunchtime concerts and Campus Pop are just a few examples. There are also the periodic meetings of Science Café (www.sciencecafeindhoven.nl) to add to this list. Bert-Jan: 'At the moment I still don't see enough of a community. We all share something, that's obvious. We are all high-tech researchers. But I still see too few people spontaneously engaging with one another. Co-workers tend to stick together in set groups at lunchtime and rarely meet new people. I want to foster the Campus spirit. Bring all those brilliant minds together. Otherwise, we are just another high-tech industrial park. Of course, it's important that things run well on a day-to-day basis. But I hope the people here soon will be saying with a sense of pride: I work at High Tech Campus Eindhoven. That's the spirit I want to facilitate. I would like to hear from everyone with ideas on how we can strengthen the sense of community," says Bert-Jan.

(ii) MiPlaza

New LC-MS instruments and a new MiPlaza contract

MiPlaza owns two Liquid Chromatography - Mass Spectrometry (LC-MS) machines. This equipment aims to benefit MiPlaza's molecular medicine research by allowing the identification and quantification of organic molecules present in small quantities in complex substances, such as bodily fluids. Further, Philips has signed an agreement with AccTec B.V. (part of TU/e Holding B.V) enabling MiPlaza to use AccTec's Singleton accelerator and beam line apparatus for Ion-Beam-Analysis. MiPlaza will use this equipment as part of its Materials Analysis services, particularly for Rutherford Backscattering Spectrometry in thin film characterization. AccTec will provide a special beam line according to Philips design. MiPlaza and AccTec will work together to extend the equipment performance.

ASML and MiPlaza enter into partnership

ASML and Philips Research are now in a Partnership Agreement to allow cooperation in the field of micro- and nanotechnology in MiPlaza. These high-tech research facilities are planned to be made available to customers and partners as part of the Campus Open Innovation philosophy. This will enable ASML and MiPlaza to use the most advanced stepper lithography in the field of micro- and nanotechnology. This will give the partners and customers of ASML and MiPlaza access to a state-of-the-art research facility which will enable new processes, devices and applications to be developed.

(iii) HomeLab

It is five years since the Philips HomeLab, a unique testing environment on the Campus, was first set up. Here researchers can test technology concepts and ideas in a home setting. The HomeLab comprises a fully-furnished living room, a kitchen, two bedrooms, a study and a bathroom. The rooms are fitted with the latest technological equipment and are full of cameras, microphones and sensors to record the most diverse range of data and also to record the users' reactions. Technologists and behavioural specialists watch from behind the screens in the observation room to see how people react. They analyze the results and these are then used to improve the technology. This sort of research is an important factor in limiting the risk associated with the launch of a product, as well as in the development of new research ideas.
In addition to the HomeLab, two new testing environments have recently been built: the Elderly CareLab and the ShopLab. The first test centre is a senior citizen’s apartment and the tests carried out here will focus primarily on the development of technology to support elderly people in the home environment. In the ShopLab research will be carried out into methods for making shops and shopping more appealing. The research program includes methods of interaction with the shopping public. Furthermore, research will be carried out into how light can help to present products in an appealing way and to enhance the shopping experience for customers (topic also referred during the PD Perspective Seminar).

(iv) Torture Room for TVs
To study how television sets react, the Home Innovation Center Eindhoven (HIC-E) of Philips Semiconductors (now NXP) has set up a special test area called the Torture Room. Tests in the Torture Room examine the signal conditions under which television sets function at an acceptable level. Some countries still use outdated transmission equipment that lacks the stability offered by more modern technologies (Brazil can be used as example). The Torture Room allows televisions to be tested under such less-than-ideal circumstances. The Torture Room does not test only Philips television sets, but also those manufactured by other companies that use Philips ICs. In the Torture Room television sets, PC cards and DVD recorders are hooked up to test equipment that generate ‘less-than-ideal’ signals. The test equipment is computer-controlled to ensure that test conditions always remain the same. The results are analyzed and entered on a score card.

These tests can also be held on location. These field tests utilize a test vehicle that can be deployed in locations around Europe. Field tests beyond Europe are also possible. Philips staff travels to Asia, South America or the United States to examine how the television sets perform. Experiences gained during field tests also can be incorporated in the Torture Room.

(v) Campus Wellness Center
The Wellness Center in The Strip, a brand-new sports centre, was officially opened on Tuesday 13 June 2006. It is equipped with fitness apparatus, training systems and expert guidance of experienced instructors. All Campus residents can make use of the Campus Wellness Center. The Wellness Center registered 400 applications in the first few weeks after opening.

9.2 – Campus Value Added

(i) Save on capital investments
- Cleanrooms, chemistry and physics laboratories: rooms in shell form
- Specialised equipment rental
- Industrial gasses and chemical storage
- Offices
- The Strip: transition from work to recreation, restaurants and cafes, reception of visitors, meeting rooms/auditorium with high-tech equipment, shops, sport & recreation, health facilities

(ii) Services
- Outsourcing capabilities
- Microstructuring (at MiPlaza cleanroom)
- Materials Analysis (MiPlaza)
- Equipment design (Philips Applied Technologies)
- Mechanical Toolshop (ETG-Campus Technology Centre)
Electronic design and prototyping (MiPlaza)
Lifetime testing services (MiPlaza)
Integrated Packaging (Philips Applied Technologies)

(iii) Value Network
Networking & Education
- Technology seminars
- Workshops and Colloquiums
- Social Events

9.3 – Especially Designed Interview Guide

a. Events investigation (based on Hoopes and Postrel, 1999)
- How the event/experience occurred?
- There are costs related to the event/experience?
  - Can you think of an event that exemplifies how much you depend on the Campus?
  - Can you think of an event that exemplifies how much another group depended on the Campus?
  - Can you think of other events which you or someone else was surprised with the contribution of the Campus?
  - Can you think of an event that went out with no contribution of the Campus?
- Can you think of a project that clearly took less time (or money) than it should have because of the contribution of the Campus?

- Which organizations have been involved in the knowledge transfer process? Which are their main activities?
- Did the HTCE participate or facilitate the process of knowledge transfer to firms?
- At what stage of the knowledge transfer process did the HTCE participate (during the process of the idea, design of R&D project, during the R&D project/ innovation)?
- Which was the role of the HTCE? Which type of services did the Campus provide to firms (bureaucracies, communication, intermediaries, business services, finding sources of finance,...)

- In which aspects of the knowledge transfer process have the Campus intervention been important (matching technology objectives, cultures, profit/benefit objectives...). Overall how important was this support?
- Would you use again the Campus services?
- According to your experiences, without the participation of the Campus, would the technology transfer process have taken longer or be more expensive?
- Did the Campus create additional problems to you or other researchers (increased prices, increased bureaucracies ...)?
- Were other organizations involved on the process of supporting knowledge transfer to firms?

c. Further questions related to the design characteristics of the campus (social capital, infrastructure, knowledge ecosystem) in terms of efficiency, frequency of usage, usage intensity and importance to the sharing of the innovation. Identification of the design characteristics active on knowledge sharing and in adopting/absorbing technologies developed or co-developed with other partners.
d. Description of the size, structure, research prestige and diversity of the informal networks involved on the development and transfer of innovations. (Based on Dahl and Petersen, 2004)

- Do you have informal contact with employees in another firm of the Campus? *
- In general how many informal contacts do you have with employees of other firms of the Campus?
- Do you have informal contact with employees in firm established outside the Campus?
- In general, how many informal contacts do you have with employees of firms established outside the Campus?
- Do you acquire knowledge through your informal contact(s) that you take advantage of in your current job? *
- From your informal contacts to which category do they belong: former colleagues, classmates, private friends, others (explain)? *
- From your informal contacts to which function do they belong: research and development, production, management, others (explain)? *
- From your informal contacts with how many did you had previous contact through formal projects? *

- How did you achieve the informal network you have today via the HTCE (focus on the role of the design characteristics)?
- Do you have any suggestion in how the HTCE can help employees to increase their informal network?
- Were you aware of that type of support? Or were the Campus that informed them about the possibility of using the obtained services and support?

e. Additional interests related to the research (expectations from Project Committee regarding Knowledge sharing & Networks (as reported by Ferrtie Aalder during an initial meeting of the project):

- What kind of assumptions are made with respect to knowledge sharing when allocating activities at HTCE?
- What is defined in partnership agreements with respect to knowledge sharing?
- What is assumed implicitly by parties residing at HTCE with respect to knowledge sharing?
- How is knowledge sharing and networking effectuated?
- What is the satisfaction with respect to knowledge sharing and networking so far?

During the interviews an important outcome was to capture whether knowledge workers think the environment of the HTCE really works, i.e. if it is indeed easier to share knowledge once member of the HTCE.
### 9.4 – Observed Routines

<table>
<thead>
<tr>
<th>Events</th>
<th>Contingency Variables</th>
<th>Relationship</th>
<th>External Philips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simulation Tool</td>
<td>Intra HTCE</td>
<td>Extra Philips</td>
<td>New</td>
</tr>
<tr>
<td>SME - Silicon Hive</td>
<td>Intra HTCE</td>
<td>Extra Philips</td>
<td>New</td>
</tr>
<tr>
<td>SE - Liquidra</td>
<td>Intra HTCE</td>
<td>Extra Philips</td>
<td>Existing</td>
</tr>
<tr>
<td>IP&amp;S</td>
<td>Intra HTCE</td>
<td>Intra Philips (not R)</td>
<td>New</td>
</tr>
<tr>
<td>SE - Philips Applied Tech Campus</td>
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<td>Intra Philips Research</td>
<td>New</td>
</tr>
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<td>Intra Philips Research</td>
<td>New</td>
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<td>Intra Philips Research</td>
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<td>Intra Philips Research</td>
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<tr>
<td>Internal knowledge flows of Philips not restricted to Philips Research</td>
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Table 3 - Events gathered in the empirical research

<table>
<thead>
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<th>Routines</th>
<th>Contingency Variables</th>
<th>Relationship</th>
<th>External Philips</th>
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<td>Extra Philips</td>
<td>New</td>
</tr>
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<td>IP &amp; Liquidra</td>
<td>Intra HTCE</td>
<td>Extra Philips</td>
<td>New</td>
</tr>
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<td>Extra Philips</td>
<td>Existing</td>
</tr>
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<td>MIPlaza</td>
<td>Intra HTCE</td>
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<td>CTT/Trainings - MIPlaza</td>
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<td>Intra Philips (not R)</td>
<td>Existing</td>
</tr>
<tr>
<td>CTT/Trainings - Phys Applied Tech</td>
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<td>Intra Philips (not R)</td>
<td>Existing</td>
</tr>
<tr>
<td>CTT/Trainings - Semiconductor</td>
<td>Intra HTCE</td>
<td>Intra Philips (not R)</td>
<td>Existing</td>
</tr>
<tr>
<td>IP&amp;S</td>
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<td>Intra Philips (not R)</td>
<td>Existing</td>
</tr>
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Table 4 - Routines gathered in the empirical research
9.5 – Qualitative Matrices of Events and Routines

(i) Intra / Extra HTCE Knowledge Flows

<table>
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<tr>
<th>Event Variables</th>
<th>Infrastructure</th>
<th>ICT</th>
<th>Social Capital</th>
<th>Knowledge Ecosystem</th>
<th>Rules and Agreements</th>
<th>Applicable Contexts</th>
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</table>

(ii) New / Existing Relationships

<table>
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9.6 – Example of mini-frameworks used in the data analysis.
9.7 – Design Principles.

Infrastructure

- Use physical proximity to sponsor knowledge sharing, by stimulating the persons involved to have frequent personal (face-to-face) contact.
- Take advantage of the physical proximity of employees freely on the knowledge sharing phases of deciding to seek and searching for knowledge. To exploit the transferring phase make use of meetings, manipulate regulations & practices or adequate financial compensation.
- To leverage new networks, physical proximity and co-location of professionals are not sufficient.
- Use shared facilities to support knowledge sharing in existing informal networks, but not to support new relationships.
- Exploit shared facilities and services as a basis for social capital design characteristics (informal network, meetings, shared identity).
- Use the access to equipments and services of shared facilities to control intellectual property.
- Exploit ICT (Campus-wide) as channel for both formal and informal communication sponsoring knowledge sharing.
- Make use of the ICT of the Campus in line with regulations & practices and financial compensation design characteristics.

Social Capital

- The exchange of knowledge is not structured. It is an organic and complex process. Therefore a strong informal network to let it happen naturally is needed.
- Informal networks do not arise spontaneously. Use other design characteristics to stimulate it.
- To achieve effective knowledge sharing stimulate informal networks in accordance with the strategy and intellectual property rights of the Anchor firm.
- Use formal meetings (e.g. colloquiums and seminars) to stimulate knowledge sharing and support the development of informal relationships and new networks.
- Elaborate formal meetings to bring groups together, focusing on specific subjects and allowing face-to-face contact between individuals with a common knowledge base and similar interests.
- Use informal meetings to create knowledge sharing opportunities.
- Explore informal meetings (at shared facilities) to sustain and grow existing networks, but do not expect the creation of new contacts without exploiting other design characteristic (e.g. mediation of knowledge brokers).
- Stimulate knowledge sharing by designing knowledge brokers to both formal and informal meetings.
- Support knowledge sharing crossing the boundaries of resident firms (in special the Anchor firm) by maintaining knowledge brokers within the Campus.
- Stimulate a shared identity, by removing physical barriers and allowing mobility within the Campus.
- Sponsor a shared identity by enhancing network level knowledge sharing among residents.
- Develop a shared identity of the Campus by managing the existing conflicts with rules & agreements and infrastructure characteristics.

Rules & Agreements

- Use Intellectual Property rights to align regulations & practices and financial compensations design characteristics and to maximize their success on sponsoring knowledge sharing.
- Exploit infrastructure and social capital design characteristics only after considering the existing Intellectual Property rights, and the design characteristics it directly influences (regulations & practices and financial compensations).
- Directly stimulate knowledge sharing at the Campus, by manipulating the regulations & practices of the Anchor firm (especially Philips Research).
- To support the Campus boundaries, use common regulations & practices with the residents.
- Through regulations & practices, facilitate the development of network and trust among the Campus residents.
- Avoid that financial compensations become a barrier for knowledge sharing, by mapping its influence on residents' routines.
- Use financial compensation to directly influence knowledge sharing, either for more or for less.

Knowledge Ecosystem

- Creating a Campus around an Anchor firm stimulate the existence of an homogeneous background
- To influence the way people share knowledge, exploit the available common knowledge and background.
- Facilitate the management of innovation, by providing diversity of knowledge within the value chain (e.g. legal and financial know-how).