Enabling Technologies Group

PHILIPS

Social and cognitive competencies in the semiconductor and medical device market

Carin Cramer
Marieke van der Zwaal

University of Twente
Enschede - The Netherlands

Social and cognitive competencies in the semiconductor and the medical device market

A theoretical overview of the concept of competency and a case study for engineers of Philips Enabling Technologies Group

BSc. Carin Cramer
Drs. Marieke van der Zwaal
University of Twente, Enschede
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Company supervisors: Drs. Vlok van Harten
Ir. Rob Brinker

University supervisors: Dr. Ida Wognum
Prof. Dr. Jan Kees Looise

Acknowledgement

In March 2006, we started our graduation project for Philips Enabling Technologies Group in Almelo. This thesis focused on the social and cognitive competencies that engineers of Philips Enabling Technology Group need to possess when working in the semiconductor and medical device market.
The research became a great learning experience in which we could explore the different aspects of working in a technical environment. This thesis was not possible without the contribution of employees and clients of Philips Enabling Technology Group and supervisors of the University of Twente.

First, we would like to thank our supervisors of Philips Enabling Technology Group, Rob Brinker and Vlok van Harten, who provided us feedback about the research and insight in the organisation. During the research we worked at the engineering department in Almelo and therefore, we would like to thank the engineers of the department. We appreciated their hospitality and we would like to thank them for making our lunch breaks so pleasant. We are really going to miss the lunch walks and talks. For the thesis, the managers of Eindhoven contributed to the research. We would like to thank Peter ten Brinke and Peter Schuerman, who were interested in our project and provided us useful support during the project. Also, we would like to thank the different engineers and managers of Philips Enabling Technology Group and Philips Medical Systems and the managers of Advanced Semiconductor Materials Europe, who provided us information about the required competencies. Finally, we would like to thank our supervisors from the University of Twente, Ida Wognum and Jan Kees Looise, who supported us during the project with scientifically advice and provided us with feedback to write this thesis report.

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Carin Cramer Marieke van der Zwaal

Summary

Philips Enabling Technology Group in Almelo and Eindhoven wants to spread its activities over another market then the semiconductor market. The medical device market is considered to be an interesting market and Philips Medical Systems is approached as a potential partner. However, Philips Medical Systems concluded that Philips Enabling Technology Group is not the right partner yet, because they are not aware of the capabilities of its engineers and of the capabilities that potential clients demand. Previous research revealed that engineers of Philips Enabling Technology Group do possess the needed functional competencies to work in the medical device market, but that Philips Enabling Technology Group is not aware of the social and cognitive competencies of engineers. This thesis was focused on investigating what social and cognitive competencies engineers of Philips Enabling Technology Group need to possess in the semiconductor market and the medical device market. A competency is reflected in this research as the underlying attributes of behaviour (paragraph 3.2). The described problem has resulted in the following research question:

Which social and cognitive competencies do the engineers of Philips Enabling Technology Group need to possess to operate in the semiconductor and medical device market?

The differences in competencies between Philips Enabling Technology Group and Philips Medical Systems are that the social competency *empathy* and the cognitive competency *knowledge of the medical device market*, which are only important for the medical device market. This is important, because it reflects the difference in end-user in both markets. In the medical device market the end-user is the patient or medical personnel whereas an operator is the end-user in the semiconductor market. This difference in end-user reflects a different approach of the engineer towards his work, which makes the ability to empathise important. Also, the engineers need knowledge of the medical device market, which can be indicated as the specific characteristics of the medical device market.
Similarities in competencies in both markets are the social competencies networking, collaboration, communication, flexible behaviour and project management and the cognitive competencies problem solving, conceptual thinking, self-development, awareness, knowledge of the own organisation and knowledge of the client that are relevant for both markets (chapter 7). These similarities indicate that engineers, who operate in one of these markets, need to possess the same competencies. The work of an engineer does not differ on other social or cognitive competencies, which indicates that the work of an engineer can be described as the same for both markets with the exception of the competencies *empathy* and *knowledge of the medical market*.
These competencies are reflected in a specific competency model for each market (sub-paragraphs 5.4.3 and 6.4.3) and in a final competency model for both markets (paragraph 7.3). This final competency model provides the answer to the research question.

It can be concluded that the social and cognitive competencies of engineers describe the capabilities of the engineers, which potential client demand. Also, this research provides Philips Enabling Technology Group the possibility to explore which social and cognitive competencies its engineers possess. However, the individual capabilities of the engineers are not defined yet and therefore the engineers have to be assessed on the social and cognitive competencies to meet the requirements of Philips Medical Systems. To fulfil this need, Philips Enabling Technology Group is recommended to develop an assessment tool, which is based on the final competency model, taking the recommendations of chapter 8 into account. However, this assessment is not sufficient enough to operate in the medical device market and therefore the social competency *empathy* and the cognitive competency *knowledge of the medical market* have to be developed by the engineers according to the recommendations, as described in chapter 9.
From this can be concluded that in case Philips Enabling Technology Group assesses the individual engineers and develops the social and cognitive competencies, Philips Enabling Technology Group can be regarded as the right partner for Philips Medical Systems.

Summary (in Dutch)

Philips Enabling Technology Group in Almelo en Eindhoven wil zijn activiteiten spreiden over andere markten dan de semi-conductor markt. Hiervoor wordt de medische markt als interessante markt bevonden en Philips Medical Systems is benaderd als potentiële klant voor deze markt. Philips Medical Systems heeft echter geconcludeerd dat Philips Enabling Technology Group nog geen goede partner is doordat Philips Enabling Technology Group niet op de hoogte is van de competenties van de eigen ingenieurs en de eisen die worden gesteld aan bekwaamheden van ingenieurs door potentiële klanten. Uit vorig onderzoek is gebleken dat de ingenieurs de functionele competenties bezitten om in medische markt te werken, maar dat Philips Enabling Technology Group zich niet bewust is van de sociale en cognitieve competenties van de ingenieurs.
Dit onderzoek richt zich op het onderzoeken van de benodigde cognitieve en sociale competenties binnen de semi-conductor en de medische markt voor de ingenieurs van Philips Enabling Technology Group. Een competentie wordt in dit onderzoek gedefinieerd als de onderliggende attributen van gedrag (paragraaf 3.2). Het beschreven probleem heeft geleid tot de volgende onderzoeksvraag:

Welke sociale en cognitieve competenties moeten ingenieurs van Philips Enabling Technology Group bezitten om in de semi-conductor markt en de medische markt te kunnen werken?

Het verschil in competenties tussen Philips Enabling Technology Group en Philips Medical Systems is dat de sociale competentie *inlevingsvermogen* en de cognitieve competentie *kennis van de medische markt* alleen van belang zijn in de medische markt. Dit is belangrijk, omdat het verschil in eindgebruiker hierin naar voren komt. In the medische markt is de eindgebruiker een patiënt of medisch personeel terwijl een operator de eindgebruiker in de semi-conductor markt is. Het verschil in eindgebruiker geeft aan dat de ingenieur een andere benadering naar de werkzaamheden moet hebben wat het vermogen om in te leven belangrijk maakt. Daarnaast heeft de ingenieur kennis van de medische markt nodig die wordt veroorzaakt door de specifieke karakteristieken van de medische markt.
Overeenkomsten in competenties tussen beide markten zijn de sociale competenties netwerken, samenwerken, communicatie, flexibel gedrag en project management en de cognitieve competenties probleem oplossen, conceptueel denken, zelfontwikkeling, bewustzijn, kennis van de eigen organisatie en kennis van de organisatie van de klant zijn belangrijk in beide markten (hoofdstuk 7). De overeenkomsten geven aan dat ingenieurs deze moeten bezitten om te werken in beide markten. Het werk van een ingenieur kan beschreven worden als hetzelfde voor beide markten met uitzondering van de competenties *inlevingsvermogen* en *kennis van de medische markt*.
Deze competenties zijn opgenomen in de specifieke competentie modellen voor elke markt (subparagraaf 5.4.3 en 6.4.3) en in het definitieve competentie model voor beide markten (paragraaf 7.3). Het definitieve competentie model beantwoord hiermee de onderzoeksvraag.

Er kan geconcludeerd worden dat de sociale en cognitieve competenties van ingenieurs de bekwaamheden van ingenieurs beschrijven die potentiële klanten belangrijk vinden. Tevens biedt dit onderzoek Philips Enabling Technology Group de mogelijkheid om de sociale en cognitieve competenties van de ingenieurs te onderzoeken. Philips Enabling Technology Group is zich echter niet bewust van de individuele competenties en daarom moet vast gesteld worden welke sociale en cognitieve competenties de ingenieurs bezitten om te voldoen aan de eisen van Philips Medical Systems. Philips Enabling Technology Group wordt geadviseerd om een assessment instrument te ontwikkelen die gebaseerd op het definitieve competentie model waarbij de aanbevelingen van hoofdstuk 8 in acht genomen moeten worden. Deze assessment is echter niet voldoende voor Philips Enabling Technology Group om in de medische markt te opereren en daarom moeten de sociale competentie *inlevingsvermogen* en de cognitieve competentie *kennis van de medische markt* ontwikkeld worden door de ingenieurs zoals beschreven in hoofdstuk 9. Op basis hiervan kan geconcludeerd worden dat wanneer Philips Enabling Technology Group de competenties van de individuele ingenieurs vaststelt en de sociale en cognitieve competenties ontwikkelt, Philips Enabling Technology Group beschouwt kan worden als een geschikte partner Philips Medical Systems.

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Appendices

1. Introduction

Philips Enabling Technology Group (ETG) is a Machine Factory that produces machines or parts of machines for the semiconductor market. Their clients will produce semiconductors from which eventually chips for electronic devices will be produced. The semiconductor market can be described as uncertain and unstable, because the market highly fluctuates and has a cyclic character. Next to this, Philips ETG is highly dependent on one client that is responsible for a big part of the revenue of Philips ETG.
This situation forces Philips ETG to spread its activities over other markets. The medical device market has similar characteristics as the semiconductor market. It requires high technology products and entails the same kind of technology as the semiconductor market. In addition, the medical device market it is stable and therefore attractive for Philips ETG.

A trend that can be observed in medical device market is the strategy to outsource different activities. Philips Medical Systems (MS), a potential client, is exploring this possibility in order to focus on their core business, which is the conceptual development of medical machines. Therefore, Philips MS is a potential partner for Philips ETG. However, in an audit in 2005 Philips MS concluded that Philips ETG is not the right partner at the moment (Philips Medical Systems, 2005). In order to become this partner Philips ETG has to change.

One of these changes is the basis of this research. Based on an audit of Philips MS (2005), Philips MS concluded that Philips ETG does not know the capabilities of their engineers and is not aware of the capabilities that potential clients demand. Philips ETG agreed to strengthen the engineering capability to serve Philips MS better with products and services.
To fulfil this agreement Yuting He, a student from the master program Business Administration of the University of Twente, conducted a research for her final thesis in 2005. This research focused on the characteristics of the medical device market, the semiconductor market, the engineering department of Philips ETG and the existing competencies of the engineers of Philips ETG.
He (2005) concluded that the functional competencies of engineers to operate in the medical device market are available within Philips ETG. However, He (2005) concluded that the social, cognitive and meta-competencies are not sufficiently available within the engineering department. Philips ETG was recommended to further investigate the social and cognitive competencies to clarify the difference between these competencies in the semiconductor market and medical device market. Philips ETG acknowledged the need to also investigate the social and cognitive competencies for the semiconductor market and therefore, this market was included in the research.
The described situation and the recommendation of He (2005) are the starting point of this research and resulted in the following research question:

Which social and cognitive competencies do the engineers of Philips ETG need to possess to operate in the semiconductor market and medical device market?

The research question will be investigated with the use of a competency research model. The development of this competency research model will be explained in chapter 3 of this thesis. The research context will be explored with the use different of documents and this will be explained in chapter 2. The content of the following two chapters and the connection of these chapters is presented in figure 1 on the next page. In chapter 4 the research methodology is explained followed by the presentation of the results in chapter 5 till 7.

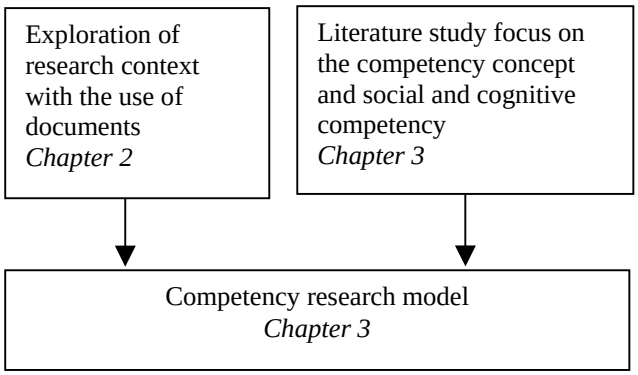

Figure 1: Content chapters 2 and 3

2. Research context

This chapter will explore the different contextual elements of the research for Philips ETG. Philips ETG and the characteristics of the locations of Philips ETG will be discussed. Next, the semiconductor market and medical device market will be described.

For this contextual exploration, different documents and sources were used to retrieve information about Philips ETG, the semiconductor market and the work of an engineer of Philips ETG. These documents are the Strategy Plan of Philips ETG (Philips, 2003) and the department description of Engineering. Sources that were used are the global site and the intranet of Philips ETG.

2.1 Philips Enabling Technology Group

Philips ETG is a worldwide equipment manufacturer that was founded in 1900 as the Machine Factory of the Philips organisation. In the first 80 years of its existence it supplied the industrial mechanisation and tooling throughout the Philips organisation. However, in the 1980s the circumstances changed and, as a consequence, caused a change for customers of Philips ETG. From that moment on Philips ETG started offering solutions for Philips and for external customers. Philips ETG also started to deliver complete systems instead of components. To reflect these capabilities better, the name Enabling Technologies Group was chosen in 2000. Philips ETG was formed consisting of six factories in four locations: Almelo and Eindhoven in the Netherlands, Singapore and in Suzhou in Asia.

Philips ETG now operates in the semiconductor market as a system supplier. This means that Philips ETG is responsible for the value chain from engineering through parts production, assembly and testing. The core activity of Philips ETG is the supply of extremely high-technology professional equipment to the global semiconductor equipment market. Philips ETG does not have any products of its own and does not apply for any product patents, instead it makes the products for its clients and applies for process patents.

To describe what the focus of Philips ETG is the mission and vision will be given. These are derived from the values of Philips, which are (Philips, 2003):

- Delight customers;
- Deliver on commitments;
- Develop people;
- Depend on each other.

The mission of Philips ETG is:
‘ETG offers its customers the ability to concentrate on their core-activities by organising their integral production process, lower their break-even point and provide them with the needed flexibility for utilising their market opportunities. ETG serves its customers in a pro-active way with high end manufacturing technology, product and production engineering in combination with excellent supply chain management on a global scale’ (Philips, 2003).

The vision of Philips ETG is:
‘ETG will be the largest world-class engineering and manufacturing company, operating world-wide, employing committed people and using outstanding suppliers, providing its customers in the semiconductor equipment business and high-tech capital equipment industries with innovative and unique technological solutions and logistic services, delivering substantial profitable growth and enhancing shareholder value’ (Philips, 2003).

Philips ETG Almelo and Eindhoven do not have a different scope within the semiconductor market, but the activities differ per location. In the next sub-paragraphs a description of Philips ETG Almelo and Eindhoven will be given.

2.1.1 Philips Enabling Technology Group Almelo and Eindhoven

The headquarters of Philips ETG is settled in Eindhoven. The departments of Philips ETG in Eindhoven are Systems/Parts, Projects and the Campus Research Centre.
The product-units Systems/Parts of Philips ETG Almelo and Eindhoven are the units that operate in the semiconductor equipment market and in professional industrial equipment market. Philips ETG Almelo and Eindhoven can be characterised as contract manufacturers, which means that they deliver products on contract to their customers.
The focus of Philips ETG Almelo and Eindhoven is to offer customers systems that will lower their breakeven point by organising integral supply chain and manufacturing process in the broadest sense. Therefore, Philips ETG Almelo and Eindhoven will focus on the following activities: supplying high-end technology systems and modules with high precision and engineering support. Because of the fact that customers know and understand their product well they could also produce the product themselves. Therefore, the customers of Philips ETG Almelo and Eindhoven can be their main competitors. However, Philips ETG Almelo and Eindhoven solves this problem by excelling in certain areas and being a good partner for their customers, which makes it possible to develop the product better or cheaper.
The difference between Philips ETG Almelo and Eindhoven is that some activities are only possible in Almelo or Eindhoven. Some machines are only located in a certain factory or a location is specialised in a certain technology.

To provide the clients of Philips ETG with better products and services the engineering department was created. The engineers of Philips ETG provide services to the clients to solve problems in the design and the production of a product. This engineering department is described in the next sub-paragraph.

2.1.2 Engineering

The department Technology & Development (T&D) consist of three engineering groups: Semiconductor, Medical & Analytical and Mechanisation. These groups are located in Almelo and Eindhoven. In this research T&D will be referred to as the engineering department.
Engineering can be described as the application of scientific and technical knowledge to solve human problems with as result the design, production and operation of useful objects or processes (Wikipedia, 2006). As described, the engineering department of Philips ETG came into existence to fulfil wishes of clients to look at the cost price of products, to investigate if a product can be made and to optimise and adjust the design of clients. This service of the engineering department can support the whole or part of the lifecycle of products. Activities of the engineers are: product creation, design for excellence, product introduction, tooling, sustaining and value engineering.
Changes in the production process and products will have the starting point at the engineering department and therefore, the engineering department can be an initiator for changes within the organisation. Thus, strategy changes within Philips ETG should first take place within the engineering department.

2.2 Semiconductor market

As described, the semiconductor market is the target market of Philips ETG. Within this market semiconductors are fabricated. A semiconductor is a material with an electrical conductivity that is intermediate between that of an insulator and a conductor (Wikipedia, 2006). From this material chips for different machines and equipment will be made and for example used in laptops or radio's.
The semiconductor market can be characterised as very uncertain and unstable, because of high fluctuations in investments. Sometimes it swings between 60% plus to 30% minus. Another threat is that Philips ETG has a few customers who buy the equipment and fabricate semiconductors. For example, Philips ETG Almelo is dependent on one customer who is responsible for nearly 70% of the revenue of Philips ETG (Philips, 2003).

Because of this unstable character, Philips ETG wants to spread activities over other markets. It focuses on a market that requires high technology products and entails the same kind of technologies

compared to the semiconductor market. The medical device market seems to be a good potential market for Philips ETG, as mentioned before. This market is described in the next paragraph.

2.3 Medical device market

The medical device market produces medical equipments that are designed to aid the diagnosis and treatment of medical problems. The basic types of equipment are: diagnostic equipment, therapeutic equipment, life-support equipment, medical monitors and medical laboratory equipment (Wikipedia, 2006). Because these machines are always necessary to diagnose and treat medical problems, the market is not highly influenced by economic growth or decrease.
A potential client for Philips ETG in this market is Philips Medical Systems (MS). Philips MS a supplier of diagnostic imaging equipment, information technology and supporting services for healthcare applications. This equipment and technology supports the patient care from diagnosis to treatment. Products that are manufactured by Philips MS are for example Cardio/Vascular X-ray.

2.4 Summary

In this chapter the context of the research is presented. Philips ETG as organisation and in specific the locations Almelo and Eindhoven are described. The engineering department of Philips ETG is described, because the research focuses on the engineers that work within this department. Also, the semiconductor and medical device market are presented to explain the context.
Competencies of the engineers are the main focus in this research, as described in chapter 1. Further explanation of the concept of competency will be provided in the following chapter.

3. Competencies further defined

In this chapter different aspects and ideas of the concept of competency will be described to provide a theoretical background for the research. Exploring the insights in literature provides a competency research model, which will be used to investigate competencies. This chapter will clarify the concept competency, describes different competency models, defines social and cognitive competencies and provides a competency research model based on this information.

3.1 Emergence of competency

The concept of competency has become important in the previous century, which is caused by the demand that employees are asked to work with large amounts of information (Skyrme, 1997). This information has to be combined, interpreted and this has to lead to new knowledge and developments (Skyrme, 1997). In the knowledge economy of today the knowledge of employees has become more important and the competitive advantage of organisations must now be achieved by the added value of knowledge to the products (Harrison & Kessels, 2004). Knowledge development and using knowledge in a appropriate way has now become an important issue for the survival of organisations.
Harrison and Kessels (2004) describe that personal knowledge is unique and therefore difficult to copy by other organisations. This makes it more important for an organisation to use and develop knowledge. Knowledge does not have a static character anymore and therefore a different approach towards knowledge in organisations is necessary (FEC, 2003). Knowledge is becoming valuable when it fits in the strategic direction of an organisation and becomes utilised in processes, products and services (FEC, 2003). Hence, it is important for organisations to maximise the knowledge productivity, instead of enlarging knowledge. In this context, knowledge can be considered as competencies, because it describes that competencies can be seen as an important tool for making the knowledge of use for the organisation (Keursten, 2000).

The changing environment of organisations causes that the demands of an organisation cannot be separated from competencies (Van der Ven, 2000). In this sense, competencies are viewed as organisational properties. Van der Ven (2000) also states that an organisation has to make sure that it is prepared for the demands of the future and therefore, has to obtain the right competencies today. The competencies that an organisation has today, determines the success of the products or services of tomorrow (Van der Ven, 2000). No longer do market positions determine how long an organisation will survive, but the capacity to create, guarantee and use unique knowledge as an input for services or products determine this (Teece, 1998).
This changing environment of organisations demands flexibility, employability and the emergence of knowledge as a production factor (Garavan & McGuire, 2001). This puts a different demand on employees (Garavan & McGuire, 2001) and the concept of competency is viewed as a response to this demand. A further explanation of competencies will be provided in the following paragraphs.

3.2 Competency and competence

After the emergence of the concept of competency different ideas about the concept became observable. A variety of definitions were formulated and different approaches towards the concept became apparent. Within this paragraph a selection of definitions is provided to establish an understanding of the concept of competency and two main competency approaches will be described.

3.2.1 Definitions

In literature many authors have contributed to the conceptual exploration of the term competency. However, a single definition that is accepted by everyone is not yet the case. Therefore, some definitions and ideas of competency will be described to provide a theoretical understanding of the concept.

Along with the term competency the term competence is used and these differ in definition. Moore, Cheng and Dainty (2002) defined the term *competence* as what people need to be able to do to perform a job well. It refers to the range of skills, which are satisfactorily performed by the employee (Rowe, 1995). The emphasis is on doing, on the question 'What can an employee do?' (Rowe, 1995). Hoffmann (1999) explains that the term competence, has been used to refer to the meaning expressed as standards. Standards are the level to which an employee should perform his job. These standards should be achieved in order to perform sufficient.
The term *competency* is defined by Moore, Cheng and Dainty (2002) as the behaviour(s) supporting an area of work. It refers to the behaviour adopted in competent performance (Rowe, 1995). The emphasis is on how employees do their work, on the question 'How do they do their job?'(Rowe, 1995). Hoffmann (1999) explains that the term competency is used to refer to the meaning expressed as behaviours.
It becomes clear that the term competence is focused on the demands of a certain job and the term competency emphasises the behaviour that is needed for the work. Two definitions will be given to provide an example about the difference in focus.

The Training Standards Agency defines competence as:
".. an action, behaviour or outcome which the person should be able to demonstrate (Horton, 2000)."
FEC (2003) describe competency as:
"The capabilities of people which allow them to act correctly in common (professional or job-related) situations and these capabilities can be developed. It means that a person is capable of choosing and using the right procedures to achieve good results."

3.2.2 Approaches

The distinction between competence and competency can further be explained with the description of the different approaches towards the concept.

Within the UK and Europe the term *competence* emerged. Competence focuses on the functional aspect of the concept (Delamare le Deist & Winterton, 2005; Hoffmann, 1999; Iles, 1993; Mériot, 2005). Competence can be used as a measure for output of learning and can be expressed in a standard that should be reached in order to perform a task (Horton, 2000). Therefore, competences refer to the range of skills, which are satisfactorily performed (Rowe, 1995).
The concept *competency* is found in the US literature and focuses on the behavioural aspect of it (Delamare le Deist & Winterton, 2005; Hoffmann, 1999; Iles, 1993; Mériot, 2005). Competency is defined as the underlying attributes of a person and refers to the meaning expressed as behaviour (Hoffmann, 1999), as indicated in the previous sub-paragraph. Therefore, competency refers to the behaviour adopted in competent performance (Rowe, 1995).

The difference between these two definitions is that the US approach focuses on searching excellent behaviour whereas the UK approach focuses on a systematic identification of the skills needed to perform a role (Horton, 2000). However, both ideas have the common purpose of improving the human performance at work (Hoffmann, 1999). This difference can also be expressed by input or output characteristics (Toolsema, 2003), which Hoffmann (1999) describes as the input-based or output-based approach. The input-based approach describes the underlying attributes, which lead to competent performance (Hoffmann, 1999). In contrary, the output-based approach describes specific performances and standards required (Hoffmann, 1999). This means that the input-based approach refers to the term competency and the US approach of competency. The output-based approach refers to the term competence and has a link with the UK approach. According to these approaches, complex jobs may best use an input-based approach, while simpler jobs can benefit from an output-based approach (Hoffmann, 1999).

The different descriptions of competency caused that the term is not enough shaped to differ from other concepts like skills or knowledge (Mulder, 2000). Besides this, the UK and US approach focus on divers aspects. The chosen definition will determine the outcomes. Hoffmann (1999) concludes that

the rational of the use of the term competency will determine the definition. Therefore, it is necessary to choose the definition that helps to achieve the goals of the research.
For this research the focus will be on the underlying attributes of the behaviour of engineers. The needed behaviour of engineers will be identified and explained. Also, the behaviour is described according to what every engineer should be able to do or demonstrate and is not compared to excellent behaviour. Therefore, the chosen term for this research is *competency*.

In this paragraph it is made explicit what kind of approaches and definitions towards the concept of competency are used in literature. In the next paragraph, the different elements of competencies that can be found within the definition will be described.

3.3 Changeability and importance of competencies

Both the US approach and the UK approach have in common that the elements knowledge, skills, attitude and other characteristics are part of the definition. These elements are also found in other definitions of competency (Schippmann, Ash, Carr, Hesketh, Pearlman, Battista, et al., 2000). Korthagen (2004) adds the element norms, values and concepts to it. These different elements can be divided into visible and non-visible elements. Competencies are presented in an iceberg structure in figure 2.

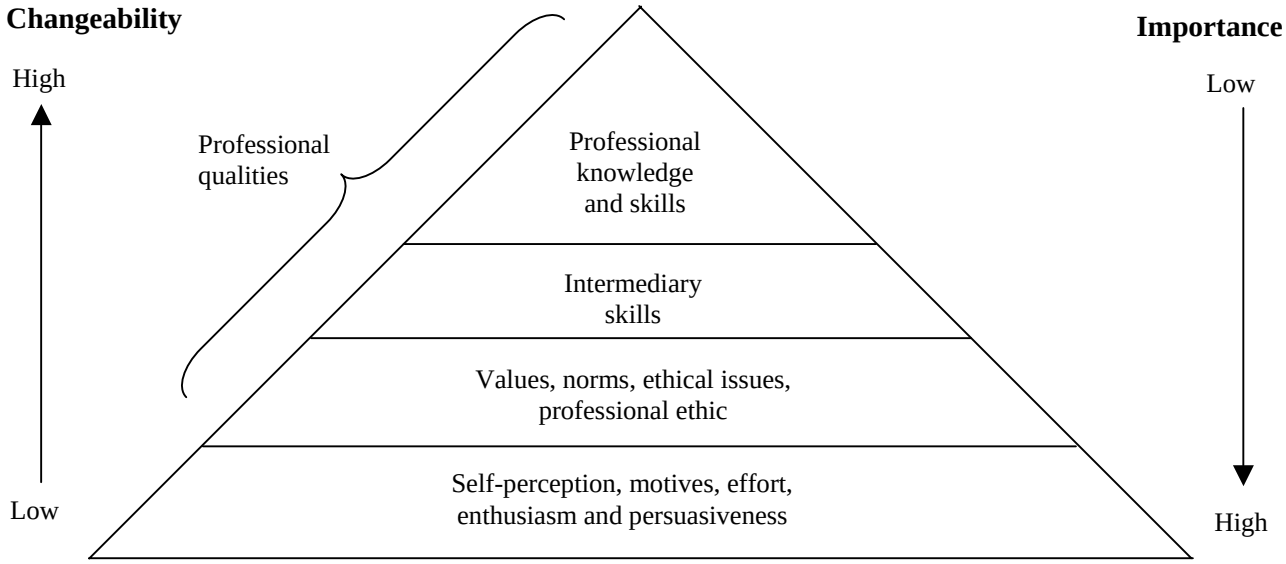

Figure 2: The human competency in an iceberg structure (Bergenhenegouwen, Mooijman & Tillema, 1999, p. 77)

The first layer ‘professional knowledge and skills’ is the visible top of the iceberg. This is the (instrumental) knowledge and skills that are important for the profession and that are necessary for adequately carrying out the task or function (Bergenhenegouwen, Horn & Mooijman, 2002). The second layer is the intermediate skills that are of use in multiple (job) situations (Ryan, 1991 in Bergenhenegouwen et al., 2002). These skills are also called ‘job skills’, which are hard to learn and are important for the flexibility and availability of the employee (Bergenhenegouwen et al., 2002). The instrumental and intermediate skills together can be considered as the capability of the profession or function (Bergenhenegouwen et al., 2002).

The third layer is the norms, values, ethical issues and professional ethic of the organisation and of the group, which a person belongs to (Bergenhenegouwen et al., 2002). This layer consists of a personal and professional framework where norms, values, ethical issues and professional ethic have received a specific place and where the personality is marked (Bergenhenegouwen et al., 2002).
These three layers form the professional qualities of a person.

The last layer, and the less visible one, consists of personality characteristics. These characteristics determine the behaviour in specific situations (Bergenhenegouwen et al., 2002). These aspects are not only hard to see, but are also hard to identify, develop and teach (Bergenhenegouwen et al., 2002).

The changeability and importance are contrary to each other as can be seen in figure 2. The more important an element is, the less changeable it is. This also means that the elements of the last two layers are harder to develop compared to the elements of the first two layers (Klarus, 2002). Elements like personal attitude, motivation and self-concept distinguish a successful employee from a not so successful employee (McClelland, 1993 in Bergenhenegouwen et al., 2002).
In the following paragraph the different levels of competencies are explained.

3.4 Competency levels

In literature different categorisations of competencies are mentioned. Van Assen (2000) makes a distinction between three levels of competencies in an organisation. These three levels of competencies, which are presented in figure 3, are the following:

- Strategic distinctive (core) competencies: the strategic ability to sustain the coordinated deployment of strategic assets in a way that helps the organisation to achieve its strategic goals;
- Organisational competencies: the specific way group and individual capabilities are linked and related to functional technological capabilities;
- Individual competencies: attributes of individual capabilities.

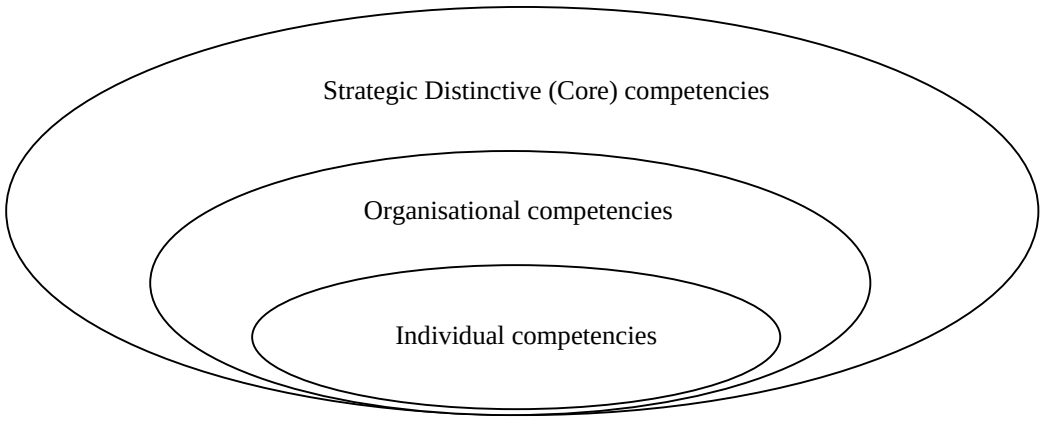

Figure 3: Three levels of competencies (Van Assen, 2000, p. 144)

These competencies can be seen as an oval, which has overlap in different competencies. Individual competencies can also been found in organisational competencies and both can be found within strategic distinctive (core) competencies. Individual and organisational competencies are needed to reach the strategic goals of an organisation. The following sub-paragraphs will further elaborate on the different competency levels.

3.4.1 Core competencies

Strategic distinctive competencies, or core competencies, are the unique strategic ability of organisations to deliver products or services (Prahalad & Hamel, 1990). It is difficult to copy from other organisations, it is constant and forms the basis of the increased perceived customer benefits of the organisation. The specialisation and the distinction of an organisation compared to other organisations are the core competencies of an organisation. Coyne, Hall, and Clifford (1997) propose that a core competency is a combination of complementary skills and knowledge embedded in a group or team that results in the ability to execute one or more critical processes to a world class standard. Hence, core competencies are the competencies of an organisation that provide competitive advantage. These competencies are hard to copy and therefore, can be a valuable asset of the organisation (Bergenhenegouwen et al., 1999). Within the environment the core competency of an organisation

provides the opportunity to add specific knowledge to the products that cannot be copied by its competitors. For the development of core competencies a development approach should be used that focuses on hard to copy competencies of employees.

3.4.2 Organisational competencies

Organisational competencies, or collective competencies, are a collective interdependent combination of knowledge, skills, attitudes, motives and learning capabilities that allow a group to work in different situations (Teurlings, Vermeulen and Wiersma, 2002). The collective competencies can be labelled as team competencies. The 'know what' and the 'know how' of a specific group of an organisation forms the foundation of the organisation (Groeneveld, 2004).
However, collective competencies are not the sum of individual competencies. When individuals or groups of employees work together it is possible to create surplus value (Teurlings, et al., 2002). These collective competencies will influence the core competencies of an organisation.

3.4.3 Individual competencies

Individual competencies come from a behavioural sciences view (Van Baalen, 1999). Individual competencies are competencies as human qualities and skills. It is about specific knowledge and skills of employees in an organisation and fundamental and personality characteristics that are specific for an employee in all kinds of tasks and situations (Bergenhenegouwen et al., 2002). Individual competencies are derived from the identity, behaviour, inspiration, perception and beliefs of an individual (Groeneveld, 2004). Therefore, individual competencies are the responsibilities and qualifications of individual employees (Sluijs & Kluytmans, 1996).
The unique combination of individual competencies can create an important competitive advantage (Teurlings et al., 2002). The combination of competencies can gain bigger or different results. This is reflected in the collective competencies.

3.5 Competency models

The different competency levels, as described in the previous paragraph, can be found in different competency models. In this paragraph the background of competency models will be described. It is explained what a competency model is and what the goal of a competency model is. In addition, generic and specific models are described.

3.5.1 Background competency models

Using competency models as the basis for human resource systems has become a worldwide trend (Lee & Wu, 2005). Competency models are sets of competencies, often organised into some groupings or clusters for a specific purpose and can be used to measure performance and to guide action (Lee & Wu, 2005). Sinnott, Madison and Pataki (2002) remark that competency models can be used to identify competencies, which employees need to have to improve performance in their current job or to prepare for other jobs. A competency model can be based on outstanding performance or average performance. In outstanding performance competencies are linked to the requirement to exhibit superior performance (Rowe, 1995). This means that outstanding employees have to define their behaviour to be used as a standard for other employees. In average performance it is made explicit what kind of performance an employee should be able to demonstrate to work on a specific task or job.
Competency models can be used for different kind of goals. Rowe (1995) describes three different goals of competency models:

- Recruitment: models to help the organisation to identify suitable candidates at the recruitment stage. The purpose is to establish the 'behaviour traits' needed in a particular job and the extent to which different candidates possess these;
- Skill assessment: models to assess whether people are competent in their work. The aim is to determine whether an employee is working to particular standards;
- Development: models to help existing staff to develop. The aim is to assess individual strengths and weaknesses so that future development can be identified.

As can be seen, the perspective of the recruitment and development goal is future orientated whereas skill assessment focuses on the past or the present (Rowe, 1995). Also, the recruitment and development goal is based on the question 'How do they do their job' whereas the skills assessment is based on the question 'What can an employee do?' (Rowe, 1995). Rowe (1995) describes that the goal of recruitment and development is based on behaviours and therefore on competencies. Skill assessment is based on competences (Rowe, 1995).
An organisation can start to develop a competency model after the goal of the model is made explicit, because a competency model can be used for different goals. A certain goal can change the impact of the selected competencies.
In literature, generic and specific competency models can be found. The differences between generic and specific competency models will be explained in the following sections.

3.5.2 Generic competency models

Generic competency models are based on the thought that learning takes place in a context and that competency exists of related competency aspects. This means that an overview of competencies is provided, which the employee has to develop to use in practice. These competency models are often static, mechanistic and seek to prescribe a fixed list of desirable competencies (Garavan & McGuire, 2001). The models can be seen as theoretical models and of general use for organisations. The models describe what has been successful behaviour in the past (Iles, 1993) and not what competencies are important to develop for the future benefit of the organisation. The generic model might not reflect the volatility of the business environment that demands organisations to constantly examining their need for competency (Iversen, 2000).
The goal of a generic competency model can be that of development or recruitment. The list of competencies can be used for the development of current employees, but also for the selection of new employees. However, with the overview it is not possible to describe whether an employee is working to a particular standard.

For example, Iversen (2000) compared the generic competency models of Boyatzis, Spencer and Spencer, Schroder and Dulewicz and concluded that five clusters of competencies are important in all competency models. These five clusters are (Iversen, 2000):

1. Intellectual/Information handling: how information is handled;
2. Achievement-/Result-orientation: how result-oriented an employee is;
3. Managing and leadership: how projects are leaded and managed;
4. Motivational/Interpersonal: what the motivation of the team is;
5. Intrapersonal: what the personality of an individual is.

This competency model focuses on superior managerial performance (Iversen, 2000). Although the authors use a different definition of the concept of competency it is possible to identify managerial competencies with the help of this model. It can be used for recruitment, because the competency model focuses on the identification of competencies.

3.5.3 Specific competency models

Specific models, or organisation-specific models, are more expressive of the language, culture and situation of the organisation, although influenced by generic models (Iles, 1993). This means that specific models use the theory of generic models, but translate it to the specific situation of the organisation. This is done because organisations need a specific model to adapt to their situation. These models generally take account of the need for flexibility and openness to change (Garavan & McGuire, 2001). A specific model holds out the promise that it can capture some of the changes management competencies associate with transitions (Iles, 1993). Therefore, it focuses more on the future than generic models do. Briscoe and Hall (1999) argue that in practice it are competency models, which are too complex and can become mired down in overly detailed competency definitions. Specific models try to prevent this by using theory in practice. Iles (1993) argues that generic models can provide input for the development of organisation specific models. These specific models tend to be equally historic and retrospective (Iles, 1993). An advantage of a specific model is that it can be anchored in the organisation reality (Iles, 1993). It is therefore more applicable to the

organisation. However, it can be concluded that the development of a specific competency model is time-consuming.
A specific competency model can be used for recruitment, skill assessment and development. It has the basis of a generic competency model, but can be used for specific situations. Therefore, skill assessment can also be the goal of a specific competency model. It can describe how an employee should be able to do a certain job and if an employee works to these standards.

For example, Mansfield and Mitchell (1996) describe a dynamic job-competency model that describes competencies in terms of the execution (and not only knowledge) of labour acts or job roles (and not only specific skills and task) in a real work context. They describe occupational competencies that exist of certain skills (Mansfield & Mitchell, 1996):

- Task skills: routine skills that are used within clearly described tasks and that have a specific result or profit;
- Task management skills: skills that are used to deal with multiple task or that are necessary for additional responsibilities that have influence on routine activities;
- Contingency management skills: skills that give an answer to irregularity and disturbances in activities, procedures and work phases;
- Environment management skills: skills which reflect that the professional in less or more extent of his or her social environment.

In this competency model the competencies are not only related to what a manager should be able to do, but it also deals with the changes in the future. Therefore, it can be used for recruitment or development.

Next to these examples, other competency models can be described. The competency model of Delamare le Deist and Winterton (2005) focuses on the functional, social, cognitive and meta-competencies, which is presented in the next paragraph.

3.6 Functional, social, cognitive and meta-competencies

A classification of competencies is the holistic competency model of Delamare le Deist and Winterton (2005), which is presented in figure 4. The model is based on a typology in which a combination of the strengths of different approaches towards competency, as described in sub-paragraph 3.2.2, is used to provide the ultimate beneficiaries for those who are participating in learning at work (Delamare le Deist & Winterton, 2005). This helps to reflect the unity of competency and the difficulty of separating competencies in practice (Delamare le Deist & Winterton, 2005).

The holistic typology is useful in understanding the combination of knowledge, skills and social competencies that are necessary for particular occupations (Delamare le Deist & Winterton, 2005). Four different dimensions of competency are defined within the model: cognitive-, social-, functional- and meta-competencies. According to the typology, knowledge and understanding is captured by cognitive competency, skills is captured by functional competency and behavioural and attitudinal competencies are captured by social competency (Delamare le Deist & Winterton, 2005). Meta-competency is concerned with facilitating the acquisition of the other substantive competencies (Delamare le Deist & Winterton, 2005). Further explanation of the competency dimensions will be provided in the following sub-paragraphs.
However, this typology does not take the complex character of competencies into account, because competency is about the combination of the different elements and is the added value of this combination. The separation of competency dimensions can be made in theory, but in practice this seems not be the case (Delamare le Deist & Winterton, 2005). Therefore, the separation cannot be used as a strict distinction, but as a different focus for competencies. Hence, a tetrahedron representation of the model is more suitable, which is presented in figure 4 and described in the following sub-paragraphs.

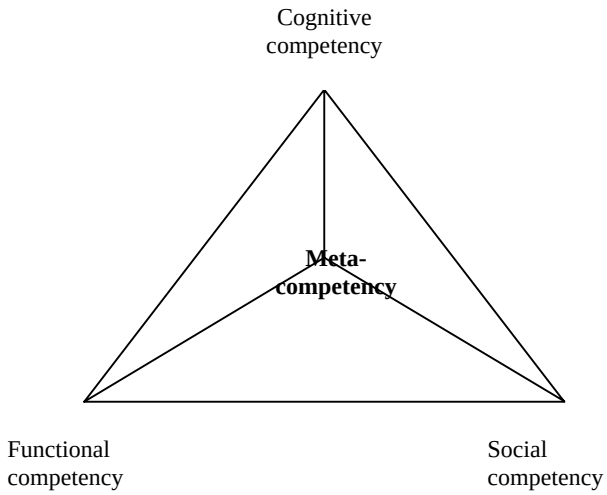

Figure 4: Holistic model of competency (Delamare le Deist & Winterton, 2005, p. 40)

3.6.1 Functional competencies

Delamare le Deist and Winterton (2005) describe that skills are captured by functional competency, as described before. In the previous research He (2005) defined functional competencies as a description of something that a person who works in a given occupational area should be able to do and be able to demonstrate. He (2005) referred to functional competencies as the technical and mechanical knowledge. She concluded that the engineers of Philips ETG possess the following functional competencies: organisational/procedures, manufacture technology, mechatronica, software, norms and miscellaneous (He, 2005). However, this description of functional competencies does not focus on the skills that an engineer should possess, but only on the technical and mechanical knowledge that an engineer needs to have. Therefore, it does not describe how this knowledge should be demonstrated.
Functional competencies are defined for this research as the technical skills that an engineer needs to possess and needs to demonstrate through his behaviour, because this research focuses on the underlying attributes of behaviour. The demonstration of behaviour will be described in depth in the social and cognitive competencies and therefore, the functional competencies of this research can be described as the technical knowledge of an engineer. This knowledge will not be taken into account in this research, because this is already made explicit for Philips ETG.

3.6.2 Social competencies

Social competencies focus on the behavioural and attitudinal aspects that a person has to possess to work within a certain profession. Straka describes social competency as the willingness and ability to experience and shape relationships, to identify and understand benefits and tensions and to interact with others in a rational and conscientious way, including the development of social responsibility and solidarity (in Delamare le Deist & Winterton, 2005). Archan and Tutschek explain that social competency is largely concerned with dealing with others and is defined as the ability and willingness to cooperate, to interact with others responsibly and behave in a group and relationally oriented way (in Delamare le Deist & Winterton, 2005). Ruegg (2003) defines the concept as the ability to use the appropriate social skills in every aspect of life. The idea of skills is also found in the definition of Mallinckrodt and Wei (2005). They define social competencies as skills needed to recruit and maintain satisfying and supportive relationships (Mallinckrodt & Wei, 2005).
The social competencies within this research will describe the behavioural and attitudinal aspects of the work of engineers. Therefore, social competencies can be described as the behaviour that one needs to have and needs to demonstrate to interact and cooperate with others and to build and sustain different relationships.

3.6.3 Cognitive competencies

To understand what cognitive competencies are, it is useful to describe the concept of cognition. In psychology it is mentioned as a term referring to the mental processes involved in gaining knowledge and comprehension, including thinking, knowing, remembering, judging and problem solving. These are higher-level functions of the brain and encompass language, imagination, perception and planning (Psychology, 2006). The use of cognition is reflected within the term cognitive competency.
Cheetman and Chivers describe a cognitive competency as the possession of appropriate work related knowledge and the ability to put this into effective use (in He 2005). They describe that it includes the basic technical, contextual, conceptual and procedural knowledge required for the profession (Cheetman & Chivers, 1996). This same kind of definition is used by the University of Texas (2006) and focuses on cognitive competencies that address knowledge and intellectual skills. This concept of cognitive competencies is expanded by Kallenberg (2000), who describes cognitive competencies in education as competencies concerning the content of a course or as relevant information of a certain profession. Marlow, Bloss and Bloss (2000) expand the concept by mentioning that these competencies relate to thoughts and understanding.
Next to these definitions, DeSimone (2002) refers to cognitive strategies instead of cognitive competencies. Cognitive strategies or strategic knowledge are skills that are used to control learning, thinking and remembering. Cognitive strategies allow us to determine what procedural knowledge and verbal information we need to perform a task (DeSimone, 2002).
Delamare le Deist and Winterton (2005) describe the concept as knowledge and understanding. Understanding can be described as not only the possession of knowledge as also the appropriately use of knowledge. Therefore, cognitive competencies refer to mental processes, the knowledge relevant for profession and the ability to use this knowledge in appropriate situations. In this research it is referred to as the knowledge that an engineer needs to perform his job.

3.6.4 Meta-competencies

Meta-competency is a concept that is used as a sort of management competency. Ramaekers (2006) describes that meta-competencies refer to the ability to see the possibilities and limitations and to act in the way that is needed. Competencies have as goal that it can be effectively used in different contexts. Fleming (in Rowanhill, 2006) supports this concept by describing a meta-competency as something that allows someone to locate a particular competency within a larger framework of understanding. Toolsema (2003) states that meta-competencies make the acquisition of new competencies possible and make present competencies more adaptive and efficient. Chivers and Cheetman (1996) describe meta-competencies as an ability to manage an ability. Meta-competencies thus reflect cognitive processes of a higher order, such as creativity and analysis (Chivers & Cheetman, 1996). Therefore, to make the concept easy to understand, it is the ability to use different competencies in the context of certain behaviour, which can be described as meta-competency (Scharnhorst, 2004). It is not about answering questions posed by predictable tasks in known words. It is about dealing with uncertainty and incomplete evidence, asking the right questions, and developing the means to resolve problems (Scharnhorst, 2006). At its most basic, it may be seen as learning to learn, flexible transfer and application of knowledge and skills across contexts or thinking outside the box (Fleming in Rowanhill, 2006). Meta-competency is situated above the other competencies in the tetrahedron (figure 4). This means that meta-competency can only be developed when the other competencies are available.

A summary of the social and cognitive competencies in literature is included in appendix 1. The tables in this appendix provide an overview of different social and cognitive competencies and their sub-competencies per author. This concludes the theoretical exploration of the concept. In the next paragraphs choices, based on the literature, are described to form a competency research model.

3.7 Choices for competency research model

In the previous paragraphs aspects of the concept of competency are described. In this research the term competency will be used, as the term reflects the underlying attributes of behaviour, which an engineer needs to have to operate in the semiconductor market and medical device market. The focus is on how behaviour(s) support the work of employees. Not on what the engineer is able to do and therefore, the US approach towards competency development fits this focus. Both the US and UK approach have the purpose of improving the human performance at work in common, but the US approach focuses on searching competent behaviour.
The behavioural aspect and the underlying attributes of behaviour are important and therefore the input-based approach is used to describe these attributes. The work of engineers fit the input-based approach best based on the fact that the tasks of engineers are complex and difficult to define.

The focus in this research is on underlying attributes of competent behaviour and therefore, it is important to have insight in the individual competencies of an engineer. In core competencies the strategy of an organisation is important and in organisational competencies the focus in on the combination of knowledge, skills, attitudes, motives and learning capabilities of a group.
As the individual employee is the focus in this research, rather than what a group can create in projects or what the strategy of the organisation is, these competencies do not play a role in this research. Thus, the focus is on individual competencies that are specific for an engineer in tasks and situations to make sure that what business demands is taken into account for the performance. However, it is important to understand that individual competencies are part of core competencies. Core competencies provide the opportunity to add specific knowledge to the products that cannot be copied by its competitors. This specific knowledge is within people and therefore, is part of individual competencies. This is also the case for organisational competencies. By using individual competencies a group will create surplus value. Therefore, in the development of individual competencies it is important to know the competencies of other individuals of the group and of the organisation.

The competency model that has to be chosen for Philips ETG has the goal to help develop, measure and manage the competencies. It has to define what competencies an engineer should possess for the semiconductor and medical market so that future development can be identified. Different authors argue to use a specific competency model for organisations purposes. This model fits within the organisational context and can be anchored in Philips ETG. It also provides a framework for the development of competencies that are crucial for the organisation. However, it is difficult to build such a model without the theoretical background of generic competency models. Hence, in this research the strategy is to use a generic model and specify it to the situation. This will allow guidance for the research and it will result in an applicable tool for the organisation. For the research the model of Delamare le Deist and Winterton (2005) will be used. It is a generic model and it provides different dimensions, which are formulated based on the strengths of the different approaches towards competency.

Although Delamare le Deist and Winterton (2005) describe the four competencies as dimensions, which cannot be separated, in this research the four dimensions will be defined as competencies with a different focus. Functional- and meta-competencies are not taken into account in this research, because functional competencies focus on the technical and mechanical elements of the work and meta-competencies are competencies to manage the other competencies. The functional competencies of engineers are already made explicit for Philips ETG and the meta-competencies can only be developed after the development of functional, social and cognitive competencies. Therefore, the focus in this research is on the social and cognitive competencies. Social competencies are defined as social skills that will allow an individual to interact and collaborate with others and to build and sustain relationships. Cognitive competencies provide the ability to use work-related knowledge in the appropriate situations.
In the following paragraph this competency research model will be described and social and cognitive competencies will be presented.

3.8 Defining the competency research model

The competency research model is based on the generic model of Delamare le Deist and Winterton (2005), which is presented in figure 5. The social and cognitive competencies can be defined as non-technical components and the functional competency as the technical competency. On the right side a collection of non-technical competencies is indicated and on the left side the technical competency can be found.

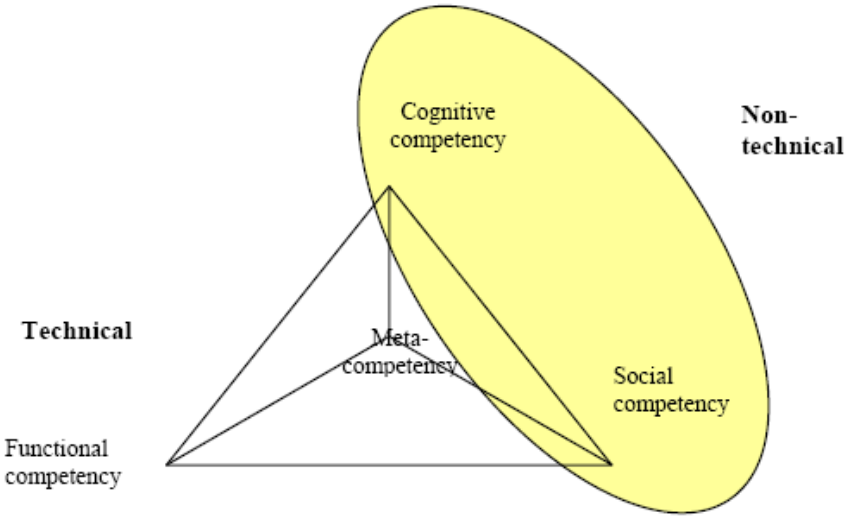

Figure 5: Competency research model non-technical competencies

This model will support the investigation although theoretical insights of the social and cognitive competencies should be added to the competency research model. An overview of social and cognitive competencies that are found in literature is included in appendix 1. These competencies form the basis on which the competency research model is developed. For the competency research model criteria are used to select the competencies. These are the following three criteria:

- The work of an engineer as context description;
- The research question;
- The similarities between the definitions of the competencies.

The description of the work of an engineer and the research question are used to analyse if a competency is useful in this research. Further, it is analysed which definitions of the competencies are similar or cover the same area of activities. Results from this analysis are presented in the tables in the next sub-paragraphs.

3.8.1 Social competencies

The social competencies of the competency research model are presented in table 1 on the next page. This subdivision provides an overview of competencies, as described in literature (appendix 1). These competencies will be further explained below the table.

Table 1: Social (sub)-competencies of the competency research model

Social competencies competency research model	
Competency	*Sub-competencies*
Social contacts	Self-efficacy
Networking	Network in own organisation
	Network in organisation of client
	Sociability
Collaboration	
Communication	Oral communication
	Written communication
	Oral presentation
	Listening
	Sensitivity
	Negotiation
Empathy	
Adaptability	

Social contacts is the first mentioned competency and is about being able to manage social contacts (Ministerie van OCW, 2000). This competency is chosen, because it demonstrates the interaction with others, which is necessary in the work of an engineer and is described as social contacts from now on. A sub-competency of having social contacts is *self-efficacy*, which Mallinckrodt and Wei (2005) define as the belief that one can initiate social contacts and can develop new friendships from initial acquaintances.
The work of an engineer and the research question indicate the need for building and sustaining different relations. The competency *networking* is about these relations and is defined as the skill to construct a network, which is useful to achieve objectives (Schakel & Smid, 2005) within the organisation of the client and within the own organisation. Therefore, a division between networking in the own organisation and networking in the organisation of the client is included in the table.
An important element of networking is sociability, which is described as the skill of mingling effortlessly with other people (Schakel & Smid, 2005). Mingling effortlessly with other people is a necessity for building and sustaining relations.

To be able to collaborate or cooperate is mentioned by different authors and therefore included in the competency research model. These competencies are defined as the same and therefore described as *collaboration.* Collaboration is captured by the ability to work with other people within the work setting. It is about achieving a common target or solving a problem together.

Communication is included in the table, because different authors mention it as an important competency. Also, engineers have contact with different people during their work and therefore it is regarded as essential to be able to communicate with these people.
In the retrieved literature only sub-competencies are defined, because of the various aspects of this competency. Based on this literature, the competency is divided up in *oral* and *written communication, oral presentation, listening, sensitivity* and *negotiation*. Oral communication is about conveying ideas and opinions clearly to others, making use of unambiguous language, gestures and non-verbal communication; adapting language and terminology whereas written communication is defined as expressing ideas and opinions clearly in properly structured, well-organised and grammatically correct reports or documents utilising language and terminology appropriate to the reader (Schakel & Smid, 2005). Oral presentation is defined as presenting ideas and facts clearly, making use of appropriate aids; tailoring presentations to the needs of the audience and listening is demonstrated in the capacity to pick up significant information from verbal communication, asking questions and investigate reactions (Schakel & Smid, 2005). The authors describe sensitivity as showing to be aware of people and the environment and one's own influence on both and negotiation is described as communicating one's own standpoints and arguments effectively and pointing out common goals in a manner leading to agreement and acceptance by all parties (Schakel & Smid, 2005).

Different authors mention the social competency *empathy*, which is defined as transferring in the perception of others (BJU, 2006).
Adaptability is added to the model to cover the ability to change ones behaviour and attitude to the circumstances or situations, which is important in the work of an engineer. Schakel and Smid (2005) define it as maintaining effectiveness by changing to circumstances, tasks, responsibilities and people.

3.8.2 Cognitive competencies

The cognitive competencies of the competency research model are presented in table 2. The subdivision provides an overview of competencies as retrieved from literature and these competencies are described below the table.

Table 2: Cognitive (sub)-competencies of the competency research model

Cognitive competencies competency research model	
Competency	*Sub-competencies*
Problem solving	Problem analysis
	Information analysis
	Anticipation
	Decision-making
Using different kinds of knowledge and being flexible with that knowledge	Conceptual
	Contextual
	Procedural
Self-development	Learning ability
Awareness	Self awareness
	Interpersonal sensitivity
	Aware of environment
	Sensitivity
Knowledge of others and himself	Knowledge of the client
	Knowledge of own organisation
	Self-knowledge

In the work of an engineer it is important to solve different problems and based on this reason the competency is chosen for this research. *Problem solving*, retrieved from literature (appendix 1), can be defined as the analysis and solving of problems in different situations to achieve the set goal.
The subdivision of problem solving was made, because this concept expresses the different elements of solving a problem by an engineer. Four elements are described by the authors and are chosen because they suite the work of an engineer. These elements are *problem analysis*, *information analysis*, *anticipating* and *making decisions*.
Problem analysis is according to Floor (2006) the signalising of problems, recognising of information, making connections between data and finding causes. This can be expanded by the definition of Schakel and Smid (2005). They describe problem analysing as identifying problems, recognising significant information, making connections between data, tracing data, tracing causes of problems and investigating relevant data (Schakel & Smid, 2005). Information analysis is the signalisation and recognition of important information in a highly informative environment in which making connections between data is important (Floor, 2006). Floor (2006) defines anticipation as the ability to recognise critical situations and react to them effectively to prevent problems by taking measures in time and decision making is described is about taking actions or giving opinions.

The competency *different kinds of knowledge* is chosen, because engineers need it for their job and it is described in literature. The researchers added to this competency the ability to be flexible with that knowledge based on the definition of cognitive competencies, which describes it as the ability to put this knowledge into effective use.
The types of knowledge an engineer uses in his work can be divided up into *conceptual knowledge*, *contextual knowledge* and *procedural knowledge* (Cheetman & Chivers, 1996). Conceptual knowledge

is described by Floor (2006) as building thinking frameworks or models, the formulation of multiple concepts and hypothesis or ideas on the base of complex information. Procedural knowledge is the knowledge about how to perform a task (Wikipedia, 2006) and contextual knowledge is a set of features, and environment, or setting in which a learner makes connections, comparisons and analogies (Wignall, 2003).

Self-development is chosen as a cognitive competency, because it is described in literature and is about the ability to use a kind of knowledge. It is described as possessing insight into one's strengths and weaknesses, and on this basis, initiates activities to increase/enhance one's knowledge, skills and competencies in order to perform more effectively (Schakel & Smid, 2005).
In literature, *learning ability* is described which supports the competency self-development and therefore chosen as a sub-competency. Learning ability is the absorption of new information and ideas and applying them effectively (Schakel & Smid, 2005).

Based on literature and on the context of the work of an engineer, *awareness* is chosen as a cognitive competency. It describes a human perception and cognitive reaction to a condition or event (Wikipedia, 2006). This can be divided in four elements: *self-awareness, interpersonal sensitivity, aware of environment* and *sensitivity*.
Self-awareness is the recognition of own personality, strengths and weaknesses and own likes and dislikes (Wikipedia, 2006). Awareness of environment is described as being informed in social and political developments or other environmental factors and using this information for the work (Floor, 2006). Schakel and Smid (2005) expand this with the awareness of economical developments. Sensitivity is described as showing oneself to be aware of other people and of the environment one is influences. It is behaviour reflecting recognition of the feeling of others (Schakel & Smid, 2005). This sub-competency has an overlap with the social sub-competency sensitivity. However, the social sub-competency is about the behaviour and the cognitive sub-competency is about the use of knowledge for this behaviour. Interpersonal sensitivity is the behaviour that shows the recognition of feelings and needs of others, transferring in the other person and showing understanding of own behaviour (Floor, 2006).

Marlow, Bloss and Bloss (2000) describe the competency understanding the perspectives of others. This is necessary for the work of an engineer because of collaboration with different people. The context of the work of an engineer indicates two different types of knowledge for understanding the perspectives of others, which are knowledge of the client and of the own organisation. To understand the perspectives of others knowledge about these others is needed. Therefore, the competency is defined as knowledge of others. However, another type of knowledge in which perspectives are important, is self-knowledge. This is added to the competency, because the engineer has to understand his own perspective in order to understand other perspectives. Therefore, the competency is described as knowledge of others and himself.
The *knowledge of the client* is described as recognising the needs and interests of the client and to take this information into account (Floor, 2006). Schakel and Smid (2005) expand this with the fact that a person should be able to recognise the interests of other parts of the organisation. This description is the same for the *knowledge of the own organisation* only expresses the needs and interests of the own organisation. Self-knowledge is also based on this description and defines the recognition of own needs and interests and to be able to take this information into account.

On the next page, the competency research model is presented based on the generic competency model of Delemare le Deist and Winterton (2005).

3.8.3 Competency research model

The research focuses on social and cognitive competencies. These competencies are defined in the previous sub-paragraphs and finalises the competency research model, as shown in figure 6. The sub-competencies are not described in this figure, but are indicated in table 1 and 2. This model will be used for the analysis of the semiconductor market and the medical device market.

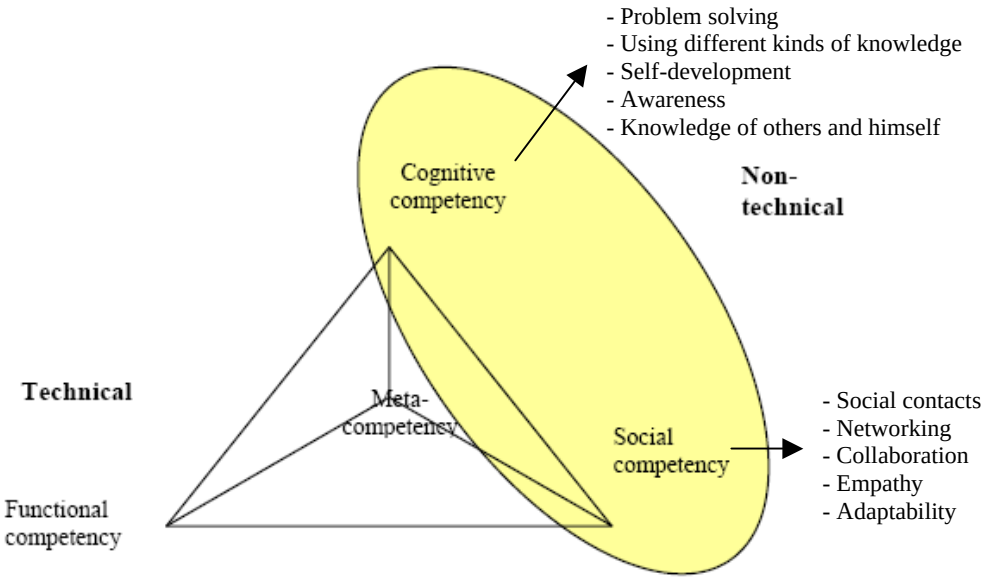

Figure 6: Competency research model

3.9 Summary

This chapter has provided a theoretical overview of the concept of competency. Competency emerged in the literature as a result from a global change in which knowledge becomes the competitive advantage of organisations. The difference between competence and competency is explained by using the UK approach and the US approach towards competency. Competence is about the occupational aspect of the job and the range of skills that are satisfactorily performed. Competency is about the underlying attributes of the behaviours of a person. Because the focus in this research is on underlying attributes of behaviour and not on what an engineer should be able to do, the term competency is chosen and will be used in this research.

The different elements of competencies can be presented in an iceberg structure (figure 2). This structure presents the relation between the importance of certain competencies and the changeability of these competencies. Competencies can also be categorised in the levels: individual, organisational and strategic distinctive (figure 3). The individual competencies will be investigated in this research although organisational and strategic distinctive competencies are also important for Philips ETG.
Competency models are used in organisations for recruitment, assessment or development objectives and can be categorised into generic and specific competency models. For Philips ETG a generic model will be made specific for which the generic model of Delamare le Deist and Winterton (2005) is used, as presented in figure 4. The functional, social, cognitive and meta-competencies as well as the choices that were made for the competency research model is described in this chapter resulting in the final competency research model as presented in figure 6 and table 1 and 2.

The following chapter will elaborate on the methodology used to investigate the needed social and cognitive competencies of engineers of Philips ETG. The competency research model will be the starting point of the research.

4. Research methodology

In this chapter, the research methodology is described beginning with the research questions and the description of the research design. After that, the research process and the data collection method are presented. Then, the research activities and the data analysis are described and finally, a summary of the chapter is given.

4.1 Research objective and research questions

The objective of the research is to provide an overview of the social and cognitive competencies that an engineer of Philips ETG needs to possess to be able to operate in the semiconductor market and the medical device market. This has resulted in the research question, as described in chapter 1:
Which social and cognitive competencies do the engineers of Philips ETG need to possess to operate in the semiconductor market and medical device market?

Within the research question two different markets can be identified. Therefore, the research question can be split up into two research sub-questions:

1. Which social and cognitive competencies do the engineers need to possess to operate in the semiconductor market?
2. Which social and cognitive competencies do the engineers need to possess to operate in the medical device market?

Each question will result in a specific competency model, which will provide an overview of the needed competencies and sub-competencies. The similarities and differences within both models will provide an answer to the main research question. The design of the research will be discussed in the following paragraph.

4.2 Research design: qualitative multi case study

The research has an explorative character, because not much information about the investigated phenomenon is available (Swanborn, 1994). Explorative research is about investigating the important characteristics of the research elements (Segers, 1999). The main goal of this research is not about testing a hypothesis, but is about exploring a typical context to find categories or dimensions (Patton, 1990). This is in line with the inductive approach, which is about building a theory based on collecting data and analysing this data (Saunders, Lewis & Thornhill, 2003). The approach allows the researchers to investigate the context and include different variables that could cause the effect or explain the phenomenon (Saunders et al., 2003).

A multi case study design with the use of qualitative data is the used strategy of this research. A case study is a study in which a few research elements are involved in a unique setting (Segers, 1999). According to Stake (2000), the case is the object of the study and is a specific, unique bounded system. Multi case study means that more cases are involved in the research (Patton, 1990). In this research the social and cognitive competencies are the research elements. The settings or cases are the semiconductor market and the medical device market, because both markets are a specific, unique bounded system in which different products and clients are present. The markets and the clients are independent of each other. Therefore, two cases are investigated which indicate a multi case study design.
Qualitative data is collected within the two cases. This data is presented in interpretive texts and reflects the experiences and perspectives of people (Patton, 1990). The use of qualitative data provides the opportunity to understand a particular problem or unique situation in great depth and provides the possibility to learn much from a few examples (Patton, 1990).

The use of a case study research and qualitative data provides the opportunity to collect in-depth information about the semiconductor market and medical device market in relation with the needed social and cognitive competencies. The research process method to investigate the competencies is presented in the following paragraph.

4.3 Research process method

The conducted research is explained in the research process method of figure 7. The main goal of the case study is to develop a specific competency model including social and cognitive competencies of engineers for the semiconductor market and the medical device market.

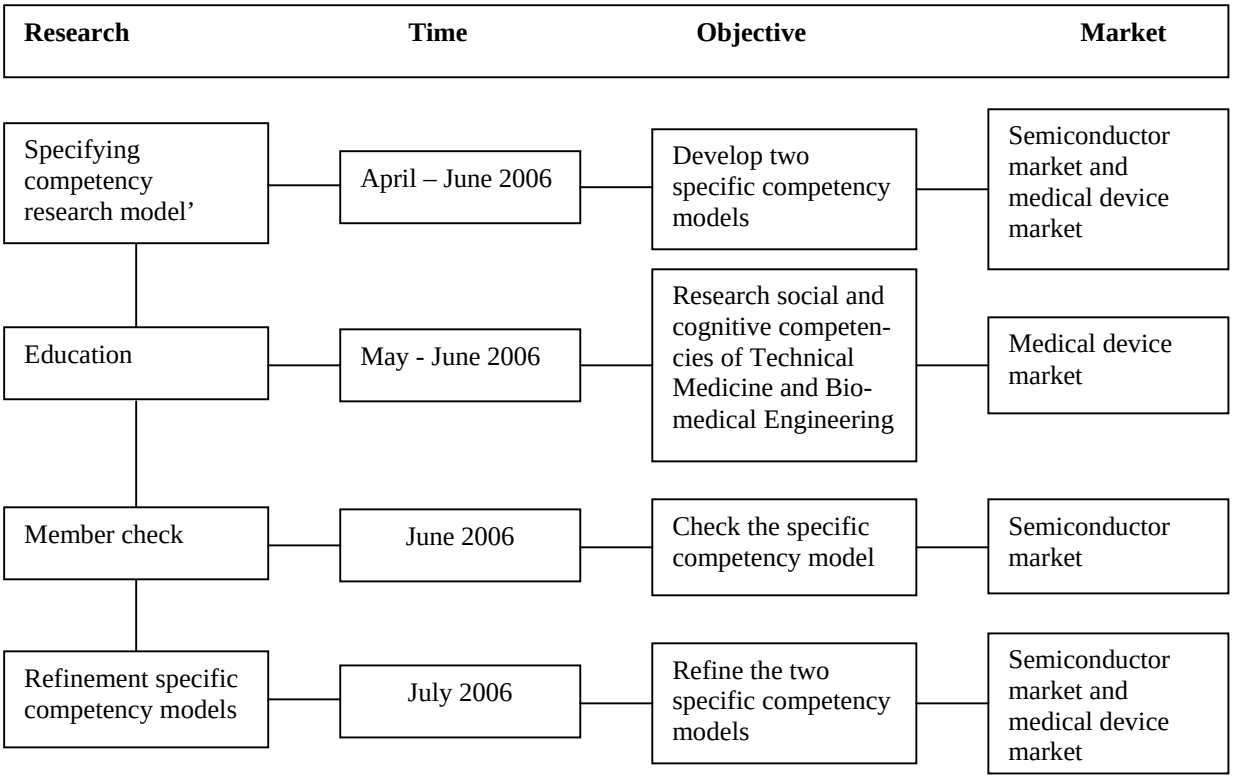

Figure 7: Research process method

The research can be divided into different research activities. Within the first research activity the specific competency models for both markets were developed by first focussing on the work of the engineer in the semiconductor market followed by focussing on social and cognitive competencies for both markets with the use of the competency research model. The lack of information about the investigated case insisted an explorative approach and made it necessary to first investigate the work of an engineer within the semiconductor market. With this information social and cognitive competencies could be further investigated.

The second research activity was conducted to investigate what competencies students obtain during their study Technical Medicine or Biomedical Engineering of the University of Twente. Also, it provides insight in what the educational staff of these studies define as important social and cognitive competencies for engineers of Philips ETG, who work in the medical device market. The respondents in this activity provided a different view about the competencies that an engineer would need to possess for the medical device market.

Within the third research activity a member check was used to confirm the specific competency model for the semiconductor market. A member check is a research activity to verify the constructions that are developed as a result of data collection and data analysis with the respondent group (Mertens, 1998). For the medical device market a member check was not possible because respondents were not available.

Finally, the specific competency models were refined with the help of clients of both markets. This was done to provide insights from a different viewpoint, which provide information from the perspectives of clients of both markets.
The different research activities will be further described in the following paragraphs highlighting interview types, construction of interview protocols, selection of the respondents and participants. The following paragraph focuses on the used data collection methods.

4.4 Data collection method

Open and focused interviews and document analysis were used as data collection method for the investigation. Interviewing was the most used collection method within this research. The data collection methods for the different activities in the research are summarised in table 3. These activities were preceded by the development of the competency research model.

Table 3: Research sources

Research	*Source*	*Data collection method*	*Objective*
Specifying 'competency research model'	Eight engineers of Philips ETG Almelo and Eindhoven	Open interviews	Research social and cognitive competencies for the semiconductor market
	One account manager Philips ETG and three managers of Philips Medical Systems	Open interviews	Research social and cognitive competencies for the medical device market
Education	Three educational staff members of the University of Twente	Open interviews	Research social and cognitive competencies of these studies for the medical device market
Member check	12 engineers and four managers of Philips ETG Eindhoven	Group discussion	To check if employees of the semiconductor market recognise the competencies of the specific competency model
Refinement	Documents of the studies: Technical Medicine and Biomedical Engineering	Document analysis	Get insight in the medical device market, explore the objectives of the studies and compare them with the specific competency model.
	Two employees of Advanced Semiconductor Materials Europe (ASME)	Focused interview	Refinement of the specific competency model for the semiconductor market from the perspective of the client
	One engineer of Philips Medical Systems (MS)	Focused interview	Refinement of the specific competency model for the medical device market from the perspective of an engineer

The used method for data collection within a qualitative multi case study design is interviewing. This data collection method provides the chance to collect information about people perspectives and ideas and it allows retrieving in-dept information about the case (Patton, 1990). Within the research a combination of open interviews and focused interviews was used. The explorative character of the research made it necessary to collect information with open interviews. An open interview provides the opportunity to ask about facts or matters as well as it provides the occasion for the respondents to give opinions about events (Yin, 1994). Focused interviews consist of a set of questions to retrieve an exact answer (Yin, 1994). Open interviews were used for the development of the specific competency models and focused interviews were used for the refinement of the specific competency models. Both were conducted with semi-structured interview protocols. These protocols contain the topics that

should be covered during the interview although the questions do not necessarily have to be asked in the same order (Saunders et al., 2003). The questions should allow the possibility to ask follow-up questions. The construction of the interview protocols will be explained in the following paragraph.
The group discussion during the member check was a presentation in which the participants discussed the specific competency model of the semiconductor market together. Characteristics of this activity will be further explained in the following paragraphs.

4.5 Interviews

The case studies focused on questions about the needed social and cognitive competencies for engineers of Philips ETG to operate in the semiconductor and medical device market. In the research process method (figure 7) interviews are used as the data collection method. This research instrument will be described according to the type of interviews and the construction of the interview protocols.

4.5.1 Interview types

The conducted interviews were individual semi-structured face-to-face interviews. This method was chosen, because face-to-face interviews provide the opportunity to ask a great variety of questions and provide the possibility to ask follow-up questions (Segers, 1999). Follow-up questions made it possible to retrieve extensive and complete answers (Segers, 1999) and were used to retrieve information that was missing.
Open and focused interviews were used to retrieve information. The open interviews retrieved information about the context of the work of an engineer and the social and cognitive competencies that engineers need to possess. The openness of the questions became less during the finalisation of the specific competency models. This is a logical consequence of the explorative character of the research. During the research the investigated phenomenon became clear and therefore, more focused questions could be formulated. This is defined as inductive analysis, which will be further explained in the data analysis paragraph. The focused interviews were conducted to retrieve exact answers about the specific competency model and provided the possibility to ask more direct follow-up questions.

4.5.2 Construction interview protocols

For the case study of both markets four different interview protocols were constructed to guide the open and focused interviews. The protocols consisted out of three parts: an introduction in which the purpose and procedure of the interview was explained, the questions and the closing-up in which the further procedure was explained (Walker, 1993 in: Segers, 1999).
All four protocols can be defined as an interview guide in which the topics and issues are included that should be discussed within the interview (Patton, 1990). The researchers could decide on the sequence and the formulation of questions during the interview (Patton, 1990).
For the development of the different questions the theory of Emans (1990) was used. This theory provides an overview of what to do and not to do when constructing questions for an interview and when conducting an interview.

The interview protocols for the semiconductor market, medical device market and education included questions about the work of the engineer and questions about the social and cognitive competencies according to the competency research model and the specific competency model.
The interview protocol education included questions about the different studies and the competencies a student should be able to obtain during the study. The interview protocols for the refinement of the specific competency models were used as a tool to retrieve additional information about these models. The questions made it possible to retrieve the client and supplier perspective towards competencies.

4.5.2.1 Specifying competency research model

In this activity of the research two different interview protocols were used. The first protocol focused on the work of an engineer in the semiconductor market and was constructed according to the work context of an engineer. The second protocol focused on the needed competencies according to the theoretical insights of the competency research model. These different protocols are explained below.

The first protocol (appendix 2) was used for interviews with engineers of Philips ETG to get insight in the work of an engineer and to make the competency research model, as described in chapter 3, specific. The protocol was formulated based on the need to obtain better understanding of the research context, the work of the engineer, the people with whom the engineer is confronted during its work, the learning needs of the engineers and their ideas regarding to the medical device market. Examples of the different elements of the interview protocol are provided in Table 4table 4.

Table 4: Items protocol work of engineer

Subject	*Item(s)*	*Question example*
Work of an engineer	1-5	What is your function?
People involved	6-10	What are difficulties when working together with others?
Learning needs	11-14	What do you want to learn?
Medical device market	15-18	What is the expected difference with the semiconductor market?

The second interview protocol (appendix 3 and 4) for the development of the specific competency model of both markets consisted out of two similar protocols with small differences. These protocols were constructed with theoretical insights of the competency research model as input. Within the competency research model different social and cognitive competencies are included and the definitions and subdivisions of these competencies formed the basis of the interview protocol. Questions about cognitive competencies were included in the protocol first, because it was expected that it would take more time to answer these questions based on the assumption that engineers would find it difficult to indicate the needed knowledge. The introduction and closing-up of the interview protocols were different to fit the research question of the market. The core of the interview protocol consisted out of the same questions, but focused on respondents of the different markets.
An overview of the questions according to the definitions of the competencies in the competency research model is provided in table 5.

Table 5: Items protocol specific competency model

Competency research model	*Item*	*Question example*
Problem solving	4-6	How do you handle the question of the client?
Different kinds of knowledge	5-6	What kind of knowledge do you need during this process?
Self-development	9-10	What kind of self-knowledge do you need during a project?
Awareness	-	-
Knowledge of others and himself	7-8	What kind of information of the client do you need?
Social contacts	12abc-13	What kind of informal contacts do you use to reach the goal?
Networking	12abc	What kind of social contacts do you have as engineer?
Collaboration	14	What is important during the collaboration?
Communication	15-16	What is important during the communication with the client?
Empathy	17	Do you need to have empathy in certain situations?
Adaptability	18	Do you have to adapt in certain situations?

Awareness is not covered with a question in the protocol, because this could be derived better from answers and described examples of interviewees. Therefore, follow-up questions were used to cover this competency. A final question for the cognitive and social competencies is included to find out if other aspects are important and were not covered by the other interview questions.

4.5.2.3 Interview protocol education

A different kind of protocol was constructed for the studies Technical Medicine and Biomedical Engineering of the University of Twente (appendix 5). This protocol included questions about context information of the two studies. Also, it included questions about the competencies that a student should acquire during the study, because these could be important within the medical device market. Questions about the measurement and development of the competencies and about the ideas of the different studies for the needed competencies of the engineers of Philips ETG were included in the protocol. This was done to create an overview of measurement and development methods within education and the required competencies within the medical device market. Examples of these questions are described in table 6.

Table 6: Items protocol education

Subject	*Item(s)*	*Question example*
Context information	1-2-6	Can you describe the education in short?
Competencies of students	3-5	Which competencies of the education competency model would you find important for the research?
Measurement and development	6-7	Which education methods do you offer the students?
Necessary competencies ETG	8-9	What is important in the medical device market for engineers of Philips ETG?

4.5.2.4 Interview protocol refinement

The interview protocol for the refinement of the specific competency model of both markets consisted out of two rather similar interview protocols (appendix 6 and 7). The questions were formulated to retrieve additional information about the competencies of the specific competency models. These models were used as input for construction of the refinement protocol. The competencies were discussed according to the specific competency model with the exception of the questions about the knowledge of the organisation and the client. These were asked first, because of lack of detailed information and the assumption of needed time to answer this question. The interview protocols consisted out of the same questions, but focused on respondents of the different markets. An example of the questions that are the same for both markets, which are based on the specific competency models, is provided in table 7. Also, examples of items are included that are different for both markets.

Table 7: Items protocol refinement model

Competency research model	Market	Question example
Networking	Both*)	Does networking of an engineer consist of these elements?
Empathy	MDM**)	Does an engineer has to empathise in aspects of the medical market?
Flexible behaviour	SCM***)	Does the engineer has to be flexible?
Adaptation	MDM	Does an engineer has to adapt during the work?
Knowledge of the medical market	MDM	Is this the knowledge that an engineer needs to possess about the medical market?

*) Semiconductor market and medical device market
**) Medical device market
***) Semiconductor market

The last four questions in table 7 are included in the interview protocols based on the fact that these are present in the specific competency model of the semiconductor or medical device market. Follow-up questions were used to find competencies that were expressed in the other market.

4.5.3 Procedure interviews

During the interviews, both researchers were present and with the permission of the interviewee the interviews were recorded with a voice recorder. The researchers asked questions according to the protocol and used follow-up questions to retrieve in-depth information. The interview protocols consisted out of a combination of facts and subjective information. Facts are about ones function or behaviour and subjective information is about attitudes, opinions and intentions (Segers, 1999). Questions to retrieve subjective information are difficult to answer and therefore, the researchers attempted to let the interviewee answer the question from a different perspective. For example, the respondents were asked to indicate which competencies a new employee should possess when starting his job at Philips ETG. This method was used during the interview depending on the situation and answers of the interviewee. The participants were asked to focus on non-technical aspects of the work of an engineer.

The interviews took approximately 1,5 hour each and afterwards the researchers made a report of each interview. This report included a summary of the interview, which was reviewed by the interviewee and provided the interviewee the opportunity to give feedback or provide additional information. The interview reports of the work of an engineer are included in appendix 8, the interview reports of the specific competency model are included in appendix 9 and 10 and the interview reports for the refinement of the specific competency model are included in appendix 12 and 13. The interview reports of education are included in appendix 11.

4.6 Selection respondents

The selection of respondents is described according to the research process method in figure 7.

4.6.1 Specifying competency research model

In the semiconductor market the engineering department of Philips ETG is located in Almelo and Eindhoven. The group of engineers consist out of about 35 engineers from which 15 work in Almelo and 20 in Eindhoven. The respondents were selected based on two criteria. The first criterion was that the engineer should be able to provide an overview of the work of an engineer and the second criterion was that the selected engineers together would represent the functions within the population. Eight respondents were selected to participate in the research based on these criteria. Two managers of the engineering departments of Almelo and Eindhoven selected the respondents by using a purposive selection method. Purposive selection is a method that is used in cases where researchers are working with small samples (Saunders, Lewis & Thornhill, 2003). A total of eight participants were selected from which four work at Almelo and four at Eindhoven.

Philips MS was selected for the research of the medical device market, because it is a potential client in the medical device market. Philips MS is located in Best and consists of 12 departments. However, the information about the number of engineers and managers was not available. The respondents were selected based on three criteria. They should be able to provide an overview of the work of an engineer in the medical device market, they would have to be familiar with work of engineers of Philips ETG and they would have to be able to describe what they expect of engineers from Philips ETG in case of an alliance. The respondents from Philips MS were selected with the help of the network of the manager of the engineering department in Almelo and with the help of one respondent. This last method is described as the snowball sampling method (Saunders, et al., 2003). Within this method researchers ask interviewees to identify other interviewees who are relevant for the study. This method was used because of difficulties to identify the correct respondents from a case in which the researcher does not have a network (Saunders et al., 2003). One respondent was not selected based on all the criteria, because the respondent was not familiar with the work of engineers of ETG. However, it was decided to interview the respondent because information about the audit of Philips MS could be gained. In total four respondents were selected.

4.6.2 Education

The studies Technical Medicine and Biomedical Engineering of the University of Twente were selected for the research based on two criteria: to provide information about the medical device market from the educational perspective and to provide an overview of competencies that were perceived as relevant for students from both studies. Technical Medicine focuses on medical technology and Biomedical Engineering focuses on solving technical problems in health care.
The respondents were selected with an Internet search and the personal network of one of the researchers. Snowball sampling was also used, but only one respondent was selected with this method. In total three respondents were selected.

4.6.3 Member check

The member check for the semiconductor market was done at Philips ETG in Eindhoven, because the researchers had less contact with engineers and the managers of the location compared to the location in Almelo. Therefore, it was indicated that this location should become more involved in the research process and the member check provided this opportunity. Next to this criterion, the member check should provide information about the completeness of the specific competency model for the semiconductor market and keep all stakeholders of Eindhoven involved in the research process. The researchers and the managers of the engineering department in Eindhoven selected the respondents for the member check. All 20 engineers of the groups Semiconductor and Medical & Analytical of the engineering department of Eindhoven were invited for the member check. The researchers also invited the Technology Manager and the Key Account Manager Medical of Eindhoven. In total 12 engineers and four managers participated in the member check.

4.6.4 Refinement specific competency model

The selection of respondents for the refinement of the specific competency model in both markets was done to provide information about the completeness of the specific competency models. Another criterion was that information should be provided by clients of Philips ETG for the semiconductor market and by engineers for the medical device market. The aim was to select two respondents for each market.

In the semiconductor market two clients were selected from all (potential) clients of Philips ETG and based on the fact that they were situated in the Netherlands. From the network of an engineer of the engineering department of Almelo and of an employee of the sales department of Philips ETG Almelo two clients of the semiconductor market were selected. Only one client of the semiconductor market participated based on the fact that the other client did not respond to the request. However, the selected client invited a colleague to participate in the same interview. Therefore, in total two respondents were selected for the refinement.
For the medical device market, the clients were selected based on the same criteria as of the semiconductor market. Three (potential) clients were selected from which only Philips MS could be used for the research based on the fact that Philips ETG did not have contacts with other potential clients. The respondents of the medical device market were selected from the network of an engineer of Almelo. Only one engineer of the medical device market was interviewed, because the other respondent was not able to participate in the research. Therefore, in total one respondent was selected for the medical device market.

4.7 Description of participants

The participants of the research are described according to the research process method in figure 7.

4.7.1 Specifying competency research model

In total eight engineers of Philips ETG were interviewed for the semiconductor market, four of the engineering department in Almelo and four of the engineering department in Eindhoven. These participants have the functions of project leader and design engineer at Almelo or Eindhoven. With six of the engineers an interview was done to explore the content of their work within the semiconductor

market and to explore Philips ETG as organisation. The other two engineers were interviewed in an in-depth interview with use of the protocol specific competency model (appendix 3) .
In total four employees were interviewed for the medical device market. Three interviews were employees of Philips MS with the functions of group leader (X-ray and Cardio Vascular) and sales manager. One interview was conducted with the key account manager Medical of Philips ETG.

4.7.2 Education

The participants of the study Technical Medicine of the University of Twente were members of the educational staff. One member worked on the development of the master program of the study and the other worked as teacher of the course professional behaviour. For the study Biomechanical Engineer the selected participant was the study advisor.

4.7.3 Member check

The member check consisted of 16 participants of the engineering groups Semiconductor and Medical & Analytical of the engineering department. One participant was the Technology Manager, one the Key Account Manager Medical, one the manager Semiconductor and one the manager Medical & Analytical. The other 12 participants were project leaders and design engineers.

4.7.3 Refinement specific competency model

Two respondents of the client Advanced Semiconductor Materials Europe (ASME) were interviewed for the refinement of the specific competency model for the semiconductor market. ASME is part of the global organisation ASM, which is a semiconductor equipment manufacturer. ASME is responsible for the design and manufacture of state-of-the-art thermal processing equipment. The first respondent was the Manager Mechanical Development, Research, Development & Engineering of ASME and the second respondent was the Director Development & Engineering of ASME. These respondents were interviewed during the same interview.
For the refinement of the specific competency model for the medical device market one participant was interviewed, who was system architect of the department Cardio Vasculair of Philips MS.

4.8 Data analysis

After conducting the interviews, qualitative data analysis was used to realise the final competency model. This analysis made it possible to transform the competency research model in a specific competency model for both markets.
The analysis of both cases was conducted in the same way and a combination was used between the deductive and inductive approach. This involved not only finding patterns and categories in the data with the inductive analysis, but also analysing the data according to theory (the competency research model) in the deductive analysis (Patton, 1990). During this analysis different steps were taken to analyse the data in a structured way. These different steps are described in table 8.

Table 8: Data analysis steps

Data analysis steps:
1. Analysis during the conduction of the interviews
2. Writing and checking reports of the interviews
3. Within-case analysis of the interviews
4. Documenting the within-case analyses
5. Developing the specific competency model for both markets
6. Use of documentation medical device market for specification
7. Within-case analysis education
8. Refinement of the specific competency model of both markets
9. Cross-case analysis
10. Developing final competency model

During the *first step*, the answers that were given by the interviewees were analysed during the interviews. This analysis was used to ask follow-up questions or to summarise the content of the answers. With these techniques the researchers made sure that the data was complete.
After the interview, a report of the interview was made as the *second step*. This report was made to describe the data as precise as possible, but not to describe exactly what was said during the interview although the mentioned skills or competencies were written down exactly. The interviewee checked this report, which offered the opportunity to provide recommendations. These recommendations were about the reconstruction of sentences, extra information about the job history of engineers or provided additional information that described the content of a certain subject better. However, all participants stated that the interview report was a good summary of the interview and few recommendations were provided to make sure that the content was more exact. These reports are included in the appendices 8 till 13.

In the *third step*, a within-case analysis is used to compare the data against the theory that is used (Miles & Huberman, 1984). In this case the theory was the competency research model. This analysis helped to reduce and display the data in a systematic manner (Miles & Huberman, 1984) and is conducted with the use of an analysis framework (appendix 14). The analysis framework was developed to check the availability of competencies within the interviews. This framework is based on the competency research model as described in chapter 3.The described phrases of the interviewees were categorised in this framework. The definitions of the competencies were used for the analysis. After this activity, the researchers analysed the within-case analysis of each other together to form one within-case result. To compare the information from all the interviews in the *fourth step*, a document was made with all the within-case analyses combined. The results from all within-case analyses were also reflected in numbers in appendix 15 and 16 to make an overview of the absent and present competencies. In the result chapters this is presented in percentages.
During the analysis of the phrases within the interview reports, the researchers also compared the different interviews with each other based on the different functions of the respondents. This was done to analyse if competencies could be applicable for only the project leader or the design engineer. Based on the content of the described competencies, which were formed based on the different phrases, it was analysed if a relation between the content and function could be found.

Both researchers carried out the analysis independently to make sure that the information was interpreted similar and the same results were retrieved. These results did not differ a lot per researcher, because all phrases could be extracted totally from the summary. However, the largest difference in the results was the fact that the definitions of the competencies were viewed slightly different per researcher for some competencies. This was the case for the social competency adaptability and for the sub-competency sensitivity of the competency communication. For the cognitive competencies this was the case for the sub-competencies self awareness, interpersonal sensitivity and sensitivity of the competency awareness. To prevent faults in assigning phrases to the different competencies the researchers used a first round to allocate phrases in the within case analysis, although this meant using the same phrases for different competencies in the analysis framework. In the second round, these phrases were discussed based on the definition of the competencies and decisions resulted in assigning the phrases to a specific competency. With the information from the within-case analyses and the discussion about the phrases the specific competency models for both markets were formed in the *fifth step*. During this step the analysis of the data was used to decide if competencies were taken into account or were placed differently to make specific competency models. Also, the differences in functions (project leader or design engineer) for the semiconductor market were researched. This was not done for the medical device market, because all respondents had a different function. Documents for the medical device market were used in the *sixth step* to make the specific competency model for the medical device market more accurate.

The analysis of the results of the interviews education were used in the *seventh step* to check if the specific competency model was accurate or that additional information had to be taken into account. A within-case was used to make a clear overview of the information. However, it was taken into account that the information of the medical device market was retrieved from different perspectives, which are

not all applicable for the engineers of Philips ETG. It was used for exploring additional information of the medical device market, which could not be retrieved from other interviews. The within-case analysis had the purpose of analysing this additional information and not to formulate competencies for the competency model. Therefore, it was not defined in numbers or percentages. Also, different documents of both studies were analysed to make the specific competency models more accurate.
The *eight step* of the research consisted of the analysis of the interviews for refining the specific competency models. The interviews were used to define if the respondents of both markets described the competencies as important and if competencies had to be removed or replaced.
In the *ninth step*, a cross-case analysis was done to analyse the data from both markets next to each other. A cross-case analysis can be described as the data in one case compared to the data in other cases (Miles & Huberman, 1984). This analysis is used to search for patterns, to find similarities and differences and to go beyond initial impressions (Eisenhardt, 1989), which lead to the description of the final competency model in the *tenth step*. Literature sources were used to describe retrieved competencies.

4.9 Reliability and validity of the research

The research is a multi case study design with the use of qualitative data. Qualitative research can describe and explain complex structures, fits with the meaning that people give and because of that it is supportive in nature (Maso, 2003). Maso (2003) describes that internal validity and internal reliability are appropriate for qualitative research. Internal reliability tells about the consistency of the organisation and the realisation of the research (Maso, 2003). Internal validity is the extent in to which the gathered information, the results and the conclusions of the different phases of the research are similar to the reality from which it is derived (Smaling, 1987). However, the research is only internal valid for the group that was interviewed and not for the population. This was due to the fact that representative sampling could not be used, because information about the whole population was not available.
External reliability is not appropriate, because the research cannot be repeated based on the fact that no hard data is measured and therefore, it depends on the researchers that carry out the research. The research cannot be generalised, because it focuses on a specific organisation and markets. Therefore, external validity is not applicable for this research.

The data analysis was done independently by the researchers to secure the internal reliability of the research. This can be described as intersubjectivity, which is an answer to the question in which the results are coloured by the personality of the researcher (Baarda & De Goede, 1990). Thus, conclusions are made based on the analysis of both researchers and this guarantees the internal reliability of the research.
A member check is used to prevent the influence of the researchers on the collection and procession of the data, which is done to secure the internal validity of the research. Also, the researchers frequently had contact about former tasks to control the interpretation of the other researcher. During the interviews, internal validity was covered by making sure that the interview setting did not influence the answers of the respondents. This was prevented by withholding comments of the researchers on the content of the answers, by stressing that it was about the experiences and vision of the respondent and by interviewing in a separate room.

4.10 Summary

In this chapter the process of the research was described according to figure 7. The research is a multi case study with two cases: the semiconductor market and the medical device market. In the description of both cases the methods and sources for retrieving the needed information is described. After conducting the interviews of both markets, the interviews with the educational staff of the University of Twente and the member check, the data was analysed. A within-case analysis was done to reduce and display the data in a systematic manner. The results of the data-analysis will be described in the following chapters starting with the results of the semiconductor market.

5. Results semiconductor market

In this chapter, the analysis of the results of the semiconductor market is presented. This will provide an answer to the research sub-question '*Which social and cognitive competencies do the engineers need to possess to operate in the semiconductor market?'*, as presented in the previous chapter.
The analysis of the results of social and cognitive competencies will be described according to the research activities: specifying the competency research model, the member check and the refinement of the specific competency model. For the research activity specifying the competency research model the competency research model, as described in chapter 3, is used as starting point. The analysis of the first research activity will be used for the development of the specific competency model for the semiconductor market. The member check describes the response to this model according to respondents of Philips ETG Eindhoven. After that, the specific competency model will be refined according to the client perspective, which will result in the final version of the specific competency model for the semiconductor market.

5.1 Analysis results specifying competency research model

The results will be analysed according to the data from the within-case analysis, which is described in appendix 15. The analysis focuses first on the presence of competencies within the interviews, which is described in percentages. Second, the description of the competencies is further analysed. This provides information about the content of the percentage in which the competencies are described and also information about relevant aspects related to the competencies and sub-competencies of the competency research model.
The analysis of the social competencies and cognitive competencies will be described separately within the following sub-paragraphs, starting with the social competencies.

5.1.1 Analysis social competencies

The data from the within-case analysis is defined in percentages to describe if social competencies and sub-competencies are present within the results, as described in table 9. These results will be described on the next page.

Table 9: Social (sub)-competencies mentioned in the interviews (%)

Competency	*Sub-competency*	%
Social contacts		100
	Self-efficacy	12.5
Networking		
	Network in own organisation	87.5
	Network in organisation of client	75
	Sociability	12.5
Collaboration		100
Communication		
	Oral communication	100
	Written communication	50
	Oral presentation	25
	Listening	75
	Sensitivity	50
	Negotiation	12.5
Adaptability		100
Empathy		87.5

N=8

All respondents mentioned the competencies *social contact*, *adaptability*, *collaboration* and the sub-competency *oral communication*, which indicates the importance of these competencies and sub-competency. Seven out of eight respondents mentioned the competency *empathy* and the sub-competency *network in own organisation*. Within three quarter of the interview reports the competencies *listening* and *network in organisation of client* is described. This indicates that these (sub)-competencies could be of importance for engineers of Philips ETG.

Four respondents mentioned the sub-competency w*ritten communication*. Three out of five project leaders described the sub-competency. Therefore, this sub-competency could be of importance for project leaders only. However, one engineer also describes this aspect. The sub-competency *sensitivity* is mentioned by four respondents, which indicates the relevance of this sub-competency.
No conclusions can be derived from the different functions of the respondents, because engineers and project leaders both describe this element.
The results of the sub-competency *oral presentation* point out that two respondents define it as important. The respondents are both project leader and therefore this competency can be of importance for project leaders. However, three other project leaders did not describe this sub-competency.
The sub-competencies *self-efficacy*, *sociability* and *negotiating* are described by one respondent, from which can be concluded that the respondents do not consider it as important for the work of an engineer.

A further analysis of these results, according to the percentages 75 till 100 and other interesting elements, will be described in the following sub-paragraphs. This analysis of (sub)-competencies will be described according to the within-case analysis, as presented in table 10.

Table 10: Within-case analysis description of social competencies within the semiconductor market

(Sub)- competency	*Respondent*)*							
	A	B	C	D	E	F	G	H
Social contacts	Client: nourish and hold on contact	Client: visiting and nourish, education sustain contact	Dealing with colleagues	Sustaining client and nourish colleagues	Building contact with client	Support and maintain client, suppliers and management	Build and maintain contact with colleagues	Attitude own person, being reliable
Self-efficacy**)	Social conversation							
Networking								
Network in own organisation**)	Maintaining internal contacts		Asking questions or advice from colleagues	Evaluating relation-ship	Using knowledge others	Maintaining relations	Maintaining network	Knowing expertise others
Network in organisation of client**)	Picking up signals client	Retrieve projects		Evaluating the relation	Using knowledge of others	Maintaining relations	Maintaining network	
Sociability**)	Social conversation							
Collaboration	Thinking along, reviewing	Sharing know-ledge	Reviewing, keeping client up-to-date, finding solutions together	Solving problems together, keeping people up-to-date	Reviewing, working with different colleagues, keeping client up-to-date	Fine-tuning each other	Solving problems together, brain-storming	Finding solutions together
Communication								
Oral communication**)	Asking questions, explain	To persuade	Discussion	Asking questions, feedback, summarise	Naming the problem, feedback	Discussion	Giving ones opinion, naming the problem, discussion asking questions	To persuade, summarising, feedback, asking questions
Written communication**)		E-mail	E-mail				E-mail	Writing correctly

(Sub)- competency	*Respondent*)*							
	A	B	C	D	E	F	G	H
Oral presentation**)	Giving presentations						Informing colleagues with presentation, short sheets	
Listening**)	Picking up signals		Listening to ideas	Listening	Listening		Listening, interpreting facial expression and body language	Listening
Sensitivity**)			Accepting project members as they are	Paying attention to reaction, not attacking personally		Accepting people as they are, have some consideration with others	Show appreciation for other opinion	
Negotiation**)	Giving opinion							
Empathy	Empathise in other one's interest, function and associations	Empathise in commitment others		Being open for other ideas, thoughts and interest	Assess someone, empathise in other and level	Empathise in others	Empathise in colleague or client, showing interest	Showing interest in others, empathise in what client wants
Adaptability	Behaviour, language	Level	Own person: being flexible	Client and meeting	Situation, communication, interest organisation	Person, role, level	Setting	Situation

(Sub)- competency	*Respondent*)*							
	A	B	C	D	E	F	G	H
Other	Leading a project, development project, future oriented, flexible in time, reachable, appointments, enthusiasm	Leading a project, setting priorities, taking responsibilities, enthusiasm, motivating people, creating commitment	Setting priorities, project approach, project management, being flexible, building trust, being a project leader, making sure people work along agreements	Generate trust, act according to different roles	Showing capabilities, planning projects, improvise, planning, aware of the costs, preparations	Showing capabilities, project management, planning, setting priorities, project leaders must make sure that engineers will do their work	Costs, time and quality focused, being positive about own organisation, do not act as a wise guy	Entrepreneurial attitude, estimating risks, do not act as a wise guy, showing expertise

N=8
*) A, D, E, F, G = project leader / B, C, H = design engineer
**) Sub-competency

5.1.1.1 Analysis content social competencies with a percentage of 100

The results, as described in table 10, will be analysed according to the description of the aspects of (sub)-competencies. All respondents mentioned the competencies *social contacts*, *adaptability* and *collaboration* and the sub-competency *oral communication* in the interview.

Social contacts is described by five respondents as contact with the client, three indicated contact with colleagues, one mentioned contact with the management and suppliers and one respondent indicated contact with education. Therefore, it can be concluded that these aspects are important for engineers. No clear difference between the competency regarding the function can be indicated, because project leaders and design engineers both mentioned these elements.
The respondents mentioned different activities related to social contacts. Three respondents mentioned the activity nourishing contact, two respondents described building contact and maintaining or sustaining contact is mentioned by two respondents. Building and maintaining contact is mentioned by project leaders and therefore it can be concluded that these elements are especially important for project leaders.

For the competency *adaptability* two respondents described adapting to the person or level of a person. Three respondents, which are all project leaders, mentioned adapting to the situation or setting. Therefore, it could be concluded that adapting to the situation is of importance for a project leader.
For the competency *collaboration* three respondents described the aspect reviewing and one respondent mentioned brainstorming as an element of the competency. Also, three respondents mentioned solving problems together and finding solutions together. From this can be concluded that knowledge is shared during these activities. Last, three respondents described keeping people or clients up-to-date as an aspect, which indicates that this is important. The different functions of the respondents do not indicate a clear relationship between these aspects and the different functions of engineers.
The mentioned aspects for sub-competency *oral communication* of the competency *communication* indicate using different methods to communicate. The respondents described methods, which all are elements of oral communication. These different methods are: asking questions, discussion, giving feedback, summarising and naming the problem. Because of the different methods, it is not possible to relate the aspects to the different functions.

5.1.1.2 Analysis content social competencies with a percentage of 87.5

The competencies with a percentage of 87.5 are *empathy* and the sub-competency *network in own organisation*.

The competency *empathy* is described by one respondent as the aspect of empathising in commitment of others and by another respondent as emphasising in the level. Empathising in the interest and needs of others is described by six of the seven respondents from which five respondents are project leaders. Therefore, this indicates the importance of this competency for project leaders.
The sub-competency *network in own organisation* of the competency *networking* is described by three respondents, who are all project leaders, as maintaining contacts. Two respondents mentioned using contacts or knowledge, whereas evaluating contacts is described by one respondent. Also, one respondent described knowing the expertise of others. Therefore, it can be concluded that these four aspects can be a division of this sub-competency. No further conclusions can be made according to the different functions of the respondents.

5.1.1.3 Analysis content social competencies with a percentage of 75

The sub-competencies *listening* and *network in organisation of client* have a percentage of 75.

Listening of the competency *communication* describes two different aspects, namely: listening and picking-up signals. Listening is mentioned by five of the respondents, which is a mix between project leaders and design engineers. Two respondents, who are both project leaders, described picking up signals. This can indicate the importance of this sub-competency for project leaders.

Network in organisation of client of the competency *networking* is described as maintaining relations or maintaining the network, evaluating the relation, using knowledge of others and retrieving and picking up signals. Two project leaders described maintaining relations or the network. The other aspects are described once and not by the same respondent. It can be concluded that these aspects are relevant and can be used for a sub-division of this sub-competency.

5.1.1.4 Analysis interesting elements social competencies

Interesting elements of (sub)-competencies with a percentage lower then 75 and elements of the category other of the within-case analysis are analysed.

Three respondents described use of e-mail as an aspect of the sub-competency *written communication* of the competency *communication* and one respondent described the aspect writing down correctly.
E-mail is a medium that can be used and writing down correctly is related to a criterion of written communication. Therefore, it can be concluded that the relevance of this sub-competency is not indicated.
In the category other five respondents indicated aspects, which are related to working in a project. These aspects are managing a project, planning a project, setting priorities, taking responsibilities, motivating people, creating commitment, making sure people work along agreements and making sure that engineers will do their work. Three of these respondents are project leaders and two are design engineers. It can be concluded that all described aspects indicate working in a project. The aspects making sure that people work along agreements and making sure that engineers do their work, indicate that delegating tasks is necessary for engineers in projects. Also, it can be concluded that the functions do not influence the aspects related to working in projects.

5.1.2 Analysis cognitive competencies

The results of the within-case analysis (appendix 15) are described in percentages to indicate if cognitive competencies and sub-competencies are present within interviews, which are presented in table 11. The results of the competencies are described on the next page.

Table 11: Cognitive (sub)-competencies mentioned in the interviews (%)

Competency	*Sub-competency*	%
Problem solving		
	Problem analysis	87.5
	Information analysis	37.5
	Anticipation	62.5
	Decision-making	62.5
Using different kinds of knowledge and being flexible with that knowledge		
	Conceptual knowledge	37.5
	Contextual knowledge	75
	Procedural knowledge	75
Self-development		87.5
	Learning ability	75
Awareness		
	Interpersonal sensitivity	50
	Self awareness	62.5
	Aware of environment	0
	Sensitivity	100
Knowledge of others and himself		
	Knowledge of the client	87.5
	Knowledge of the own organisation	100
	Self-knowledge	50

N= 8

All respondents mentioned the sub-competencies *sensitivity* and *knowledge of the own organisation*. This could indicate the importance of these sub-competencies for engineers. The competency *self-development* is mentioned by seven out of the eight respondents. Also, seven respondents mentioned the sub-competencies *problem analysis* and *knowledge of the client.* This could indicate the importance of these sub-competencies and this competency for engineers. A relationship between the functions of the respondents and the mentioned competencies cannot be concluded from the data, because in all cases one design engineer out of three design engineers did not mention the competency or sub-competencies.

Six respondents described the sub-competencies *procedural knowledge*, *contextual knowledge* and *learning ability*. From the respondents four project leaders mentioned these sub-competencies, which are not the same project leaders and therefore a relation between the functions cannot be found.

The sub-competencies *anticipation*, *decision-making* and *self-awareness* are described by five respondents. Three project leaders and two design engineers described the sub-competencies *anticipation* and *decision making* and four project leaders and one design engineer described the sub-competency *self-awareness.* The differences between the functions of the engineers do not indicate a relationship between the function and the needed sub-competencies. The presence of the described competencies and sub-competencies within the interview indicates its relevance.

The results indicate that four respondents described *interpersonal sensitivity* and *self-knowledge*. This last competency is described by three out of five project leaders and could be relevant for this function. For *self-knowledge* no coherence could be found between the respondents and their function. *Information analysis*, *conceptual knowledge* and *contextual knowledge* are described by three respondents and therefore are not very important for an engineer. However, the respondents that mentioned contextual knowledge also described conceptual knowledge. Two of these three respondents are design engineers and one respondent is a project leader. The sub-competency *aware of environment* is not indicated as important for engineers, because no respondents described the competency.

The within-case analysis of cognitive competencies is presented in table 12 on the next page. Further analysis of the description of the competencies and sub-competencies according to the percentages 100, 87.5 and 75 and interesting elements will be described in the following sub-paragraphs.

Table 12: Within-case analysis description of cognitive competencies within the semiconductor market

(Sub)-competency	*Respondent*)*							
	A	B	C	D	E	F	G	H
Problem solving								
Problem analysis**)	Making associations, view from another perspective	Overlook the whole process	Working pragmatic think of simple solutions	Analyse and validate problems	Knowing impact of question	Finding solutions, analyse problem	Finding solutions to clarify problem, analyse if problem is well under-stood	
Information analysis**)				Naming and ranking the problem, analysing sources	Knowing what to take into account, estimating the solution, understand the question		Clarifying the question and understanding the question	
Anticipation**)	Thinking forward	Fast reaction, thinking about possible solutions	Being not to complicated		Solution is personal		Checking if question is understood, anticipate on situation	
Decision-making**)	Find an easy solution	React fast to needs of clients	Making choices		Make decisions, ability to improvise		Manage problem	
Using different kinds of knowledge and being flexible with that knowledge								
Conceptual knowledge**)	Conceptual thinking	Have an overview			Conceptual thinking			
Contextual knowledge**)	What something delivers	Aspects of products	Working in projects		The costs, market	Costs of project, product	Costs, reliability	

(Sub)-competency	*Respondent*)*							
	A	B	C	D	E	F	G	H
Procedural knowledge**)		Knowing the last developments	Design choices	Knowing the technique understand the machine	Technical knowledge, project approach, systematic working	Knowledge of machine and product	Technology, function machine	
Self-development	Figure out what is needed, learning in practice	Continuity is important	Figure out and reflect with others what is needed	Evaluate	Analyse own behaviour, reflect	Keep up with own development, willing to learn, self-analysis	Investing time in personal improvements, knowing particular needs per role	
Learning ability**)	Visiting conferences, literature	Acquiring knowledge outside expertise area		Courses, Internet, contact group	Courses, internet	Internet		Internet, feedback others
Awareness Self-awareness**)	Knowing own strengths and weaknesses, judge people			Feedback on impact behaviour	Knowing what to offer or can or cannot do		Knowing own strengths and weaknesses,	Knowing own strengths and weaknesses and what you can or cannot do
Interpersonal sensitivity**)	Adapt to others conscious		Brining across enthusiasm	Knowing what others are able to do, being open to others, showing interest in others				Reflecting on contacts
Aware of environment**)								

(Sub)-competency	*Respondent*)*							
	A	B	C	D	E	F	G	H
Sensitivity**)	Figure out reasons behind behaviour, knowing others	Knowing capabilities of others	Accepting members as they are, showing appreciation for knowledge and efforts others, respect	Showing own capabilities and know-ledge, open to others, show interest	Deal with different people, estimate others, knowing capabilities and limitation of others	Trust others, accepting people as the are, have some consideration of others, knowing capabilities	Knowing strengths and weaknesses of others, appreciate others opinion	Showing interest
Knowledge of others and himself								
Knowledge of the client**)	Understanding the question of the client, knowing: right persons, interest, culture, market and what the client is up to, doing preparations, procedures	Procedures within organisation, interest, potential needs		Knowing who is the client, interests, internal processes what can be said	Knowing what the client wants, culture and client	Priorities of client, knowing the organisation, knowing persons within the organisation, doing preparations	Market, product, developments client, competitors, knowing what the client wants, people, why they choose for Philips ETG	Intention, market and market position, product, interest, machine
Knowledge of own organisation**)	Right persons, culture, market,	Formal and informal procedures, right persons	Which internal knowledge can be communicated	Interests, client, internal process, persons	Interests, colleagues and management	Vision, which information can be shared, right persons	Internal aspects, competencies, capabilities, facilities	Products and activities, realistic view of the organisation
Self-knowledge**)	Knowing own strengths and weaknesses					Knowing what you are able to do or not to do	Knowing own strengths and weaknesses, knowing what you are able to do or not to do	Knowing own and colleagues strengths and weaknesses

N=8
*) A, D, E, F, G = project leader / B, C, H = design engineer
**) Sub-competency

5.1.2.1 Analysis content cognitive competency with a percentage of 100

The results, as described in table 12, will be analysed according to the description of the aspects of (sub)-competencies. The sub-competencies with a percentage of 100 are *sensitivity* and *knowledge of the own organisation.*

Five respondents mentioned knowledge of others or knowledge of the capabilities, strengths and weaknesses of others as aspects of the sub-competency *sensitivity* of the competency *awareness*. Four of these respondents are project leaders and this could indicate the importance of this aspect for project leaders. Two respondents mentioned the aspect showing appreciation towards others and two respondents indicated the aspect accepting others as they are as an element for sensitivity.
A variety of aspects are mentioned for the sub-competency *knowledge of the own organisation* of the competency *knowledge of others and himself.* The aspects are about the culture, the people and management, the internal procedures, market, interest, competencies and capabilities and vision. These aspects indicate a subdivision of *knowledge of the own organisation* and the importance for project leaders and design engineers.

5.1.2.2 Analysis content cognitive competency with a percentage of 87.5

The sub-competencies *problem analysis* and *knowledge of the client* and the competency *self-development* have a percentage of 87.5.

Three out of seven respondents used the description analyse, validate or clarify the problem for the sub-competency *problem analysis* of the competency *problem solving*. These three respondents are all project leaders, which could indicate the importance of this element for project leaders. Finding solutions or thinking of simple solutions is mentioned by three respondents and one respondent mentioned working pragmatically. Three other respondents indicated making associations, viewing the problem from another perspective, overlooking the whole process or knowing the impact of the questions as elements of problem analysis. These described aspects all indicate different methods of how a problem can be analysed. Therefore, it can be concluded that no other sub-competencies have to be formed.

The respondents described different aspects of *knowledge of the client* of the competency *using different kinds of knowledge and being flexible with that knowledge* which are: understanding the client, the interest, the intentions, the product, the market and competitors, the persons, the internal processes, the culture and the organisation of the client. These aspects indicate a division of the sub-competency and it can be concluded that these aspects are important for the engineers. One respondent described knowing what the client is up to and another respondent mentioned the intention of the client. These aspects indicate that the engineers should know the vision of the client, which can also be a subdivision of the competency. A relationship between the aspects and the different functions is not the case.
For the competency *self-development* three respondents described the aspect self-analysis with a different description. One respondent mentioned the term self-analysis and the other two respondents described it as the analysis of own behaviour and about figuring out what is needed. Based on these descriptions, it could be concluded that self-analysis is needed for self-development. Two respondents indicated reflecting on learning needs, individually or with the help of others. Therefore, reflection could be an aspect of self-development. No conclusions can be extracted from the different functions of the respondents and the described aspects.

5.1.2.3 Analysis content cognitive competency with a percentage of 75

Six respondents mentioned the sub-competencies *procedural knowledge* and *contextual knowledge* of the competency *using different kinds of knowledge and being flexible with that knowledge* and the sub-competency *learning ability* of the competency *self-development.*

The sub-competency *procedural knowledge* is described by five respondents as the possession of technical knowledge or knowledge about technology and technical developments. Three respondents mentioned understanding the machine and these aspects indicate the possession of technical knowledge and therefore can be defined as aspects of functional competencies.
One respondent described knowledge of systematically working and having a project approach as aspects of *procedural knowledge*. However, this does not indicate the relevance of these aspects.
For the sub-competency *contextual knowledge,* three respondents mentioned the costs of a project, two respondents described the products and one respondent mentioned knowledge of the market as elements. These elements are related to the client and therefore, it can be concluded that the engineer needs specific knowledge of the client.
For the sub-competency *learning ability* five respondents described using Internet, courses, literature and conferences as sources for learning. These elements could be of importance for the sub-competency, because five out of six respondents mentioned this. Last, it can be concluded that there is no relation between the sub-competencies and the functions of the respondents, because both functions describe these aspects.

5.1.2.4 Analysis interesting elements cognitive competencies

The results of the sub-competency *anticipation* of the competency *problem solving* indicate elements of anticipation, described differently by all five respondents. This might be the case, because it are examples of how an engineer can prevent problems. Therefore, it can be concluded that no other sub-competencies can be drawn from the results.
Decision-making, which is also a sub-competency of the competency *problem solving* is described by five respondents as examples of how to make decisions. Therefore, although described differently the five respondents indicated aspects, which reflect the sub-competency decision-making.
For the sub-competency *self-awareness* of the competency *awareness* three respondents, who differ in function, indicated the aspect knowing own strengths and weaknesses. Two respondents, who also indicated the previous aspect, described the aspect knowing what the engineer is capable of. It can be concluded that these aspects both mention the use of strengths and weaknesses and therefore no division have to be made for the sub-competency.

The sub-competency *self-knowledge* of the competency *knowledge of others and himself* is described by four respondents. Knowledge of own strengths and weaknesses is mentioned by three of the four respondents. Knowing what you are capable of is described by two of the four respondents, which are both project leaders. However, two out of five project leaders are not enough to drawn conclusions from. Also, it can be indicated that the results of this sub-competency have an overlap with the results of the sub-competency self-awareness. Therefore, it can be taken into consideration to combine these sub-competencies.

Based on the analysis of the social and cognitive competencies and sub-competencies the competency research model, as described in chapter 3, is made specific. The description of this is described in the following paragraph on the next page.

5.2 Development of specific competency model

The analysis of the results of the eight interviews is used to provide the opportunity to develop a specific competency model for the semi-conductor market. To form this model the social and cognitive competencies of the competency research model, as described in chapter 3, will be adjusted according to the results of the interviews with the eight respondents starting with the social competencies. Also, a description is provided that indicates the relevance of the different functions of the respondents for the social and cognitive competencies of engineers. Last, a summary of the social and cognitive competencies of the specific competency model is provided.

5.2.1 Social competencies

The social competencies within the competency research model and the developed specific competency model are presented in table 13 and modifications according to the results are described below the table.

Table 13: Social (sub)-competencies of the competency research model and the specific competency model

Competency research model		**Specific competency model**	
Social competency	*Sub-competencies*	*Social competency*	*Sub-competencies*
Social contacts Networking	Self-efficacy Network in own organisation Network in organisation of client Sociability	Networking	Building contact Maintaining contact Evaluating contact Using contacts
Collaboration		Collaboration	Dealing with different people Using teamwork methods*) Keeping stakeholders up-to-date Sharing knowledge
Communication	Oral communication Written communication Oral presentation Listening Sensitivity Negotiation	Communication	Using communication techniques**) Listening Persuasiveness Interpretation of signals
Empathy		-	
Adaptability		Flexible Behaviour	Changing the behaviour according to the situation
		Project management	Motivate people Manage people Set out project steps Planning and organising Delegation Creating commitment Taking responsibility

*) Brainstorming and reviewing
**) Asking questions, discussion, giving feedback, summarising and naming the problem

In the specific competency model *networking* is formed based on competencies *networking* and *social contacts.* This was done, because an overlap in competencies can be extracted from the analysis of the results. Both competencies indicate contacts with different people and describe that these contacts have to be build, maintained, evaluated and used. Although project leaders described *building* and *maintaining contacts* it is concluded that these are important aspects for the competency networking.

All engineers work with contacts and therefore should possess these aspects. Also, during the interview the project leader was asked to describe what kind of competencies were relevant for an engineer. Therefore, building and maintaining contacts is important for all engineers. Although only one respondent described evaluating contacts, this sub-competency is taken into account. This is because a link can be seen between *using* and *evaluating contacts* and knowing the expertise of others. *Sociability* is removed, because not any respondent described this sub-competency.

For the competency *collaboration* the analysis of the results indicate that the aspects keeping people or clients up-to-date, teamwork methods like reviewing and brainstorming, working with different people and sharing knowledge have to be described as sub-competencies. The sub-competency *keeping stakeholders up-to-date* is formed from the aspect keeping people or clients up-to-date, because this describes the mentioned aspect better. The sub-competency *using teamwork methods* is formulated to indicate teamwork methods like reviewing and brainstorming. Working with different people is extracted based on the fact that the respondents described that they have to work with colleagues and others. Last, *sharing knowledge*, although mentioned once, is described as a sub-competency, because the respondents described that they have to work together to find a solution or solve problems. To do this right, the engineers have to share knowledge with others and therefore this sub-competency is relevant for an engineer.

In the analysis of the results of the competency *communication* is described although a different kind of division of sub-competencies is indicated. For oral communication different techniques to communicate are described. Therefore, it is concluded that the sub-competency *communication techniques* is used in the specific competency model. Also, the respondents mentioned *persuasiveness* as a communication technique. However, it is chosen to include this as a separate sub-competency because it is a different technique then indicated for the sub-competency using communication techniques and it is more a way to negotiate.
The aspects, described for *written communication*, almost all indicate e-mail as important. However, the definition, as described in chapter 3, describes the sub-competency as focusing on writing documents well and not what kind of medium is used and therefore, this competency is removed. *Oral presentation* is also removed from the model, because only two respondents described this element and six respondents did not describe anything for this sub-competency. *Listening* is described by respondents as important and therefore used for the specific competency model. However, *picking up signals* is also mentioned. Although two respondents describe this sub-competency it is concluded that this should be taken into account based on the definition of the sub-competency. The definition indicates picking up significant information and investigates reactions. To do this right, the engineers have to focus on verbal communication but also on other signals. *Sensitivity* is removed from the model, because the analysis of the results makes clear that the described aspect is better reflected by the cognitive competency sensitivity. Last, *negotiation* is removed from the model because it is described by one respondent, which is not enough to base conclusions on.

The analyses of the results of the competency *empathy* indicate aspects that can be described as *awareness*, because it are aspects that refer to mental processes. Therefore, this competency is combined with the cognitive competency *awareness* and removed from the model.
Adaptability is replaced by the competency *flexible behaviour*, because this competency reflects the described aspects of the respondents better. The different aspects like behaviour, level, client, meeting, situation, communication, role, setting, interest organisation and person indicate that an engineer has to adapt to a lot of different aspects and therefore, has to be flexible. To describe this competency better it is chosen to use the sub-competency: *changing the behaviour according to the situation.*
According to the analysis of the results of the category other of the analysis framework, *project management* is included in the specific competency model. Also, the sub-competencies motivate people, manage people, create commitment, delegate task, set out project steps and planning and organising are indicated by the respondents and therefore added to the specific competency model. This is emphasised by the results of the cognitive sub-competencies *procedural* and *contextual knowledge*, which indicate knowledge of working systematically and working in projects.

5.2.2 Cognitive competencies

The cognitive competencies within the competency research model and the developed specific competency model are presented in table 14, which presents the competency research model and the specific competency model to describe the modifications according to the eight interviews. The modifications will be described below the table.

Table 14: Cognitive (sub)-competencies of the competency research model and the specific competency model

Competency research model		**Specific competency model**	
Cognitive competency	*Sub-competencies*	*Cognitive competency*	*Sub-competencies*
Problem solving	Problem analysis Information analysis Anticipation Decision-making	Problem solving	Problem analysis Anticipation Decision-making
Using different kinds of knowledge and being flexible with that knowledge	Conceptual Contextual Procedural	Conceptual thinking	-
Self-development	Learning ability	Self-development	Reflection Self-analysis Using sources to develop*)
Awareness	Self awareness Interpersonal sensitivity Aware of environment Sensitivity	Awareness	Self awareness Interpersonal sensitivity Sensitivity
Knowledge of others and himself	Knowledge of the client Knowledge of own organisation Self-knowledge	Knowledge of the client	Knowledge of the: -Culture -Internal processes -Interest -Vision -Product -Market and competitors
		Knowledge of the own organisation	Knowledge of the: - Culture - Internal processes - Interest - Vision - Competencies and capabilities

*) E.g. Internet, courses and colleagues

The sub-competency *problem analysis* of the competency *problem solving* is described by the respondents although different examples of the ways to analyse problems are described. The definition of problem analysis also describes different aspects. Therefore, no changes are made according to the analysis of the results. However, some aspects that are mentioned for problem analysis, refer to *conceptual knowledge* and therefore they are taken into account for the sub-competency conceptual knowledge. This is further described at the description of the sub-competency conceptual knowledge.
Three respondents described aspects of the competency *information analysis*, which are different, and therefore it is concluded that the sub-competency should not be taken into account for engineers.
Different aspects for the sub-competency *anticipation* are described, which are all aspects of how engineers can anticipate on situations. Therefore, it is concluded that anticipation is a relevant sub-competency of the competency problem solving and included in the model. This reasoning is also the

case for the sub-competency *decision-making*, which indicates different examples of how to make decisions. Therefore, although different examples are given, it is concluded that decision-making, as described in chapter 3, is important for engineers and included in the model.

For the competency *using different kinds of knowledge and being flexible with that knowledge* the sub-competency *conceptual knowledge* is described. It is indicated as conceptual thinking or having an overview, which is important for all engineers. Therefore, it is chosen to describe this as conceptual thinking. *Procedural knowledge* is described by the respondents as technical knowledge or knowledge of technical developments and therefore is relevant for an engineer. However, the sub-competency shows overlap with the sub-competency knowledge of the client of the own organisation. Therefore, it is concluded that this sub-competency is removed from the model and the results are taken into account for the competency knowledge of other and himself. Last, almost the same can be described for the sub-competency *contextual knowledge* with the difference that it only reflects the aspects: costs of projects, products and knowledge of the market. These aspects are relevant when working with a client. Therefore, these aspects are taken into account in the sub-competency knowledge of the client.

Self-development is described in the specific competency model with the sub-competencies reflection, self-analysis and using sources to develop. The last sub-competency is derived from the sub-competency *learning ability*. For this sub-competency the respondents described different sources for learning and therefore the sub-competency is adjusted to represent these results. The sub-competencies *reflection* and *self-analysis* are derived from the fact that respondents described different elements for the competency self-development. These elements focus on how the engineers can figure out what they need. It is concluded that this can better be reflected by the sub-competencies *reflection* and *self-analysis* and therefore are added to the model.

For the competency *awareness* the sub-competencies *self-awareness*, *interpersonal sensitivity* and *sensitivity* are selected as relevant for engineers. *Self-awareness* is defined by the respondents as knowing own strengths and weaknesses and knowing what an engineer is capable of. Both can be seen as an element of knowing own strengths and weaknesses and therefore describe the sub-competency self-awareness, which is included in the model. For *interpersonal sensitivity* four respondents described various aspects, which all indicate that engineers have to project themselves in someone else. This is especially important when working with others and therefore is chosen to include interpersonal sensitivity in the model. *Aware of environment* is removed from the model, because the respondents did not describe this sub-competency. Knowledge of others or knowledge of the capabilities, strengths and weaknesses of others are described as aspects of the sub-competency *sensitivity*. The definition of this sub-competency indicates that it is about showing to be aware of others, which is reflected in the analysis of the results. Therefore, this competency is taken into account for engineers.

Self-knowledge is removed from the model, because an overlap with the sub-competency self-awareness is indicated. Therefore, knowledge of others and himself is changed in *knowledge of the client* and *knowledge of the own organisation*. Knowledge of the client and knowledge of the own organisation is considered to be important for engineers and therefore the sub-competencies are described as separate competencies. For *knowledge of the client* various aspects are described to indicate the kind of knowledge that an engineer needs to possess. These aspects, and the aspects described for contextual knowledge, cannot be combined and therefore the sub-competencies knowledge of the culture, internal processes, interest, vision, product, competitors and market are added to the model. This is also the case for *knowledge of the own organisation* for which knowledge of the culture, internal processes, interest, vision and of competencies and capabilities are included in the model.

5.2.3 Relevance functions of respondents

The analysis of the social and cognitive competencies is described according to the different functions of the engineers. The competencies and sub-competencies indicate some small differences in functions (project leader and design engineer). However, the interviews were conducted with respondents about the work of an engineer although the respondents have a different function as an engineer. Also, the interview was conducted to retrieve important aspects of the work of an engineer. This description does not indicate that the developed specific competency model cannot be used for both functions, because the aspects that can be of importance for one of the functions are also relevant for the other function. This is also mentioned in the description of relevant competencies or sub-competencies as described above. However, it could be that some (sub) competencies are more relevant for a typical function, but the results do not indicate this specifically.

5.2.4 Summary

The social and cognitive (sub)-competencies of the specific competency model are summarised in table 15 to present all competencies for an engineer in the semiconductor market.

Table 15: Competencies of specific competency model

Specific competency model	
Social competencies	*Cognitive competencies*
Networking	Problem solving
Collaboration	Conceptual thinking
Communication	Self-development
Flexible behaviour	Awareness
Project management	Knowledge of the client
	Knowledge of the own organisation

5.3 Results member check

The specific competency model was presented for engineers of the engineering groups Semiconductor and Medical & Analytical of the engineering department of Philips ETG Eindhoven. The 16 participants of this meeting were asked to provide feedback or additional information about the social and cognitive competencies that an engineer needs to possess in the semiconductor market.

The 12 engineers and four managers considered all social competencies important for the work of an engineer although some questions were asked about the definitions of the competencies. The competency *flexible behaviour* was not clear for four out of 12 engineers although the other participants did not have comments. Therefore, the definition of the competency and its sub-competency was elaborated on during the meeting. Using communication techniques was changed in *using communication methods*, because the participants indicated that they perceived techniques as something else. This had to do with the function of the engineer in which techniques are defined as completely different. After this, all participants concluded that the social competencies are clear and that they are relevant for the work of an engineer.
All participants perceived the cognitive competencies of the specific competency model as relevant and clear. However, four engineers needed additional explanation about the competency *awareness*. The situation in which this competency was used needed to be described further. After this explanation all participants concluded that the cognitive competencies are relevant.

The participants could not provide additional information about other competencies although the competency *entrepreneurship* was mentioned. However, they described this as a competency that might be relevant for the medical device market and not for the semiconductor market.

One engineer asked if this model could be perceived as complete if only engineers were interviewed. These engineers can have a different view then clients that have to work with the engineers. The four managers agreed with this statement. Some engineers could imagine this, but others could not.
Because this aspect is perceived as important it is taken into account and clients of the semiconductor market were approached for the refinement of the model. The results of this refinement are described in the next paragraph. For the medical device market this recommendation is also taken into account and engineers that work in this market are approached for the refinement of the specific competency model.

5.4 Results refinement specific competency model

The specific competency model is refined based on the interview results with two respondents of the semiconductor market. These respondents were clients of Philips ETG that are working at Advanced Semiconductor Materials Europe (ASME). The analysis of the social and cognitive competencies is described in the next sub-paragraphs. This paragraph finalises with the presentation of the final version of the specific competency model of the semiconductor market.

5.5.1 Analysis social competencies

The results of the social (sub)-competencies are described according to correctness of these (sub)-competencies indicated by the respondents are presented in table 16. Sub-competencies or competencies that the respondents mentioned as not correct are described further below the table.

Table 16: Correctness social competencies derived from the interview

Competency	*Correct*	*Not correct sub-competencies*
Networking	Yes	
Collaboration	No	Using different teamwork methods Keeping stakeholders up-to-date
Flexible behaviour	Yes	
Communication	No	Written communication
Project management	Yes	

Two sub-competencies have to be changed slightly according to the respondents to describe better what is indicated. The sub-competency *using different teamwork methods* of the competency *collaboration* is according to the respondents not complete and should be expanded with the method normal meetings. Also, the results indicate that the sub-competency *keeping stakeholders up-to-date* of the same competency should change, because the respondents described that the word stakeholders does not include all the people that are involved.
According to the analysis of the results the competency *communication* does not cover all the elements that an engineer should be able to perform. *Written communication* is indicated by both respondents as important for an engineer, because the engineer has to write reports for non-technical people.
The results did not reveal any other social competencies that were not included in the specific competency model.

5.5.2 Analysis cognitive competencies

The results of the cognitive (sub)-competencies are described according to correctness of these (sub)-competencies indicated by the respondents are presented in table 17 on the next page. Sub-competencies or competencies that the respondents mention as not correct are described below the table.

Table 17: Correctness cognitive competencies derived from the interview

Competency	*Correct*	*Not correct sub-competencies*
Problem solving	Yes	
Conceptual thinking	No	Coming up with different directions or solutions Thinking outside the usual domain
Awareness	Yes	
Self-development	Yes	
Knowledge of the own organisation	No	Knowledge of the vision
Knowledge of the client	No	Knowledge of the mission, vision and values

The respondents indicated that the sub-competencies *coming up with different directions or solutions* and *thinking outside the usual domain* should be included for the competency *conceptual thinking*, because these sub-competencies are important for engineers.
The respondents described that the sub-competency knowledge of the vision of the competency *knowledge of the own organisation* should be expanded with the mission and the values of the organisation. This is because it is part of the culture of an organisation and therefore it should be added to the model to describe the competency knowledge of the own organisation correctly.
For the competency *knowledge of the client* knowledge of the mission, vision and values of the client are not indicated as important. The respondents described that these elements are relevant for the organisation as a whole. The engineer has only contact with a part of the organisation and therefore these elements are not important for the work.
The results did not reveal any other cognitive competencies that were not included in the specific competency model.

5.3.3 Final specific competency model

The results of the refinement are described in the analysis of social and cognitive competencies, as presented in the previous sub-paragraphs, and are taken into account for the refinement of the specific competency model. All aspects are considered to provide a better overview of the competencies that engineers need to have to perform the job although only two respondents were interviewed. However, the recommendations that are suggested do not have a great impact on the social and cognitive competencies. It makes the competencies more correct, because the sub-competencies do not have overlap with each other or are made more specific. Therefore, the changes are made according to the recommendations of the respondents. The final version of the specific competency model of the semiconductor market is presented in table 18 on the next page.

Table 18: Final version specific competency model semiconductor market

Specific competency model semiconductor market			
Social competencies		*Cognitive competencies*	
Competencies	*Sub-competencies*	*Competencies*	*Sub-competencies*
Networking	Building contact Maintaining contact Evaluating contact Using contacts	Problem solving	Problem analysis Anticipation Decision-making
Collaboration	Dealing with different people Using teamwork methods*) Keeping people involved up-to-date Sharing knowledge	Conceptual thinking	Coming up with different directions or solutions Thinking outside the usual domain
Communication	Using communication methods**) Written communication Listening Persuasiveness Interpretation of signals	Self-development	Reflection Self-analysis Using sources to develop***)
Flexible Behaviour	Changing the behaviour according to the situation	Awareness	Self awareness Interpersonal sensitivity Sensitivity
Project management	Motivate people Manage people Set out project steps Planning and organising Delegation Creating commitment Taking responsibility	Knowledge of the client	Knowledge of the: - Culture - Internal processes - Interest - Product - Competitors
		Knowledge of the own organisation	Knowledge of the: - Culture - Internal processes - Interest - Vision, mission and values - Competencies and capabilities

*) Brainstorming, reviewing and normal meetings
**) Asking questions, discussion, giving feedback, summarising and naming the problem
***) E.g. Internet, courses and colleagues

5.5 Conclusion

Specifying the competency research model, the member check and the refinement of the specific competency model were the three research activities for the semiconductor market that are relevant for answering the research sub-question ‘Which social and cognitive competencies do the engineers need to possess to operate in the semiconductor market?’.
The results of these research activities indicated competencies and sub-competencies that an engineer needs to possess to work in the semiconductor market. An analysis of the percentages and the content of the research revealed that engineers need specific social and cognitive (sub)-competencies. The member check and the refinement of this specific competency model confirmed this. Also, changes were made to refine the specific competency model according to the recommendations of engineers and managers of Philips ETG Eindhoven and according to managers of the client ASME.

This refinement concluded with the social competencies networking, collaboration, communication, flexible behaviour and project management and the cognitive competencies problem solving, conceptual thinking, self-development, awareness, knowledge of the client and knowledge of the own organisation. Also, sub-competencies were defined to describe the competencies in-depth, which are presented in the final version of the specific competency model for the semiconductor market in table 18. The engineers of Philips ETG need to possess these social and cognitive competencies and sub-competencies to work in the semiconductor market. Therefore, this specific competency model answers the research sub-question, as stated above.

In the following chapter the results of the medical device market will be described and in chapter 7 the differences in social and cognitive (sub)-competencies between both markets will be presented.

6. Results medical device market

This chapter presents the analysis of the results of the medical device market. These results are discussed according to the results of the within-case analysis of the medical device market (appendix 16) and provides an answer to the research sub-question '*Which social and cognitive competencies do the engineers need to possess to operate in the medical device market'*, as described in chapter 4.
The results of the analysis of social and cognitive competencies will be described according to the activities: specifying competency research model, education and refinement specific competency model. The focus in specifying the competency research model is on social and cognitive competencies for engineers in case an alliance is formed with an organisation that operates in the medical device market. The results of the interviews with education focuses on the competencies needed for an engineer to work directly with the customers within the medical device market. In the refinement of the specific competency model the model will be adjusted according to the perspective of a client. Finally, the specific competency model for the medical device market is presented and a conclusion is given.

6.1 Analysis specifying competency research model

In total four respondents were interviewed for the development of the specific competency model of the medical device market. These respondents are three managers of Philips MS and one key-account manager of Philips ETG. The results will be analysed according to the data from the within-case analysis, which is described in appendix 16. The analysis focuses first on the presence of competencies within the interviews, which is described in percentages. Then, the description of the competencies is further analysed. This provides information about the content of the percentage in which the competencies are described and also information about relevant aspects related to the competencies and sub-competencies of the competency research model.
The analysis of the social competencies and cognitive competencies will be described separately within the following sub-paragraphs, starting with the social competencies.

Within the analysis of the social and cognitive competencies, a comparison between the different functions of the respondents and the described aspects is not included. This was not applicable for the analysis of the results of this market, because the respondents work in complete different departments of Philips MS, and the functions differ, even though they are managers. Therefore, no conclusions can be drawn from this.

6.1.1Analysis social competencies

The data from the within-case analysis is defined in percentages to describe if social competencies and sub-competencies are present in the interviews, as presented in table 19 on the next page. The results are described below the table.

Table 19: Social (sub)-competencies mentioned in the interviews (%)

Competency	*Sub-competency*	*%*
Social contacts		100
	Self-efficacy	0
Networking		
	Network in own organisation	50
	Network in organisation of client	100
	Sociability	0
Collaboration		100
Communication		
	Oral communication	100
	Written communication	100
	Oral presentation	50
	Listening	100
	Sensitivity	0
	Negotiation	0
Empathy		100
Adaptability		75

N=4

All respondents mentioned the competencies *social contact, empathy* and *collaboration,* the sub-competencies *network in organisation of client* of the competency *networking* and the sub-competencies *oral communication, written communication* and *listening* of the competency *communication.* This indicates the importance of these competencies and sub-competencies for engineers in the medical device market.
Three respondents indicated the relevance of the competency *adaptability* and therefore it can be concluded that this competency is important for engineers. Two and the same respondents mentioned the sub-competency *network in own organisation* of the competency *networking* and described the sub-competency *oral presentation* of the competency *communications.* This does not fully indicate the importance of these sub-competencies, but the percentages point out the importance of these sub-competencies. None of the respondents mentioned the sub-competencies *self-efficacy* of the competency *social contacts* and *sociability* of the competency *networking*. Therefore, it should be taken into consideration if these sub-competencies are relevant for engineers. Also, none of the respondents mentioned the sub-competencies *sensitivity* and *negotiation of* the competency *communication* and therefore the relevance of these sub-competencies should be taken into account.

The results of the within-case analysis for the social competencies are described in table 20 on the next page. These results will be used for the description of the percentages 100 and 75 and interesting elements, which will be described in the sub-paragraphs below the table.

Table 20: Within-case analysis description of social competencies within the medical device market

(Sub)-competency	*Respondent*)*			
	J	K	L	M
Social contacts	Being open, building trust, building relations, honesty, estimate others, contacts in project setting, open-minded	Rely on each other, building and maintaining trust	Building and sustaining contact, frequent contact, informal contact	Keeping client up-to-date
Self-efficacy**)				
Networking				
Network in own organisation**)	Reflect on relation, use network to solve problems, knowing the right people to achieve goals	Organise things within own organisation		
Network in organisation of client**)	Using network to figure out medical terms, evaluate relation, honesty and openness, attitude towards client is important, knowing right people	Working with others, maintain relation and contact	Use network to solve problems	Building and maintaining relations
Sociability**)				
Collaboration	Collaborate with engineers and clients, being open for suggestions, fine-tuning for efficiency and quality	Specifying together, working with Philips MS, using experiences, interact to find solutions, doing suggestions	Multi-disciplinary teams, interaction between both groups, knowing how to deal with people	Active participation, being a member of a team, give feedback and response, keeping client up-to-date
Communication				
Oral communication**)	Being a conversation partner, discussion, asking questions, checking if information is understood well	Asking questions, being to-the-point and clear, summarise, checking if it is well understood	Checking if the question is well understood, feedback, inquire, knowing effects formal communications	Asking critical questions, keep asking questions, feedback
Written communication**)	Document agreements	Planning in writing, being clear and understandable, brief and correct reports, specifications	Without language errors, good reports	Document results, choices and agreements, summarise
Oral presentation**)	Spread design within organisation, giving presentations to client and colleagues, selling, explaining, showing knowledge and understanding	Have general presentation skills		
Listening**)	Listen	Listen	Listen and showing this	Listen
Sensitivity**)				

(Sub)-competency	*Respondent*)*			
	J	K	L	M
Negotiation**)				
Empathy	Line of thought Philips MS, understanding others, empathise with patient and medical personnel	Understanding why is it a problem, empathise with reader	Culture differences, different expectations, empathise client for understanding important issues and reactions	Empathise environment and application product, needs of medical personnel
Adaptability	Being open for questions of colleagues, adjusting demands to capacities of own organisation	Deal with different people and different cultures	Adjusting work procedures and communication to each other, dealing with angry customers	
Other	Project leader knows when to include another member, not act as a wise guy, giving client feeling of good relation, apply human factor, do not be arrogant, client friendly, coaching other engineers, being commercial, other people will work with the machine, generating medical language, knowing when to delegate tasks, knowing economical impacts of choices, partner has more knowledge	Entrepreneurial attitude, willingness to work, aware of costs, owner of problem, wanting to renew and achieve best result, challenging, extrovert, having control over quality and costs, showing what Philips ETG can offer, interact fully	Service, covering whole product, willingness to work, showing enthusiasm, final customer is the hospital, patient should have a good experience, it is about human lives, perception is important in medical world, translating knowledge to another expertise area	Keeping promises, do not have any fear to ask questions, showing expertise, extrovert, interested attitude, being pro-active, cleaning of machine, wondering about issues, arouse interest, aware of costs, curious people are needed, interest in products, taking responsibility

N=4
*) J = manager Philips ETG / K, L, M = manager Philips MS
**) Sub-competency

6.1.1.1 Analysis content social competencies with a percentage of 100

The results, as described in table 20, will be analysed according to the description of the aspects of (sub)-competencies. All respondents mentioned the competencies *social contact, empathy* and *collaboration,* and the sub-competencies *network in organisation of client, oral communication, written communication* and *listening.*

Two respondents described that aspects of the competency *social contacts* indicated the need to build and maintain contact. Also, two respondents mentioned building trust and maintaining trust is mentioned by one respondent. Two respondents mentioned frequent contact with the client and keeping the client up-to-date. This last aspect indicates frequent contact with the client and therefore it can be concluded that the engineers have to maintain contact by frequently getting in touch with the client. The described aspects should be taken into consideration for the development of the specific competency model.
Aspects described for the sub-competency *network in organisation of client* of the competency *networking* have overlap with the competency social contacts. Two respondents mentioned maintaining the relation, one respondent described building a relation and one respondent pointed out

evaluating the relation. Two respondents indicated using the network to solve problems or to figure things out. Therefore, it can be concluded that these aspects are important for networking and have an overlap with the competency social contacts.

Four respondents indicated the aspects interaction, specifying together, fine-tuning, doing suggestions, giving feedback and response as important activities for *collaboration.* These aspects should be taken into account for the development of the specific competency model. Three respondents mentioned that engineers should work within multi-disciplinary teams and collaborate with the engineers of the client or work with Philips MS. These aspects indicate that the engineers should be able to work with different people and therefore, this aspect should be taken into account. Another respondent described keeping the client up-to-date as an element of collaboration. This element is also mentioned for social contacts, but is regarded as important for collaboration and therefore it should be taken into consideration for this competency.

The sub-competency *oral communication* of the competency *communication* is indicated by four respondents, which described several communication techniques. These techniques are: discussion, asking questions, summarising, giving feedback and checking if the question or problem is well understood. Therefore, it can be concluded that these techniques indicate a subdivision of the sub-competency. Other described aspects like clear and to-the-point communication, which refer to the quality of the communication and therefore should not be taken into account.

The respondents mentioned different elements of the sub-competency *written communication* of the competency *communication*. These elements are: document agreements, writing planning and specifications, document results and describing choices. These elements are topics of a report and therefore do not indicate a subdivision of this sub-competency. Other aspects refer to the quality of the reports, which is not important for this sub-competency.
All respondents described the aspect listening for the sub-competency *listening* of the competency *communication.* Therefore, it can be concluded that listening is important for engineers.
All respondents mentioned the competency *empathy*. They indicated different areas in which an engineer should empathise in, namely: the client, the patient, medical personnel, the reader and the environment. This indicates a subdivision of the competency and should be taken into consideration.

6.1.1.2 Analysis content social competencies with a percentage of 75 and interesting elements

Tree respondents indicated adaptability from which two respondents describe different aspects to which an engineer should *adapt* its behaviour. These aspects are: the demands, the work procedures and communication. One respondent indicated the ability to work with different people and cultures, which refers to changing its behaviour. These aspects refer to situations in which an engineer has to modify its behaviour and should be taken into account, because changing the behaviour is regarded as important for engineers.
The sub-competency *network in own organisation* of the competency *networking* is indicated by two respondents. One respondent mentioned the aspects reflecting on the relation, using network to solve problems and knowing the right people. The first two aspects are also mentioned for the sub-competency *network in organisation of client*, which indicates an overlap with aspects of this sub-competency.

One respondent indicated aspects of social competencies of the category other, which refer to managing a project. These aspects focus on tasks of a project leader, coaching another engineer and knowing when to delegate tasks. This should be taken into account for the formation of a competency, which indicates managing a project.
Three respondents indicated the aspect of being aware of the costs of economical impact of choices. This aspect relates to the design of the machines and effects of technical solutions. Therefore, it can be concluded that the aspects reflect functional competencies and this is not taken into account in the research. Last, two respondents indicated the aspects of the human factor. They indicated that perception and patient experience are important to take into account during the design of machine. The machines are also designed to help people or save lives. The human factor is related to understanding

where the machine will be allocated and who will work with the machine. For that reason, it reflects the ability to emphasise in different people and situations and this has an overlap with the competency *empathy*.

6.1.2 Analysis cognitive competencies

The data from the within-case analysis is defined in percentages to describe if cognitive competencies and sub-competencies were present in the interviews, as presented in table 21. The results will be described below the table.

Table 21: Cognitive (sub)-competencies mentioned in the interviews (%)

Competency	*Sub-competency*	*%*
Problem solving		
	Problem analysis	100
	Information analysis	0
	Anticipation	0
	Decision making	75
Using different kinds of knowledge and being flexible with that knowledge		
	Conceptual knowledge	75
	Contextual knowledge	100
	Procedural knowledge	75
Self-development		100
	Learning ability	75
Awareness		
	Self awareness	75
	Interpersonal sensitivity	75
	Aware of environment	75
	Sensitivity	50
Knowledge of others and himself		
	Knowledge of the client	100
	Knowledge of own organisation	50
	Self-knowledge	75

N=4

The sub-competencies *analysing problems, contextual knowledge* and *knowledge of the client* and the competency *self-development* are described by all respondents. This could indicate that these sub-competencies are important for engineers in the medical device market.
Decision making, conceptual knowledge, procedural knowledge, learning ability, self-awareness, interpersonal sensitivity and *aware of environment* are sub-competencies, which are described by three out of four respondents. This points out that these sub-competencies can be relevant for the work of an engineer. The sub-competencies *sensitivity* and *knowledge of the own organisation* are mentioned by half of the respondents, which indicate that the sub-competencies are not relevant for engineers.
Information analysis and *anticipation* are absent in the interviews and from this can be concluded that these sub-competencies are not relevant for engineers.

A further analysis of these results, according to the percentages 100 and 75, will be described in the following sub-paragraph. The within-case analysis is presented in table 22 on the next page.

Table 22: Within-case analysis description of cognitive competencies medical device market

(Sub)-competency	*Respondent*)*			
	J	K	L	M
Problem solving				
Problem analysis**)	Understand choice Philips MS, understand what is asked and why it is asked, translate concept to design, think of alternatives, challenge demands of client	Being broader then own area, analysing problems, knowing possibilities of solutions, use solutions, finding solutions	Understand choice Philips MS, thinking of solutions for practice	Knowing which effects influences the costs
Information analysis**)				
Anticipation**)				
Decision-making**)	Making choices, adapt and challenge yourself, argumentation choices, taking what is able or not able into account	Thinking about solutions		Thinking along about solutions, thinking along with client, being critical to Philips MS
Using different kinds of knowledge and being flexible with that knowledge				
Conceptual knowledge**)	Conceptual thinking	Conceptual thinking		Develop concepts
Contextual knowledge**)	Having knowledge of: sub-module, application machine and role of patient and doctor, insight in process hospital, taking small things into account	Understanding system demands, knowing what product does	Knowing product, system, model, context of product, end-user and requirements and expectation of client, understand how a doctor uses a system and deals with product, understanding medical world	Knowing things that are normal for Philips MS, understand place and condition modules, understanding were product is used, being up-to-date about integration of systems
Procedural knowledge**)		Having knowledge of: medical regulation, testing, test coverage and quality demands	Knowing safety regulations	Testing and documenting is the basis, kind of paint work that is used
Self-development	Wanting to generate knowledge, wanting to learn in conversations, developing through self-knowledge	Gathering knowledge by working closely together with Philips MS	Gathering knowledge by experiences in the market	Search for answers

(Sub)-competency	*Respondent*)*			
	J	K	L	M
Learning ability**)	Using Internet for specifications, critical reflection		Magazines, publications, find information behind desk	Gathering knowledge by: talking to key-account, Internet and reports
Awareness				
Self-awareness**)	Being aware of role towards other people, accept that other have better insight in subject matter		Being aware of that a person misses information, knowing position own person, showing what your good at	Showing what your good at
Interpersonal sensitivity**)	Estimate if client is open, knowing where activities end	Giving feedback, being interested, having understanding of each other, let people be as they are, knowing which knowledge is available in project and using this knowledge	Knowing that a client can react differently	
Aware of environment**)		Being able to deal with different cultures and nationalities	Cultural differences	Lots of investments in Philips MS, markets grows stable
Sensitivity**)	Being aware of own role		Understanding each others expectations	
Knowledge of others and himself				
Knowledge of the client**)	Having knowledge of sub-module, of setting of product, use of system and machine, knowing starting points of client	Knowledge of: machine, sub-module, interfaces, context and market Philips MS, product and what happens in projects. Understand way of thinking Philips MS, long term thinking	Knowledge of the: system, product, key-account, product creation process, expectations and client. Knowing what is going on at client, what weaknesses are of client	Knowing: business Philips MS, trends and work Philips MS, understanding infrastructure Philips MS, knowing what is going on at Philips MS, Philips MS deals with: pressure of costs and competition
Knowledge of own organisation**)	Knowing which machines can be made within Philips ETG, knowing where the boundaries are	Knowing what Philips ETG can and cannot do		
Self-knowledge**)		Knowing what your talking about, have everything straighten out	Knowing that you: are the right person, how you can come across, that you miss information, what weaknesses are	Knowing where you are and what weaknesses are

N=4
*) J = manager Philips ETG / K,L,M = manager Philips MS
**) Sub-competency

6.1.2.1 Analysis content cognitive competencies with a percentage of 100

The results, as described in table 22, will be analysed according to the description of the aspects of (sub)-competencies. All respondents mentioned the sub-competencies *analysing problems, contextual knowledge* and *knowledge of the client* and the competency *self-development.*

The described aspects of the sub-competency *analysing problems* of the competency *problem solving* are all examples of ways to analyse problems or aspects that can be used for problem analysis. This indicates that the sub-competency is complete and other aspects should not be included.
The respondents described *contextual knowledge,* which is a sub-competency of the competency *using different kinds of knowledge and being flexible with that knowledge,* as different types of knowledge like: knowledge of machines, products and requirements. This indicates that the engineer needs to have knowledge of the market where he operates in. Therefore, it can be concluded that this sub-competency can better be reflected by the sub-competency *knowledge of the client* of the competency *knowledge of others and himself*.
For *self-development* the respondents described different ways to gather knowledge, which provides the possibility to develop. Therefore, it can be concluded that this competency is important for engineers.
The sub-competency *knowledge of the client* of the competency *using different kinds of knowledge and being flexible with that knowledge* is described by respondents as different types of knowledge like: product creation process, market, product, interests of clients and the world of the client. Knowledge of the market is indicated by the respondents as knowledge of the business and the trends within the market. Interests of the clients are indicated by the respondents as understanding the starting point of Philips MS or understanding what is going on at Philips MS. This indicates that knowledge of the client has to be divided into different divisions to fit the results.

6.1.2.2 Analysis content cognitive competencies with a percentage of 75

The sub-competencies *decision making, conceptual knowledge, procedural knowledge, learning ability, self-awareness, interpersonal sensitivity* and *aware of environment* are described by three of the respondents.

Three respondents described various elements of the sub-competency *decision making* of the competency *problem solving,* which all focus on how to make decisions or find solutions. This indicates that this sub-competency is important for engineers in the medical device market.
The sub-competency *conceptual knowledge* of the competency *using different kinds of knowledge and being flexible with that knowledge* is described by two respondents as conceptual thinking and by one respondent as developing concepts. Further, no other elements are described and from this can be concluded that conceptual knowledge is not the best representation for this description. It indicates more a way of thinking and acting then a certain kind of knowledge that is needed.
Three respondents defined *procedural knowledge,* which is a sub-competency of *using different kinds of knowledge and being flexible with that knowledge,* as knowledge of different elements like: medical regulations, testing, safety rules. This indicates that procedural knowledge focuses on different types of knowledge that are needed to work effectively in the medical device market.
The aspects that three respondents described for the sub-competency *learning ability* of the competency *self-development* are all kinds of sources that can help engineers to develop. Therefore, it can be concluded that learning ability describes the sources that are of use for the development of an engineer.

The results of the sub-competencies *self-awareness, interpersonal sensitivity* and *aware of environment* of the competency *awareness* are all described by three, but not the same respondents. The results of *self-awareness* point out that an engineer should be aware of his own person during collaboration. Therefore, it can be concluded that this sub-competency is of use for engineers. Respondents described *interpersonal sensitivity* as having and using knowledge of others in work related situations. Thus, it can be concluded that this sub-competency describes the ability of engineers to work effectively with others. Aspects, described by two respondents of *aware of environment,* are

cultural differences whereas one respondent described financial aspects of Philips MS. Therefore this indicates the relevance of this sub-competency.
Last, *self-knowledge* of the competency *knowledge of others and himself* is described by the respondents as having knowledge about yourself. This has an overlap with the sub-competency self-awareness and therefore it is suggested to combine these two sub-competencies.

6.2 Development specific competency model

The analysis of the results of the four interviews with employees of Philips MS and Philips ETG is used for the development of a specific competency model. To develop this model the social and cognitive competencies of the competency research model, as described in chapter 3, will be adjusted according to the results of the interviews with the four respondents, starting with the social competencies. Last, a summary of the social and cognitive competencies of the specific competency model will be provided.

6.2.1 Social competencies

The social competencies within the competency research model and the developed specific competency model are presented in table 23. The transformation to the specific competency model is described below the table.

Table 23: Social (sub)-competencies of the competency research model and the specific competency model

Competency research model		**Specific competency model**	
Social competency	*Sub-competencies*	*Social competency*	*Sub-competencies*
Social contacts Networking	Self-efficacy Network in own organisation Network in organisation of client Sociability	Networking	Building contact Maintaining contact Evaluating contact Using contact
Collaboration		Collaboration	Dealing with different people Keeping stakeholders up to date
Communication	Oral communication Written communication Oral presentation Listening Sensitivity Negotiation	Communication	Using communication techniques*) Listening Written communication Oral Presentation
Empathy		Empathy	Empathise with patient Empathise with client Empathise with medical personnel
Adaptability		Flexible behaviour	Changing the behaviour according to the situation
		Project management	Manage people Taking responsibility

*) Discussion, asking questions, summarising, giving feedback and checking if the question or problem is well understood

In the specific competency model for the medical device market the competencies *networking* and *social contacts* are combined and formulated as *networking*. This was done, because an overlap in aspects could be derived from the results, which was caused by the fact that the respondents described relations and contacts as the same. The suggested sub-competencies that could be found within the results, for this competency are: building and maintaining contacts or relations, evaluating or

reflecting the relation, using the network to solve problems. It is concluded that contacts and relations and evaluating and reflecting are described as the same. Therefore, the formed sub-competencies of networking according to the results are *building a network, maintaining a network, evaluating a network* and *using the network.*

Collaboration is described by all respondents as relevant and therefore included in the model. However, two sub-competencies can be used to make the competency more specific. The respondents described that the engineers have to work with different people from which the sub-competency *dealing with different people* is formed. Also, the results indicated that during the work the engineer has to inform the client about the work. However, the engineers work with different people and this suggest that the engineer has to keep all people with whom they work up-to-date. Therefore, the sub-competency *keeping stakeholders up-to-date* is added to the model.

The competency *communication* is added to the model, because all respondents described multiple aspects of this competency. However, some changes are made in the sub-competencies to fit the results.
The results of *oral communication* indicated several activities and to fit this description the sub-competency *using communication techniques* is formed. The sub-competencies *listening* and *written communication* are also added to the specific competency model. The respondents described various aspects of *written communication*, which all explain how topics of a report have to be written.
The respondents described that an engineer has to explain and present knowledge in presentations. Although only two respondents described this, the sub-competency is included in the model based on the fact that it is regarded as important for engineers. Last, *negotiation* and *sensitivity* are removed from the model, because not one respondent described it as relevant for engineers in the medical device market.

The competency *empathy* is described by all respondents and therefore included in the model. The results indicate that an engineer has to empathise in the patient, in the client and in the various persons that work in a hospital and deal with the devices that are produced. Therefore, three sub-competencies are formed: *empathise in patient, empathise in client* and *empathise in medical personnel*.

The results of the competency *adaptability* indicate the fact that an engineer has to change ones behaviour and attitude to the circumstances and situations. However, the results indicated not only that the behaviour has to be changed, but also that the engineer should be open to all kinds of different situations. The competency *flexible behaviour* reflects the results better, because this describes more that an engineer has to be flexible in his behaviour all the time and not only in certain situations. To fit this new description the sub-competency is defined as *changing the behaviour according to the situation*, which describes the aspects as stated above.

The competency *project management* is added to the model to indicate the ability to manage a project and to take responsibility, as described in the category other of the analysis framework. These aspects are also described as sub-competencies.

6.2.2 Cognitive competencies

The cognitive competencies within the competency research model and the developed specific competency model are presented in table 24 on the next page. This table shows the transformation of the specific competency model according to the four interviews, which will be described on the next page.

Table 24: Cognitive (sub)-competencies of the competency research model and the specific competency model

Competency research model		Specific competency model	
Cognitive competency	*Sub-competencies*	*Cognitive competency*	*Sub-competencies*
Problem solving	Problem analysis Information analysis Anticipation Decision-making	Problem solving	Problem analysis Decision making
Using different kinds of knowledge and being flexible with that knowledge	Conceptual Contextual Procedural	Conceptual thinking	-
Self-development Awareness	Learning ability Self awareness Interpersonal sensitivity Aware of environment Sensitivity	Self-development Awareness	Using sources to develop*) Self-awareness Awareness of environment Interpersonal sensitivity
Knowledge of others and himself	Knowledge of the client Knowledge of own organisation Self-knowledge	Knowledge of the own organisation	Knowledge of the: - Competencies and capabilities - Interest
		Knowledge of the client	Knowledge of the: - Culture - Product and process - Interest - Internal process - Infrastructure - Vision
		Knowledge of the medical market	Knowledge of the: - Medical norms - Medical regulations - Safety rules - Testing and registrations

*) E.g. Internet, courses and colleagues

The competency *problem solving* is included in the model based on the results. However, not all sub-competencies are described by the respondents. *Problem analysis* and *decision-making* are included in the model whereas *anticipation* and *information analysis* are removed. The results described different aspects of how a problem can be analysed and therefore this sub-competency *problem analysis* is included. The results of decision-making are focused on how to make decisions or find solutions, which indicates the importance of this sub-competency. Anticipation and information analysis are not described by the respondents and therefore removed from the model.

The sub-competencies *contextual knowledge* and *procedural knowledge* are removed from the model. This is done because contextual knowledge reflects different aspects of the sub-competency knowledge of the client and procedural knowledge indicates knowledge of the medical market. These aspects are taken into account in the description of these competencies.
Conceptual knowledge is indicated as a way of thinking and therefore, this sub-competency is indicated as *conceptual thinking*. Also, the results indicate that the sub-competency does not describe other aspects. Therefore, the competency *using different kinds of knowledge and being flexible with that knowledge* is removed from the model and conceptual thinking is described as a separate competency.

Self-development is included in the model because all respondents mentioned the competency. However, the sub-competency *learning ability* is replaced by the sub-competency *using sources to develop*. This is done, because the respondents described different sources to develop when indicating the ability to learn.
Based on the interviews of four respondents the competency *awareness* is included in the model. However, not all sub-competencies, as described in the competency research model, are taken into account in the specific competency model. The results of *self-awareness, interpersonal sensitivity* and *aware of environm*ent fit with the definitions of the sub-competencies, as described in chapter 3. However, *sensitivity* is removed from the model, because not one respondent described the sub-competency.

Knowledge of others and himself is removed from the model, because the sub-competency *self-knowledge* is removed. *Self-knowledge* is removed from the model, because the results indicate that self-awareness is similar to self-knowledge.
The sub-competency *knowledge of the medical market* is added and sub-competencies *knowledge of the client* and *knowledge of the own organisation* are included in the model. However, for all sub-competencies the respondents indicate subdivisions. Therefore, the sub-competencies knowledge of the client, own organisation and medical market are included in the model as separate competencies. Respondents described the following sub-divisions for knowledge of the client: internal process, product, interests client, competencies and capabilities and world of client. World of the client is indicated as the culture, the vision and the infrastructure of the client. These different aspects are described as sub-competencies of knowledge of the client.
Last, different aspects of the medical device market are described for the sub-competency *procedural knowledge*. Therefore, the competency *knowledge of the medical market* is included with some sub-competencies. *Knowledge of medical norms, medical regulations, safety rules* and *testing and registrations* are defined as separate sub-competencies of this competency.

6.2.3 Summary

The social and cognitive (sub)-competencies of the specific competency model are summarised in table 25 to present all competencies for an engineer in the semiconductor market.

Table 25: Competencies of specific competency model

Specific competency model	
Social competencies	*Cognitive competencies*
Networking	Problem solving
Collaboration	Conceptual thinking
Communication	Self-development
Empathy	Awareness
Flexible behaviour	Knowledge of the client
Project management	Knowledge of the own organisation
	Knowledge of the medical market

6.3 Results education

In total, three staff members of the University of Twente were interviewed. Two staff members are involved in the study Technical Medicine and one in the study Biomedical Engineering. Data from the interviews are analysed according to the analysis framework, which is included in appendix 17. The results are compared with the specific competency model.

For the social competencies the following conclusions can be drawn from the results. One respondent indicated that students should use their network to achieve different goals. All the respondents indicated that students should work in multi-disciplinary teams and collaborate with different people. For the competency *communication* the aspects asking questions and discussing are mentioned by two respondents. Two respondents described the competency *empathy* and mentioned the aspects patient

perception and understanding that the client does not have the same technical background. Last, two respondents indicated that the engineers should adapt to the communication of the reader. The student should acquire these aspects during education to use in their future jobs. Both studies educate students to become an engineer in a medical organisation. Therefore, it can be concluded that the same competencies are necessary and that results confirmed the social competencies *networking, collaboration, communication, empathy* and *flexible behaviour*.

For the cognitive competencies, the respondents indicated that engineers should make choices, analyse the problem and solve problem. These aspects indicate the importance of the competency *problem solving.* Two respondents mentioned aspects that relate to the medical device market. Engineers should have some knowledge of the medical terms, understand the environment in which the machine will be situated and understand that it takes some time to put the product on the market. These issues relate to the competency *knowledge of the medical device market.* All the respondents mentioned aspects related to *self-development*. Students should reflect on collaboration and figure out which talents could be developed further. These aspects indicate the competency self-development.
As mentioned before, the students should acquire these competencies during their study and put these into practice in future jobs. Therefore, the respondents confirmed the competencies *problem solving, knowledge of the medical device market* and *self-development.* However, it should be taken into account that the results focus on the situation in which an engineer works directly for hospitals or medical device manufacturers. This is not the focus of the research and therefore further conclusions cannot be drawn from this.

6.4 Results refinement

For the refinement of the specific competency model a document analysis and an interview were conducted. One engineer of Philips MS was interviewed to refine the specific competency model and different documents were analysed. Results from the document analysis will be presented first, followed by the results of the interview.

6.4.1 Document analysis

Documents of the studies Technical Medicine and Biomedical Engineering were analysed to check the model. These documents were a self-evaluation report of Biomechanical Engineering (Biomedical Engineering, 2005) and a master's programme application of Technical Medicine (Technical Medicine, 2005). The self-evaluation report (Biomedical Engineering, 2005) confirmed the competencies *collaboration, conceptual thinking* and *self-development* and the sub-competencies *using communication techniques, written communication, problem analysis* and *self- analysis.* The application masters programme (Technical Medicine, 2005) confirmed the competencies *collaboration, flexible behaviour* and *self-development* and the sub-competencies *using communication techniques, taking responsibility, problem analysis* and *self-analysis.* The analysed documents of both studies did not disclose any other relevant social or cognitive competencies it only confirmed the above described social and cognitive competencies of the specific model for the medical device market.

6.4.2 Analysis social competencies

The results of the social (sub)-competencies are described according to correctness of these (sub)-competencies indicated by the respondents are presented in table 26 on the next page. Sub-competencies or competencies that the respondent mentioned as not correct are described below the table.

Table 26: Correctness social competencies derived from the interview

Competency	*Correct*	*Not correct sub-competencies*
Networking	Yes	
Collaboration	No	Using different teamwork methods
		Sharing knowledge
Communication	No	Persuasiveness
		Interpreting signals
Flexible behaviour	Yes	
Empathy	Yes	
Project management	No	Motivate people
		Set out project steps
		Planning and organising
		Delegation
		Creating commitment

The respondent regarded the sub-competencies *using different teamwork methods* and *sharing knowledge* for the competency *collaboration* as important. Teamwork methods are necessary to collaborate right and sharing knowledge has to be included because team members have to share knowledge about the medical device market to operate effectively. The methods that are used by engineers for collaboration are reviewing and brainstorming, which have to be included as sub-competencies.
Communication is extended with the sub-competencies *persuasiveness* and *interpreting signals*. Based on the results, these sub-competencies are regarded as important elements of communication especially for having discussions with other people where signals have to be picked up to communicate well.
Based on the results, *project management* can be enlarged with the sub-competencies *motivate people, set out project steps, planning and organising, delegation and creating commitment,* because the respondent described these as important for project-management.
The results did not reveal any other social competencies that were not included in the specific competency model.

6.4.3 Analysis cognitive competencies

The results of the cognitive (sub)-competencies are described according to correctness of these (sub)-competencies indicated by the respondents are presented table 27. Sub-competencies or competencies that the respondent mentioned as not correct are described below the table.

Table 27: Correctness cognitive competencies derived from the interview

Competency	*Correct*	*Not correct sub-competencies*
Problem solving	No	Anticipation
Conceptual thinking	No	Coming up with different directions and solutions
		Thinking outside the usual domain
Awareness	Yes	
Self-development	No	
Knowledge of the own organisation	No	Knowledge of the culture
		Knowledge of the internal process
		Knowledge of the vision
Knowledge of the client	No	Knowledge of the decision making process
		Knowledge of the infrastructure
		Knowledge of the process
		Knowledge of the culture
		Knowledge of the vision
Knowledge of the medical market	No	Knowledge of medical regulations

The respondent indicated that *anticipation* of the competency *problem solving* can be relevant for engineers who work in the medical device market. However, it is more a preference then a requirement, which indicates that this competency could be important in some situations.
Conceptual thinking can be extended with the sub-competencies *coming up with different directions and solutions* and *thinking outside the usual domain* according to the respondent. This is needed because the respondent described that it is important for an engineer to think of different solutions for a problem and because engineers need to view a problem from different perspectives to do the work effectively.
For the competency *self-development* the respondent described that the sub-competency *reflection* can be of use for an engineer. This describes the ability to evaluate not only ones own behaviour, but also evaluate the cooperation between team members and the client.
The respondent indicated that the aspects knowledge of the culture, of the internal process and of the vision can be added to the sub-competency *knowledge of own organisation* to make the competency complete.

Knowledge of the client can be extended with *knowledge of the decision making process*, because it is important to know where decisions are made, according to the respondent. Also, the respondent indicated *knowledge of the infrastructure* as not very important. The vision of the client is not important, only the *vision of the project* where the engineer works on is important. The respondent described that the process is mentioned twice in the model: once to reflect the product creation process and once to reflect the bureaucratic process. Last, *knowledge of the culture* is considered as important by the respondent.
Within the competency *knowledge of the medical market* the sub-competency *knowledge of medical regulations* can be obliterated from the model according to the respondent. The respondent indicated that the sub-competency *knowledge of medical norms* covers these regulations.
The results did not reveal any other cognitive competencies that were not included in the specific competency model.

6.4.4 Final specific competency model

The results that are described in the analysis of social and cognitive competencies of the refinement are not all taken into account for the refinement of the specific competency model. All aspects for the social competencies are considered to provide a better overview of the competencies that engineers needs to possess. Although only one respondent was interviewed it is concluded that these aspects reflect the work of an engineer well and therefore are included in the model.
However, the recommendations of the respondent for the cognitive competencies are not all taken into account. *Anticipation* is included, because the respondent described that it is preferable to anticipate. Also, the competencies *conceptual thinking* and *self-development* are taken into account. The sub-competency *reflection* is included in the model, because it is regarded as an important aspect of self-development.

However, the recommendation about the *knowledge of the decision making process* for the competency *knowledge of the client* is not taken into account, because this element is covered by the sub-competency *internal process.* The sub-competency knowledge of the product and process, will be altered in *knowledge of the product* for the competency *knowledge of the client* based on the fact that it is mentioned twice in the model. Other sub-competencies are included in the model according to the results.

Knowledge of the infrastructure will be removed from the model, because it is covered by the sub-competency *knowledge of the internal process*. The sub-competency *knowledge of the vision of the project* is included in the model to reflect the fact that engineers have to be aware of it.
Last, within the competency *knowledge of the medical market* the sub-competency *knowledge of medical regulations* is obliterated from the model. The results indicate that the sub-competency *knowledge of medical norms* covers these regulations. The final version of the specific competency model is presented in table 28 on the next page.

Table 28: Final version specific competency model medical device market

Specific competency model medical device market			
Social competencies		*Cognitive competencies*	
Competencies	Sub-competencies	Competencies	Sub-competencies
Networking	Building contact Maintaining contact Evaluating contact Using contact	Problem solving	Problem analysis Decision making Anticipation
Collaboration	Dealing with different people Keeping stakeholders up to date Using different teamwork methods*) Sharing knowledge	Conceptual thinking	
Communication	Using communication methods**) Listening Written communication Oral communication Oral presentation Persuasiveness Interpretation of signals	Self-development	Using sources to develop***) Reflection
Empathy	Empathise with patient Empathise with client Empathise with medical personnel	Awareness	Self-awareness Awareness of environment Interpersonal sensitivity
Flexible behaviour	Changing the behaviour according to the situation	Knowledge of the own organisation	Knowledge of the: - Culture - Internal process - Interest - Vision - Competencies and capabilities
Project management	Manage people Motivate people Taking responsibility Set out project steps Planning and organising Delegation Creating commitment	Knowledge of the client	Knowledge of the: - Culture - Product - Interest - Internal process - Competitors - Vision of the project
		Knowledge of the medical market	Knowledge of the: - Medical regulations - Safety rules - Testing and registrations

*) Brainstorming and reviewing
**) Discussion, asking questions, summarising, giving feedback and checking if the question or problem is well understood
***) E.g. Internet, courses and colleagues

6.5 Conclusion

An analysis of the results of the research activities specifying competency research model, education and refinement of the specific competency model resulted in the final version of the specific competency model for the medical device market. The developed competency model (table 28) includes the required social an cognitive competencies for engineers within the medical device market and it therefore answers the sub-research question: '*Which social and cognitive competencies do the engineers need to possess to operate in the medical device market?'*.

The results of the research activity specifying competency research model indicated the modification of the competency research model in which the model is made specific for the medical device market. Results of the research activities education and refinement confirmed modified social and cognitive (sub)-competencies of the specific competency model. Also, it provided adjustments to the model.

The final version of the specific competency model includes the following social competencies: networking, collaboration, communication, empathy, flexible behaviour and project management. The included cognitive competencies are: problem solving, conceptual thinking, self-development, awareness, knowledge of the own organisation, knowledge of the client and knowledge of the medical device market. These competencies and the sub-competencies are included in table 28.

In the following chapter, a cross-case analysis will be presented to evaluate the differences and similarities between the needed social and cognitive competencies of the semiconductor market and the medical device market. The developed final versions of the specific competency models of both markets will be used for the analysis.

7. Cross-case analysis

In this chapter, a cross-case analysis is carried out to analyse the specific competency models of the semiconductor market and medical device market, as presented in chapter 5 and 6. This provides an answer to the research question '*Which social and cognitive competencies do the engineers of Philips ETG need to possess to operate in the semiconductor market and medical device market?'*.
The results of the cross-case analysis will be presented, which will result in the final competency model and after that the differences in competencies in the semiconductor and medical device market will be discussed. Last, in the conclusion an answer will be given to the research question.

7.1 Cross-case-analysis

In the previous chapters, the competency research model is specified and refined for the semiconductor market and medical device market. In this paragraph, a cross-case analysis is done to compare data of the semiconductor market with the data of the medical device market. This analysis is done to find patters and to describe the differences and similarities between the two specific competency models. The differences in these two specific competency models are analysed, starting with the social competencies, and a conclusion is drawn.

7.1.1 Analysis differences social competencies

The differences of the social competencies in the specific competency models are presented in table 29. The column in the middle describes (sub)-competencies that are present or absent in the semiconductor market and this is represented for the medical device market in the right column.

Table 29: Differences within social competencies of the semiconductor and medical device market

(Sub)-competency	*Semiconductor market*	*Medical device market*
Collaboration		
	Keeping all *people* involved up-to-date	Keeping all *stakeholders* involved up to date
	Using different teamwork methods (e.g. reviewing, brainstorming and *normal meetings*)	Using different teamwork methods (e.g. reviewing, brainstorming)
Communication	-	Oral presentation
Empathy	-	Empathy with patient, client and medical personnel

For the competency *collaboration* two differences can be found in the sub-competencies. In the semiconductor market the engineers should *keep all people up-to-date* whereas in the medical market *all stakeholders should be kept up-to-date*. However, in the refinement phase of the semiconductor market the respondents described that the word stakeholders does not necessarily imply all people. Using the sub-competency *keeping all people involved up-to-date* prevents this difference.
The second difference concerns the methods of the sub-competency *using different teamwork methods*. The methods reviewing, brainstorming and normal meetings can be used for *collaboration* in both markets. However, the use of the method normal meetings is described for the sub-competency *using different teamwork methods* in the semiconductor market. This is also applicable for the medical device market and therefore can be included in the final competency model.

The respondents of the medical device market described the sub-competency *oral presentation* as important, because it is a method that can be used to keep all people involved up-to-date. In line with this argumentation and the observed fact that engineers use this method, it is justified to conclude that this sub-competency is of use for both markets.
Last, the sub-competencies *empathy with patient, client and medical personnel* are described for the medical market. These sub-competencies are not needed for the semiconductor market, because of the

type of devices that are produced within this market. *Empathy* could be important for an engineer in the semiconductor market, but this competency is already covered in the cognitive competency *awareness*. Therefore, the competency *empathy* is unique for the medical device market and it can be concluded that this competency should not be taken into account for the semiconductor market.

7.1.2 Analysis differences cognitive competencies

Cognitive competencies differ in the two specific competency models, as presented in table 30. The column in the middle describes competencies that are present or absent in the semiconductor market and in the right column this is presented for medical device market.

Table 30: Differences within cognitive competencies of the semiconductor and medical device market

Competencies	Semiconductor market	Medical device market
Self-development	Self-analysis	-
Awareness	-	Aware of environment
	Sensitivity	-
Knowledge of the own organisation	Vision, mission and values	Vision of a project
Knowledge of the client	Market and competitors	Competitors
	Vision of a project	-
Knowledge of the medical market	-	Knowledge of medical norms
	-	Knowledge of safety rules
	-	Knowledge of testing and registration

The sub-competencies *self-analysis* is not described for the competency *self-development* in the medical device market. However, self-analysis can be of importance in both markets and not only for the semiconductor market, because it is important for an engineer to analyse himself in order to develop. Therefore, this sub-competency can be included in the model for the medical device market.

The sub-competency *aware of environment* of the competency *awareness* describes the importance of being informed about social, political and economical developments. These elements are described for the medical device market, because of characteristics of the products that are produced. However, economic elements are also very important for the semiconductor market and therefore the sub-competency is also relevant for the semiconductor market.
The sub-competency *sensitivity* of the competency *awareness* is described for the semiconductor market only. However, the results of this sub-competency indicate similar aspects of *interpersonal sensitivity* in the medical device market. It can be concluded that these aspects reflects the sub-competency *interpersonal sensitivity* better and that the sub-competency *sensitivity* should be removed from the model.

For engineers of Philips ETG the own organisation does not change in case they work on projects for the semiconductor market or the medical device market. Therefore, it is concluded that the sub-competency *knowledge of the vision of a project, mission and values* of the competency *knowledge of the own organisation* is of importance for both markets.

The difference for the competency *knowledge of the client* is that within the semiconductor market the *knowledge of the market and competitors* it is important whereas respondents of the medical device market only described competitors as relevant. The market is described within the medical device market as *knowledge of the medical market* and therefore knowledge of the market should be included for the semiconductor market. *Knowledge of competitors* should be described for both markets.
The sub-competency *knowledge of vision of the client* is important for the medical device market. The vision of the client, especially the vision in projects, is important for both markets and not only for the

medical device market. Therefore, it is relevant for an engineer to understand the vision of the client before starting a project with the client.
Knowledge of the medical market is unimportant for engineers who work on projects within the semiconductor market. Thus, this competency should only be taken into account for the medical device market.

7.1.3 Conclusion

According to the conclusions that are made in the previous sub-paragraphs, it can be concluded that the two specific competency models have an overlap in most social and cognitive competencies. However, there are some differences that have to be taken into account when combining the specific competency models. These differences are the social competency *empathy* and the cognitive competency *knowledge of the medical market* for the medical device market and the cognitive sub-competency *knowledge of the market* of the competency *knowledge of the client* of the semiconductor market. Thus, the specific competency models can be combined to a certain extent in the final competency model for both markets, which is described in the next paragraph.

7.2 Final competency model

In the previous paragraph, the similarities and especially the differences of both specific competency models were discussed and conclusions were drawn. It is concluded that both specific competency models can be combined to a certain extent in a final competency model, which is presented in table 31 on the next page.
All competencies are described for both markets with the exception of the social competency *empathy* and cognitive competency *knowledge of the medical market*, which are only applicable for the medical device market. Also, the sub-competency *market of the client* of the cognitive competency *knowledge of the client* is not used for both markets, because it is only applicable for the semiconductor market.

Table 31: Final competency model

Final competency model			
Social competencies		*Cognitive competencies*	
Competency	*Sub-competency*	*Competency*	*Sub-competency*
Networking:	Building contact Maintaining contact Evaluating contact Using contacts	*Problem solving:*	Problem analysis Anticipation Decision making
Collaboration:	Dealing with different people Using different teamwork methods *) Keeping all people involved up-to-date Sharing knowledge	*Conceptual thinking:*	Coming up with different directions of solutions Thinking outside the usual domain
Communication:	Using communication methods **) Listening Persuasiveness Interpretation of signals Written communication Oral Presentation	*Self-development:*	Reflection Self-analysis Using sources to develop****)
Flexible behaviour:	Changing the behaviour style according to the situation	*Awareness:*	Self-awareness Interpersonal sensitivity Awareness of the environment
Project management:	Motivate people Manage people Set out project steps Planning and organising Delegation Creating commitment Taking responsibility	*Knowledge of the own organisation:*	Knowledge of the: • Culture • Internal process • Interest • Vision, mission and values • Competencies and capabilities
Empathy)***	Empathise with patient Empathise with client Empathise with medical personnel	*Knowledge of the client:*	Knowledge of the: • Culture • Internal process • Interest • Vision of the project • Product • Competitors • Market of the client*****)
		Knowledge of the medical device market)***	Knowledge of the: • Medical norms • Safety rules • Testing and registration

*) Brainstorming, reviewing and normal meetings in teamwork
**) Discussion, asking questions, explaining, doing proposes, naming the problem, checking if problem is understood, summarising and giving feedback
***) Applicable for medical device market
****) E.g. internet, courses and colleagues
*****) Applicable for semiconductor market

7.2.1 Differences semiconductor and medical device market

In chapter 5 and 6 the final versions of the specific competency models of both markets are presented, which are combined in the final competency model, as presented in table 31.
According to the conclusions that are made in the previous sub-paragraphs, it can be concluded that the two specific competency models have an overlap in most social and cognitive competencies.
However, the difference in competencies between an engineer who works in the medical device market and an engineer who works in the semiconductor market are the social competency *empathy* and the cognitive competencies *knowledge of the medical market* and *knowledge of the market of the client*. The first two describe competencies that are needed in the medical device market and the last competency is only applicable for the semiconductor market. It can be concluded that the differences between both markets is caused by the difference in end-user and the specific characteristics of the medical device market. In the medical device market the end-user is the patient or the medical personnel whereas the end-user in the semiconductor is an engineer. Therefore, the engineers of Philips ETG have to obtain knowledge about the medical device market and have to be able to empathise in the patient and in medical personnel. Typical characteristics of the medical device market are medical norms, safety rules and testing and registration. Therefore, an engineer has to possess knowledge about these characteristics when working in the medical device market.

In the following paragraph, the competencies and sub-competencies of the final competency model are defined according to literature.

7.3 Defining the competencies of the final competency model

The competencies and sub-competencies, as described in table 31, are of use for engineers in both markets with the exception of some competencies. The definitions of these competencies differ to some extent from the competency research model, which is caused by the results indicating other competencies and sub-competencies then described in chapter 3. The definitions of these competencies will be described in the next sub-paragraph, starting with the social competencies. Also, appendix 18 provides an overview of the final competency model with all definitions.

7.3.1 Social competencies defined

Networking is defined in chapter 3 as the skill to construct a network, which is useful to achieve objectives (Schakel & Smid, 2005). However, the sub-competencies indicate more aspects then only to construct a network. Therefore, the competency is expanded and defined as developing, maintaining and using relations inside and outside the own organisation which are useful in achieving objectives (Schakel & Smid, 2005; Floor, 2006). The definitions of the sub-competencies are based on this definition and the research, which are described as:

- Building contact: to make contact and form relations with important persons for the work or function (Floor, 2006);
- Maintaining contact: to maintain contact with important persons for the work or function and to take advantage of the contact for own goals (Floor, 2006) and to have informal contacts with important people for the work or function;
- Evaluating contact: to be able to evaluate a relationship and to decide if it is valuable for now or in the future;
- Using contacts: to find the right persons for support or cooperation to reach the goal (Floor, 2006).

In chapter 3, the competency *collaboration* is captured by the ability to work with other people within the work setting. It is about achieving a common target of solving a problem together. To state this more clearly the competency is defined as contributing effectively to a joint result or solution to a problem (Schakel & Smid, 2005), which represent the description in chapter 3.

The definition of the sub-competencies are based on this definition and described as:

- Dealing with different people: to be able to make teamwork effective by being able to work with different people;
- Using different teamwork methods: to be able to use the methods brainstorming, reviewing and normal meetings in teamwork;
- Keeping all people involved up-to-date: to keep everybody within a team, or persons that have helped, up-to-date about the progress (Floor, 2006);
- Sharing knowledge: to be able to transfer the knowledge that is needed for the work to all persons in the team and to make sure that this information helps people to learn form each other.

In chapter 3, the competency *communication* was not defined, because of the various sub-competencies. However, based on the sub-competencies in the final competency model the competency is defined as the process of exchanging information and the reacting according to that information. The sub-competencies listening, oral presentation and written communication are defined the same as in chapter 3 and therefore not described. However, communication is expanded with other sub-competencies, which are defined according to the competency:

- Using communication methods: to be able to use the communication methods discussion, asking questions, naming the problem, checking if problem is understood and giving feedback well;
- Persuasiveness: attempting to persuade others to adopt a certain standpoint and trying to come to agreement by making use of appropriate arguments and methods (Schakel & Smid, 2005);
- Interpretation of signals: being able to read the body language of another person and react to it effectively.

Flexible behaviour and *project management* are not described in chapter 3 and therefore definitions of these competencies and their sub-competencies are formulated according to new retrieved literature, which fit the results of the research.
Flexible behaviour is a competency, which can be defined as modifying one's behaviour to reach a set goal when problems or opportunities arise (Schakel & Smid, 2005; Floor, 2006). For this competency the sub-competency *changing the behaviour style according to the situation* was retrieved from the results. The definition of this sub-competency is based on the definition of the competency. It is defined as to be able to change own behaviour in case of opportunities or problems. *Project management* is described as proper management of a project or a part of a project to achieve a collective result. The sub-competencies of these competencies are defined as following:

- Motivate people: to stimulate people to take action and to be involved to reach a certain result (Floor, 2006);
- Manage people: to involve the right people in the team and for the work;
- Set out project steps: to describe the different steps within the project;
- Planning and organising: determining goals and priorities effectively and stipulating the time, activities and resources required to achieve the set goals (Schakel & Smid, 2005);
- Delegation: assessing one's own responsibilities and authority to the appropriate employees in an ambiguous manner, making effective use of employees' time and skills (Schakel & Smid, 2005);
- Creating commitment: bringing the persons' own behaviour in line with that of the team and the project;
- Taking responsibility: to take responsibility for own tasks and for tasks of the team.

The competency e*mpathy* is defined in chapter 3 as transferring in the perception of others (BJU, 2006). The results of the research indicate that an engineers needs to empathise in three aspects, namely: the patient, the client and the medical personnel. For all three sub-competencies the definition is the same as for the competency, only others is defined as the patient, client or medical personnel.

7.3.2 Cognitive competencies defined

The competency *problem solving* and the sub-competencies *problem analysis*, *anticipation* and *decision-making* are defined the same as in chapter 3 and therefore not described in this sub-paragraph.

Conceptual knowledge is defined in chapter 3 as the building of thinking frameworks or models, the formulation of multiple concepts and hypothesis or ideas on the base of complex information (Floor (2006). However, the competency is defined research as conceptual thinking, which indicates the same description as conceptual knowledge.
The research indicated two sub-competencies, which are defined according to this definition:

- Coming up with different directions of solutions: to be able to think of different solutions for the problem;
- Thinking outside the usual domain: to be able to see a problem from different viewpoints.

The competency *self-development* is described the same as in chapter 3, namely: possessing insight into one's strengths and weaknesses, and on this basis, initiates activities to increase/enhance one's knowledge, skills and competencies in order to perform more effectively (Schakel & Smid, 2005). However, the sub-competencies that are retrieved according to the results have to be defined, which is done according to new retrieved literature and according to results of the research:

- Reflection: a process of reviewing an experience of practice in order to describe, analyse, evaluate and so inform learning about practice (Reid, 1993);
- Self-analysis: to be able to analyse the own strengths and weaknesses and to search for personal feedback (Floor, 2006);
- Using sources to develop: to be able to use different sources to develop (e.g. Internet, courses, and colleagues).

The competency *awareness* and the sub-competencies *self-awareness*, *interpersonal sensitivity* and *aware of environment* are described in chapter 3 and these definitions are used in the final competency model.

Knowledge of the client and *knowledge of the own organisation* are defined similar as in chapter 3 although the client or own organisation is indicated in the definition. The competencies are described as the possession of information of the client or Philips ETG and the ability to use that information.
The sub-competencies of the competencies that are described in the final competency model have overlap. Both competencies define knowledge of the culture, internal processes and interest, which are defined as:

- Knowledge of the culture: to know what elements play a role in the culture;
- Knowledge of the internal process: to be able to understand and recognise the internal processes;
- Knowledge of the interest: to be able to understand and recognise the interest of the organisation.

The competency *knowledge of the organisation* also indicates the following sub-competencies:

- Knowledge of the competencies and capabilities: to be able to understand which competencies and capabilities the organisation has and to use this information in the work;
- Knowledge of the vision, mission and values: to be able to understand the vision, mission and values and use these within the work.

The other sub-competencies of the competency *knowledge of the client* are:

- Knowledge of the vision of a project: to be able to understand and recognise the vision of a project;
- Knowledge of the product: to be able to understand the product;
- Knowledge of competitors: to be able to find out what the competitors are and to use this knowledge in different situations.

Last, the sub-competency *knowledge of the market of the client* of the competency *knowledge of the client* is only applicable for the semiconductor market because this aspect is described for the medical

device market as *knowledge of the medical market*. The definition of the sub-competency *knowledge of the market of the client* is the possession of information about the market of the client and the ability to use that information.

The competency knowledge of the medical market is not described in chapter 3, because this competency was selected based on the results. The definition of this competency is defined the same as that of the *knowledge of the client* and *knowledge of the organisation*, namely: the possession of information of the medical device market and the ability to use that information. In the results three sub-competencies are described, which can be defined as the following:

- Knowledge of medical norms: to be able to understand the medical norms (e.g. UL, IEC, CSA and MRI);
- Knowledge of safety rules: to be able to understand and use the safety rules;
- Knowledge of testing and registration: to be able to understand what the testing and registration is all about and to use is effectively.

7.4 Conclusion

The specific competency models of the semiconductor and medical device market of chapter 5 and 6 are combined to some extent in the final competency model, as presented in table 31. The specific competency models already provided answers to the research sub-questions and this final competency model provides an answer to the research question '*Which social and cognitive competencies do the engineers of Philips ETG need to possess to operate in the semiconductor market and medical device market?'*.

The competencies that an engineer needs to possess for the semiconductor market are somewhat different from the competencies in the medical device market. The competencies *empathy* and *knowledge of the medical market* are only defined for the medical device market, because they are only applicable in this market. The sub-competency *knowledge of the market of the client* of the competency *knowledge of the client* is only defined for the semiconductor market. This represents the specific market, which is described for the medical device market as the competency *knowledge of the medical market*.

From this difference can be concluded that the social and cognitive competencies of engineers differ, because of specific characteristics of the medical device market. These characteristics demand that the engineer should have knowledge of medical norms, safety rules and testing and registration and should apply this into the design of a project. Also, the engineer should be able to empathise in the context of the product and in the fact that the product is used for patients and not for other engineers, which is the case in the semiconductor market. The other social and cognitive competencies do not differ from market to market and therefore, these are regarded as similar.

The competencies and sub-competencies of the engineers have to be developed to work effectively in both markets. However, before this can be done it should be made explicit how Philips ETG can assess these competencies. Without the assessment of competencies Philips ETG does not know the (sub)-competencies that have to be developed by individual engineers. Therefore, the assessment and the management of these competencies are described in the following chapter and recommendations are presented. When this is made explicit, chapter 9 will provide insight in how individual engineers can develop the social and cognitive competencies for the semiconductor and medical device market.
After these chapters, conclusions of the research will be described and recommendations are presented in chapter 10. Last, some aspects of the research are discussed in chapter 11.

8. Competency management and assessment

The competency model presented in the previous chapter can be used for organisational purposes, for instance for competency management or assessment. Within this chapter recommendations for such an application is provided for Philips ETG.

8.1 Competency management

The specific competency model for the semiconductor market and the medical device market can be used for the management of competencies. Competency management is defined as a set of activities which focuses on acquiring needed competencies and the optimal use and development of available competencies to reach organisational targets and allow high performance of employees (Beirendonck, 1998, p. 124). Competency management can be used in the present to become active in the medical device market.

The first step of competency management is to determine which competencies are necessary for a strategy or organisational target (Sluijs & Kluytmans, 1996). The research has focused on determining which social and cognitive competencies are needed in the semiconductor market and the medical device market. Obtaining the needed competencies is the second step of competency management (Sluijs & Kluytmans, 1996). This can be achieved through hiring new employees who possess those competencies and developing competencies within the current employees (Sluijs & Kluytmans, 1996). The organisation can also obtain the competencies through alliance, joint venture, merger, acquisition and co-makership with an organisation that already possess the required competencies (Sluijs & Kluytmans, 1996). Although, the recommendations will not focus on the last described method, the organisation is recommended to further explore it.

Two conditions for competency management should to be taken into account in case of implementation. The first is the alignment of the HR policy with the organisational strategy and targets, referred as vertical fit (Van der Heijden, Van der Heijden, Reidinga, Schutte & Volz, 1999). The second condition deals with de integration of HR systems and activities. These need to support the strategy and it is defined as horizontal fit (Van der Heijden, et al., 1999). For example selection and development activities should focus on the needed competencies. Vertical and horizontal fit are presented in figure 8.

Figure 8: Vertical and horizontal fit of competency management (Van der Heijden, et al., 1999)

8.2 Competency assessment

Competency assessment can be used to determine if the needed social and cognitive competencies are available within the organisation or if job applicants possess these competencies. It can therefore be used as evaluation or selection method (Seegers, 1998). However some constraints need to be taken into consideration when assessing competencies.

8.2.1 Constraints of assessment

The first constraint is about the observation of competencies of an employee. Competencies are not observable as such (Kroft & Weeren, 2004), but they reveal itself through the behaviour of people (Maesen de Sombreff & Schakel, 1999). Korthagen (2004) acknowledged this by arguing that competencies are difficult to assess. The approach has been to make a list of competencies and to measure the related behaviour and not the underlying attributes (Korthagen, 2004). It means that only the behavioural aspects of a competency are used for the assessment. This can be seen as a restriction of the concept competency, because competency is about the underlying attributes (like knowledge and skills) of behaviours, as described in the theoretical chapter of the thesis. However it is difficult to assess the underlying attributes, and therefore the measurement should focus on behavioural aspects.

The second constraint is concerned with restrictions of assessment of the competencies. The validity of assessment should be taken into account, in other words does the assessment measure what it is intended to measure (Swanborn, 1994). In case of measuring competencies by focusing only on the behaviour the validity aspect is erroneous because the underlying attributes are not assessed. Korthagen (2004) indicates this by arguing that the integrated character of competencies are not taken into account by competency assessment. The integrated character is, however, hard to assess and Tillema (2004) therefore argues for the use of authentic situations in the assessment of competencies. According to Tillema (2004) the relation with the authentic situation determines the validity of a competency and these elements cannot be separated. Therefore the assessment should be based on realistic tasks in the context of work, which will allow a better insight of the competency. The assessment of the competencies can be linked with the projects in which an engineer works and therefore includes the realistic work situation. This is however difficult to put into practice in the case of employee selection and therefore competency assessment is more applicable for assessing the available competencies within the current employee group. Assessment for employee selection should include previous work experiences to meet the condition about the realistic tasks.

Korthagen (2004) mentioned as the third constraint the reliability of competency assessments. Reliability is the consistency of results using the same measurement method (Swanborn, 1994). Different results are obtained by assessment of competencies via the use of identical instrument, and this illustrates the underlying unreliability of the assessment. (Korthagen, 2004). Methods to improve the reliability of the assessment include training for assessors and discussion between the assessors to clarify the criteria for the assessment (Korthagen, 2004).

Luken (2004) provides the fourth and fifth constraints related to the assessment. Competencies are not stable and will change over a period of time (Luken, 2004). One assessment does not provide a clear picture of the competency of a person throughout his career. Therefore the assessment of competencies should regularly be conducted to observe development of the competencies. This is impossible for employee selection in this case and therefore the assessment only provides a random indication of the competencies.
Another constraint is the subjectivity of the assessment because of the human dimension (Lukken, 2004). It could be the case that personal relations will interfere with the assessment results or that consequences of the outcome will influence the assessment. Employees will assess their colleagues advantageously if the outcomes will have particular effects (Waldman & Atwater, 1998 in: Jellema, 2000).

Competency assessment can be used for selection purposes, for clarifying training needs and for investigating performances for salary or promotional related decisions. However, competency assessment cannot be valid and reliable and subjectivity will always influence the results. It is therefore unacceptable to solely determine salaries or promotions according to this method. Competency assessment should be used for selection purposes or to determine training needs and decide which activities should be chosen. Interventions for competency development will be presented in the following chapter. The next sub-paragraph will discuss different assessment instruments.

8.2.2 Assessment instruments

Different tools are used for the assessment of competencies. Berkel, Hofman, Kinkhorst and Lintelo (2003) define three different methods for the assessment of competencies. These methods are (Berkel, et al., 2003, p. 16):

- Self-assessment: a person reflects on its own competencies by using a questionnaire;
- Peer assessment or 360° feedback method: colleagues, managers or other people involved will assess the competencies of an employee;
- Expert assessment: an expert observes the behaviour of an employee and will assess the competencies.

The 360° feedback method is regarded as a useful tool for the assessment of the social and cognitive competencies of engineers. This method allows collecting feedback of the behaviour of an employee from different perspectives (Togt, Kemp, Son & Antonides, 1997). Togt, et al. (1997) define this method as using the perceptions of the employee himself and the people directly and indirectly involved within his/her work setting. Therefore, self-assessment is also part of the 360º feedback method. According to Seegers (1998) a kind of objectiveness can be achieved through this method.

The 360° feedback method is regarded as a useful method for assessing the competencies of engineers because they work quite independently and autonomously in projects and have their own responsibilities. It allows the observation of the competencies within realistic situations from different perspectives. It is indeed questionable if a manager, not involved in the project, can have an accurate overview about the behaviour of an engineer within this project. Project work is the main activity of the engineers and therefore, colleagues, project members and project leaders can present concrete situations in which the social and cognitive competencies are revealed through behaviour. Therefore, evaluation about the results of the assessment with the different assessors should take place. This will enlarge the validity of the assessment and will allow a better understanding of the perspectives of the assessors and ultimately will provide feedback for the engineers.

It is recommended to involve a facilitator for the assessment. This person can guide the assessment, make sure that the assessment takes place and facilitate the evaluation of the outcomes. Competency assessment according to this approach is new for the organisation and for the employees and therefore support from a facilitator is recommended. This facilitator can be an employee of the HR department, another employee of the organisation or a HR consultant of an external organisation.
As mentioned before it is recommended to use competency assessment for selection purposes or investigating training needs. Using the 360º feedback method for promotions or salaries demand that the method is valid and reliable. Research has however indicated that the 360 º feedback method is not a valid and reliable instrument but is regarded as a useful tool for development of employees (Jellema, 2004). The feedback can be used as an input to determine the training needs and to make decisions related to the development of the employees (Jellema, 2004). Therefore, it is recommended to use the 360º feedback method as a decision tool for the interventions methods that can be used for the development of the competencies. The following chapter will present several interventions for the development of the social and cognitive competencies.

8.2.3 Assessment tool

Items for an assessment tool are included in appendix 19. These items are formulated as suggestions for an assessment tool and are based on the definitions of the social and cognitive competencies and results of the interviews. These suggestions can be used as an input for the development of an assessment tool for engineers of Philips ETG. Examples of the items are included in table 32.

Table 32: Examples of items for the assessment tool

Sub-competency	*Item*
Dealing with different people	Can work in a multidisciplinary team
Interpretation of signal	Is able to interpret the facial expression during communication
Self-awareness	Is able to recognise his/her own personality, strengths, weaknesses, likes and dislikes
Knowledge of the medical norms	Has knowledge of the medical norms and apply these within the designs

The development of this assessment tool can be done as part of a course of the study Educational Design Management and Media of the University of Twente. Student will develop the assessment tool and will examine the validity and reliability of this instrument.
After development it is recommended to discuss the new tool with the different assessors in an effort to clarify the criteria of the assessors and achieve consensus about those criteria. Consensus about the criteria will enlarge the reliability of the assessment.

Another topic that need to be discussed is the rating scale of the results. Drejer (2000, p. 215) defines different levels of competency development which can be used for the assessment of competencies:

- Novice;
- Advanced beginner;
- Proficient;
- Expert;
- World class.

The currently used scale by Philips ETG is also adequate. However, social and cognitive competencies are difficult to classify into different levels because they are complex and influences each other. For example the social competency communication is influenced by the cognitive competency knowledge of the client. An engineer can communicate effectively with the client when knowledge of this client is available, however possessing of knowledge about the client does not necessary mean that the engineer can communicate with the client since communication skills are in addition required. Therefore, it is recommended to find a rating scale that is applicable for the social and cognitive competencies and discuss this scale with the different people involved.
Another rating scale can be without numbers or different levels and is represented by a line on which a dot is placed. The ends of the line represent absence of the competency (left hand side) and superior level of the competency (right hand side). An example of such a rating scale in presented in figure 9.

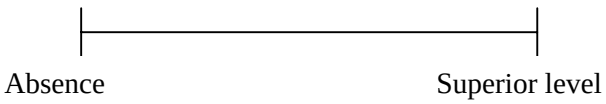

Figure 9: Sample rating scale

This rating scale will allow observing developments of the competencies, because social and cognitive competencies are hard to classify in different scales. Therefore the changes of these competencies are difficult to observe and a relative rating scale could be useful.

8.2.4 Assessment for development

Competencies are changing over time. The assessment of competencies should therefore be regular, allowing for these changes to be observed. The assessment should also be linked with realistic tasks in the work context, and therefore the assessment should be linked with the project in which an engineer works or even become part of the project activities. A follow-up of the assessment is important for it to be effective (Heijden, Heijden, Reidinga, Schutte & Volz, 1999). The content and timing of the follow-up should be clear, to improve the effectiveness of the interventions. The recommended assessment instrument is also perceived as a useful instrument for development and therefore it is recommended to combine assessment and development. Two methods to link the assessment and development are described below.

8.2.4.1 Assessment at the start of a project

The assessment can take place at the beginning of a project and the engineer can decide which competencies should be further developed. Self-assessment can be used in this case. It is recommended to then select only a few competencies among those to be developed. It stays manageable in this way and the engineer can oversee the changes. The Personal Development Plan and other interventions, which will be described in chapter 9, can be used for the development of the competencies.
The interventions can take place during the duration of the project. After the project another assessment should be conducted. The 360° feedback method can be used in this case. It allows obtaining feedback from the different project members or project leader about the behaviour of the engineer. As a consequence reflection on the developed competencies can take place and the engineer can adjust the Personal Development Plan. Adjusting the plan provide the possibility to continuously improve the competencies of the engineer.

8.2.4.2 Assessment after a project

In this case the assessment takes place at the end of a project. This will allow reflecting on the behaviour of the engineer by using the 360° feedback method. In this case the engineer will get feedback from different perspectives and discussion about the feedback can take place. Discussion is regarded as a useful method to clarify perspectives and get more insights in the behaviour of an engineer. A colleague can view the behaviour in a different way than the engineer him/her self. This can be a useful source for assessing social competencies, because these competencies are about the interaction between people.
After the assessment and discussion the development of the selected competencies can take place. It is recommended to select a few competencies to improve the development potential as mentioned before. The development can be achieve with different intervention methods and should be followed by an assessment to clarify if the selected competencies are improved. Assessment with the 360° feedback method or with the help of a mentor can be used in this case. It is advised to assess the competencies in order to evaluate the impact of the interventions and provide feedback to the engineer.

Both described methods focuses on the development of the competencies. This is in line with the recommendation that competency assessment should not be used for promotions or salaries decisions. Other combinations of competency assessment and development are also possible. It is however important that integration between assessment and development is accomplished. The suggested methods provide the opportunity to use competency management for the career development of the engineers because continuous competency development becomes possible. The next paragraph will describe expected issues related to the introduction of competency management.

8.3 Implementation of competency management

Implementing competency management, like every change within the organisation, can meet some resistance from the employees. In this case, the engineers and managers are expected to change their respective working habits. They should conduct other activities and these can be viewed as extra workload. Therefore a facilitator for the change is recommended. This can be a staff member of the HR department or another employee. This facilitator has the task to control and support the activities of competency management. The facilitator is skilled in the field of competencies and has the willingness to support the organisation in using a new system. This employee has to help the engineers with the assessment and development. It is important that the facilitator will motivate the engineers to cooperate. Experiences have shown that the workload will restrain the progress of the changes and therefore is it important to have an employee familiar with competency management and capable of motivating engineers to pursue continuing these activities.

The implementation of competency management is also influenced by the support it receives from the management within the organisation. Management should show interest in the success of these changes and provide the necessary sources. Time should for instance be provided because it is an important aspect for successful changes within organisations. Other sources as money and opportunities to get acquainted with the new activities are also important because implementing competency management means investing in it (Lap & Rijn, 1998). It also demands for an organisational culture and climate in which development of competencies is possible and learning is one of the core competencies of the organisation (Bergenhenegouwen, Horn & Mooijman, 2002). Although not considered as strict criteria for success, the organisation should keep in mind that competency management will benefit from such a culture and climate.

Another issue that should be taken into consideration is the ideas behind competencies. The development of competencies is at odds with the traditional organisational principles (Bergenhenegouwen, Horn & Mooijman, 2002). These principles are about hierarchical systems with formally defined positions including a description of responsibilities and tasks (Bergenhenegouwen, Horn & Mooijman, 2002). An alternative is an organisation in which the employee is the centre (Lawler in: Bergenhenegouwen, Horn & Mooijman, 2002) and in which the organisation is based around the available competencies rather than the previous mentioned positions (Seegers, 1998). Such changes of organisational structure also require adjustments in the physical and conceptual infrastructures of HR departments (Lindgren, Henfridsson & Schultze, 2004). The physical infrastructure is the systems & practices and the conceptual infrastructure is the assumptions & beliefs (Lindgren, Henfridsson & Schultze, 2004). For example the selection of employees should be based on the required competencies of an organisation. These described consequences mean a radical organisational change and are not expected to take place by Philips ETG within a short time. However, these issues should be taken into consideration in case implementing competency management. Implementation is a process, which is accompanied with several issues that hinder the success of the it.

8.4 Further recommendations

Recommendations related to competency management are provided in this paragraph. It is recommended for Philips ETG to set a frequency of assessing the competencies. This frequency should be suitable for the organisation and allow determination of developed competencies and integration of the assessment with development.

An additional recommendation is to follow the training *giving and receiving feedback*, which will be described in appendix 21, before the assessment takes place. This training will improve the effectiveness of the assessment and can improve the 360° feedback method within which the engineers should give and receive feedback.

A final recommendation is to explore the possibilities of using e-HRM for competency management. E-HRM is a way of implementing HR strategies, policies and practices in organisations through a conscious and direct support or full use of web-technology-based channels (Ruël, Bondarouk & Looise, 2004, p. 365-366). This means that HRM activities are conducted with the use of web-based technologies and it is a way of applying HRM (Ruël, Bondarouk & Looise & 2004). For example web-based technologies can offer other solutions for the documentation of competencies instead of an Excel sheet, which is in use at the moment. It will also permit access to the data for the employees working with competency management. The organisation could explore the benefits of web-based technology for competency management.

8.5 Summary

Within this chapter different recommendations concerning competency assessment and management are provided. The validity and reliability of competency assessment is discussed in the second paragraph. It is recommended to assess the competencies based on realistic task in the work context, for example in projects, and focus on the behaviour of engineers. The assessors need to be trained and they should discuss the criteria with each other. The 360° feedback method is recommended as a tool for the assessment. Discussion about the outcomes of an assessment as part of the process is also recommended. The assessment tool should be developed and different indicators are included in the appendix 19.

Within this chapter different recommendations are provided concerning the management of competencies. These recommendations are:

- Further explore the possibilities of hiring and aligning to obtain the needed competencies;
- Use competency assessment for the determination of training needs;
- Discuss the rating scale of the assessment;
- Integrate competency assessment and development;
- Select a few competencies for the development and interventions;
- Involve a facilitator for the implementation of competency management and for support of competency assessment;
- Management support and interest should be present for implementation of competency management;
- Provide time, money and opportunities for the changes;
- Keep in mind the required organisational culture, climate and principles for successful competency management;
- Choose a suitable frequency of competency assessment;
- Make use of the training *giving and receiving feedback* (appendix 21) before the assessment takes place;
- Explore the possibilities of using e-HRM for competency management.

9. Development of competencies

In this chapter a description is provided of how the social and cognitive competencies of the competency model, as presented in chapter 7, can be developed. After describing the concept of competency development, the differences in competencies of the semiconductor and medical device market will be presented and the chosen learning types and interventions will be described according to this difference. The social competency *empathy* and the cognitive competency *knowledge in the medical* market, as described in chapter 7, are only applicable for the medical market and these are described as the difference. The development of all competencies will be described in appendix 21.
Then, the constraints of the development of all competencies are described according to the iceberg structure of Bergenhenegouwen, Mooijman and Tillema (1999) followed by a description of the implementation of competency development. The changes and the development of the management will be described and finally, a summary is given.

9.1 Competency development

This research focuses on the term competency, as described in chapter 3, which reflects the underlying attributes of behaviour. Therefore, the emphasis lies on the way employees do their work and not on what the engineer is capable of. Thus, it is about the behaviour that an engineer needs to have to operate in the semiconductor and medical device market. This focus will also be used to define how the social and competencies can be developed.
The process of developing a competency model has been described in chapter 4 till 7. However, before Philips ETG is able to use the competency model in a structured way, the development of the competencies has to be described. Competency development is part of competency management, which is the realisation of competency policy and focuses on competency modelling, assessment and development (Mulder, 2001). Mulder (2001) describes competency development as the learning process in which new competencies can be obtained or in which the control of already existing competencies can be enlarged. The development of competencies will lead to existing competencies that are broader or more in-dept and will solve competency discrepancies (Wesselink & Mulder, 2004).
Competency development should not solely focus on working with competencies; it is about the desired development of employees (Wesselink & Mulder, 2004. Thus, competency development makes it possible to develop employees in a way the organisation demands or in a way the employee desires. An active development policy will lead to an improved performance in the work situation and this provides added value for the organisation (Wesselink & Mulder, 2004).
However, before describing how the competencies can be developed the differences in competencies between the semiconductor and the medical device market will be discussed.

9.2 Differences in competencies

The medical device market is very stable and therefore attractive for Philips ETG in addition to the semiconductor market. Therefore, Philips ETG wants to spread its activities over this market. However, the social and cognitive competencies, as described in chapter 7, differ between both markets. The social competency *empathy* and the cognitive competency *knowledge of the medical market* are only relevant for the medical device market, whereas the sub-competency *knowledge of the market of the client* is only applicable for the semi-conductor market. Therefore, it can be concluded that engineers and managers of Philips ETG, who are going to work in the medical device market, have to be aware of the fact that some competencies and sub-competencies are different compared to the semiconductor market. Also, they have to be aware of the fact that the medical device market is a new market and that the engineers do not possess these competencies yet. This points out a different perspective towards the market, because the ability to empathise and the knowledge of the medical market indicate a slightly different approach of an engineer towards the work. It is concluded that, when Philips ETG wants to work effectively on projects with clients in the medical device market, the engineers have to adapt this approach before and during the work in projects. How the competencies *empathy* and *knowledge of the medical market* can be developed is described in the next paragraph, which presents the different learning types and interventions for the development of the social and

cognitive competencies of engineers and describes the chosen interventions for the competencies *empathy* and *knowledge of the medical market*.

9.3 Learning types and interventions

To develop the social and cognitive competencies, different learning types and interventions can be selected. The learning types that can be described are off-the-job training and on-the-job training or learning. Off-the-job training is in literature often defined as classroom training and is described as conducting training away from the work setting (DeSimone, Werner & Harris, 2002). On the contrary, on-the-job training or learning involves conducting training at a trainee's regular workstation. On-the-job training can be described as an actual training at the organisation whereas on-the-job-learning are methods that an individual or group employees can undertake; a trainer is not always applicable. For both types of learning, advantages and disadvantages are described in table 33, which will be taken into account for the selection of interventions. Also, examples of interventions are mentioned for both learning types. These interventions will be described further in this paragraph.

Table 33: Advantages and disadvantages of learning types

Learning type	*Pro*	*Con*	*Types of interventions*
On-the-job training or learning	- Facilitates transfer - Reduces costs (no training facilities needed)	- Constraints (noise, chance to be disturbed)- Risk of damage (disruption of production schedule)- Safety (experimenting with chemicals or materials)- Inconvenience	(Online) collaboration tools, feedback, coaching, Personal Development Plan/Portfolio, reflection, mentoring and job instruction training
Off-the-job training	- Variety of learning techniques - Control of learning climate (no distractions) - Efficient delivery (large number of employees)	- Low transfer - Increased costs (travel, room rental)	Classroom training

Next to the other elements, transfer is described as important for both learning types. Transfer refers to the relationship between intentional actions aimed at the development of employees in organisations on the one hand and the actual consequences of those actions on the other hand (Nijman, 2004). Therefore, transfer of training is critically important to ensure that employees perform their jobs effectively. Cormier and Hagman (in Nijman, 2004) indicate that transfer of learning (training) takes place when previously acquired knowledge and skills exert an influence on the learning and use knowledge and skills in other – new – situations. Transfer is referred to as both transfer of learning and transfer of training, depending on whether the situation being transferred to is a learning or work situation (Gielen in Nijman, 2004). On-the-job training facilitates transfer, because it practises tasks on the job and therefore the learning environment is the work environment, as described in table 33. However, off-the-job training is perceived to have low transfer, because of dissimilarities of the job setting. Transfer, and the other elements, are taken into account for developing the social and cognitive competencies of engineers. The different interventions that can be selected for the development of the social and cognitive competencies are described in the next sub-paragraph.

9.3.1 Interventions social and cognitive competencies

To define which interventions are relevant for this research a literature study has been performed to retrieve these interventions. The interventions that were retrieved are: self-paced learning, job-aids, (online) collaboration tools, feedback, coaching, job rotation, Personal Development Plan/Portfolio, action learning, reflection, 360° feedback, mentoring, job instruction training and classroom training, which can be described as training and non-training interventions. The definitions of these interventions and the advantages or disadvantages of the interventions are described in appendix 20. However, based on the definitions of the interventions from the literature study it is concluded that not all interventions are applicable to Philips ETG. Therefore, self-paced learning, job-aids, job rotation, action learning and 360° feedback are not considered in this research.
Self-paced learning is a method that costs too much time and money to develop for individual engineers of Philips ETG. Job-aids cannot be applied to develop social and cognitive competencies, because the procedure of engineering tasks is complicated and is different in every situation. For example, an instruction schedule about how to perform a task is not applicable to engineers, because the task is too divers. Job rotation cannot be used, because there is only one department or position important in this research. Action learning is a method that focuses on extending the ability to learn and not on individual competencies. Last, 360º feedback cannot be used, because it is a method to assess which competencies have to be developed and not a development method.
In the next paragraph, the interventions that are selected for the development of the different competencies and the chosen interventions for the competencies *empathy* and *knowledge of the medical market* of the medical device market are described.

9.4 Development of the competencies empathy and knowledge of the medical market

The interventions that are chosen for the development of the competencies are chosen based on four criteria: they should fit in the work environment and the work of an engineer, transfer should be taken into account, the learning methods should be of use within the organisation and the possibilities of the Core Curriculum (2006) of Philips should be taken into account. The Core Curriculum (2006) of Philips is a curriculum for technical and other skills, which describes training interventions for employees of the Philips organisation. The chosen interventions for the competencies *empathy* and *knowledge of the medical market* are described in table 34. The availability within the Core Curriculum of Philips, the intervention choice and the development of all competencies are described in the competency development plan, which is presented in appendix 21.
The chosen interventions for the competencies *empathy* and *knowledge of the medical market* are explained, because these indicate the difference between both markets and are competencies that are not possessed yet by engineers of Philips ETG.

Table 34: Interventions for competencies empathy and knowledge of the medical market

Competency	*Intervention*
Social competency	
Empathy	- Document analysis and discussion about the medical device market - Day in the hospital, which will be guided by research questions for the engineers and will be evaluated by all engineers - Presentation/training thinking perspectives, which will need to be developed - Use of thinking perspectives in projects
Cognitive competency	
Knowledge of medical market	- Document analysis, which can be provided by Philips MS - Documentation about relevant information - Training for regulations and testing. This training needs to be found with help of Philips MS by the managers and engineers themselves

The development of all social and cognitive competencies is, for most competencies, based on two aspects. First, new knowledge has to be gathered and second, engineers have to learn how to use that knowledge. For example, the competency *empathy* consists of four interventions. The day in the hospital and the document analysis are necessary to retrieve new knowledge about the patient, client and medical personnel whereas the training helps to learn how to empathise with others during a project. The use of the thinking perspectives in practice is a method to facilitate the transfer of the training. Engineers learn with the use of different techniques in classroom training, although the facilitation of transfer is low. Therefore, this on-the-job intervention is chosen, which facilitates transfer although of some disadvantages.
The competencies *empathy* and *knowledge of the medical market* indicate an overlap in competencies. For both competencies the engineers need knowledge about the medical market. Therefore, it can be concluded that the interventions for retrieving the knowledge for both competencies can be combined in order to develop the competencies, because the same information or knowledge is retrieved. This has to be taken into account when developing these competencies.

This overlap in social and cognitive competencies cannot only be indicated for the competencies *empathy* and *knowledge of the medical market*. All competencies can have overlap with each other, because of the use of different competencies in encountered situations. For example, a situation in which the engineer and the client are not communicating well may lead to the conclusion that an engineer has problems with communication. However, before using the interventions, as described in the competency development plan (appendix 21), it should be clear if this actually is the competency that the engineer lacks. Communication problems can also occur when the engineer does not has sufficient knowledge about the market, product or vision of the client. This example shows that careful research is necessary to find out which competency really needs to be developed. Otherwise engineers are confronted with an intervention they do not need, creating resistance towards competency development in general. This has to be avoided, because awareness of the own development decreases when resistance occurs, which is not the intention of competency development. The previous chapter describes how the assessment has to take place to avoid this problem from occurring.
However, this overlap in competencies in not the only problem for the development of the social and cognitive competencies. Other constraints of competency development have to be taken into account, which are described in the next paragraph.

9.5 Constraints competency development

The constraints of the development of social and cognitive competencies are described according to the iceberg structure of Bergenhenegouwen et al. (1999) as presented in chapter 3. Competencies can be described in visible and non-visible elements, as presented in the iceberg-structure in chapter 3. This iceberg structure consists of four layers: professional knowledge & skills, intermediate skills, values, norms, ethical issues and professional ethic and personality characteristics (Bergenhenegouwen et al., 1999), which are defined in chapter 3 and again on the next page. Also, the iceberg-structure is presented again on the next page in figure 2.

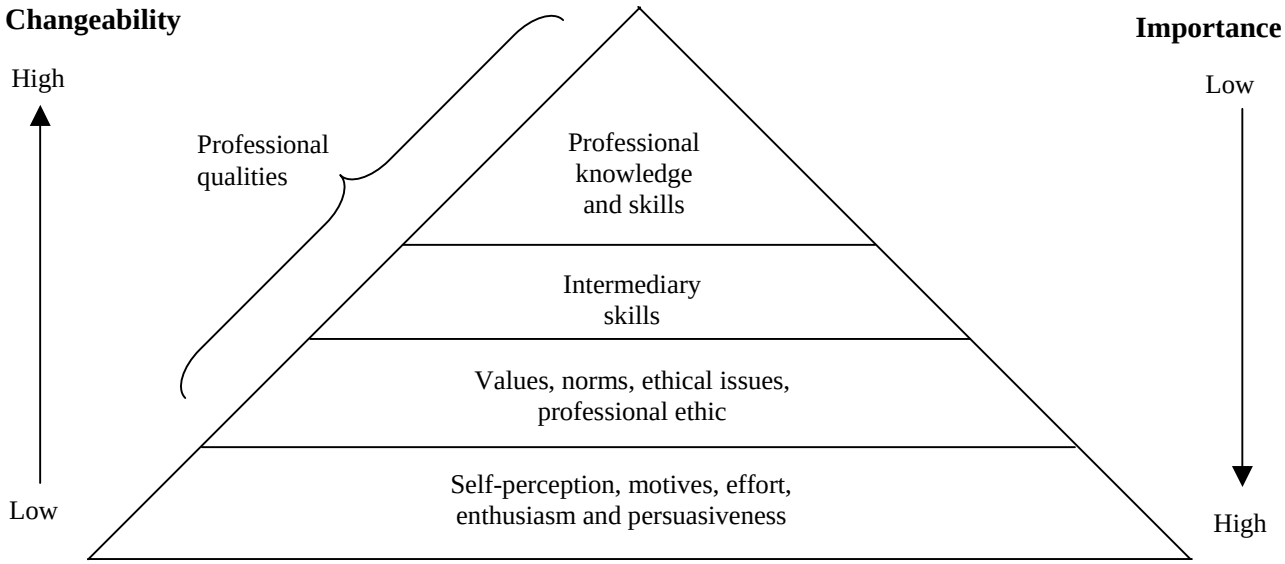

Figure 2: The human competency in an iceberg structure (Bergenhenegouwen et al., 1999, p. 77)

The elements at the top of the iceberg are more visible compared to the elements at the bottom of the iceberg. Also, competencies at the bottom of the iceberg are harder to develop or learn than the ones at the top of the iceberg (Bergenhenegouwen, Horn & Mooijman, 2002).

The social and cognitive competencies of engineers, which are described in detail in chapter 7, can be defined according to these different layers of the iceberg structure (Bergenhenegouwen et al., 2002):

- Professional knowledge & skills: the (instrumental) knowledge and skills that are important for the profession and that are necessary to adequately carry out the task or function;
- Intermediary skills: job skills;
- Norms, values, ethical issues and professional ethic: a personal and professional framework where norms, values, ethical issues and professional ethic have received a specific place and where the personality is marked;
- Self-perception, motives, effort, enthusiasm and persuasiveness (personality characteristics): these characteristics determine the behaviour in specific situations.

The four layers describe different aspects of the human competency and based on the content of the competencies this indicates that the social and cognitive competencies of engineers can be classified as different aspects. The analysis of each competency individually provides an overview of the ability to develop, which is described in the next sub-paragraph.

9.5.1 Social and cognitive competencies further defined into the layers of the iceberg structure

Almost all social competencies can be defined as intermediary skills, except the competencies *flexible behaviour* and *empathy*. *Networking*, *collaboration*, *communication* and *project management* are defined as intermediary skills based on the fact that they are social competencies that are needed to perform the job as engineer. They are general behavioural skills that are a condition to operate effectively in an arbitrary position or role (Schakel & Smid, 2000) and therefore increase the flexibility and availability of an engineer.

Flexible behaviour can be described as a mixture of an intermediary skill and a personality characteristic. It is an intermediary skill because the engineer has to cope with different situations causing the engineer to change the behaviour. However, it depends on the personality of the engineer if the adoption of other behaviour is possible. *Empathy* is a mixture of an intermediary skill and professional knowledge & skills. The *knowledge of the patient, client and medical personnel* that the engineer needs to have can be described as professional knowledge, which is reflected by the competency *knowledge of the medical market*. This is specific knowledge that is relevant for the

utilisation of a functional domain (Schakel & Smid, 2000). However, the ability of *empathising* can be described as an intermediary skill, because the engineers need to have insight in the medical market and therefore in the task of an engineer in the medical market.
For the cognitive competencies three different layers are present, namely: professional knowledge & skills, intermediary skills and personal characteristics. *Knowledge of the organisation, knowledge of the client, knowledge of the medical market* and *conceptual thinking* are professional knowledge & skills. These four competencies are observable knowledge or qualities that an engineer needs to have to perform his job. *Conceptual thinking* is a competency that forms the essence of the work of an engineer and therefore it is a quality that an engineer has to possess before even starting the job.
Problem solving is an intermediary skill that the engineer uses for technical and other tasks. The problem solving of technical tasks can be categorised under professional knowledge & skills. However, this competency focuses on other elements than technical elements. These elements are important for the flexibility and availability of an engineer and are proceedings that are of use in multiple situations.
Awareness and *self-development* are combinations of intermediary skills and of personal characteristics. They are intermediary skills because they consist of elements that are of use in multiple situations. However, they also are personality characteristics that determine the behaviour in specific situations. Personal characteristics are in themselves, not behaviour, but form the background or condition for the behaviour (Schakel & Smid, 2000). The characteristics are important for the estimation of the possibilities to develop employees (Schakel & Smid, 2000). An overview of the social and cognitive competencies according to the iceberg structure is presented in table 35.

Table 35: Social and cognitive competencies according to the iceberg structure

Layer iceberg structure (Bergenhenegouwen et al., 1999)	*Social competencies*	*Cognitive competencies*
Professional knowledge and skills		Knowledge of the organisation, client and medical market, conceptual thinking
Intermediary skills	Networking, collaboration, communication, project management, flexible behaviour, empathy	Problem solving, awareness and self-development
Values, norms, ethical issues and professional ethic		
Personality characteristics	Flexible behaviour	Awareness, self-development

This division of competencies in layers indicates that social and cognitive competencies cannot be developed in the same way, which will be described in depth in the next sub-paragraph.

9.5.2 Social and cognitive competencies described according to changeability

Competencies at the top of the iceberg are more changeable then competencies at the bottom of the iceberg, as stated above. Therefore, Philips ETG has to find out if the personal characteristics of engineers do not make it difficult or impossible to develop a competency. To define this, the engineer's personality profile has to be determined to find out which competencies can be developed and which cannot, because the developmental potential of competencies is to some extent determined by a person's personality profile (Schakel, Smid & Wognum, 2006). This personal profile can best be described according to the Big Five, which describes personality characteristics. Personality psychologists have concluded in the past years that the underlying qualities of the variety of personality characteristics can be described in five dimensions (De Fruyt, 2001), which are presented in table 36 on the next page. These differences in dimensions are formed according to the dimensions extraversion, neurotism, agreeableness, conscientiousness and openness to experience (De Fruyt, 2001).

Table 36: The dimensions of the Big Five

Introvert	Extrovert
Emotional stability	Neurotism
Cooperative solutions	Individualism
Spontaneousness	Planned behaviour
Openness to experiences	Conservatism

From an individual's personality profile the developmental potential of competencies may be predicted, which indicates that the extent to which the actual performance level of a competency can be predicted may differ per competency (Schakel, Smid & Wognum, 2006). For example, Schakel, Smid and Wognum (2006) describe that from an extrovert might be expected to develop the competency *networking* with more ease than an introvert.
When the personality characteristics of engineers of Philips ETG are made specific with the Big Five model, engineers of Philips ETG can develop competencies, which they are able to develop. However, developing competencies does not necessary has to succeed when the personality characteristics of the engineer fit the competency. Also, other boundary conditions have influence on the developmental potential of competencies. Schakel and Smid (2000) describe the situation and the previous learning experiences of an employee as a boundary condition next to the personal characteristics. For the development of competencies it is important that the situation, where the engineer works in, is consistent with the learning needs of an engineer. The organisations structure, the work processes, the technical infrastructure and the culture (Schakel & Smid, 2000) have to make it possible for an engineer to develop competencies in a stimulating organisation and should not hinder the learning process.
The last aspect, that has to be taken into account when developing competencies, is the previous learning experiences of engineers. These experiences contain the personal values, the preferred way of learning and the attitudes towards own and other ones behaviour (Schakel & Smid, 2000). Therefore, it is important to develop competencies that are not based on negative experiences or on situations that the engineer does not like. Further, Schakel and Smid (2000) suggest that the chosen learning methods should be perceived as pleasant to get the best results.

To provide engineers with the best setting for developing the social and cognitive competencies Philips ETG should be aware of the personal characteristics, the situation and the previous learning experiences as boundary conditions of competency development. Therefore, these aspects should be taken into account for the development of the different competencies. Also, as can be seen in table 34 and in appendix 21, the chosen interventions cannot be carried out that easily based on the time that is involved and the difficulty of changeability of a competency. Therefore, Philips ETG is recommended to choose one or two competencies to develop. More competencies to develop is impossible for an engineer, because competency developments costs time and by choosing too much competencies the engineer cannot develop the competency in depth.
In the next paragraph, the implementation of competency development for both markets is described although the focus is on the competencies that are needed for the medical device market.

9.6 Implementation competency development

The engineers of Philips ETG are used to find solutions for certain knowledge problems themselves. These knowledge problems are often based on techniques, which the engineers need for the job. However, the introduction of the social competency *empathy* and the cognitive competency *knowledge of the medical market* require a different way of working on the development of competencies than the present approach. Not only do the engineers have to be aware of the consequences of certain behaviour, but also other methods are used for personal development. The different aspects of competency development, as described in appendix 21, have to be introduced gradually. However, when Philips ETG wants to spread its activities over the medical device market, the competencies that make a difference have to be developed first. Therefore, the social competency *empathy* and the

cognitive competency *knowledge of the medical market* have to be developed to some extent before carrying out activities in the medical device market. In this paragraph, the different steps that have to be taken to implement competency development are described. The focus during these steps lies on the competencies that are important for the medical device market and not on all necessary competencies. Also, the important aspects of the work of a manager in the implementation are described.

9.6.1 Steps to implement competency development

As a part of the gradual introduction of the competency development, the benefits for the engineers and for the organisation have to be made explicit. In this way, it is made clear that competency development is not only for the benefit of the organisation, but also for their benefit. A personal benefit is that competency development offers the engineers the possibility to work in both markets and makes them responsible for their own career. An organisational benefit is that Philips ETG can spread activities over the medical device market effectively and that the potential of the individual engineer is utilised best.
The steps that have to be taken to implement the differences in competencies and competency development are described in table 37. These steps are described in depth below the table.

Table 37: Implementation steps competency development of the medical device market

Implementation steps	*Description*
1. Management awareness	Before implementing the plan the management has to support competency development and be aware of differences with the semiconductor market
2. Adjusting the environment for competency development	The environment of the engineers has to be changed to make sure that competency development has a good chance to succeed in the medical device market
3. Development of interventions empathy and knowledge of the medical market	The interventions need to be developed before the start of the implementation
4. Introducing competency development	An introduction with the goals of competency development has to be presented to all engineers from both locations with the focus on entering the new market and therefore and the competencies *empathy* and *knowledge of the medical market*
5. Presenting the interventions and assessment that will be used for all engineers	A presentation will be the starting point of the use of the different interventions for the competencies *empathy* and *knowledge of the medical market*
6. Assessing the engineers	The assessment of engineers has to be done with the help of the assessment tool (chapter 8)
7. Defining the interventions for the engineers	According to the assessment the engineers have to develop specific competencies and the competencies *empathy* and *knowledge of the medical market*

In order to make sure that competency development is properly implemented it should be made explicit that the management of competencies is very important. This is described in the *first step* that has to be taken, which is described in chapter 8. Philips ETG needs to explore the organisational conditions for the implementation of competency management. Also, the managers of Philips ETG have to be aware of the differences in competencies between the semiconductor and the medical device market.

Adjusting the environment in the organisation, to a more suitable environment for competency development, is the *second step*. To properly develop the competencies the engineers should have the possibility to use the right interventions and opportunities. To make this process as easy as possible, the environment should support all opportunities to develop competencies. Therefore, it should be clear within the organisation how this development should take place, having the consequence that some aspects of the work environment have to be changed. An example of this change is that the competency development of engineers is always an issue and not only when there is a small amount of projects. This means that time and space should be provided in order to make it possible for engineers to develop.

The interventions have to be developed before the start of the implementation. This *third step* is especially important for the support of the engineers and managers for competency development. Therefore, the interventions of the competencies *empathy* and *knowledge of the medical market* have to be designed or organised. The chances of success in the medical device market are likely to decrease when engineers cannot develop the competencies that they need for working in the medical device market, because of the fact that the interventions are not designed or organised.

The *fourth step* of the implementation is the introduction of competency development with a description of the goals and the benefits for the organisation and the individual engineer. In this introduction the differences in competencies between the semiconductor market and medical device market have to be presented. This introduction is the start of the implementation, which will be followed by a period of changes. Not only the way of developing competencies will change, but also the projects that have to be done. These will not solely focus anymore on the semiconductor market, but also on the medical device market. Therefore, this introduction has to be facilitated well to create the effect of enthusiastic engineers, who are willing to develop. This introduction has to be done by the Human Resources (HR) department and the managers of the engineering departments in Almelo and Eindhoven to provide the engineers a solid plan of actions.
The assessment that an engineer has to undertake and the interventions are presented in the *fifth step*. It should be clear what the goals of the assessment are and what actions can be expected based on the assessment. Also, the interventions that will be used for all engineers have to be described and implemented to make sure that all engineers are up-to-date about the steps that will be taken in the next period.

Last, the *sixth* and *seventh step* of competency development is the start of the actual competency development of engineers, to develop specific competencies and the competencies *empathy* and *knowledge of the medical market*. The assessment tool, as described in the previous chapter, will be used to assess the engineers and conclusions from this assessment will lead to the use of interventions. The choices for certain types of development have to be made by the engineer and the manager together taking the boundary conditions of learning, personal characteristics, the situation and previous learning experiences into account.

To guide the implementation well, the managers of the engineers of Philips ETG also have to develop themselves. The situation in which the managers work changes and for the success of this change the managers have to develop themselves. This development is described in the next sub-paragraph.

9.6.2 Development of the management

The support of the management is important for the implementation of competency development and for success in the medical device market, because the management has to carry out the change. Therefore, the approach towards competency development is top-down, making it easy to understand that the management has to support the change not only in words but also in acts. However, the managers of the engineering department have to deal with both individual goals and organisational goals, especially because these last goals are the ones where they are accounted for (Wesselink & Mulder, 2004). Therefore, not only the engineers, but also the managers need time to adapt competency development. However, the managers have to be able to select activities, in cooperation with the engineer, to work on the development of competencies (Wesselink & Mulder, 2004). The

managers and the engineers regularly have to work with the competency model to adopt the change and to make sure that when working with the competency model it does not cost too much time (Mulder, 2001). Therefore, the introduction of competency development does not only have to be supported by the strategic top of an organisation, but also by the managers of the organisation. If one of these elements does not identify the benefits of competency development it is very likely that the change will not be successful. An example of this is that the regulations that an organisation takes are not in line with the development of employees. Other aspects are described as more important and therefore the development of competency is oppressed. To avoid this, the role and the responsibilities of the managers in competency development have to be looked at.
This makes it possible for a manager to carry out competency development and to provide the engineers the support they need to develop competencies. The strategic management has to define the goals of the managers and has to account them for both the organisational and individual goals.
Also, the managers have to be supported by the HR-department, who can coach and help the managers with the change. The cooperation between the managers and the HR-department provides the ability for competency development to succeed and to create support in the different engineering departments of the organisation.

9.7 Summary

In this chapter, it is researched how Philips ETG has to implement competency development. Competency development makes it possible to develop employees in a way the organisation, in this case Philips ETG, demands or in a way the employee desires. The social and cognitive competencies, as described in table 31 of chapter 7, have to be developed in order to make sure that the engineers work effectively in the semiconductor and medical device market. The differences in competencies between both markets, the social competency *empathy* and the cognitive competency *knowledge of the medical market*, have to be taken into account when Philips ETG wants to spread its activities over the medical device market. Therefore, these competencies have to be developed first when Philips ETG wants to work in this market.
Different interventions, with learning types that describe on-the-job training or learning and off-the-job training, are selected to develop all competencies (appendix 20). A combination of these learning types provides the engineers the ability to develop all competencies effectively. The interventions for every competency are described in the competency development plan (appendix 21).

However, these competencies cannot be developed without taking the boundary conditions for competency development into account. The personal characteristics, the situation and the previous learning experiences of engineers determine if a competency can be developed. The personal characteristics are described according to the iceberg structure and this indicates that competencies differ from importance and changeability. To make sure that an engineer is able to develop a competency, Philips ETG is recommended to define the personality profile of an engineer according to the Big Five dimensions.
The steps that Philips ETG has to take to implement competency development, with the focus on the medical device market, are described in table 37. The steps in the implementation will provide Philips ETG the ability to implement competency development structured. Also, it will help to develop the competencies *empathy* and *knowledge of the medical market* when Philips ETG wants to spread its activities over de medical device market. Special attention has to be paid to the managers who have to implement and carry out the change effectively. The managers of the engineering department have to be supported by the strategic management and HR-department to implement competency development well. This support will determine the success of competency development.

In the following chapter, the conclusions of this research are described and recommendations are presented.

10. Conclusions and recommendations

Based on literature, observations and the results, several conclusions can be drawn regarding the developed competency model of this research. Based on a review of the findings, a final conclusion is provided in this chapter to answer the research question. Recommendations are provided, which focus on the use of the competency model and on the medical device market. Last, recommendations for further research are provided.

10.1 Review of findings

Philips ETG has the need to spread activities over other markets such as the medical device market, as described chapter 1. This is caused by the fact that the semiconductor market highly fluctuates, has a cyclic character and Philips ETG is highly dependent on one client. Philips MS, a potential client of Philips ETG, concluded in an audit (Philips Medical Systems, 2005) that Philips ETG does not know the capabilities of their engineers and is not aware of the capabilities that potential clients define as important for engineers. Based on this, previous research recommended to further investigate the social and cognitive competencies of engineers to clarify the differences between these competencies in the semiconductor and medical device market, which is described in the following research question:
Which social and cognitive competencies do the engineers of Philips ETG need to possess to operate in the semiconductor market and medical device market?

To answer the research question a context exploration, literature study, research within the semiconductor market and within the medical device market were conducted. The review of these findings is described in the next sub-paragraphs.

10.1.1 Context exploration and literature study

The context of the research was explored in chapter 2 to retrieve information about the organisational aspects of Philips ETG, the engineering department and the work of an engineer. This information was used for the different interviews. A literature study was done to acquire a theoretical background, as described in chapter 3, in which the concept of competency and especially the social and cognitive competencies are explained. The goal of this literature study was to form a competency research model, which was based on the literature and includes social and cognitive competencies and their sub-competencies.
The conclusion of the context exploration and the literature study is the competency research model, as presented in chapter 3, which was formed according to the research question, the work of an engineer and similarities between social and cognitive competencies that were described in literature.

10.1.2 Semiconductor market

The results of the research sub-question ‘Which social and cognitive competencies do the engineers need to possess to operate in the semiconductor market?’ are presented in chapter 5 of this thesis. To answer this question, different respondents were interviewed. First, eight engineers of Philips ETG Almelo and Eindhoven were interviewed in an individual open interview and after that a member check was done in Eindhoven with 16 respondents from which 12 were engineers and four were managers. Last, during the refinement two respondents from ASME were interviewed in a focused interview.
During these three activities, the competency research model of chapter 3 was specified and refined according to the situation of engineers in the semiconductor market. This specific competency model, which is described in table 18 of chapter 5, is the answer to the research sub-question. This model describes the social competencies networking, collaboration, communication, flexible behaviour and project management and the cognitive competencies problem solving, conceptual thinking, self-development, awareness, knowledge of the own organisation and knowledge of the client. Also, sub-competencies are indicated, which are described in chapter 5. These (sub)-competencies are the social and cognitive competencies that an engineer needs to possess in the semiconductor market. Therefore, these (sub)-competencies are the answer to the research sub-question, as stated above.

10.1.3 Medical device market

The results of the research sub-question 'Which social and cognitive competencies do the engineers need to possess to operate in the medical device market?' are presented in chapter 6 of this thesis. Different respondents were interviewed to provide an answer to this question. First, one key-account manager of Philips ETG and three managers of Philips MS were interviewed during an open interview about the competency research model. Then, one staff member and one teacher of the study Technical Medicine and one study advisor of Biomedical Engineering of the University of Twente were interviewed in an open interview to describe what kind of competencies an engineer needs to possess to work in the medical device market and what competencies they indicate as important for students of these studies. Last, one system architect of Philips MS was interviewed during a focused interview for the refinement of the specific competency model.
During these three activities the competency research model, as described in chapter 3, was transformed into a specific competency model for the medical device market. The final version of this specific competency model, as presented in table 28 of chapter 6, includes the social competencies networking, collaboration, communication, empathy and flexible behaviour and the cognitive competencies problem solving, conceptual thinking, self-development, awareness, knowledge of the own organisation, knowledge of the client and knowledge of the medical market. Also, sub-competencies of these competencies are defined in chapter 6.
These (sub)-competencies are the social and cognitive competencies that an engineer needs to possess to work in the medical device market. Therefore, these (sub)-competencies are the answer to the research sub-question, as stated above.

10.1.4 Final competency model

The context exploration, literature study and the research sub-questions for the semiconductor and medical device market are both relevant for answering the research question 'Which social and cognitive competencies do the engineers of Philips ETG need to possess to operate in the semiconductor market and medical device market?'.
The competency research model was formed according to the context and the literature study and was made specific for both markets. These specific competency models are compared and combined to some extent in the final competency model, which is presented in table 31 of chapter 7. The final competency model with the related definitions is included in appendix 18. The social competencies that an engineer needs to possess for both markets are networking, collaboration, communication, flexible behaviour and project management. The cognitive competencies problem solving, conceptual thinking, self-development, awareness, knowledge of the own organisation and knowledge of the client are defined as important for both markets.

However, the social competency *empathy* is also included in the model, but is only applicable for the medical device market. The sub-competencies of empathy are empathising with the patient, empathising with the client and empathising with medical personnel. These sub-competencies are the specific characteristics of the medical device market and therefore are not needed within the semiconductor market. The cognitive competency *knowledge of the medical market* is included in the model for the medical device market whereas the cognitive sub-competency *knowledge of the market* of the competency knowledge of the client is included in the model for the semiconductor market. The sub-competencies of knowledge of the medical device market are knowledge about the norms, safety rules, testing and registration, which demand for a new approach towards the engineering process and are very important within the medical device market. Therefore, these competencies are only relevant for or the semiconductor market or the medical device market.

10.2 Conclusion

The described difference in competencies in both markets and the described social and cognitive competencies in the final competency model provide an answer to the research question of this thesis and fills the gap that was described by Philips MS. As indicated before, the competencies that an engineer needs to possess for the semiconductor and medical device market are the same for five out of six social competencies and for six out of seven cognitive competencies. The social competencies only have to be expanded for the medical device market with *empathy* and the cognitive competencies with *knowledge of the medical market* to describe the needed competencies. For the semiconductor market the competencies only have to be expanded with the sub-competency *knowledge of the market* of the client.
The difference in competencies, empathy and knowledge of the medical market, between the semiconductor and medical device market can be explained by the difference in end-user of the products that are developed. In the semiconductor market the end-user is an operator whereas the patient or the medical personnel is the end-user in the medical device market. This indicates a different perspective towards the development of products and therefore, a different approach from engineers towards the work. Next to this ability, the engineers need to have knowledge of the medical device market. This knowledge can be indicated as the specific characteristics of the medical device market.

The final competency model indicates that Philips ETG is now aware of the capabilities that potential clients demand although it does not indicate that Philips ETG is aware of the capabilities of its engineers. It only indicates that Philips ETG does know which capabilities are defined as important in both markets and which competencies an individual engineer should possess. An assessment should define if these capabilities are available in the individual engineers of Philips ETG.
However, based on these results it can be concluded that Philips ETG is the right partner for Philips MS. This can be concluded, because it can be assumed that the competencies that are the same for both markets are available within Philips ETG. These competencies are needed for the semiconductor market in which the engineers already operate. Based on the fact that the engineers already participate in the semiconductor market, it is indicated that the competencies of the specific competency model of the semiconductor market are to some extent available within Philips ETG. However, it is not assessed yet which competencies every individual engineer does or does not possess. Therefore, Philips ETG has to take some actions to meet the requirements of Philips MS, which is included in the following paragraph.

10.3 Recommendations

The conducted interviews, the research results and the conclusions have resulted in recommendations regarding the requirements described in the audit of Philips MS (Philips Medical Systems, 2005). These recommendations are included in this paragraph to provide opportunities for Philips ETG to benefit from the research and are described for the use of the final competency model (table 31), for necessary actions or recommendations for the medical device market and for further research.

10.3.1 Using competency model

The competencies of the final competency model, and in specific the competencies *empathy* and *knowledge of the medical market*, are explored according to the management, assessment and development. This exploration has lead to recommendations about these aspects, which are described in chapter 8 and 9. Recommendations of these three aspects are summarised below.

10.3.1.1 Assessment

For the *assessment* of competencies it is important to link assessment with the projects of the engineers and to use it for development activities. The 360º feedback method is recommended to use for the assessment, because it is a useful method for competency development and provides feedback from different perspectives. A follow up of the assessment must be organised to use the assessment outcomes and therefore it is recommended to integrate the activities of assessment and development. This will allow to observe changes in competencies and to detect if development activities have the

intended effect. Next to this, it is recommended to assess the competencies on a frequent basis, which is suitable for Philips ETG. The frequency will also provide opportunities to observe changes in social and cognitive competencies of the engineers.
Philips ETG is recommended to use the final competency model and the suggested items for an assessment tool (appendix 19) to develop this tool further. This tool can be used to determine in what extent the engineers possess the necessary competencies and should include behavioural aspects as indicators of the competencies, because competencies are revealed through behaviour as described in chapter 8.

10.3.1.2 Development

The recommendations for the *development* of competencies describe aspects that are necessary to indicate before developing a specific competency. Competencies cannot be selected for all engineers to develop, because personal characteristics and other boundary conditions like the situation and the previous learning experiences influence the development. Therefore, Philips ETG is recommended to make personality profiles of every engineer according to the Big Five dimensions to define if specific competencies can be developed. Also, Philips ETG is recommended to select one or two competencies for the development, because it is difficult to develop more competencies at once.
Next to this, Philips ETG is recommended to take the differences between the semiconductor market and the medical device market into account when engineers have to develop the competencies. The social competency *empathy* and the cognitive competency *knowledge of the medical market* are only relevant for the medical device market and therefore are important to develop before working on projects in this market.
Also, Philips ETG is recommended to develop the competencies according to the competency development plan (appendix 21), but before this is done the implementation steps for the medical device market of competency development (table 37) should be taken into account to implement competency development well. During this implementation the role of the managers is very important, because they have to carry out the implementation together with the HR-department. Also, the managers should have the ability to execute the organisational as well as the individual goals. Therefore, success of competency development depends on the support of the strategic management, managers of the engineering departments and the HR-department.

10.3.1.3 Management

The management of competencies is the most important aspect of implementing the final competency model. It is important that the HR strategy is aligned with the organisational strategy and targets (chapter 8). Therefore, competency management has to be developed before the assessment and the development of competencies can be implemented. Philips ETG has to explore how competency management can be used within the organisation to meet the recommendations of this research. Thus, Philips ETG needs to explore the organisational conditions for the implementation of competency management. For example, Philips ETG should decide which strategy can be used to obtain the needed competencies.

Another issue related to implementing competency management is the cultural difference between Almelo and Eindhoven. This difference can indicate that competency management, and competency assessment and development, is executed differently. Philips ETG is recommended to make sure that both engineering departments work closely together when implementing competency management. Then, it can be made sure that it is implemented similar within both locations and problems are discussed together.

10.3.2 Medical device market

The competencies of engineers for the medical device market differ from the semiconductor market. When Philips ETG wants to spread its activities over the medical device market, Philips ETG needs to be aware of these differences. Therefore, recommendations for operating in the medical device market are described on the next page.

The results of the interviews, as described in appendix 8 and 9, indicate that engineers of Philips ETG do not have knowledge of the medical device market yet and therefore it is recommended to *obtain knowledge about the medical device market* in advance of the collaboration with Philips MS.
Philips MS has to be approached to help Philips ETG to obtain the knowledge. This has to be done, because potential clients will appreciate the efforts to obtain knowledge of their market and the acquired knowledge will help the engineers to function better within this market.
Other relevant knowledge can only be obtained during collaboration and because of this engineers are recommended to have an active attitude during collaboration. They should make sure that they understand why things are done in a certain way and ask questions to retrieve more information. The interviews (appendix 10 and 13) with respondents of Philips MS suggest that clients appreciate an active attitude and it provides the client the idea that an engineer of Philips ETG is reliable and participates actively in the process.

Next to obtaining knowledge about the medical market, the competency *empathy* should be assessed in advance of working in the medical market and also during collaboration with Philips MS. Philips ETG has to get aware of the availability of this competency within the own organisation. Empathy should be developed in case the competency is not or insufficient available within the organisation. The assessment and development of this competency should take place in advance of working on projects, because the medical device market demands the possession of this competency.

Another recommendation is made based on of *events of the past*. The relationship with Philips MS is affected by the fact that Philips ETG has broken a relationship in the past with Philips MS that can affect the planned collaboration. Even though employees of Philips ETG have changed since then, the employees of Philips MS are still aware of it. This event had impact on the relation between the organisations and this can affect the future relationship. Philips ETG is highly recommended to be aware of this, because a good relationship and trust in the supplier is very important for the existence of an alliance. Therefore, Philips ETG should take measurements to guarantee a long lasting partnership and communicate this effectively with Philips MS.

10.3.3 Further research

In this sub-paragraph, recommendations are made for further research.

The first recommendation is about the characteristics of the medical device market. Only one respondent of the medical device market indicated that an *entrepreneurial attitude of engineers* is demanded. However, discussion with the managers of Philips ETG revealed that higher management of Philips ETG wants the engineers to be more active, especially in development projects. In the research it is not observed that the semiconductor and medical device market demands for this attitude. Therefore, Philips ETG is recommended to research what the own organisation expects from the engineers in certain projects to explore if this attitude is necessary in projects of both markets.

The research resulted in the final competency model, which is based on results of interviews with different respondents of the semiconductor and medical device market. This model is an indication of the needed social and cognitive competencies for engineers of Philips ETG for both markets based on the fact that the number of respondents and the respondent group restrict *generalisation* of the outcomes. However, literature indicated that the social and cognitive competencies are found in different studies and therefore provide the theoretical background of the model. The developed competency model can be further anchored within the organisation and market by follow-up research, in which different (potential) clients should be involved. However, the competency model will still be specific for engineers of Philips ETG and the market they are operating in.

Another recommendation is that a *larger respondent group* of the population should be included in the research in case the competency model should become applicable for the whole semiconductor or the medical device market. This investigation can focus on transforming the developed competency model into a general competency model for both markets. The general model can be used in case Philips

ETG wants to start operating in other aspects of the markets or start collaborating with other clients of both markets.

Last, in the theoretical chapter of this thesis the competency model of Delemare le Deist and Winterton (2005) is presented as the generic model for this research. In this model the functional, social, cognitive and meta-competencies are described. Meta-competencies were not taken into account in this research, because it was concluded that these competencies could only be developed when the functional, social and cognitive competencies were developed. These competencies are now explicit for Philips ETG and therefore, Philips ETG is recommended to research what meta-competencies an engineer needs to possess when working in the semiconductor and medical device market. However, this is only relevant when the functional, social and cognitive competencies of engineers of Philips ETG are developed.

11. Discussion and reflection

This chapter reflects on the methodological aspects, the usability of the competency model, the involvement of stakeholders and the implementation of the research. These aspects are discussed in the following paragraphs.

11.1 Methodological aspects

The methodological aspects that will be discussed in this paragraph are the data collection method, the selection of respondents, the analysis method and the reliability and validity. The data collection will be discussed first.

11.1.1 Data collection method

The chosen data collection method in this research was the interview, which provides the chance to collect information about people perspectives and ideas and allows retrieving in-depth information about the case (Patton, 1999). However, it can be questioned if this is the right method for all activities in the research. The respondents were interviewed, during the research, about their opinions and ideas of what competencies an engineer needs to possess in the semiconductor and medical device market, which is a rather subjective approach. Based on this reason, other data collection methods like a questionnaire could have been chosen for the refinement of the specific competency models. In that case more respondents could provide additional information about the competencies and therefore the developed specific competency models could be a better representation of competencies for the engineers of Philips ETG. In the refinement phase it was difficult to find respondents and therefore a questionnaire is considered as an inadequate method.
However, a questionnaire could have been of use for the refinement of the specific model of the semiconductor market, because more respondents could provide information about the specific competency models at the beginning of the research. The investigation of both cases was explorative, because not much information about social and cognitive competencies was available. This indicates that interviews were the best method to choose, because the interviews helped to retrieve in-dept information. This, next to the fact that it was difficult to select respondents in the refinement activity, supports the use of interviews as the best method to collect data.

11.1.2 Construction of interview protocols

The construction of the interview protocols was done according to the context of the work of an engineer and according to the competency research model. As described above, in interviews the respondents have the possibility to provide subjective, in-depth, and a great deal of information. Therefore, it can be discussed if the protocols were constructed in the right way and if the construction helped to retrieve all the social and cognitive competencies.
The interview protocol ‘work of an engineer’ of the semiconductor markets provides the respondents the opportunity to be subjective. However, the results from these interviews are compared with the results of the interviews with the use of the interview protocol ‘specific competency model’ and it was concluded that the results are almost the same. The interview protocol ‘specific competency model’ is based on literature about social and cognitive competencies and other research findings like the context of the work of an engineer. This is not the case for the interview protocol ‘work of an engineer’, which is constructed according to the context of the work of an engineer and the subjects the researchers wanted to investigate. However, based on the fact that the results of both interviews where quite the same, it can be concluded that the construction of the interview protocols was done to retrieve objective information, which covered the work and the competencies of an engineer.

11.1.3 Selection of respondents

In the research different viewpoints of respondents were retrieved, but it can be questioned if these viewpoints are a representation of the population, which play a role in this research. Next to this, it can be discussed if the respondents represent the population and if competencies were missed based on selection of respondents.
The small amount of respondents for both markets indicates that the specific competency model of both markets is only applicable for the specific situation of the engineers of Philips ETG working in the semiconductor market and working for Philips MS. In the semiconductor market the engineers themselves and a client of Philips ETG provided information about social and cognitive competencies. Also, other clients or even for example sales managers of Philips ETG could indicate other competencies. However, the research question focused on what engineers need to possess in a specific market and not on what the own organisation expects. Other clients could also provide other competencies, but in this research this was not possible based on the fact that other clients were located too far for the research or clients are not able to participate in the research. In the medical device market only a manager of Philips ETG was interviewed and one engineer and several managers of Philips MS. This indicates that the retrieved competencies are only applicable for engineers that work in projects for Philips MS. It was not possible to interview respondents from other potential clients in the medical device market, because no contacts were available for the researchers.

The engineers of semiconductor market, that were interviewed, were a representation of the population of engineers of Philips ETG, because eight out of 35 engineers participated in the research. These respondents have different functions and therefore this selection is a representation. However, the respondents that were selected for the education activity and the refinement activity are not a representation of the population. This is not a representation, because the amount of respondents is too small and the number of respondents in the population is not known. This indicates that the specific competency models and the final competency models are only applicable for the engineers of Philips ETG in both markets.

Based on these discussion points, it can be concluded that the retrieved competencies were included for this specific group. However, if other clients or managers of Philips ETG participated in the research it is possible that other competencies could be retrieved. This was not possible, because of time reasons and of lack of respondents or contacts. Therefore, the competency model is about the specific situation of an engineer of Philips ETG in the semiconductor or medical device market.

11.1.4 Data analysis method

The data analysis of the interviews with respondents from both markets was done during and after the interviews by the researchers separately and together. It can be questioned if this method is the best for the research and if the results can be interpreted differently.
The analysis of the answers of the respondents was done during the interviews by the researchers separately. This analysis helped to indicate if follow-up questions were needed. The retrieved information depends on the researcher as a person and could differ when other researchers conducted the interview. However, the interviews were based on interview protocols, which were constructed according to the literature and a context exploration. The goal of the interviews was clear for the researchers, the constructed interview protocols guided the interviews and follow-up questions were used to retrieve additional information. Therefore, the retrieved information could not differ a lot from when other researchers conducted the interviews.
The within-case analysis was done separately by the researchers and according to the analysis framework, which was made based on literature about social and cognitive competencies. The within-case analysis of both researchers resulted in similar outcomes, they agreed on most retrieved competencies. Based on fact that the researchers used the analysis framework and discussed the outcomes the similarities in outcomes indicate that the results were not interpreted differently during the data analysis.

For the medical device market the interview protocol 'specific competency model' and the analysis framework were used. Both were based on the literature study and the competency research model. Therefore, it can be questioned if the analysis of the results of the medical device market did not miss any competencies. In the analysis framework the category 'other' is used to describe competencies or phrases, which cannot be placed somewhere else in the framework. Also, questions were asked in the interviews to retrieve other competencies that were different from the literature study. However, it cannot be stated that all competencies were retrieved. An exploration of the context of the medical device market similar to the context exploration of the semiconductor market could have prevented this. However, the small amount of potential respondents restrained this.

11.1.5 Reliability and validity

The reliability and validity of the research is described in chapter 4. The internal reliability was secured by the separate analysis of the researchers whereas external reliability is not appropriate because the research cannot be repeated. Open interviews and especially the follow-up questions depend on the researchers. The research is described as internal valid although only for the group that was interviewed and external validity was not applicable, because the research could not be generalised based on the fact that it focused on specific organisations and markets. However, it is questioned if this research could have been made reliable and valid.
The research could can be external reliable when the research is repeated. This is the case when using for example a questionnaire. However, this was not applicable because interviews were indicated as the best method to use. Internal reliability was secured by the separate analysis of the researchers.
The research is already internal valid for the group that was researched, but not for the population. When the population was indicated, enough respondents can participate and another method to conduct the research can be used to cover internal reliability. However, these three could not be done for this research based on the fact that the research had an explorative character.
External validity could be applicable for the research when the competencies of engineers as occupational group are researched. However, this research was done for Philips ETG, which is a specific organisation that operates in a specific market. Therefore, this indicates that the research could be more reliable or valid, but then the research question would differ completely from the research question in this thesis.

11.2 Usability of the competency model

The final competency model, as presented in chapter 7, is a model in which all retrieved competencies are defined. This model provides the engineers and managers of Philips ETG a good overview of what an engineer needs to possess for the semiconductor and medical device market. Managing this final competency model is described in chapter 8. However, to manage this competency model right the managers and the engineers have to state if a (sub)-competency is available within a person or is developed well. This indicates that a scale should be used, which indicates different behaviour levels of a competency to point out if an engineer possesses a (sub)-competency or that it is should be further developed. Therefore, the (sub)-competencies should be made explicit according to the behaviour of an engineer to indicate the level in which the engineers possess the (sub)-competencies. To make the final competency model easy to use for the engineers and the managers of Philips ETG the assessment items should be described according to the behaviour, which help the engineers and managers to decide if a (sub)-competency is possessed or not. Therefore, it can be concluded that the competency model is of use for Philips ETG. However, the competencies should be described according to different levels of behaviour, which indicate to what extent an engineer possesses the competency.

11.3 Involvement and implementation

The research was done for Philips ETG in Almelo and Eindhoven and the researchers were located in Almelo. However, because of the fact that the target group was located in both locations it was concluded that all engineers should be involved in the research. Therefore, different research activities and presentations were done at Almelo and Eindhoven. Also, not only engineers but also managers of Almelo and Eindhoven were involved in the process, because the final competency model has to be implemented in both locations. However, during the research it was concluded that both locations are different from each other, because they differ in culture and also because of active participation of stakeholders in the research. This point outs that the managers of Philips ETG Almelo are involved in the process whereas the managers of Philips ETG Eindhoven do not participate actively even though they define the research as important. This is could not be prevented because the researchers worked at Almelo. The involvement of the managers and engineers of Philips ETG Eindhoven could have been higher when one of the managers was also the mentor of the researchers and when the researchers worked more at Eindhoven. This was not possible because of distance and time issues.

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Appendix 1: Social and cognitive competencies in literature

Table 38: Social Competencies retrieved from literature

Source	*Competencies*
Mallinckrodt and Wei (2005) Ministerie OCW (2000)	Social self-efficacy Collaborate Empathy Communicate Dealing with conflicts Having social contact
Taylor, Liang, Tracy, Williams and Seigle (2002)	Topics of the Social Skills Rating System: Cooperation Assertion Empathy Self-control
Vries (2001 in: Liikamaa, Koskinen and Vanharanta, 2003)	Cluster of social competencies for leaders: Influence Political awareness Empathy
Schakel and Smid (2005)	The behavioural competency model with six competency areas: *In the area of enterprise* Networking Oral communication; Oral presentation Written communication Listening Sensitivity Negotiating Teamwork Sociability *In the area of personality* Adaptability *In the area of motivation* Integrity Organisational loyalty

Table 39: Cognitive competencies retrieved from literature

Source	*Competencies*
Marlow, Bloss and Bloss (2000)	Reading (about knowledge that is needed for the job) Using steps for problem solving Decision making Understanding the perspective of others Understanding behavioural norms Self-awareness
Kallenberg (2000)	Knowledge of concepts Knowledge of methods and techniques Knowledge of rules and procedures Political sensitivity Anticipation
Cheetman and Chivers (1996)	Conceptual knowledge Procedural knowledge Contextual knowledge
Floor (2006)	Administrative sensitivity Conceptual flexibility Information analysis Interpersonal sensitivity Learning ability Aware of environment Ability to judge Problem analysing Self-development
Schakel and Smid (2005)	Sensitivity Problem analysing Organisational sensitivity Learning ability Self-development Vision
Toolsema (2003)	Making judgements Processing information Analysing information Making decisions Solving problems Thinking creatively Update and use relevant knowledge

Appendix 2: Interview protocol work of engineer (in Dutch)

Wij willen je graag bedanken voor de medewerking die je verleent aan onze afstudeeropdracht. Zoals we al op de bijeenkomst van 10 april/26 april hebben aangegeven gaat ons onderzoek over sociale en cognitieve competenties in de medische markt. In het interview zullen wij deze termen niet gebruiken. We zullen hier spreken over niet-technische competenties. Zoals je ziet, wordt het interview opgenomen en de geluidsopname wordt niet aan anderen gegeven.

Persoonlijke vragen

1. Wat is je functie?
2. Hoe lang heb je deze functie?
3. Welke opleiding heb je gedaan?

Semi-conductor markt

Wij willen nu ingaan op de niet-technische aspecten van het werk in de semi-conductor markt. Hierbij gaat het om benodigdheden/bekwaamheden die van belang zijn bij het uitvoeren van je werkzaamheden binnen deze markt.

Het werk als ingenieur

4. Zou je een omschrijving kunnen geven van belangrijke elementen uit je werk.
    a. Kun je daar voorbeelden van geven?
    b. Wat heb je in de praktijk geleerd wat je niet tijdens je opleiding hebt gehad?
    c. Wat kwam je tegen in de praktijk dat je niet verwacht had?

5. Zou je een goede ingenieur kunnen omschrijven aan de hand van hoe hij zich gedraagt
    a. Wat is belangrijk voor jou?
    b. Kun je een voorbeeld geven?

Wensen/eisen vanuit de markt en van de klant

6. Kun je het eerste contact met de klant omschrijven, hoe verloopt dat?
    a. Wat zijn de verwachtingen van de klant?
    b. Hoe ga je om met de verwachtingen?
    c. Hoe merk je wat de verwachtingen zijn?
    d. Wat vind je lastig in het contact met de klant

7. Zijn er ook algemene behoeftes die bij elke klant gevonden kunnen worden?

8. Hoe gaat het contact verder met de klant?
    a. Wat is belangrijk als het project loopt?
    b. Wat is belangrijk bij de afronding?

Samenwerken

9. Wat is belangrijk bij de samenwerking tijdens een project?
    a. Zijn er dingen die je lastig vind aan samenwerken met anderen?
    b. Wat heb je geleerd in de praktijk?

Verwachtingen management

10. Wat voor eisen stelt het management aan je ten aanzien van het werken in projecten?
    a. Kun je een voorbeeld geven?
    b. Wat vind je hieraan lastig?
    c. Wat vind je nuttig?
    d. Wat het je geleerd in de praktijk?

Leerbehoefte en leerervaringen

11. Welke leermogelijkheden worden je aangeboden bij Philips?
12. Waaraan heb je deelgenomen?
13. Waar heb je behoefte aan?
14. Wat zijn je ervaringen met het beoordelen van je ontwikkeling?

Medische markt

Wij willen het nu hebben over de medische markt.

15. Heb je ervaringen met deze markt?
16. Kun je grote verschillen aangeven ten aanzien van de niet-technische elementen tussen de medische markt en de semi-conductor markt?
17. Waarom zijn deze niet-technische aspecten anders?
18. Wat verwacht je dat het grootste verschil is tussen de huidige markt?

Afsluiting

19. Heb je nog andere opmerkingen/vragen met betrekking tot dit interview?
20. Heb je nog andere informatie die naar jou idee belangrijk is voor onze opdracht?

Wij willen je hartelijk bedanken voor je medewerking. Is het mogelijk dat wij nog om aanvullende informatie kunnen vragen wanneer we daar behoefte aan hebben? Het interview zal uitgewerkt worden en deze uitwerking wordt je voorgelegd. Je kunt dan aangeven of het verslag een goede weergave van het interview is.

Appendix 3: Interview protocol specific competency model semiconductor market (in Dutch)

Wij willen je graag bedanken voor de medewerking die je verleent aan onze afstudeeropdracht. Zoals we al op de bijeenkomst van 10 april/26 april hebben aangegeven gaat ons onderzoek over sociale en cognitieve competenties in de medische markt.
Zoals je ziet wordt het interview opgenomen en de geluidsopname wordt niet aan anderen gegeven. Heb je hier bezwaar tegen?

Persoonlijke vragen

1. Wat is je functie?
2. Hoe lang heb je deze functie?
3. Welke opleiding heb je gedaan?

Cognitieve competenties

1. Hoe ga je met de vraag van de klant aan de slag?
2. Wat voor kennis heb je nodig in dit proces?
3. Wat moet voor acties moet je wel of juist niet doen?
4. Wat voor kennis van de klant heb je nodig?
5. Wat moet je weten van de eigen organisatie?
6. Wat voor zelfkennis heb je nodig gedurende een project?
7. Hoe ben je bezig met ontwikkelen?
8. Zijn er ook nog andere aspecten belangrijk?

Sociale competenties

1. Wat voor sociale contacten heb je als engineer? (klant, management, collega's)
   a) Hoe moet je je gedragen bij de klant?
   b) Wat is er in het contact belangrijk om te weten?
   c) Zijn er nog specifieke acties die je hiervoor uitvoert?
2. Wat voor informele contacten gebruik je allemaal om je doel te bereiken?
3. Wat is er belangrijk tijdens de samenwerking? (Klant, eigen organisatie)
4. Wat is er belangrijk tijdens de communicatie naar de klant toe? (presenteren, mondelinge communicatie en schriftelijke communicatie?
5. Wat is er belangrijk tijdens de communicatie naar de eigen organisatie toe? (presenteren, mondelinge communicatie en schriftelijke communicatie?
6. In hoeverre moet je je kunnen inleven in een bepaalde situatie?
7. In hoeverre moet je je aanpassen aan een situatie?
8. Zijn er nog andere aspecten belangrijk?

Medische markt

Wij willen het nu hebben over de medische markt.

1. Heb je ervaringen met deze markt?
2. Kun je grote verschillen aangeven ten aanzien van de niet-technische elementen tussen de medische markt en de semi-conductor markt?
3. Waarom zijn deze niet-technische aspecten anders?
4. Wat verwacht je dat het grootste verschil is tussen de huidige markt?

Afsluiting

1. Heb je nog andere opmerkingen/vragen met betrekking tot dit interview?
2. Heb je nog andere informatie die naar jou idee belangrijk is voor onze opdracht?

Wij willen je hartelijk bedanken voor je medewerking. Is het mogelijk dat wij nog om aanvullende informatie kunnen vragen wanneer we daar behoefte aan hebben? Het interview zal uitgewerkt worden en deze uitwerking wordt je voorgelegd. Je kunt dan aangeven of het verslag een goede weergave van het interview is.

Appendix 4: Interview protocol specific competency model medical device market (in Dutch)

Wij willen je graag bedanken voor de medewerking die je verleent aan onze afstudeeropdracht. Onze afstudeeropdracht gaat over de sociale en cognitieve competenties die een ingenieur moet bezitten om in de semi-conductor markt en medische markt goed te kunnen functioneren. Heb je er bezwaar tegen als het interview opgenomen wordt? Deze opname zal niet aan anderen gegeven worden.

Persoonlijke vragen

1. Kun je aangeven wat voor werk je precies doet?
2. Kun je de medische markt omschrijven?
3. Wat doet een ingenieur precies voor werk in de medische markt?

Cognitieve competenties

We willen het nu hebben over de cognitieve competenties. Hierbij is het belangrijk dat je aangeeft welke kennis een ingenieur moet bezitten.

4. Hoe gaat de ingenieur met de vraag van de klant aan de slag?
    a. Wat voor kennis heeft hij nodig in dit proces?
    b. Wat moet voor acties moet je wel of juist niet doen?
    c. Wat voor kennis van de klant heeft de ingenieur nodig?
    d. Wat moet de ingenieur weten van de eigen organisatie?
    e. Wat voor zelfkennis is nodig gedurende een project?
    f. Hoe moet de ingenieur zichzelf ontwikkelen?
    g. Zijn er ook nog andere aspecten belangrijk?

Sociale competenties

Nu willen we het hebben over de sociale competenties van een ingenieur. Het is hierbij belangrijk dat je aangeeft welke vaardigheid een ingenieur moet hebben.

5. Wat voor sociale contacten heeft een ingenieur? (klant, management, collega's)
    a. Hoe moet hij zich gedragen bij de klant?
    b. Wat is er in het contact belangrijk om te weten?
    c. Zijn er nog specifieke acties die je hiervoor uitvoert?
6. Wat voor informele contacten moet de ingenieur gebruiken om het doel te bereiken?
7. Wat is er belangrijk tijdens de samenwerking? (Klant, eigen organisatie)
8. Wat is er belangrijk tijdens de communicatie naar de klant toe? (presenteren, mondelinge communicatie en schriftelijke communicatie?
9. Wat is er belangrijk tijdens de communicatie naar de eigen organisatie toe? (presenteren, mondelinge communicatie en schriftelijke communicatie?
10. In hoeverre moet de ingenieur zich kunnen inleven in een bepaalde situatie?
11. In hoeverre moet de ingenieur zich kunnen aanpassen aan een situatie?
12. Zijn er nog andere aspecten belangrijk?

Afsluitende vragen

13. Kun je de grootste verschillen tussen de medische en de semi-conductor markt aangeven?
14. Kun je het grootste verschil tussen een ingenieur uit de medische en de semi-conductor markt noemen?
15. Heb je nog tips die ons verder kunnen helpen met dit onderwerp?

Wij willen je hartelijk bedanken voor je medewerking. Is het mogelijk dat wij nog om aanvullende informatie kunnen vragen wanneer we daar behoefte aan hebben? Het interview zal uitgewerkt worden en deze uitwerking wordt je voorgelegd. Je kunt dan aangeven of het verslag een goede weergave van het interview is.

Appendix 5: Interview protocol education (in Dutch)

Wij willen je graag bedanken voor de medewerking die je verleent aan onze afstudeeropdracht. Deze opdracht gaat over de sociale en cognitieve competenties die een ingenieur van Philips Enabling Technologies Group moet bezitten om in de medische markt te kunnen werken.

Sociale competentie: de bereidheid en bekwaamheid om relaties te vormen, om voordelen en spanningen te identificeren en om interactie te hebben met anderen in een rationele en gewetensvolle manier.
Cognitieve competentie: het bezit van geschikte werk gerelateerde kennis en de bekwaamheid om dit effectief te gebruiken.

In het onderzoek zullen wij deze competenties als niet-technische competenties definiëren. Wat wij graag van jou zouden willen weten is welke competenties er vanuit de opleiding zijn geformuleerd voor afgestudeerde TG/BMT-er. Daarbij willen wij ons dus richten op de niet-technische competenties. Daarnaast willen we graag meer weten over belangrijke aspecten van de medische markt.

Doel: het achterhalen welke competenties een TG/BMT-er moet verwerven tijdens zijn opleiding. Daarnaast achterhalen wat belangrijke elementen van de medische markt zijn.

Vragen

Competenties

1. Kun je kort de opleiding beschrijven?
2. Wat is je functie precies?

Uitleg van het onderzoek

Medische markt

3. Welke competenties binnen jullie competentieprofiel zou jij daar voor nodig achten?
4. Heb je nog andere ideeën van competenties die daarvoor nodig zijn?
5. Welke niet-technische competenties leren studenten nog meer binnen de opleiding?
6. Welke onderwijsmethoden bieden jullie aan?
7. Hoe meten jullie de competenties?
8. Kun je de medische markt waarin een TG/BMT-er functioneert beschrijven?
9. Wat zouden daarin belangrijke richtlijnen zijn voor de ingenieur van Philips ETG?

Is de geïnterviewde ingegaan op de competenties omgaan met verschillende actoren en omgaan met relaties in het werkveld?

Wij willen je hartelijk bedanken voor je medewerking. Is het mogelijk dat wij nog om aanvullende informatie kunnen vragen wanneer we daar behoefte aan hebben? Het interview zal uitgewerkt worden en deze uitwerking wordt je voorgelegd. Je kunt dan aangeven of het verslag een goede weergave van het interview is.

Appendix 6: Interview protocol refinement specific competency model semiconductor market (in Dutch)

Wij willen je hartelijk bedanken voor medewerking aan ons onderzoek. Het onderzoek richt zich op de sociale en cognitieve competenties die een ingenieur van Philips ETG moet bezitten om in de semi-conductor markt te kunnen werken. Aan de hand van een aantal interviews met ingenieurs hebben wij een competentie model opgesteld waarin deze competenties beschreven staan. Graag zouden we willen achterhalen of deze competenties kloppen vanuit het perspectief van de klant.

Persoonlijke vragen

1. Wat is je functie?
2. Hoe heb je contact met de ingenieurs van ETG?

Het competentie model met alleen de sociale competenties tonen en per onderdeel een korte uitleg geven (de klant heeft het model van tevoren kunnen inzien).

Sociale competenties

3. Bestaat netwerken voor een ingenieur uit deze onderdelen?
   Zo ja, wat mis je? Zo nee, zou je de competenties specifieker kunnen maken?
4. Bestaat het samenwerken van de ingenieur uit deze onderdelen?
   Zo ja, wat verwacht je als klant? Zo nee, zou je de competentie als klant nog specifieker kunnen maken?
5. Moet de ingenieur zich op deze aspecten flexibel opstellen?
   Zo ja, zijn er nog andere elementen? Zo nee, op welke dan nog meer?
6. Zijn deze onderdelen de communicatievaardigheden die een ingenieur moet bezitten?
   Zo ja, zijn er nog andere elementen (schriftelijke communicatie)? Zo nee, in hoeverre moet een ingenieur schriftelijk communiceren?
7. Bestaat het managen van projecten uit deze onderdelen?
   Zo ja, wat mis je? Zo nee, zou je de competenties specifieker kunnen maken?

Het competentiemodel met de cognitieve competenties tonen. In geval van tijdsdruk: hierbij beschrijven dat we de kennis als eerste specifieker willen maken en daarom bespreken we deze eerst.

Cognitieve competenties

8. Zijn dit de competenties die een ingenieur moet bezitten op het gebied van kennis van de eigen organisatie? Zo nee, welke mis je nog? Zo ja, zou je precies kunnen beschrijven bij elk onderdeel wat jij als klant belangrijk vindt dat de ingenieur moet weten van de eigen organisatie?
9. Zijn dit de competenties die een ingenieur moet bezitten op het gebied van kennis van de klant? Zo nee, welke mis je nog? Zo ja, zou je precies kunnen beschrijven bij elk onderdeel wat jij als klant belangrijk vindt dat de ingenieur moet weten van de klant?
10. Zijn dit de verwachtingen waaraan een ingenieur moet voldoen met betrekking tot het oplossen van een probleem?
    Zo ja, wat mis je? Zo nee, zou je de competenties specifieker kunnen maken?
11. Moet de ingenieur goed conceptueel kunnen denken?
    Zo ja, kun je de competentie uitbreiden? Zo nee, waarom niet?
12. Moet een ingenieur zich bewust zijn van zichzelf en anderen?
    Zo ja, wat mis je nog bij de competenties? Zo nee, waarom niet?
13. Moet de ingenieur zichzelf kunnen ontwikkelen?
    Zo ja, gebruikt hij daar nog andere competenties voor? Zo nee, waarom niet?

Afsluiting

14. Zijn er nog andere competenties die je mist in het competentie model waarvan je echt vind dat de ingenieur deze moet bezitten?
15. Heb je nog andere opmerkingen/vragen met betrekking tot dit interview?

Wij willen je hartelijk bedanken voor je medewerking. Is het mogelijk dat wij nog om aanvullende informatie kunnen vragen wanneer we daar behoefte aan hebben? Het interview zal uitgewerkt worden en deze uitwerking wordt je voorgelegd. Je kunt dan aangeven of het verslag een goede weergave van het interview is.

Appendix 7: Interview protocol refinement specific competency model medical device market (in Dutch)

Wij willen je hartelijk bedanken voor de medewerking aan ons onderzoek. Het onderzoek richt zich op de sociale en cognitieve competenties die een engineer van Philips ETG moet bezitten om in de medische markt te kunnen werken. Aan de hand van een aantal interviews met medewerkers van Philips Medical Systems hebben wij een competentie model opgesteld waarin deze competenties beschreven staan. Graag zouden we willen achterhalen of deze competenties kloppen vanuit het perspectief van een engineer die in de medische markt werkt.

Persoonlijke vragen

1. Wat houdt je functie precies in, welke werkzaamheden voer je uit?

Het competentie model met alleen de sociale competenties tonen.

Sociale competenties

2. Bestaat netwerken voor een ingenieur uit deze onderdelen?
   Zo ja, wat mis je? Zo nee, zou je de competenties specifieker kunnen maken?
3. Bestaat het samenwerken van de ingenieur uit deze onderdelen?
   Zo ja, welke methodes gebruik je allemaal? Zo nee, zou je de competentie nog specifieker kunnen maken?
4. Zijn deze onderdelen de communicatievaardigheden die een ingenieur moet bezitten?
   Zo ja, kun je ze nog specifieker maken? Zo nee, welke mis je nog?
5. Bestaat het inleven voor een ingenieur in de medische markt uit deze onderdelen?
   Zo ja, kun je ze nog specifieker maken? Zo nee, welke mis je nog?
6. Bestaat het managen van projecten uit deze onderdelen?
   Zo ja, wat mis je? Zo nee, zou je de competenties specifieker kunnen maken?
7. Moet een ingenieur zich kunnen aanpassen gedurende zijn werk?
   Zo ja, hoe dan? Zo nee, waarom niet?

Het competentiemodel met de cognitieve competenties tonen. In geval van tijdsdruk: hierbij beschrijven dat we de kennis als eerste specifieker willen maken en daarom bespreken we deze eerst.

Cognitieve competenties

8. Zijn dit de competenties die een ingenieur moet bezitten op het gebied van kennis van de eigen organisatie? Zo nee, welke mis je nog? Zo ja, zou je precies kunnen beschrijven bij elk onderdeel wat jij als klant belangrijk vindt dat de ingenieur moet weten van de eigen organisatie?
9. Zijn dit de competenties die een ingenieur moet bezitten op het gebied van kennis van de klant? Zo nee, welke mis je nog? Zo ja, zou je precies kunnen beschrijven bij elk onderdeel wat jij als klant belangrijk vindt dat de ingenieur moet weten van de klant?
10. Zijn dit de competenties die een ingenieur moet bezitten op het gebied van kennis van de medische wereld? Zo nee, welke mis je nog? Zo ja, zou je precies kunnen beschrijven bij elk onderdeel wat jij als klant belangrijk vindt dat de ingenieur moet weten van de klant?
11. Zijn dit de verwachtingen waaraan een ingenieur moet voldoen met betrekking tot het oplossen van een probleem?
    Zo ja, wat mis je? Zo nee, zou je de competenties specifieker kunnen maken?
12. Moet de ingenieur goed conceptueel kunnen denken?
    Zo ja, kun je de competentie uitbreiden? Zo nee, waarom niet?
13. Moet een ingenieur zich bewust zijn van zichzelf en anderen?
    Zo ja, wat mis je nog bij de competenties? Zo nee, waarom niet?

14. Moet de ingenieur zichzelf kunnen ontwikkelen?
    Zo ja, gebruikt hij daar nog andere competenties voor? Zo nee, waarom niet?

Afsluiting

15. Zijn er nog andere competenties die je mist in het competentie model waarvan je echt vind dat de ingenieur deze moet bezitten?
16. Heb je nog andere opmerkingen/vragen met betrekking tot dit interview?

Wij willen je hartelijk bedanken voor je medewerking. Is het mogelijk dat wij nog om aanvullende informatie kunnen vragen wanneer we daar behoefte aan hebben? Het interview zal uitgewerkt worden en deze uitwerking wordt je voorgelegd. Je kunt dan aangeven of het verslag een goede weergave van het interview is.

Appendix 8-13 are not included in this report.

Appendix 14: Analysis framework

Name Interviewee:

Social competencies		
Competency	*Rule number*	*Description*
1. Social contacts • Self-efficacy		
2. Networking • Network in own organisation • Network in organisation of client • Sociability		
3. Collaboration		
4. Communication • Oral communication • Oral presentation • Written communication • Listening • Sensitivity • Negotiating		
5. Empathy		
6. Adaptability		
7. Other competencies		

Cognitive competencies		
Competency	*Rule number*	*Description*
1. Problem solving • Information analysis • Anticipation • Decision making • Analysing problems		
2. Using different kinds of knowledge and being flexible with that knowledge • Conceptual • Contextual • Procedural		
3. Self-development • Learning ability		
4. Awareness • Self awareness • Interpersonal sensitivity • Aware of environment • Sensitivity		
5. Knowledge of others and himself • Knowledge of own organisation • Knowledge of the client • Self-knowledge		
6. Other competencies		

Description competencies

Social competencies

Social contacts:	Being able to manage social contacts
Self-efficacy*):	One can initiate social contact and develop new friendships from initial acquaintances
Networking:	To construct a network, which is useful to achieve objectives
Network in own organisation*):	To construct a network in the own organisation which is useful to achieve objectives
Network in organisation of client*):	To construct a network in the organisation of the client, which is useful to achieve objectives
Sociability*):	Mingling effortlessly with other people
Collaboration:	The ability to collaborate within the work setting
Communication:	Being able to communicate
Oral communication*):	Conveying ideas and opinions clearly to others, making use of unambiguous language, gestures and non-verbal communication; adapting language and terminology
Oral presentation*):	Presenting ideas and facts clearly, making use of appropriate aids; tailoring presentation to needs of audience
Written communication*):	Expressing ideas and opinions clearly in properly structured, well-organised and grammatically correct reports or documents utilising language and terminology appropriate to the reader
Listening*):	The capacity to pick up significant information from verbal communication, asking questions and investigate reactions
Sensitivity*):	Showing to be aware of people and the environment and one's own influence on both
Negotiating*):	Communicating one's own standpoints and arguments effectively and pointing out common goals in a manner leading to agreement and acceptance by all parties
Empathy:	Transferring in the perception of others
Adaptability:	Maintaining effectiveness by changing to circumstances, tasks, responsibilities and people

Cognitive competencies

Problem solving:	The analysis and solving of problems in different situations to achieve the set goal
Information analysis*):	
Anticipation*):	To recognise critical situations and react to it effectively to prevent problems by taken measures in time
Decision-making*):	To make decisions by taking actions or giving opinions
Problem analysis*):	Identifying of problems, recognising of information, making connections between data and finding causes, tracing causes of problems and investigating relevant data

Using different kinds of knowledge and being flexible with that knowledge	Use different kind of knowledge and have the ability to put this knowledge into effective use
Conceptual knowledge*):	Building thinking frameworks or models, the formulation of multiple concepts and hypothesis or ideas on the base of complex information
Contextual knowledge*):	A set of features, and environment, or setting within which a learner makes connections, comparisons and analogies
Procedural knowledge*):	The knowledge about how to perform a task
Self-development:	Possessing insight into one's strengths and weaknesses and on this basis initiate activities to increase/enhance one's knowledge, skills and competencies in order to perform more effectively
Learning ability*):	The absorption of new information and ideas and applying them effectively
Awareness:	Human perception and cognitive reaction to a condition or event
Self-awareness*):	The recognition of own personality, strengths and weaknesses and own likes and dislikes
Interpersonal sensitivity*):	The behaviour that shows the recognition of feelings and needs of others, transferring in the other person and shows understanding of own behaviour
Awareness of environment*):	Being informed in social, political and economical developments or other environmental factors and using this information for the work
Sensitivity*):	Showing oneself to be aware of other people and the environment one's own influence on both and reflecting recognition of the feeling of others
Knowledge of the others and himself:	Understanding the perspective of other and himself
Knowledge of own Organisation*):	Recognising the needs and interests of others of the organisation and take this information into account
Knowledge of the client*):	Recognising the needs and interests of the client and to take this information into account
Self-knowledge*):	Recognising the needs and interests of his own and takes this information into account

*) Sub-competency

Appendix 15: Within-case analysis semiconductor market (in Dutch)

Table 40: Within-case analysis of social competencies semiconductor market (in Dutch)

(Sub)-competentie	*Persoon A*	*Persoon B*	*Persoon C*	*Persoon D*	*Persoon E*	*Persoon F*	*Persoon G*	*Persoon H*
Sociale contacten	Klant koesteren, klant vasthouden, informeel contact, interne contacten	Klant bezoeken, klant koesteren, relatie opbouwen, contact onderhouden (onderwijs en klant)	Met monteurs omgaan,	Je gezicht laten zien, het gaat om dialoog tussen Philips en klant, instant houden van relatie, band collega's goed houden	Relatie opbouwen met klant	Klanttevredenheid, contact met toeleveranciers, management en klanten, ondersteunen van klanten, klant indruk geven dat je alles voor hem doet, nauw contact hebben, onderhouden relaties	Geïnteresseerd zijn, contact onderhouden, relaties met collega's opbouwen	Belang contact niet uit het oog verliezen, imago ophouden, betrouwbaar overkomen, informeel contact
Vertrouwen op sociaal gebied	Sociaal praatje							
Netwerk in eigen organisatie	Interne contacten bijhouden		Collega's om advies vragen of specifieke vragen stellen	Evalueren wat je aan relatie hebt	Gebruik maken van kennis in anderen, expertise en specialisme collega's kennen	Kennissenkring voor oplossingen, onderhouden relaties	Netwerk onderhouden, iets terug doen,	Expertise ander weten
Netwerken in organisatie van de klant	Signalen van de klant oppikken, praten met klant om binnen komen	Achter projecten komen		Evalueren wat je aan relatie hebt	Gebruik maken van kennis in anderen, acquisitie	Onderhouden relaties	Netwerk onderhouden, iets terugdoen	
Sociaal zijn	Sociaal praatje							

(Sub)-competentie	*Persoon A*	*Persoon B*	*Persoon C*	*Persoon D*	*Persoon E*	*Persoon F*	*Persoon G*	*Persoon H*
Samenwerken	Aansturen, aanjagen, motiveren, binnen grenzen werken, taakgericht, mensen laten meedenken, mening geven, reviewen, laten zien wat je doet	Van elkaar leren, kennis overdracht	Reviewen, afspraken vastleggen, niet opjagen, klant op hoogte houden, samen naar oplossingen zoeken, positief zijn	Gezamenlijk problemen oplossen, ideeën overdragen, mensen deelgenoot van probleem maken, terugkoppelen, ideeën valideren	Oplossing afstemmen met klant, meedenken, ideeën genereren, reviewen, voorstellen doen, werken met verschillende collega's	Verschilt met klant of engineer, eerlijk zijn, diplomatiek, realistisch, aftemmen op elkaar	Wisselwerking beide partijen, terugkoppelen, samen oplossen, aanspreken op werk, discussiëren, brainstormen, terugkoppelen, positief beeld van ETG schetsen,	Samen een oplossing vinden, informatie delen, draagvlak creëren, aangeven dat je iets niet begrijpt, niet uitstralen dat je alles weet bij samenwerken met klant
Mondelinge communicatie	Aandacht besteden aan waar klant mee bezig is, niet alles zeggen, vragen stellen, kort en krachtig vertellen, uitleggen	Overtuigen, telefoon, face-to-face	Discussiëren, eigen mening geven, duidelijk zijn in communicatie	Rolverdeling tijdens gesprek kennen, vragen stellen, terugkoppelen, samenvatten, benoemen	Uitgangspunten vastleggen, laten zien dat je het begrijpt, afspraken vastleggen, benoemen en terugkoppelen	Formeel afspraken maken, overleggen, vloeiend communiceren, oplossing aandragen	Afspraken maken, mening beargumenteren, vraag terugspelen, telefonisch, conference call, vragen stellen, discussiëren	Overtuigen, reëel beeld schetsen, zeggen wanneer je iets niet begrijpt, samenvatten, terugkoppelen, vragen stellen, feedback vragen, gedachtegang formuleren
Mondelinge presentatie	Presentaties geven						Collega's informeren door presentatie, korte sheets	
Schriftelijke communicatie		E-mail	E-mail				Schriftelijk, e-mail,	Alles goed opschrijven
Luisteren	Signalen klant oppikken		Naar ideeën luisteren	luisteren	luisteren		Luisteren, mimiek en lichaamstaal interpreteren	Luisteren
Sensitiviteit			Projectleden in waarde laten	Letten op reactie, niet op persoon gooien		Mensen in hun waarde laten, rekening houden met anderen	Laten zien dat je waarde hecht aan mening ander	
Onderhandelen	Mening geven							

(Sub)-competentie	*Persoon A*	*Persoon B*	*Persoon C*	*Persoon D*	*Persoon E*	*Persoon F*	*Persoon G*	*Persoon H*
Inlevingsvermogen	Doorgronden gedrag ander, functie inschatten, interesses wekken, rekening houden met associaties	Achter problemen klant komen, inleven in commitment		Openstaan voor andere ideeën, gedachten en belangen begrijpen	Inschatten wie je tegenover je hebt, inleven in de ander en in verschillend niveau	Inschatten van de klant, inleven in anderen	Inleven in collega en klant, kunnen verplaatsen in ander, inspelen op situatie, naar interesses vragen	Interesse tonen, ander gevoel geven dat hij niet dom is, inleven in wat de klant wil en verwacht
Aanpassingsvermogen	Gedrag aanpassen, aan proces aanpassen, rekening houden met associaties, taal aanpassen	Aan niveau aanpassen	Geen interne informatie verstrekken, flexibel zijn,	Aanpassen aan interesses klant en wensen van de klant, aanpassen aan rol gesprek	Aanpassen aan situatie, aanpassen communicatie, aanpassen aan belang organisatie	Aanpassen aan persoon tegenover je, aanpassen aan rol die je hebt, aanpassen aan niveau	Aanpassen aan rol per setting	Aanpassen aan situatie
Overige	Project leiding, verloop project, toekomstgericht	Project leiding, prioriteiten stellen, verantwoordelijkheden nemen	Prioriteiten stellen, weerstand kunnen bieden,		Laten zien wat je in huis hebt	Laten zien wat je in huis hebt	Kosten, tijd en kwaliteitsbewust zijn	Ondernemerschap, risico's inschatten en nemen, geen betweter zijn,

Table 41: Within-case analysis cognitive competencies semiconductor market (in Dutch)

(Sub)-competentie	*Persoon A*	*Persoon B*	*Persoon C*	*Persoon D*	*Persoon E*	*Persoon F*	*Persoon G*	*Persoon H*
Informatie analyse				Problemen benoemen en ranken, hulpbronnen analyseren	Weten waar je rekening mee moet houden, inschatten oplossingen, de vraag begrijpen		Vraag verhelderen, vraag begrijpen	
Anticiperen	Vooruit kunnen denken	Snel reageren, nadenken over mogelijke oplossingen	Niet te ingewikkeld willen zijn		Oplossing is persoonsafhankelijk		Controle of vraag begrepen is, anticiperen op situatie	
Beslissen	Makkelijke oplossing vinden	Snel reageren op wensen klant	Keuzes maken		Beslissingen kunnen nemen, kunnen improviseren		Probleem managen, oplossen of uitbesteden	
Probleem analyse	Associaties leggen, van andere kant bekijken, link leggen	Het gehele proces overzien	Pragmatisch werken, simpele oplossingen bedenken	Weten wat de klant echt wil, analyseren en valideren van het probleem	Inzicht impact vraag	Oplossingen vinden, realistische kijk, verhaal oplossing probleem duidelijk maken	Oplossingen bedenken om probleem te verduidelijken, analyseren of vraag goed begrepen is	
Conceptueel	Conceptueel denken	Overzicht hebben			Conceptueel denken			
Contextueel	Weten wat iets opbrengt en oplevert	Aspecten van het product kennen	Kennis hebben van het werken in projecten,		Kennis hebben van de kosten, kennis hebben van de branche	Kosten project weten, kennis hebben van product en project	Kosten, betrouwbaarheid en eenvoud kennen	
Procedureel		Laatste ontwikkelingen kennen	Ontwerpkeuzes maken	Techniek kennen, machine begrijpen	Technische kennis, kennis hebben van projectmatig en systematische werken	Machine kennen, product kennen	Technologie kennen, functie machine kennen	

(Sub)-competentie	*Persoon A*	*Persoon B*	*Persoon C*	*Persoon D*	*Persoon E*	*Persoon F*	*Persoon G*	*Persoon H*
Zelfontwikkeling	Zoeken naar wat je nodig hebt, leren in de praktijk	Continuïteit is belangrijk voor technologische ontwikkeling	Kijken naar wat nodig is, overleggen met anderen	Evalueren	Kritisch zijn, eigen gedrag analyseren en aan werken, reflecteren	Eigen ontwikkeling bijhouden, techniek bijhouden, willen leren, zelf analyse	Tijd stoppen in verbeteren zwakke punten, per rol weten waaraan je jezelf moet ontwikkelen	
Leervermogen	Beurzen bezoeken, literatuur lezen	Buiten eigen vakgebied kennis opdoen		Het beestje kun je niet veranderen, cursussen, internet, contact groepen	Cursussen, gebruik van computer	Zoeken naar leren, gebruik internet		Gebruik van internet, feedback vragen
Zelf-bewustzijn	Eigen sterktes en zwaktes kennen, inschatten van jezelf en anderen			Impact gedrag terugkoppelen	Laten zien wat je te bieden hebt, laten zien wat je wel of niet kan		Eigen sterke en zwakke punten zien, weten wat je zelf wel en niet kan, eigen rol kennen per gesprek	Sterke en zwakke punten kennen, kunnen aangeven wat je wel en niet kan
Interpersoonlijke sensitiviteit	Bewust aanpassen aan mensen, andere personen inschatten		Enthousiasme overbrengen	Weten wat anderen kunnen en dit eruit halen, betrokken krijgen, erkennen wat ze doen, open staan voor anderen, belangstelling tonen				Reflecteren op contacten, opstellen zoals je bent
Bewust van de omgeving								

(Sub)-competentie	*Persoon A*	*Persoon B*	*Persoon C*	*Persoon D*	*Persoon E*	*Persoon F*	*Persoon G*	*Persoon H*
Sensitiviteit	Doorgronden waarom iemand zich zo gedraagt, sterkten en zwakten ander weten, grenzen van anderen kennen	Weten wat mensen kunnen	Leden in hun waarde laten, laten merken dat kennis en inzet gewaardeerd worden, laten merken dat je zaken aanneemt, respect hebben	Duidelijk zeggen wat je wel of niet kan, wat je wel of niet weet, open staan voor anderen, belangstelling tonen	Om kunnen gaan met verschillende mensen, inschatten van mensen, laten zien dat je luistert, weten wat anderen kunnen, sterke/zwakke punten ander kennen	Vertrouwen hebben in de ander, letten op mening anderen, mensen in hun waarde laten, rekening houden met anderen, kwaliteiten zien en deze benutten	Sterke punten anderen zien, weten wat voor sterke en zwakke punten er in het team zitten, waarde hechten aan andermans mening, informeren naar zaken die anderen interesseert, leefomgeving ander kennen	Interesse tonen en laten blijken
Kennis van de eigen organisatie	Weten wie de juiste contactpersonen zijn, doel relaties kennen, cultuur kennen, markt kennen, inzicht hebben in wat er speelt, sterke punten markt kennen	Weten hoe alle werkt binnen de organisatie, weten welke mensen nodig zijn en waar deze te vinden zijn	Weten welke kennis je kan verspreiden en welke niet	Welke belangen spelen een rol, weten wie de klant is, interne processen, weten wie de ander is	Laten zien wat je te bieden hebt, eigen organisatie en belangen kennen, collega's en management kennen	Visie ETG kennen, weten wat je kan vertellen over ETG, weten wie je waar voor in kan schakelen	Weten wat concurrenten doen, interne kennis hebben, informatie over concurrenten weten, competenties en capaciteiten kennen, faciliteiten kennen, weten wat ETG nodig heeft van de klant	Weten wat ETG doet, reëel beeld hebben van het bedrijf

(Sub)-competentie	*Persoon A*	*Persoon B*	*Persoon C*	*Persoon D*	*Persoon E*	*Persoon F*	*Persoon G*	*Persoon H*
Kennis van de organisatie van de klant	Weten wat de klant vraagt, weten wie de juiste contactpersonen zijn, doel relaties kennen, cultuur kennen, weten waar de klant mee bezig is, voorwerk doen, proces kennen, markt kennen, inzicht hebben in wat er speelt, sterke punten markt kennen	Weten hoe alles werkt binnen de organisatie, interesses klant kennen, beeld hebben van potentiële behoeftes		Welke belangen spelen een rol, weten wie de klant is, interne processen, weten wie de ander is, weten wat je wel/niet kan zeggen	Weten wat de klant wil, cultuur klant kennen, klant kennen	Prioriteiten klant kennen, scoringskans klant kennen, het bedrijf kennen, de persoon kennen, voorwerk doen	Business en product klant kennen, inzicht toekomst klant kennen, weten wat concurrenten doen, weten wat de klant wil, kennis van persoon tegenover je, weten waarom ze voor ETG kiezen	Intentie klant kennen, gebied en marktpositie kennen, product van de klant kennen, doel kennen, machine kennen
Zelfkennis	Eigen sterktes en zwaktes kennen					Weten wat je kan en niet kan	Eigen sterke en zwakke punten zien, weten wat je zelf wel en niet kan	Eigen sterke en zwakke punten kennen, Sterke punten collega's kennen
Overig	Flexibel zijn in tijdsbesteding, bereikbaarheid en afspraken, enthousiasme	Aansturen, voorwaarden scheppen, enthousiasme, niet te veel druk uitoefenen mensen motiveren, commitment creëren	Projectaanpak, projectmanagement, flexibel zijn, vertrouwen creëren, projectleider zijn, mensen aanspreken om zich aan afspraken te houden	Vertrouwen kweken, handelen naar verschillende rollen	Grote lijnen uitzetten in project, improvisatie, grote lijnen project uitzetten, plannen, kostenbewust, voorbereiden	Project management, plannen, grote lijnen uitzetten, prioriteiten stellen, projectleider moet ervoor zorgen dat de engineers het werk doen	Positief zijn over de organisatie, geen betweter zijn	Expertise laten blijken, senioriteit uitstralen

Table 42: Social (sub)-competencies semiconductor market present in interviews (in Dutch)

	Respondent							
(Sub)-competentie	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*
Sociale contacten	1	1	1	1	1	1	1	1
Vertrouwen op sociaal gebied	1	0	0	0	0	0	0	0
Netwerk in eigen organisatie	1	0	1	1	1	1	1	1
Netwerken in organisatie van de klant	1	1	0	1	1	1	1	0
Sociaal zijn	1	0	0	0	0	0	0	0
Samenwerken	1	1	1	1	1	1	1	1
Mondelinge communicatie	1	1	1	1	1	1	1	1
Mondelinge presentatie	1	0	0	0	0	0	1	0
Schriftelijke communicatie	0	1	1	0	0	0	1	1
Luisteren	1	0	1	1	1	0	1	1
Sensitiviteit	0	0	1	1	0	1	1	0
Onderhandelen	1	0	0	0	0	0	0	0
Inlevingsvermogen	1	1	0	1	1	1	1	1
Aanpassingsvermogen	1	1	1	1	1	1	1	1

Table 43: Cognitive (sub)-competencies semiconductor market present in interviews (in Dutch)

	Respondent							
(Sub)-competentie	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*
Informatie analyse	0	0	0	1	1	0	1	0
Anticiperen	1	1	1	0	1	0	1	0
Beslissen	1	1	1	0	1	0	1	0
Probleem analyse	1	1	1	1	1	1	1	0
Conceptueel	1	1	0	0	1	0	0	0
Contextueel	1	1	1	0	1	1	1	0
Procedureel	0	1	1	1	1	1	1	0
Zelfontwikkeling	1	1	1	1	1	1	1	0
Leervermogen	1	1	0	1	1	1	0	1
Zelfbewustzijn	1	0	0	1	1	0	1	1
Interpersoonlijke sensitiviteit	1	0	1	1	0	0	0	1
Bewust van de omgeving	0	0	0	0	0	0	0	0
Sensitiviteit	1	1	1	1	1	1	1	1
Kennis van de eigen organisatie	1	1	1	1	1	1	1	1
Kennis van de organisatie van de klant	1	1	0	1	1	1	1	1
Zelfkennis	1	0	0	0	0	1	1	1

Appendix 16: Within-case analysis medical device market (in Dutch)

Table 44: Within-case analysis of social competencies medical device market (in Dutch)

(Sub)-competentie	*Persoon J*	*Persoon K*	*Persoon L*	*Persoon M*
Sociale contacten	Openheid, vertrouwen, relatie opbouwen, eerlijkheid, ander inschatten, contacten in project settingen, open-minded	Van elkaar op aan kunnen, vertrouwen opbouwen en vasthouden	Relaties aangaan en onderhouden, frequent contact is belangrijk, contactpersoon moet 1 klant zijn, persoonlijke relatie moet goed zijn, informeel contact, dolletje kunnen maken	Klant op de hoogte houden
Vertrouwen op sociaal gebied				
Netwerk in eigen organisatie	Reflecteren op relatie, netwerk om problemen te verhelpen, intern netwerk kennen, weten met wie te communiceren om doel te bereiken	Regelen binnen ETG		
Netwerken in organisatie van de klant	Netwerk gebruiken voor medische termen te achterhalen, reflecteren op relatie, eerlijkheid en openheid voor huidige en toekomstige relatie, termen specificaties achterhalen, relatie met klant staat of valt met manier waarop engineer acteert en zich opstelt, contact met klant, weten met wie te communiceren om doel te bereiken	Regelen bij anderen, contact onderhouden, relatie onderhouden	Netwerk om problemen te verhelpen	Relaties opbouwen en onderhouden
Sociaal zijn				

(Sub)-competentie	*Persoon J*	*Persoon K*	*Persoon L*	*Persoon M*
Samenwerken	Samenwerken met engineers klant, coachen, openstaan voor suggesties, afstemmen om product beste en efficiëntste manier te maken	Samen specificeren, gebruik maken van ervaringen, samenwerken met Philips MS, uitdagend voor de groep, wisselwerking om oplossing te vinden, voorstellen doen, meedenken, acties van beide kanten	In multidisciplinair team kunnen werken, wisselwerking tussen beide partijen, weten hoe je met mensen om kan gaan	De klant is de partner, actief participeren, zichzelf als lid van het team beschouwen, feedback geven aan Philips MS, tijdig respons geven aan Philips MS, klant op de hoogte houden
Mondelinge communicatie	Gesprekspartner, gedachtegang Philips MS volgen, discussie, vragen stellen, communiceren, keuzes verspreiden in de organisatie, toetsen, vaststellen of informatie is overgekomen	Goede communicatie-vaardigheden, goede vragen stellen, to-the-point, bondig, helder, samenvatten, checken of het goed begrepen is, a-politiek	Controleren of de vraag goed is begrepen, terugkoppelen, navragen, uitleg vragen, telefonisch contact, effecten formele communicatie weten	Kritische vragen stellen, doorvragen, terugkoppelen, feedback aan klant geven
Mondelinge presentatie	Opzet verspreiden in de organisatie, duidelijk informatie overbrengen, feedback geven, inspelen, benoemen, presentaties geven aan klant en collega's, ideeën en keuzes en aanpak presenteren en verkopen, uitleggen, inzicht en kennis weergeven,	Algemene presentatievaardigheden		
Schriftelijke communicatie	Afspraken schriftelijk communiceren, afspraken documenteren	Schriftelijke plannen moeten eenduidig, duidelijk en helder zijn, goede schriftelijke vaardigheden, kort, bondig en helder, specificaties en testplannen schrijven, gestructureerd en helder denken en dit opschrijven, goed rapport leveren	Geen taalfouten, testrapporten in orde zijn	Resultaten vastleggen, keuzes vastleggen, afspraken formeel vastleggen, samenvatten, doorvragen, e-mail

(Sub)-competentie	*Persoon J*	*Persoon K*	*Persoon L*	*Persoon M*
Luisteren	Luisteren	Luisteren	Luisteren, laten merken dat je luistert	Luisteren
Sensitiviteit				
Onderhandelen				
Inlevingsvermogen	Inleven in gedachtegang klant, begrip hebben voor anderen, inlevingsvermogen, inleven in dat patiënt zich niet op zijn gemak voelt, verplaatsen in referentie klant, verplaatsen in patiënt	Begrijpen waarom iets een probleem is, kunnen verplaatsen in de lezer	Rekening houden met cultuurverschil-len en elkaars verwachtingen, in de ogen van de andere partij kunnen kijken waarom ze bepaalde aspecten belangrijk vinden, reactie anderen begrijpen	Inleven in waar het product komt te staan, wat er mee moet gebeuren en wat de klant wil
Aanpassingsvermogen	Open staan voor vragen collega's, eisen aanpassen aan de mogelijkheden van ETG	Om kunnen gaan met verschillende mensen en culturen	Werkwijze en communicatie op elkaar aanpassen, om kunnen gaan met boze klanten	
Overig	Klanttevredenheid, projectleider weet wanneer hij iemand anders moet inschakelen, niet vooringenomen zijn, klant gevoel van goede verstandhouding geven, ETG kunnen vertrouwen, humane factor, toepassen op patiënt, niet arrogant zijn, klantvriendelijk-heid	Ondernemerschap, 9 tot 5 mentaliteit, werklust, er voor gaan, geen betweter zijn, kostenbewust zijn, eigenaar van het probleem zijn, vernieuwend en uitdagend zijn, het beste resultaat willen bereiken, extrovert zijn	Service, het gehele product afdekken; de commercie en productie, bereid om aan de slag te gaan, enthousiasme tonen, hoe kom je over op de klant, de uiteindelijke klant is het ziekenhuis, gebruikers moeten een positieve ervaring hebben, het gaat om mensenlevens/de patiënt	Beloftes nakomen, geen schroom hebben, expertise laten blijken in gesprek, extroverte personen, houding moet geïnteresseerd zijn, pro-actief zijn, schoonmaak-baarheid apparaten

Table 45: Within-case analysis of cognitive competencies medical device market (in Dutch)

(Sub)-competentie	*Persoon J*	*Persoon K*	*Persoon L*	*Persoon M*
Informatie analyse				
Anticiperen				
Beslissen	Keuzes maken, eisen aanpassen en uitdagen, redenen keuzes beargumenteren, rekening houden met wat wel/niet kan	Nadenken over oplossingen		Meedenken over oplossingen, meedenken met klant, kritisch naar PMS zijn
Probleem analyse	Keuzes PMS begrijpen, begrijpen wat er wordt gevraagd, waarom wordt het gevraagd, vertalen van concept naar design, alternatieven bedenken, eisen van de klant uitdagen	Breder kijken dan eigen gebied, probleem analyseren, verschillende mogelijkheden van oplossingen weten, oplossingen toepassen, vernieuwend zijn, oplossingen vinden	Begrijpen waarom keuzes door PMS gemaakt zijn, oplossingen voor de praktijk maken	Weten welke effecten invloed op de kostprijs hebben
Conceptueel	Conceptueel denken	Conceptueel denken		Concepten ontwikkelen

(Sub)-competentie	*Persoon J*	*Persoon K*	*Persoon L*	*Persoon M*
Contextueel	Kennis van submodules kennis van toepassing machine, inzicht in gehele proces ziekenhuis kennen, rekening houden met kleine details, rol patient en de arts kennen	Systeemeisen begrijpen, weten wat apparaat doet	Product, systeem en module kennen, weten hoe de arts het systeem gebruikt, kennis van de medische markt, weten hoe arts met een product omgaat, context van het product kennen, weten hoe de medische wereld in elkaar zit, eindgebruiker en requirements kennen en gebruiken, weten wat iets inhoud en consequenties kennen, verwachtingen kennen, gebruikers zullen niet eerst de handleiding doorlezen	Zaken weten die voor PMS vanzelfsprekend zijn, besef hebben van plaats apparaat en voorwaardes modules, weten waar het apparaat gebruikt gaat worden, op de hoogte zijn van integratie systemen en dit meenemen in ontwerp
Procedureel		Kennis hebben van medische normen, kennis hebben van medische wetgeving (UL, IEC, CSA en chinese wetgeving), testbaarheid, testcovarage, kwaliteitseisen	Veiligheidseisen spelen een rol (röntgen en MRI),	Testen en vastleggen is de basis, soort lak die gebruikt wordt (schoonmaakbaarheid)
Zelfontwikkeling	Kennis willen genereren, willen leren in gesprekken, door zelfkennis verder ontwikkelen	Door nauw samenwerken met PMS kunnen engineers kennis vergaren	Kennis vergaren door ervaring op te doen in de markt	Op zoek gaan naar antwoorden
Leervermogen	Via internet specificaties achterhalen, kritisch reflecteren		Tijdschriften en publicaties, achter bureau informatie zoeken	Kennis krijgen door praten met Key Account, Internet, rapporten

(Sub)-competentie	*Persoon J*	*Persoon K*	*Persoon L*	*Persoon M*
Zelfbewustzijn	Bewust zijn van de rol die hij ten aanzien van andere mensen heeft, accepteren dat anderen beter inzicht hebben in materie		Bewust zijn dat persoon informatie mist, weten waar je staat op persoonlijk terrein, laten zien waar je goed in bent	Laten zien wat je kan/goed in bent
Interpersoonlijke sensitiviteit	Inschatten of de klant open kaart speelt, weten waar werkzaamheden ophouden	Feedback geven, belangstellend zijn, begrip hebben voor elkaar, elkaars vakmanschap waarderen, iedereen in zijn waarde laten, weten welke kennis in projecten aanwezig is en deze kennis gebruiken	Weten dat de klant op een ander manier kan reageren	
Bewust van de omgeving		Om kunnen gaan met verschillende culturen en nationaliteiten	cultuurverschillen	Veel investeringen in Philips MS, markt groeit stabiel
Sensitiviteit	Bewust zijn van eigen rol		Elkaars verwachtingen begrijpen	
Kennis van de eigen organisatie	Weten welke producten gemaakt kunnen worden binnen Philips ETG, weten waar grenzen liggen	Weten wat Philips ETG wel en niet kan		
Kennis van de organisatie van de klant	Kennis van submodules PMS kennen, setting van het product, toepassing machine, uitgangspunten klant kennen	Kennen van het apparaat, van het systeem, van de submodule en van de interfaces, van de context van Philips MS en de markt van Philips MS, kennis hebben van het product en van wat er gebeurd in een project, Philips MS heeft een functionele en project-as en hierdoor lange termijn denken, gedachtegang Philips MS begrijpen	Het product en systeem kennen, weten wie de key account is, weten wat PMS voor bedrijf is, weten wat er gaande is bij de klant, weten wat zwaktes zijn, productiecreatie proces kennen, weten wat de verwachtingen zijn	Zaken Philips MS kennen, trends Philips MS kennen, weten waar Philips MS zich mee bezig houdt, het werk van Philips MS heeft bepaalde infrastructuur, Philips MS heeft te maken met kostendruk, intense concurrentie, innovatie, prijsdruk

(Sub)-competentie	*Persoon J*	*Persoon K*	*Persoon L*	*Persoon M*
Zelfkennis		Goed weten waar hij het over heeft en op orde hebben,	Weten dat je de geschikte persoon bent, weten hoe je over kan komen, weten dat je informatie mist, weten wat zwaktes zijn	Weten waar je staat, weten wat zwaktes zijn
Overie	Coachen van de andere engineer, commerciële rol van engineers, product wordt gemaakt voor een mens, patiënten voelen zich niet op het gemak, mensen gaan met het apparaat werken, taal genereren als het mogelijk is, weten waar werkzaamheden ophouden en doorgegeven moeten worden aan de volgende, economische impact van keuzes is voor economische bedrijfsvoering, gesprekspartner heeft meer kennis	Kwaliteit en kostprijs onder controle hebben, laten zien wat ETG kan, kwaliteitsbeheersing, volwaardige rol in wisselwerking, TPD onderhouden	Een stuk beleving is belangrijk in de medische wereld, om kunnen gaan met boze klanten, weten hoe kennis en kunde te vertalen is naar andere wereld	Expertise laten blijken, zaken afvragen en interesses wekken, kostenbewust zijn, nieuwsgierige mensen nodig, interesse hebben in het product, verantwoordelijkheid nemen

Table 46: Social (sub)-competencies medical device market present in interviews (in Dutch)

	Respondent			
(Sub)-competentie	*J*	*K*	*L*	*M*
Sociale contacten	1	1	1	1
Vertrouwen op sociaal gebied	0	0	0	0
Netwerk in eigen organisatie	1	1	0	0
Netwerken in organisatie van de klant	1	1	1	1
Sociaal zijn	0	0	0	0
Samenwerken	1	1	1	1
Mondelinge communicatie	1	1	1	1
Mondelinge presentatie	1	1	0	0
Schriftelijke communicatie	1	1	1	1
Luisteren	1	1	1	1
Sensitiviteit	0	0	0	0
Onderhandelen	0	0	0	0
Inlevingsvermogen	1	1	1	1
Aanpassingsvermogen	1	1	1	0

Table 47: Cognitive (sub)-competencies medical device market present in interviews (in Dutch)

	Respondent			
(Sub)-competentie	*J*	*K*	*L*	*M*
Informatie analyse	0	0	0	0
Anticiperen	0	0	0	0
Beslissen	1	1	0	1
Probleem analyse	1	1	1	1
Conceptueel	1	1	0	1
Contextueel	1	1	1	1
Procedureel	0	1	1	1
Zelfontwikkeling	1	1	1	1
Leervermogen	1	0	1	1
Zelfbewustzijn	1	0	1	1
Interpersoonlijke sensitiviteit	1	1	1	0
Bewust van de omgeving	0	1	1	1
Sensitiviteit	1	0	1	0
Kennis van de eigen organisatie	1	1	0	0
Kennis van de organisatie van de klant	1	1	1	1
Zelfkennis	0	1	1	1

Appendix 17: Within-case analysis education (in Dutch)

Table 48: Within-case analysis education of social competencies (in Dutch)

(Sub)-competentie	*Persoon 1 (TG)*	*Persoon 2 (TG)*	*Persoon 3 (BMT)*
Sociale contacten	Collega's en medeprofessionals	Collega's en medeprofessionals	
Vertrouwen op sociaal gebied			
Netwerk in eigen organisatie			Netwerk gebruiken
Netwerken in organisatie van de klant			Netwerk gebruiken
Sociaal zijn			
Samenwerken	In projecten samenwerken, multidisciplinair werken	Multidisciplinair samenwerken, samenwerken met verschillende mensen, zichzelf en anderen beoordelen	Samenwerken met techneuten, in projecten samenwerken, samenwerken met verschillende disciplines en experts, multidisciplinair
Mondelinge communicatie	Verschillende vakgebieden	Juiste vragen stellen, uitleggen, communiceren met collega's en medeprofessionals, debatteren	Overleggen, discussieren, doorvragen, kritische vragen stellen
Mondelinge presentatie			
Schriftelijke communicatie			
Luisteren			Klant aan het woord laten
Sensitiviteit			
Onderhandelen			
Inleveringvermogen	Patiëntbeleving		Klant bezit geen niet de technische kennis, eindgebruiker is geen technisch persoon
Aanpassingsvermogen	Communicatie aanpassen aan de ander		Verplaatsen in de lezer (voor protocollen)
Overige			Affiniteit met de zorg

Table 49: Within case analysis education of cognitive competencies

(Sub)-competentie	*Persoon 6 (TG)*	*Persoon 7 (TG)*	*Persoon 5 (BMT)*
Informatie analyse			
Anticiperen			
Beslissen	Keuzes maken en beschrijven waarom dit gedaan is		
Probleem analyse		Probleem oplossen, analyseren, oplossing vinden, systematisch zaken uitvragen, analyseren van meerwaarde technieken	Probleem oplossen, analyseren, oplossing vinden, preciese definiering van het project, context verkennen
Conceptueel			
Contextueel	Jargon medische wereld kennen, product kennen, omgeving apparaat kennen, randvoorwaarden van de kliniek kennen	Trails, vanuit context abstraheren, weten dat woorden verschillende betekenissen hebben, bewust zijn van toepassing apparaat	
Procedureel	Tijd is langer voordat het product op de markt is		
Zelfontwikkeling	Reflecteren op samenwerken	Verder kunnen ontwikkelen	Zaken zelf uitzoeken, persoonlijke spiegel ontdekken van talenten en waar je goed in bent
leervermogen			
Zelfbewustzijn			
Interpersoonlijke sensitiviteit			
Bewust van de omgeving			
Sensitiviteit			Techniek wordt gebruikt door leken
Kennis van de eigen organisatie			
Kennis van de organisatie van de klant			
Zelfkennis		Weten wie je bent en wat je kunt	
Overige			

Appendix 18: Final competency model including definitions

Table 50: Final competency model including definitions of the competencies and sub-competencies

Social competencies		
Competency and definition	*Sub-division*	*Description sub-division*
Networking: The development, maintaining and using relations inside and outside the own organisation which are useful in achieving objectives (Schakel & Smid, 2005; Floor, 2006)	Building contact	To make contact and form relations with important persons for the work or function (Floor, 2006)
	Maintaining contact	To maintain contact with important persons for the work or function and to take advantage of the contact for own goals (Floor, 2006). To have informal contacts with important people for the work or function
	Evaluating contact	To be able to evaluate a relationship and to decide if it is valuable for now or in the future
	Using contacts	To find the right persons for support or cooperation to reach the goal (Floor, 2006)
Collaboration: Contributing effectively to a joint result or solution to a problem (Schakel & Smid, 2005)	Dealing with different people	To be able to make teamwork effective by being able to work with different people
	Using different teamwork methods	To be able to use the methods brainstorming, reviewing and normal meetings in teamwork
	Keeping all people involved up-to-date	To keep everybody within a team or person that have helped up-to-date about the progress (Floor, 2006)
	Sharing knowledge	To be able to transfer the knowledge that is needed for the work to all persons in the team and to make sure that this information helps people to learn form each other
Communication: The process of exchanging information and the reacting according to that information	Using communication methods	To be able to use different methods to communicate well: • Discussion; • Asking questions; • Naming the problem; • Checking if problem is understood; • Giving feedback; • Summarising.

Social competencies		
Competency and definition	*Sub-division*	*Description sub-division*
	Listening	To pick up significant information from verbal communication, asking questions and investigate reactions (Schakel & Smid, 2005)
	Persuasiveness	Attempting to persuade others to adopt a certain standpoint and trying to come to agreement by making use of appropriate arguments and methods (Schakel & Smid, 2005)
	Interpretation of signals	Being able to read the body language of another person and react to it effectively
	Written communication	Expressing ideas and opinions clearly in properly structured, well-organised and grammatically correct reports or documents utilising language and terminology appropriate to the reader (Schakel & Smid, 2005)
	Presentation	Presenting ideas and facts clearly, making use of appropriate aids; tailoring presentation to the needs of the audience (Schakel & Smid, 2005
Flexible behaviour: Modifying one's behaviour to reach a set goal when problems or opportunities arise (Schakel & Smid, 2005; Floor, 2006)	Changing the behaviour style according to the situation	To be able to change own behaviour in case of opportunities or problems
Project management: Well management of a project or a part of a project to achieve a collective result	Motivate people	To stimulate people to take action and to be involved to reach a certain result (Floor, 2006)
	Manage people	To involve the right people in the team and for the work
	Set out project steps	To describe the different steps within the project
	Planning and organising	Determining goals and priorities effectively and stipulating the time, activities and resources required to achieve the set goals (Schakel & Smid, 2005)

Social competencies		
Competency and definition	*Sub-division*	*Description sub-division*
	Delegation	Assessing one's own responsibilities and authority to the appropriate employees in an ambiguous manner, making effective use of employees' time and skills (Schakel & Smid, 2005)
	Creating commitment	Bringing the persons' own behaviour in line with that of the team and the project
	Taking responsibility	To take responsibility for own tasks and for tasks of the team
Social competency only applicable for the medical device market		
Empathy: The transferring in the perception of others (BJU, 2006)	Empathise with patient	To be able to transfer into the perception of the patient
	Empathise with client	To be able to transfer into the perception of the client
	Empathise with medical personnel	To be able to transfer into the perception of medical personnel

Cognitive competencies		
Competency and description	*Sub-division*	*Description sub-division*
Problem solving: Analysis and solving problems in different situations to achieve the set goal	Problem analysis	The identifying of problems, recognising of information, making connections between data and finding causes (Schakel & Smid, 2005; Floor, 2006)
	Anticipation	To recognise critical situations and react to them effectively to prevent problems by taken measures in time (Floor, 2006)
	Decision making	Making decisions by taking actions or giving opinions (Floor, 2006??)
Conceptual thinking: Building thinking frameworks or models and the formulation of concepts or ideas according to complex information (Floor, 2006)	Coming up with different directions of solutions	To be able to think of different solutions for the problem
	Thinking outside the usual domain	To be able to see a problem from different view points
Self-development: Possessing insight into one's strengths and weaknesses and on this basis initiating activities to increase/enhance one's knowledge, skills and competencies in order to perform more effectively (Schakel & Smid, 2005, Floor, 2006)	Reflection	Reflection is a process of reviewing an experience of practice in order to describe, analyse, evaluate and so inform learning about practice (Reid, 1993)
	Self-analysis	To be able to analyse the own strengths and weaknesses and to search for personal feedback (Floor, 2006)
	Using sources to develop	To be able to use different sources to develop (e.g. Internet, courses, colleagues)
Awareness: The perception and reaction to a condition or event (Wikipedia, 2006)	Self-awareness	The recognition of own personality, strengths and weaknesses and own likes and dislikes (Wikipedia, 2006)
	Interpersonal sensitivity	To be able to show the recognition of feelings and needs of others, transferring in the other person and showing understanding of own behaviour (Floor, 2006)
	Awareness of the environment	To be informed in social, political and economical developments or other environmental factors and using this information for the work (Schakel & Smit, 2005; Floor, 2006)

Cognitive competencies		
Competency and description	*Sub-division*	*Description sub-division*
Knowledge of the own organisation: The possession of information of Philips ETG and the ability to use that information	Knowledge of the culture	To know what elements play a role in the culture and to be able to adapt the culture
	Knowledge of the internal process	To be able to understand and explain the internal processes
	Knowledge of the interest	To be able to understand, use and recognise the interest of the organisation
	Knowledge of the vision, mission and values	To be able to understand the vision, mission and values and use these within the work
	Knowledge of the competencies and capabilities	To be able to understand which competencies and capabilities the organisation has and to use this information in the work
Knowledge of the client: The possession of information of the client and the ability to use that information	Knowledge of the culture	To know what elements play a role in the culture
	Knowledge of the internal process	To be able to understand and recognise the internal processes
	Knowledge of the interest	To be able to understand and recognise the interest of the organisation
	Knowledge of the vision of a project	To be able to understand and recognise the vision of a project
	Knowledge of the product	To be able to understand the product
	Knowledge of the competitors	To be able to find out what the competitors are and to use this knowledge in different situations
Sub-competency only applicable for semiconductor market		
	Knowledge of the market of the client	The possession of information of the market of the client and the ability to use that information
Cognitive competencies only applicable for the medical device market		
Knowledge of the medical device market The possession of information of the medical device market and the ability to use that information	Knowledge of medical norms	To be able to understand the medical norms
	Knowledge of safety rules	To be able to understand and use the safety rules
	Knowledge of testing and registration	To be able to understand what the testing and registration is all about and to use is effectively

Appendix 19: Assessment items

Table 51: Assessment items social competencies

Competency	*Sub-competencies*	*Suggested items*
Networking	Building contact	Is able to make contact and form business relations
	Maintaining contact	Purposively executes different actions to maintain contact - E.g. invites clients to the factory
	Evaluating contact	Evaluates the value of a certain contain if it is still useful for business purposes
	Using contacts to find support and cooperation	Is able to get things done from the contact Is able to get support from the contact - E.g. asks questions to the right colleagues about certain issues
Collaboration	Dealing with different people	Is able to deal with different people with different backgrounds and or disciplines Can work in a multidisciplinary team
	Using different teamwork methods	Is able to participate in a review session Is able to participate in a brainstorm session Is able to participate in a normal meeting
	Keeping all people involved up to date	Communicates issues to the people involved Communicate the process of a project Has a pro-active attitude towards people involved
	Sharing knowledge	Is able to transfer his knowledge to others Is able to learn from his colleagues and other people involved
Communication	Using communication methods	Is able to participate in discussion Is able to ask questions that will clarify the situation of demonstrates understanding of the issues Is able to explain issues to different people involved Is able to propose different things Is able to name the problem to the people involved Ask questions or summarises the conversation in order to check if the problem is well understood Is able to give feedback to different people involved
	Listening	Is able to listen actively and picking up significant information - Demonstrating by asking the right questions.
	Persuasiveness	Able to persuade other people about certain standpoints and come to agreement with the use of arguments - E.g. other people will take the standpoint into consideration
	Interpretation of signals	Is able interpret the body language during communication Is able to interpret the facial expression during communication
	Written communication	Is able communicate in a reasonable way, using the correct grammar, reports are properly structured and well organised or are in the correct language and terminology for the reader

Competency	*Sub-competencies*	*Suggested items*
	Presentation	Is able to present information or ideas in a proper way Is able to tailor the presentation to the needs of the audience - E.g. uses the right terminology
Flexible behaviour	Changing the behaviour style according to the situation	Is able to change the communication style to the situation Is able to use the right words Is able to change its body language
Empathy	Empathise with patient	Recognises the patient perception - Shows it on several issues, e.g. communication, the proposes, the design decisions
	Empathise with client	Recognises the client perception - Shows it within the collaboration
	Empathise with medical personnel	Recognises the medical personnel perception - E.g. adjusting the design for non-technical people
Project management	Motivate people	It able to stimulate people to take actions of become involved to reach certain goals
	Manage people	Involves the right people for the project
	Set out project steps	Is able to describe the appropriate steps of a project
	Planning and organising	Is able to determine goals and priorities effectively and stipulates time, activities, and resources required to achieve the goals
	Delegation	Is able to assess one's own responsibilities and authority to others, in an ambiguous way, making effective use of other's time and skills
	Creating commitment	Is able to bring the behaviour of others in line with the project of team
	Taking responsibility	Takes responsibility for one's own work or work of a team

Table 52: Assessment items cognitive competencies

Competency	*Sub-competencies*	*Suggested items*
Problem solving	Problem analysis	Is able to identify problems, recognise information, makes connections between data and find causes Is able to explore the context
	Anticipation	Is able recognise critical situations and react effectively to prevent problem by taking measures in time
	Decision making	Is able to make decisions by taking actions or committing oneself by expressing opinions
Conceptual thinking	Coming up with different directions of solutions	Is able to generate different solutions for a problem
	Thinking outside the usual domain	Is able to oversee a problem form different point of views
Awareness	Self-awareness	Is able to recognise the own personality, strengths, weaknesses, likes and dislikes
	Interpersonal sensitivity	Is able to show the recognition of feelings and needs of other, transferring in the other and showing understanding of own behaviour (on that person?)
	Awareness of the environment	Shows to be informed of the social, economic and political developments or other environmental factors and uses this information for the work
Self-development	Reflection	Is able to review an experience of practice and analyse and evaluate this practice to learn of it
	Self-analysis	Is able to analyse the own strengths and weaknesses and to search for personal feedback
	Using sources to develop	Is able to use different sources for the development - Magazines - Internet - Colleagues - Courses
Knowledge of the own organisation	Knowledge of the culture	Shows to have sufficient knowledge of the culture - E.g. appropriately have informal contact with colleagues - E.g. using the right way to approach people
	Knowledge of the internal process	Shows to have sufficient knowledge of the internal process - E.g. by involving the right people during a project - E.g. activating the procedures at the right time
	Knowledge of the interest	Show to have sufficient knowledge of the organisational interest - E.g. by choosing the right projects
	Knowledge of the vision, mission and values	Shows to have sufficient knowledge of the vision, mission and values - E.g. to make decisions in line with these elements

Competency	*Sub-competencies*	*Suggested items*
	Knowledge of the competencies and capabilities	Shows to have sufficient knowledge of the competencies and capabilities within the organisation - E.g. choosing the right people for a project - E.g. informing the client in a right way
Knowledge of the client	Knowledge of the culture	Shows to have sufficient knowledge of the culture - E.g. approaching the people involved in a correct manner - E.g. using the right language with the client
	Knowledge of the product	Shows to have sufficient knowledge of the product - E.g. the possibilities of the product - E.g. the constraints of the product - E.g. the requirements of the product
	Knowledge of the interest	Shows to have sufficient knowledge of the client interest - E.g. proposes in line with the interest
	Knowledge of the internal processes	Shows to have sufficient knowledge of the internal process of the client - E.g. approaches the right people - E.g. hand in applications within the right departments
	Knowledge of the market	Shows to have sufficient knowledge of the market of the client - E.g. knowledge of the developments in the market
	Knowledge of the competitors	Shows to have sufficient knowledge of the competitors of the cliens - E.g. knowledge of the interests or development of the competitors
Knowledge of the medical device market	Knowledge of medical norms	Has knowledge of the medical norms and apply these within the designs - E.g. UL, IEC, CSA and MRI
	Knowledge of safety rules	Has knowledge of the safety rules within the medical device market and applies these within the design
	Knowledge of testing and registration	Has knowledge of the testing and registration procedures within the medical device market and can work with it.

Appendix 20: Interventions

Table 53: Types of interventions

Intervention	*Description*
1. Self-paced learning (with e-learning)	An individualised method, which provides the individual employee an approach that may be done in a variety of setting (e.g. web-based training, computer based learning) (DeSimone, Werner & Harris, 2002).
2. Job-aids	A document that has information or instruction on how to perform a task. It guides the user to do the task correctly and is used while performing the task, when the person needs to know the procedure (e.g. checklist and flow charts) (New York State Department of Civil Service, 2006).
3. (Online) collaboration tools	To expedite information sharing and to accelerate decision making, teams are using new tools – tools that are changing our definition of the workplace (e.g. white boards, discussion groups, internet presentations and document collaboration) (BPR Online Learning Centre, 2006).
4. Feedback	A way of pro-active communication through which one person offers structured information to another about the impact of their actions or behaviour with the intention to assist the other person with the improvement of these actions or the behaviour (BBC Training & Development, 2005).
5. Coaching	An employee and that person's supervisor focus on examining employee performance and taking actions to maintain effective performance and correct performance problems (DeSimone et al., 2002)
6. Job rotation	A series of assignments to different positions or departments for a specified period of time (DeSimone et al., 2002)
7. Personal Development Plan/ Portfolio	An organised, purposeful documentation of the professional development and of the learning process of the owner (Ritzen & Kösters, 2002).
8. Action learning	People are researching their own practice and develop solutions for it. It is a dynamic and powerful learning concept that focuses on extending the learning ability of individuals and organisation by working on problems in practice (Action learning, 2006)
9. Reflection	A process in which someone tries to restructure his or her knowledge and/or experiences.
10. 360° feedback	A method and tool that provides an answer to the question which competencies an employee shows in his or her current job (Beirendonck, 1998).

Intervention	*Description*
11. Mentoring	A senior manager is paired with a more junior employee for the purpose of giving support, helping the employee learn the ropes, and preparing the employee for increasing responsibility (DeSimone et al., 2002)
12. Job instruction training	A sequence of instructional procedures used by the trainer to train employees while working in their assigned job (DeSimone et al., 2002)
13. Classroom training	Approaches that are conducted outside the normal work setting (DeSimone et al., 2002)

Table 54: Pro(s) and con(s) interventions

Intervention	*Pro*	*Con*
Self-paced learning with e-learning	- On-demand availability - Reduces stress and increases satisfaction for slow or quick learners - Interactivity engages users - Reduced burden of responsibility of mastery - Reduced costs (reduction of time spent away from the job) - Learning time is reduced - Consistent delivery of content - Facilitates transfer	- Technology issues of the learners - Reduced social and cultural interaction - Expensive to develop - Technology issues (whether the existing technology infrastructure can accomplish the training goals) - Cultural acceptance in organisation
Job-aids	- Reduces costs - Consistent delivery of content - Facilitates transfer	- Not flexible in learning about a task - Not intended to produce learning - Learning that does occur as a result of using the job aid is incidental
(Online) collaboration tools	- Reduces time in sharing knowledge - Can be used in different settings and spaces - Reduces costs (no meetings and conferences needed)	- Slow e-communication is frustrating - Big gap between employees who have access to technology and who has not - Lot of time needed to get in started and working - Support needed throughout the whole organisation
Feedback	- Facilitates transfer - Reduces costs (no training facilities needed) - Individual employees can develop themselves - Provides the ability to develop constantly	- Often considered as criticism - Time needs to be taken to use feedback in pairs or groups
Coaching	- Facilitates transfer - Reduces costs (no training facilities needed) - Individual employees can develop themselves	- No appropriate coaches are available at Philips ETG - Managers and supervisors need to have an active and positive role
Job rotation	- The personnel is challenged - Knowledge and skills are distributed throughout the organisation	- Not every function is appropriate for job rotation - Specific knowledge is threaten to disappearance - The training period is very long for some functions - Employees need to desire to change their job

Intervention	*Pro*	*Con*
Personal Development Plan/ Portfolio	- Reduces costs (employees can grow inside the organisation) - Facilitates transfer - The individual employee can develop	- Needs to be changed constantly - The goals need to be formulated beforehand - The organisation needs to provide learning materials to develop
Action learning	- Makes it possible to work on own goals - Reduces costs (no training facilities needed)	- A process coach is needed, which is not available at Philips ETG - The organisation needs to provide learning materials to develop - The learner needs to take responsibility for own learning
Reflection	- Facilitates transfer - Reduces costs (no training facilities needed) - Makes it possible to work on own goals	- Needs to be done on regular and significant base - In the beginning it needs to be presented and guided by a coach
360° feedback	- Is based on the views of multiple persons - Gives insight in the individual employee	- It needs to be conducted carefully (employees cannot help each other) - Employees can give answers that are liked by the environment - Multiple persons need to take time to describe behaviour of individual
Mentoring	- Facilitates transfer - Reduces costs (no training facilities needed) - The employee has someone to go to when having difficulties in the work - The individual is stimulated by a colleague	- The mentor needs to have enough experience - The employees of Philips ETG might not be appropriate as mentor
Job instruction training	- Training is done on-the-job which reduces costs - Uses the work of the employee as basis for the training - Facilitates transfer	- A trainer is needed to perform tasks - Training needs have to be assessed before the training
Classroom training	- Offers a variety of learning techniques - Control of learning climate (no distractions) - Efficient delivery (large number of employees)	- Low transfer - Increased costs (travel, room rental)

Appendix 21: Development competency plan social and cognitive competencies

The development of social and cognitive competencies for Philips ETG is described per competency. For the development of the competencies four criteria are taken into account, namely: the work and the work environment of the engineers, transfer, the learning methods should be of use in the organisation and the possibility of using elements of the Core Curriculum of Philips. The development plan for every competency describes if elements of the Core Curriculum are available followed by the interventions that are chosen. Further, the steps that have to be taken into account to develop the competencies are presented. An overview of interventions per competency is provided in table 55 and after that interesting elements are described. Last, all competencies are described in depth according to the four criteria in table 56 and table 57.

Table 55: Interventions social and cognitive competencies

Competency	*Intervention*
Social competency	
Networking	- Training networking, which will need to be developed - Giving and receiving feedback sessions - Use of Personal Development Plan
Collaboration	- Giving and receiving feedback sessions - Structured meetings and arrangements to keep all people up-to-date - Use of Personal Development Plan (PDP)
Communication	- Training communication, which will need to be developed - Giving and receiving feedback sessions - Use of Personal Development Plan - Working with a mentor for the sub-competency written communication. This coach will need to learn about coaching. - Training 'high impact presentation' of the Core Curriculum (2006) for the sub-competency oral presentation
Flexible Behaviour	- Trajectory flexible behaviour, which will need to be developed. This trajectory is provided by a teacher/coach - Use of reflections in the Personal Development Plan
Empathy	- Document analysis and discussion medical device market - Day in the hospital, which will be guided by research questions for the engineers and will be evaluated by all engineers - Presentation/training thinking hats, which will need to be developed
Project Management	- Training 'Working in a team' from the Core Curriculum (2006) of Philips - Working with a mentor, who will need to learn about coaching. - Giving and receiving feedback sessions - Use of Personal Development Plan
Cognitive competency	
Problem Solving	- Some elements can be trained in the training 'Working in a team' from the Core Curriculum (2006) of Philips - Working with mentor, who needs to learn how to coach someone - Giving and receiving feedback sessions - Use of Personal Development Plan
Conceptual thinking	- Working with a mentor, who needs to learn how to coach someone - Use of reflection in the Personal Development Plan - Use of discussion during reviewing and normal meetings
Awareness	- Working with a mentor, who needs to learn how to coach someone - Giving and receiving feedback sessions - Use of reflection in the Personal Development Plan

Competency	*Intervention*
Cognitive competency	
Self-development	- Presentation about self-analysis and reflection - Contact person for development - Giving and receiving feedback sessions - Use of reflection in the Personal Development Plan
Knowledge of own organisation	- Discussion session about the knowledge with a representation of the engineers - Documentation about the discussion session
Knowledge of client	- Discussion session about the knowledge with engineers from the project - Documentation about the discussion session
Knowledge of medical market	- Document analysis which can be provided by Philips MS - Documentation about relevant information - Training for regulations and testing. This training needs to be found with help of PMS by the managers and engineers themselves.

For the social competencies networking, communication and flexible behaviour *classroom training* is the chosen intervention to gather knowledge. The training has to be developed in order to engineers to offer the knowledge that needs to be acquired. Therefore, training objectives for the engineers are described in appendix 21. It is suggested that students from the education Educational Design Management & Media of the University of Twente can participate in the design of these interventions. This is chosen because the students have the ability to design it based on the needs of the engineers and the possibility to explore the competency in depth with help of the educational staff of the study. Also, this will reduce the costs of designing the interventions by an educational bureau.

The intervention *giving and receiving feedback* is selected to offer the ability for engineers to learn from each other. In the first six interviews of the semiconductor market, engineers described that they have the need to learn from each other and only learn from a meeting with the manager about their job performance. Project leaders or other colleagues can provide better insight in the desired behaviour and the job. Based on this need, the intervention *giving and receiving of feedback* is selected. This selected intervention needs to be introduced during and at the end of project. The rules of feedback have to be taken into account when using this method and therefore the HR-department has to provide a training/presentation about using feedback. Some practise is recommended before the engineers can use it.

The *Personal Development Plan* (PDP) will be used for the personal reflections of an engineer. The PDP that is applicable is the already available PDP of Philips ETG, which will provide the engineers the ability to work on an action plan and reflect upon themselves. This, in combination with the outcomes of competency measurements, will provide the engineer with the possibility to reflect upon actions, feedback of others and personal reflections. However, it is observed that the engineers do not really use the available PDP and are not aware of the benefits. Thus, when implementing the competency development plan the PDP will have to be presented by the HR-department and will have to be coupled with other interventions like feedback. Also, the PDP has to be an important instrument when talking about the development of competencies.

The methods *mentoring* and *coaching* are described as useful interventions. These interventions are not only based on the four criteria, but also on the needs of engineers which where described in the first six interviews of the semiconductor market. The engineers want to be supported by someone in the development of competencies. Also, the engineers identify mentoring and coaching as a helpful tool for new or not that experienced engineers. Therefore, mentoring or coaching is chosen when working on competencies that are difficult to develop or are new for the engineer like for example project management.

Last, it is suggested that the engineers have a *contact person*, to whom they can talk when developing competencies, especially for the competency self-development. This is also based on the described need of engineers in the first six interviews of the semiconductor market as well as on the observations of the researcher when working at the engineering department. A contact person can help engineers to find solutions for competency problems and is able to advice engineers about interventions. This contact person can be someone from the HR-department, who knows a lot about the different interventions and is able to extract needs from listening to engineers or other employees.
The development of social and cognitive competencies is described in table 56 and table 57.

Table 56: Development of social competencies

Networking
The development, maintaining and using relations inside and outside the own organisation, which are useful in achieving objectives (Schakel & Smid, 2005; Floor, 2006). Layer iceberg structure: Intermediary skill
Availability within Core Curriculum of Philips For the development of the competency networking there is no training available within the Core Curriculum (2006) of Philips. A training is available at Schouten & Nelissen, a bureau that has a collaboration with Philips and offers different kinds of trainings to Philips. However, this training is not appropriate for the engineers of Philips ETG.
Intervention choice To retrieve knowledge about networking there is chosen to use a classroom training that makes this possible. However, a disadvantage of classroom training is low transfer. To make sure that the transfer is guaranteed on-the-job learning is chosen. The methods that are of use for this competency are the use of feedback and a Personal Development Plan. These methods will make it possible for engineers to be aware of the learned information in practice. Other interventions were considered to be not usable, because of the work of the engineer. Often the engineer uses the competency networking in situations, which are not appropriate for a mentor, coach or other tools. Thus, feedback and the Personal Development Plan are considered as the best interventions to make sure that the transfer can be guaranteed.
Development of competency networking The training about networking needs to be developed by Philips. For this development the training needs to fit with the needs of the engineers. Therefore, the training needs to consist of the following objectives: • To analyse what clients and colleagues have to offer; • To learn the rules of networking; • To know how to build, maintain and evaluate relations; • To know how to use the network; • To practice networking in role-plays or other methods. This training needs to be provided by a trainer or someone from the HR department who knows a lot about networking and can guide the engineers. It can be made by one of the bureaus where Philips has a relationship with or by students of the course Atelier 4 from the education Educational Design Management & Media of the University of Twente. To take care of the transfer, feedback sessions with colleagues and managers can be used to provide the engineer with additional information to develop the competency. These feedback sessions can be done in one-on-one sessions, but also in project groups. It is suggested that the project group should use feedback during one or two sessions during the project and at the end of a project. However, it is important that the engineers use feedback well and therefore it is important that they learn how to give and receive feedback according to the feedback rules. These rules have to be presented and practised, which can be done by an employee of the HR-department or a trainer.

Networking

The Personal Development plan (PDP) can be used to reflect upon the feedback of others and situations in which networking was practised. The PDP that is developed by Philips ETG can be used for this reflection. However, the engineers will need to learn how this PDP is used and they might need some guiding during the beginning of the use of the PDP. This can be provided by the HR-department.

Collaboration

Contributing effectively to a joint result or solution to a problem (Schakel & Smid, 2005).

Layer iceberg structure:
Intermediary skill

Availability within Core Curriculum of Philips
Within the Core Curriculum (2006) of Philips or at bureaus where Philips collaborates with is not a training available for the competency collaboration.

Intervention Choice
It depends on the sub-competency what kind of interventions are of use for the development of the competency collaboration. For the sub-competencies it is not the case of gathering knowledge, but more about using the knowledge in practice. Therefore, the interventions feedback and a collaboration tool like presentations can be used to develop the sub-competencies. Also, these interventions are of use to secure the transfer of the training.
To reflect upon the development of the competencies and the feedback or presentation the Personal Development Plan (PDP) is appropriate.

Other interventions were not applicable for the development of this competency, because the researcher defined that the feedback of manager and colleagues is more applicable then the feedback of a trainer, coach or mentor. The manager and colleagues of an engineer work more intensive with the engineer then a trainer, coach or mentor does.

Development of competency collaboration
The intervention giving and receiving feedback can be used in the same way as is described for the competency networking. During and at the end of a project the engineers should use feedback to enhance the collaboration in the team and to develop their personal competencies. However, it is important that the engineers use feedback well and therefore, it is important that they learn how to give and receive feedback according to the feedback rules. These rules have to be presented and practised, which can be done by an employee of the HR-department or a trainer.

Also, during the project the engineers should use meetings, appointments or other kinds of conversation forms to keep all people up-to-date. This means that it should be a goal during a project for an engineer to keep people up-to-date. One of the tools to keep all people involved up-to-date is the use of presentations or the sharing of documents in the same place. In this way people have access to all the information and can ask questions about the project. However, the engineer has to make sure that clients also are kept up-to-date. Giving presentations can do this or taking into account that information should be shared at meetings.

The engineer can use his PDP to reflect upon the competency. The PDP that is developed by Philips ETG can be used for this reflection. However, the engineers will need to be learned how this PDP is used and they might need some guiding during the beginning of the use of the PDP. This can be provided by the HR-department. Also, it is relevant for feedback sessions and for collaboration at other moments. This will make it possible to develop the competency and to see improvement.

Communication

The process of exchanging information and the reacting according to that information.

Layer iceberg structure:
Intermediary skill

Availability within Core Curriculum of Philips
The Core Curriculum (2006) of Philips or an other bureau does not provide a training about all aspects of communication that are relevant for the engineers. For several aspects there are trainings available, which focus on one or several communication aspects.

Intervention choice
To gather the knowledge that is needed for the competency communication classroom training is chosen as intervention. However, a disadvantage of classroom training is low transfer. To prevent this, the on-the-job interventions feedback, mentoring and the Personal Development Plan (PDP) are chosen to facilitate transfer. These interventions are also methods to facilitate the use of the learned knowledge and therefore, the combination between gathering and using knowledge is facilitated. However, for the sub-competency presentation a training within the Core Curriculum can be of use for the engineer.

Other interventions were not applicable for the competency communication, because the researcher defined these as too complicated to use.

Development of competency communication
For the training about communication it is suggested to adjust a training from a bureau, for example Schouten & Nelissen, is according to the sub-competencies of the competency model. In this case different methods for the different sub-competencies can be practised, which cannot be too much work according to the trainings that are available within Schouten & Nelissen. The training has to consist of the follwing objectives:

- To learn about and practise different communication methods;
- To learn how to use listening as an aspect of the work;
- To learn how to use arguments to come to an agreement together;
- Being able to recognise and interpretate body signals;
- Being able to write a report or document which focuses on the reader;
- Being able to use communication methods for teamwork;
- Being able to provide a clear presentation.

The sub-competency oral presentation can be developed with the help of the training ‘high impact presentation’ of the Core Curriculum (2006) of Philips. This training can be found in the Core Curriculum of Philips (2006).

The giving and receiving of feedback with colleagues and the manager should be used to make sure that the transfer is facilitated. These feedback sessions can be done in one-on-one sessions, but also in project groups. It is suggested that the project group should use feedback during one or two sessions during the project and at the end of a project. However, it is important that the engineers use feedback well and therefore, it is important that they learn how to give and receive feedback according to the feedback rules. These rules have to be presented and practised, which can be done by an employee of the HR-department or a trainer.

Also, it is suggested that for the sub-competencies written communication and oral presentation the engineer will be assisted by a mentor or coach, which will provide the engineer with recommendations for improvement. The choice of a mentor or coach depends on the availability of such a person in the organisation. Also, for the written communication it is recommended that it is someone who can adapt the view of a reader and does not have a technical background. This helps the engineer to write a report that can be read by a non-technical person.

Communication

The PDP will provide the engineer the ability to reflect on the feedback and training, which helps him to develop the competency. The PDP that is developed by Philips ETG can be used for this reflection. However, the engineers will need to be learned how this PDP is used and they might need some guiding in the beginning. This can be provided by the HR-department.

The training 'Coaching for performance and growth' of the Core Curriculum (2006) of Philips can be used to develop the coaching skill of mentors or coaches. In the beginning, the coach will also have to be coached by someone to develop his coaching skill. In the organisation and especially in the HR-department a coach needs to be found to guide the engineer to become a coach.
This process of learning to be a coach should also be documented in the Personal Development Plan and be used during feedback sessions in projects or at other appropriate moments.

Flexible behaviour

Modifying one's behaviour to reach a set goal when problems or opportunities arise (Schakel & Smid, 2005; Floor, 2006)

Layer iceberg structure:
Intermediary skill/personal characteristic

Availability within Core Curriculum of Philips
For the competency flexible behaviour no training within the Core Curriculum (2006) of Philips or at bureaus where Philips collaborates with, is available.

Intervention choice
To gather the knowledge that is needed for the development of the competency flexible behaviour and to use this knowledge a traject is chosen as the best intervention. This traject is a combination between classroom training and on-the-job interventions which facilitate transfer. This is chosen because of the fact that the competency is described as a combination between an intermediary skill and personal characteristics. This last implies that flexible behaviour is a competency that is hard to develop. Therefore, the engineers need a trainer or coach who can help them develop this competency and provide methods, which will help the engineer to be aware of the behaviour. Next to this, the Personal Development Plan (PDP) and reflections are used to reflect on the traject and the competency.

Other interventions were not possible to use, because of the fact that no good mentors or coaches are available within Philips. Also, an external coach should be provided because this makes it less difficult for engineers to talk about difficult situations.

Development of competency flexible behaviour
The traject that needs to be developed for the competency flexible behaviour should be provided by a trainer/coach who trains the engineers once a month in improving the behaviour. During the rest of the month the engineers will receive assignments to focus on their behaviour. This is all done so that the engineer can get insight in his own behaviour. The objectives of this traject are:

- To focus on the individual problems;
- To provide methods to change the behaviour;
- To practice these methods in plays that are based on real life;
- To use reflection and other methods to reflect on the behaviour.

This traject can be designed by students of the course Atelier 4 of the education Educational Design Management & Media of the University of Twente. Also, a teacher from the study Business Administration might be asked to help the students to design the project or to coach the traject.

Reflections and assignments are used to provide the engineer information about the own behaviour and the possibilities of changing the behaviour. Reflections that can be done are the circle reflection, triangle reflection and line reflection (Procee, 2003). The students should research the possibilities of these and other reflections. The Personal Development Plan can be used for this reflection. However, the engineers will have to learn how this PDP is used and they might need some guiding in the beginning of using the PDP. This can be provided by the HR-department.

Empathy

The transferring in the perception of others (BJU, 2006)

Layer iceberg structure:
Intermediary skill

Availability within Core Curriculum of Philips
The Core Curriculum (2006) of Philips or a bureau with whom Philips collaborates does not have a training available that fits this competency.

Intervention choice
For the competency empathy it is difficult to define interventions, because of the complex character of empathy. Before an engineer is able to empathise with the patient, client and medical personnel it is important to understand the market in which these persons work. Therefore, within this competency a combination of interventions is chosen to gather the knowledge of these persons and to use this knowledge to transfer into the perceptions of others.
The interventions that are chosen are combinations of collaboration tools, off-the-job training and classroom training.
To gather the knowledge a collaboration tool, document analysis, discussion and a visit to a hospital are used as interventions. This makes it possible to retrieve the knowledge and to transfer into the perceptions of others. Also, this last is done with the use of a classroom training/presentation about the thinking perspectives. With this intervention the employees are able to transfer into the perceptions of others. To facilitate the low transfer of classroom training it is suggested that the project leaders use this last intervention actively in the month after the training.

Other interventions were not used, because a mentor or coach for this competency is not available within Philips ETG. The medical device market is new market for Philips ETG and therefore these are not a lot of employees who have experience with in this market. Also, the use of the Personal Development Plan (PDP) or reflections are not of use, because of the fact that it is important to gather the needed knowledge.

Development of competency empathy
The chosen collaboration tool is a combination of a document analysis and a discussion. The engineers should read document in groups about the views of patient and medical personnel, which can be provided by Philips MS. This information should be discussed in small groups and a summary of important information should be documented in a place, which all engineers can access.
The of-the-job intervention that is chosen, is a visit to the hospital A day in the hospital with the goal to find out where the product will be placed and to learn more about the patient and the medical personnel. This day has to be done with the help of assignments and a discussion afterwards. This discussion will provide the engineers with extra information about the medical market and makes it possible to define with each other what is important. This information should also be documented in a place that can be accessed by all engineers.

For the knowledge of the client it is suggested that the engineer should do preliminary work about the sub-competencies to be aware of the different elements. This is also a document analysis in small groups or alone. When working in a group, a discussion about the information is possible. However, the information has to be documented for all engineers, because they might need it in the future.

To have empathy with the patient, client and the medical personnel it is important that the engineers learn how to use these perceptions when developing a product. Therefore, the activity ‘thinking perspectives’ is suggested. To view a problem or solution from the different perspectives the method that is based on the ‘Thinking hats’ of Edward de Bono can be used. The different perspectives can be described according to four different hats, which represents the views of an engineer, a client, a patient and the medical personnel. When an engineer wears a certain hat it is the intention to look at the problem from the view of the person it represents. This teaches engineers to be aware of the perceptions of others. Not only can this method be used in discussion groups, but also in other

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situations like meetings, reviews and brainstorming.
A short training or presentation can explain this method, which can be presented by the HR-department of Philips ETG. During the training the engineers not only learn how to use the method, but also practice it together. During the work the engineers have to take the time to use this method and to view a problem or solution from different aspects. Therefore, it is suggested that the project leader uses this method actively during meeting.

Project management

Well management of a project or a part of a project to achieve a collective result.

Layer iceberg structure:
Intermediary skill

Availability within Core Curriculum of Philips
In the Core Curriculum (2006) of Philips the training 'Working in a project' is available for learning about the basis of project management. However, this is interesting for employees who are new in the field of project management and not for employees who have experience with project management. Also, a training available is at Elsevier, a bureau where Philips collaborates with. However, this training is very technical oriented.

Intervention choice
As described above, the intervention that is selected for new employees or employees who hardly worked with project management is the classroom training 'Working in a team'. To facilitate the transfer of this training or to learn other employees about project management, the interventions mentoring, feedback and the Personal Development Plan are used.
The training will provide engineers with the knowledge of project management and the other interventions will teach engineers how the information can be used. Therefore, a combination is made between the advices of a mentor, the feedback of colleagues and the own reflections. The combination of these three will provide insight in the competency and make it possible for engineers to develop the competency.

Other interventions were not used, because these interventions provide the learning ability that an engineer needs. This could be done in a different way, but the researcher chose these interventions based on the work environment and the work of an engineer.

Development of competency project management
The training 'Working in a team' is described in the Core Curriculum of Philips (2006) and will not be described in this document.
It is recommended that engineers, who have experience with project management, have a mentor or coach who can coach the engineer during project management. The mentor provides the engineer with feedback or tips that he needs for developing the competency. The selection of a mentor or coach depends on the availability of a good mentor within Philips ETG.

This intervention is combined with feedback sessions. During and at the end of a project the engineers should use feedback to enhance the collaboration in the team and to develop their personal competencies. However, it is important that the engineers use feedback well and therefore, it is important that they learn how to give and receive feedback according to the feedback rules. These rules have to be presented and practised, which can be done by an employee of the HR-department or a trainer.

During the process of coaching and learning about project management the engineer has to reflect in the Personal Development Plan. Also, during the feedback sessions after the project the engineer has to use the feedback that is received from colleagues. The focus, during the coaching period, should be to create a pro-active attitude towards project management.

Project management
The coach has to have good project management skills and also has to know how the engineer can be coached. The training 'Coaching for performance and growth' of the Core Curriculum (2006) of Philips can be used to develop this coaching skill. In the beginning, the coach will also have to be coached by someone to develop his coaching skill. In the organisation and especially in the HR-department a coach has to be selected to guide the engineer to become a coach. This process of learning to be a coach should also be documented in the Personal Development Plan and be used during feedback sessions in projects or at other appropriate moments.

Table 57: Development methods cognitive competencies

Problem Solving
Analysing and solving problems in different situations to achieve the set goal. Layer of iceberg structure: Professional knowledge and skills
Availability within Core Curriculum of Philips The Core Curriculum (2006) of Philips or a bureau with whom Philips collaborates does not have a training that fits this competency. New employees can practice some elements of problem solving in the training 'Working on a project' from the Core Curriculum (2006). However, this training does not completely focus on the development of the competency problem solving.
Intervention choice Problem solving is a competency that can be developed with the interventions classroom training mentoring and the Personal Development Plan (PDP). Mentoring provides the engineers with knowledge of the competency and the ability to use the knowledge in practice. The PDP is used to help the engineer to reflect upon the feedback and on own experiences. Therefore, it provides extra information for the engineer. Also, new employees can practice some elements of problem solving in the training 'Working on a project' from the Core Curriculum (2006). The transfer of this training is facilitated by the on-the-job interventions mentoring and the PDP. Other interventions were not used, because of the character of the competency and the work environment and work of the engineer. Off-the-job training is perceived as not relevant, because the knowledge that has to be learning can better be gathered with the help of on-the-job interventions. Also, collaboration tools, Job instruction training and coaching were perceived is not relevant. This is because a colleague can better provide the engineer with the information, because of own experiences with the market and the competency.
Development of competency problem solving The mentor can coach an engineer to develop the competency solving problems. This mentor should assist the engineer in the phase of problem solving, which is not focused on the technical problems only, but also on other problems. Also, for technical problems the engineer can ask questions to other colleagues who know a lot about the technical elements of the problems. The mentor will assist the engineer with all elements. The engineer reflects upon the learning in the PDP and also uses reviewing and brainstorming sessions to reflect upon the competency. The PDP that is developed by Philips ETG can be used for this reflection. However, the engineers will need to be learned how this PDP is used and they might need some guiding during the beginning of using the PDP. This can be provided by the HR-department. New employees can practice some elements of problem solving in the training 'Working on a project' from the Core Curriculum (2006). However, this training does not completely focus on the development of the competency problem solving. Therefore, this training can only be used for new employees who can also learn from the other elements.

Problem Solving

The coach will have to know how the engineer can be coached. The training 'Coaching for performance and growth' of the Core Curriculum (2006) of Philips can be used to develop this coaching skill. In the beginning, the coach will also have to be coached by someone to develop his coaching skill. In the organisation and especially in the HR-department a coach needs to be found to selected the engineer to become a coach.

Conceptual thinking

Building thinking frameworks or models and the formulation of concepts or ideas according to complex information (Floor, 2006).

Layer of iceberg structure:
Professional knowledge and skills

Availability within Core Curriculum of Philips
For the competency conceptual thinking there is no training available within the Core Curriculum (2006) of Philips or at bureaus that work with Philips.

Intervention choice
The competency conceptual thinking is an important element of the work of an engineer. Therefore, it is suggested that an engineer has to have this competency when becoming an engineer of Philips ETG. However, to develop this competency even more the engineer needs to have a mentor who can coach him in generating ideas. On this process the engineer needs to reflect in his Personal Development Plan (PDP). Also, the collaboration tool of discussion groups can be used when working together with other colleagues in meetings or reviews to become better in this competency.

Other interventions were not selected based on the fact that the competency acquires some creativity, which cannot be learned in classroom training or in job instruction training. Also, a coach is not applicable because a mentor can provide more feedback. The mentor works in the environment whereas the coach often does not.

Development of competency conceptual thinking
The mentor can coach an engineer to develop the competency conceptual thinking. This mentor should assist the engineer in the phase of conceptual thinking. Therefore, the engineer should ask feedback from the mentor when applicable and the mentor needs to provide feedback.

The engineer reflects upon the learning in the PDP and also uses discussion during reviewing and brainstorming sessions to reflect upon the competency. The PDP that is available at Philips ETG can be used for this reflection. However, the engineers will need to be learned how this PDP is used and they might need some guiding during the beginning of the use of the PDP. This can be provided by the HR-department.

The coach will have to know how the engineer can be coached and the training 'Coaching for performance and growth' of the Core Curriculum (2006) of Philips can be used to develop this coaching skill. In the beginning, the coach will also have to be coached by someone to develop his coaching skill. In the organisation and especially in the HR-department a coach needs to be selected to guide the engineer to become a coach.

Awareness
The perception and reaction to a condition (Wikipedia, 2006). Layer of iceberg structure: Intermediary skill/personal characteristic
Availability within Core Curriculum of Philips The Core Curriculum (2006) of Philips or a bureau with whom Philips collaborates does not have a training that fits this competency.
Intervention choice The competency awareness is difficult to develop because of the combination of intermediary skills and personal characteristics. Especially this last is important, because this knowledge some aspects are difficult to develop when it is in the personal characteristics of an engineer. Therefore, the interventions that are chosen are based on this thought. However, the organisation needs to be aware of the fact that a competency is difficult to develop and that it should be expected that behaviour is difficult to change. To focus on the aspects of awareness reflection, coaching, feedback and the Personal Development Plan (PDP) are used as interventions. This is chosen because these interventions can make engineers aware of the competency. Other interventions were not chosen based on the fact that they were not usable for this competency. A mentor or trainer will not be able to change the personal characteristics of the engineer only the own reflection combined with the feedback of others will.
Development of competency awareness Reflection can be used to reflect upon own and other one's strengths, weaknesses, likes and dislikes. Also, this can help to be more aware of social, political and economical development. Reflections that can be done to make engineers aware of this competency are the circle reflection, triangle reflection and line reflection (Procee, 2003). Also, other reflections types can be of use, but the coach or the HR-department should research this. The coach is an external person or someone from the HR-department who can help the engineer to be more aware of certain elements. Reflections are done together with the coach and talked through with the coach. The coach can ask for additional information to provide the engineer with a clear view of the competency. Together they should work on the development of the competency, which is too difficult to do alone. In this process the feedback retrieved in the feedback sessions with colleagues can be used to get a better picture of the competency. During and at the end of a project the engineers should use feedback to enhance the collaboration in the team and to develop their personal competencies. However, it is important that the engineers use feedback well and therefore, it is important that they learn how to give and receive feedback according to the feedback rules. These rules have to be presented and practised, which can be done by an employee of the HR-department or a trainer. The engineer reflects upon the learning in the PDP to reflect upon the competency. The PDP that is developed by Philips ETG can be used for this reflection. However, the engineers will need to be learned how this PDP is used and they might need some guiding during the beginning of using the PDP. This can be provided by the HR-department.

Self-development

Possessing insight into one's strengths and weaknesses and on this basis initiating activities to increase/enhance one's knowledge, skills and competencies in order to perform more effectively (Schakel & Smid, 2005, Floor, 2006).

Layer of iceberg structure:
Intermediary skill/personal characteristic

Availability within Core Curriculum of Philips
Within the Core Curriculum (2006) of Philips or a bureau with whom Philips collaborates there is not a training that fits this competency.

Intervention choice
The competency self-development can be difficult to develop, because it is a combination between intermediary skills and personal characteristics. Especially this last will make it difficult to make engineers aware of the fact that self-development is needed. Therefore, this competency expresses that engineers have to become aware that they need to be involved in their own development. This is not only for the benefit of the organisation, but also for them.
For the development of this competency a combination between reflection, classroom training, feedback and the Personal Development Plan (PDP) are chosen. Also, a contact person/coach is needed to guide the process. On-the-job learning and training is chosen to facilitate transfer for of the classroom training.

Other interventions were not applicable, because it does not fit the work environment or the possibilities of the organisation.

Development of competency self-development
The engineers need to learn more about reflection, self-analysis and the ways to find sources to develop. For this process a presentation needs to be given by the HR-department to explain the methods of reflection and self-analysis. This also needs to be practiced by the engineers with help of the HR-department. Also, the engineers need to be made aware by the HR-department and by each other of the methods that can be used for development. Therefore, during the training or presentation the engineers need to discuss where they all can find information to develop. This needs to be documented and placed somewhere, where everybody has access to.

For the self-development the engineers need to have a contact person (or coach) who can help them with their questions and development. The manager of the department cannot help the engineers with all their questions. Therefore, someone outside the department needs to be a contact person also. This contact person is able to help the engineers and provide them with the information or help they need. This contact person can be someone from the HR-department.

In this process the feedback retrieved in the feedback sessions with colleagues can be used to get a better picture of the competency. During and at the end of a project the engineers should use feedback to enhance the collaboration in the team and to develop their personal competencies. However, it is important that the engineers use feedback well and therefore, it is important that they learn how to give and receive feedback according to the feedback rules. These rules have to be presented and practised, which can be done by an employee of the HR-department or a trainer.

The engineer reflects upon the learning in the Personal development Plan to reflect upon the competency. The PDP that is developed by Philips ETG can be used for this reflection. However, the engineers will need to be learned how this PDP is used and they might need some guiding during the beginning of using the PDP, which can be provided by the HR-department.

Knowledge of the own organisation
The possession of information of Philips ETG and the ability to use that information. Layer of iceberg structure: Professional knowledge and skills
Availability within Core Curriculum of Philips There is no training available for the development of knowledge of the own organisation in the Core Curriculum (2006) of Philips or at other bureaus.
Intervention choice The competency knowledge of the own organisation it is about retrieving knowledge. Therefore, this competency should not be that complex to develop. For this development the intervention collaboration tools is chosen, which consist of a document analysis and a discussion group. Other interventions were not chosen based on the uncomplicated character of the competency and on the fact that other interventions would be too costly compared to what is been learned.
Development of competency knowledge of own organisation To possess knowledge of the own organisation is important for every engineer to know the sub-competencies of the competency. Therefore, a group of engineers and the manager need to discuss together what the culture, the internal processes, the interest, the vision, mission and values and the competencies and capabilities are. The results of this discussion needs to be documented somewhere that all engineers can access. This discussion has to be repeated after some time to make sure that the information is still correct. Also, it has to be taken into account that it can differ from market to market. Philips ETG can have a different interest when working in the semiconductor market then when working in the medical device market.

Knowledge of the client
The possession of information of the client and the ability to use that information Layer of iceberg structure: Professional knowledge and skills
Availability within Core Curriculum of Philips There is no training available for the development of knowledge of the client in the Core Curriculum (2006) of Philips or at other bureaus.
Intervention choice The competency knowledge of the client is about retrieving knowledge. Therefore, this competency should not be too complex to develop. For this development the intervention collaboration tools is chosen, which consist of a document analysis and a discussion group. Other interventions were not chosen based on the uncomplicated character of the competency and on the fact that other interventions would be too costly compared to what is been learned.
Development of competency knowledge of the client The possession of knowledge of the client is important for the engineer that works in project with the client. Therefore, a group of engineers need to find out together what the culture, the product, the interest, the internal processes and market and the competitors are of the client. The results of this research needs to be documented somewhere that all engineers can access. This search has to be repeated when starting a new project of the client to make sure that the information is still correct.

Knowledge of the medical device market

The possession of information of the medical device market and the ability to use that information

Layer of iceberg structure:
Professional knowledge and skills

Availability within Core Curriculum of Philips
There is no training available for the development of knowledge of the client in the Core Curriculum (2006) of Philips or at other bureaus.

Intervention choice
The competency knowledge of the medical market is about retrieving knowledge. However, this knowledge is mostly completely new for the engineers. Therefore, for this development the intervention collaboration tools is chosen, which consist of a document analysis and a discussion group. Also, classroom training can be used, but this needs to be researched by the manager and engineers, because this is focused on technical elements.

Other interventions were not chosen based on the uncomplicated character of the competency and on the fact that other interventions would be too costly or not applicable.

Development of competency knowledge of the medical market
The possession of knowledge of medical regulations, safety rules and testing and registration can be researched with the help of internet and Philips MS. Philips MS knows which information is important for a certain project and therefore, the engineers need to work together with PMS to make sure that the knowledge is gained. Therefore, documents are analysed by a group of engineers who discuss this information to get a better insight in the medical market. This information needs to be documented for all engineers and provides all the engineers the knowledge that is needed to work on a project for the medical device market.

For the training the engineers, together with the HR-department or the manager, need to find out which training or other method has to be done to gain the technical knowledge.