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FRONT END OF INNOVATION IN INDUSTRIAL ORGANIZATION

Constructive research

Master's Thesis in
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“There is only one song, and Adam and Eve wrote it; the rest is a variation on a theme.”

- Keith Richards, 1997

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ABBREVIATIONS

FEI	Front End of Innovation
NPD	New Product Development
NCD	New Concept Development
SPD	Strategic Problem Deconstruction

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VAASAN YLIOPISTO
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TIIVISTELMÄ

Tutkielman aiheena on innovaatioprosessin ensimmäinen vaihe, joka on englanninkieliseltä termiltään ’front end of innovation’. ’Front end of innovation’ on innovatiivisten konseptien alustava tutkimus- ja suunnitteluvaihe ennen varsinaista tuotekehitystä. Tutkielman tavoitteena oli suunnitella tehokkaan ideatuotannon ja konseptikehityksen käsitteellinen malli.

Teollisuudessa ’front end of innovation’ mielletään usein epäselväksi käsitteeksi, jota on vaikea ymmärtää ja hallita. Etenkin innovatiiviseen luovuuteen liittyvät kysymykset pyritään selittämään ympäripyöreillä mielikuvilla ihmeellisestä yksilölahjakkuudesta. Akateeminen kirjallisuus ideaaliin front end-vaiheeseen liittyen on hajanaista ja tulkinnanvaraista. Front end-vaihe sivuaa useita eri tieteenaloja, joka vaikeuttaa merkittävästi sen kokonaisuuden ymmärtämistä. Näin ollen tämä tutkielma on toteutettu konstruktiivisella tutkimusmenetelmällä, joka pyrkii ratkaisemaan jonkun tietyn ongelman yhdistelemällä teoreettista ja käytännöllistä tietoa useasta eri lähteestä.

Tutkielman ratkaisu on johtamisrakenne, niin kutsuttu käsitteellinen malli, joka tehostaa front end-vaiheen sellaisten ideoiden tuotantoa ja konseptien kehitystä, jotka tuovat arvoa loppuasiakkaalle. Tutkielman malli perustuu ongelman ratkaisu-metodiin, jossa ongelma on analyysin kohteena. Ongelma puretaan alaongelmiksi, jotka pyritään ratkaisemaan löytämällä jo olemassa olevia ratkaisuja ympäristöstä. Kyseinen prosessi on iteratiivinen eikä sillä ole määrättyä vaihejärjestystä. Mallin soveltamista havainnollistettiin kolmessa työpajassa pienessä mittakaavassa ja työpajan osallistujat vastasivat kyselyyn, joka mittasi heidän kokemustensa laatua. Tulokset osoittavat, että mallia soveltavassa organisaatiossa tulee olla innovatiivinen kulttuuri, jossa johtoryhmä laatii normit kommunikaatiolle ja yhteisymmärryksen rakentamiseen. Mallin soveltaminen tapahtuu eri organisaation toimintojen poikkitieteellisellä yhteistyöllä, joka suosii matalaa hierarkiaa ja leikkimielistä ilmapiiriä. Ajan mittaan innovaatiostrategia, ja sen kyvykkyys selviytyä front end-vaiheen epävarmuudesta, määrittävät liiketoiminnan menestyksen.

AVAINSANAT Front end – vaihe, radikaali innovaatio, ongelman ratkaisu, luovuus, innovatiivinen strategia

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ABSTRACT

The subject of the thesis is the first phase of innovation process called the front end of innovation. The front end of innovation is the preliminary research and design phase of innovative concepts before the detailed development phase of a product. The goal of the thesis was to design a conceptual model for efficient idea generation and concept development.

The front end of innovation in the industry is commonly seen as a fuzzy construct that is difficult to understand and manage. Especially issues with innovative creativity are often treated with vague notions of inexplicable individual talent. The academic literature related to an ideal front end-phase is fragmentary and ambiguous. Front end of innovation considers profoundly various fields of research, which complicates the understanding of general view. Therefore, this research has been conducted as a constructive research, which pursues to solve a specific problem by combining theoretical and practical knowledge from various sources.

The designed solution is a managerial construction, so called conceptual model, to operate efficiently in the front end of innovation by generating ideas and developing concepts that deliver value for the end customer. The designed model establishes itself on the method of problem solving, where a problem is the target of analysis. The problem is deconstructed into a web of subproblems, which are pursued to be solved by seeking existing solutions from sources in surroundings. The process is iterative and non-sequential. Three workshops were conducted to demonstrate the use of the model in small scale and a questionnaire was produced to measure the experiences of the participants. The results indicate that the organization applying the model shall possess a strong innovative culture, where senior management establishes the norms for communication and consensus building. The model is applied in a cross-functional and interdisciplinary manner that favors non-hierarchical and playful atmosphere. In the course of time, the innovation strategy, and its ability to cope with the uncertainty in the front end of innovation, will define the success of the business.

KEYWORDS Front End of Innovation, radical innovation, problem solving, creativity, innovative strategy

1. INTRODUCTION

Globalization has driven local businesses around the globe to compete with each other, and replaced local markets with global trade of countless opportunities and threats. Constantly more competitive environment has forced companies to cut down costs and improve efficiency to the finest detail. The development of information technology has given the opportunity for faster communication and knowledge transfer between people enabling rapid improvement in all of the business functions, resulting in shorter product life cycles and more effective manufacturing. Good examples of this are the mobile phone industry where a smart phone's life span is expected to be just 4.6 years in average (CEA, 2014), or the assembly line work where the labor costs of a product have been cut down tremendously after year 2000 with the help of automatized robots.

In order to stay strong in the competition, the role of innovation in business is ever more increasing its importance. When competition is harsh and rivals boast regularly with new services and high technology, innovation possesses such a competitive advantage that it is rightfully called the fountain of success. However, the success does not come free, as the challenge is to identify the customer needs and to respond to those needs with right products. Companies need systematic methods and tools of customer needs assessment and innovation management to be able to respond efficiently to this challenge.

A strategy must be established about how to utilize the human capital of the company including individual knowledge, talents, skills, abilities, experience and intelligence of personnel to produce value for the business (Becker, 2016). The strategy comprehends how knowledge is shared among organization and the way data is collected, analyzed and distributed between the stakeholders that contribute to innovation capabilities. The aim of the strategy is to build a frame that supports the generation of innovations, innovations that possess value for the end customer. Innovations get started with good ideas in a phase called Front End of Innovation (FEI) that precedes New Product Development (NPD). The purpose of this study is to create an idea generation model for this strategy that operates in the Front End of Innovation-phase.

1.1. Research methodology and structure

The thesis applies constructive research approach to study the research questions. In constructive research the aim is to solve a practical problem while producing an academically appreciated theoretical contribution (Lehtiranta et al., 2015). The thesis seeks to answer the following research questions:

What are the managerial requisites for an industry organization to be innovative?

How innovations are born?

How do you manage the generation of innovation?

According to Kasanen et al. (1993), the constructive research approach solves managerial problems by means of constructing models, diagrams, tools or organization charts. The constructive research approach begins by identifying a practically relevant research problem in the industry or literature. After defining the problem, the researcher shall focus on solving the problem by acquiring broad knowledge of the problem situation and search for the relevant theories in literature that may contribute to constructing the solution (Lehtiranta et al., 2015). The research process follows the steps of six distinctive phases (Kasanen et al., 1993; Lehtiranta et al., 2015) that are described below in the manner they took place in the thesis.

(1) *select a relevant problem*; A problem was offered by a company operating in the industry of electrical parceled goods. The research questions were defined according to their description of challenges that they evaluate to be the present key factor of success in the business.

(2) *obtain an understanding of the study area*; A comprehensive literature review was conducted of the essential topics related to the research questions.

- The chapter 2. Front End of Innovation covers the organizational aspects of industrial innovation describing the ideal of front end of innovation as well as

the impact and the challenges that one will confront in this starting period of innovation. Additionally, the social requisites and structures in the organization are addressed emphasizing the important role of a leader in an innovative environment.

- The chapter 3. Principles of Innovation studies what is creativity and how do we get ideas. The chapter presents how ideas gradually evolve towards concepts and various kinds of innovations, and focuses along the way particurlarly on the strategy to discover radical innovations.
- The chapter 4. Conceptual Models of Front End Innovation represents the development of conceptual models to manage the front end of innovation, and discusses the strengths and weaknesses of each model in order to find out the optimal solution to innovation generation.

(3) *design one or more applicable solutions*; On the basis of literature review executed in chapters 2., 3. and 4., an improved conceptual model is developed in chapter 4 to manage the front end. The model is developed by combining the strongest features of conceptual models found in the literature and to meet the requirements encountered in industry. This phase of constructive research embraces the characteristics of typical innovation by combining knowledge from various sources, even from very unexpected areas. Thus, to come to the conclusions conducted in this study, an innovative process was undergone that is similar to the mentioned conclusions.

(4) *demonstrate the solution's feasibility*; Chapter 5. describes how the application of the conceptual model, developed in chapter 4., was experimented in three workshops that featured the use of a problem solving tool in small scale. The method of the problem solving tool is in a central role in the developed conceptual model that allows the thesis to assume the feasibility of the model also when applying it in large scale. Additionally, a survey was conducted for the electrical engineering company, which provided the research problem, and the results of the survey evidence further the feasibility of the model.

(5) *link the results back to the theory and demonstrate their practical contribution*; Chapter 5. discusses the connection between the results and the literature review,

offering further managerial implications.

(6) *examining the general usability of the results*; Chapter 6. concludes the deductions of the thesis in one chapter, and considers additionally the general reliability and validity of the thesis.

1.1.1. Validity and Reliability in Constructive Research

The constructive research conducted in this thesis is a qualitative research that applies deductive reasoning by selecting a relevant problem, obtaining an understanding of the field of research and designing a solution or a construction to the initial research questions (Lehtiranta et al., 2015). A developed construction differs from anything that existed before and solves an explicit problem. The construction in this thesis is a managerial construction which refers to an entity that solves problems in running business organizations (Kasanen et al., 1993). Construct validity refers usually to the functionality of the construction, in other words, whether the construction is able to solve the organisational problem for which it was designed (Lukka, 2000; Oyegoke, 2011; Lehtiranta et al., 2015). The construct validity can be measured in following ways:

1. Measuring the truthfulness of the study by using practical reasoning, which implies that in a conditional sense, a technical norm is true if and only if doing *X* is really unavoidable in order to reach *A* under conditions of *B* (Niiniluoto, 1985).
2. Assessing the practical usefulness by means of relevance, simplicity and easiness of operation (Niiniluoto, 1985). One must consider whether the construction works and is capable of solving the problems of the study. Simplicity is commonly referred to a feature of quality when something is easy to understand or explain. Hence, it may be assumed that a functional construction is relevant, simple and easy to use (Kasanen et al., 1993).
3. By conducting a market test to validate the value of the construction on an actual market. To test the true pragmatic adequacy of a construction takes a lot of time

and effort, therefore Kasanen (1986) defined market tests of varying strength, mimicing the competition of products on a market:

- *Weak market test*: "Has any manager responsible for the financial results of his or her business unit been willing to apply the construction in question in his or her actual decision making?"
- *Semi-strong market test*: "Has the construction become widely adopted by companies?"
- *Strong market test*: "Have the business units applying the construction systematically produced better financial results than those which are not using it?"

Additionally, to prove that the method of construction is scientific, the construction needs to have theoretical connections in one or more specific theoretical frameworks (Kasanen et al., 1993). This further improves the scientific validity of the construction but also supports the claim that the construction would be applicable in other cases as well than solely in its original event of study. The latter addresses the external validity of the study, telling whether the results of the study are generalizable also outside of the research. Kasanen et al. (1993) argue this objective might have been met already by designing a working managerial construction. If a solution can solve problems that it was intended to solve in one firm, arguably the solution will have problems solved also in other firms in similar situation. Kasanen et al. (1993) explain: *"A managerial construction is like a product competing in the market of solutions, not a statistical statement."* Therefore, the arguments for generalizability are substantially different for a constructive study than for other studies of statistical method. In a pragmatic sense, practical usability is the major factor of truthfulness that verifies a managerial construction. On this basis, Kasanen et al. (1993) reason that the whole idea of generalization could be proposed other way around by arguing that if an adequate, working construction has been created, what are the more general features which have become visible in the appliance of the construction. As a result of this, Lehtiranta et al. (2015) consider that constructive research can be regarded as following the abductive logic of reasoning, which involves a cyclical alternation between the deductive and inductive processes. However, in general and in this thesis only deductive reasoning is

applied to conduct the constructive research and further examination of the thesis hypotheses in inductive logic has been left out.

The constructive research in this thesis is a causal study seeking to explain why performing *X* enables *A* to happen under conditions of *B*. Internal validity examines the quality of conclusions that claim to explain the consequences between all the named factors. If the researcher interprets the results without being aware of an additional factor that has a major impact on the end result, the research design has failed and imposes a threat to internal validity (Yin, 2009). Moreover, a constructive research typically involves inferences in the study. There is an inference every time an event cannot be directly observed, either because of technical reasons or the researcher's abilities of interpretation (Yin, 2009). Internal validity considers the appropriateness of the study by assessing is the evidence convergent, are the methods of study adequate, and if the causal direction of conclusions is precise (Yin, 2009; Saunders et al., 2009). Internal validity in relation to research methods addresses the competence of the methods to measure what they are intended to measure (Saunders et al., 2009). This brings forth a concern whether the method measures the reality that it actually should be measuring. To overcome the suspicion and be certain of the right methods and results, researchers look for other relevant evidence that support the results concluded with the initial method and judge the relevance of results by the nature of research (Saunders, 2009).

Reliability is in close relation to internal validity. Reliability examines the consistency of findings that have been achieved with the concerned methods and procedures of research (Saunders, 2009). The purpose of reliability is to minimise the amount of errors and the depth of biases in a study (Yin, 2009). According to Easterby-Smith et al. (2008), reliability can be assessed proposing following questions:

- Has the design eliminated all alternative explanations?
- Will the measures yield the same results on other occasions?
- Will similar observations be reached by other observers?

- Is there transparency about data collection and interpretation?

In order to reach a good reliability in research, explicit documentation of all the study events and procedures is important. This allows external reviewers to be convinced of the decency of research (Yin, 2009). Therefore, Yin (2009) recommends to make as many steps as operational as possible and to conduct research as if someone were always looking over your shoulder.

2. FRONT END OF INNOVATION

Every product, which is developed and commercialized into the market, starts with hitting on an idea that for any individual, in the very beginning, has potential of making good business. This is the initial target of a stage called Front End of Innovation (FEI) that precedes the well-structured and formalized New Product Development (NPD) or Stage Gate™ process (Koen et al., 2001). The objective of FEI is to generate beneficial business ideas while at the same time reducing the risk to invest time and money in the product development by anticipating the eventual threats and opportunities of an idea or concept before it receives major funding and time allocation (Koen et al. 2001; Khurana et al. 1997). The outcome of a successful operation in FEI would be that more high-profit product concepts enter the NPD, and less NPD-projects fail due to unrealistic budgeting, false customer insight, and other reasons (Koen et al. 2001).

In the last couple of decades, the continuously advancing information technology has shown the way for improved capabilities of concurrent engineering where rapid prototyping and well-established supplier partnerships have reduced the time for product design and development (Khurana et al. 1997). In the midst of development, many companies have recognized the importance of a front-end process, and Reid & Brentani (2004) even consider the front-end as the root of success especially when aiming for radical innovation. Yet understanding the character of FEI has been a challenge for both the academics and the industry, as most often the front-end is applied only for incremental innovation projects in which the organization is involved from the beginning. In these cases, FEI is considered more a formal phase of a New Product Development project rather than its own entity with distinctive features (Reid & Brentani, 2004). However, FEI differs notably from NPD as Koen et al. (2001) describe; "*...the activities in the FEI are often chaotic, unpredictable and unstructured. In comparison, the NPD is typically structured, which assumes formalism with a prescribed set of activities and questions to be answered."* This chapter describes the various characteristics of FEI, emphasizing the impact and importance of FEI for the whole business performance.

2.1. What is the Front End of Innovation?

The front end of innovation (FEI) is commonly defined as the initial, often chaotic, phase of developing a new product, which starts from the idea generation or opportunity identification, continues to opportunity analysis and idea selection, and finishes by an approval to development, or concept's rejection (Koen et al., 2001; Kim & Wilemon, 2002a). According to the interpretation of Smith & Reinertsen (1992) the FEI starts already when the need for a new product is first apparent, whether the company acts on it or not. This kind of need could be mandated by a competing product or a new government regulation. The FEI terminates when the firm commits significant human resources to develop a response to this need.

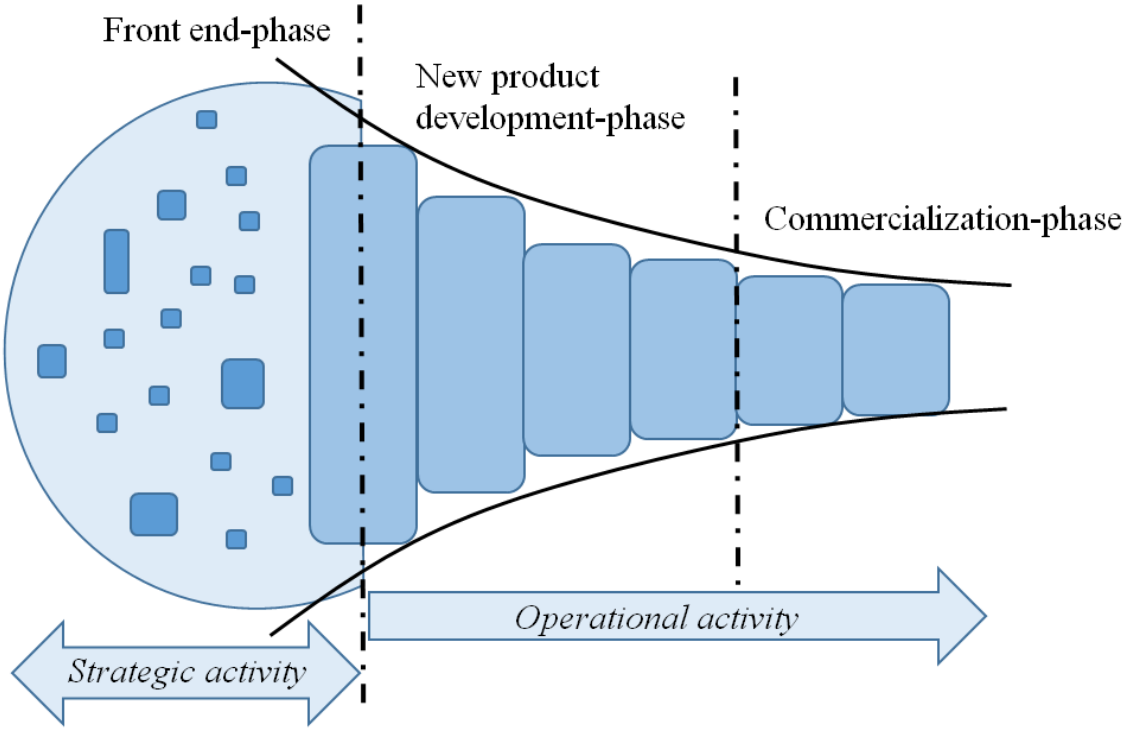

Figure 1. A framework of Front End of Innovation

Khurana & Rosenthal (1998) define the front end to include product strategy formulation and communication, opportunity identification and assessment, idea generation, product definition, project planning and executive reviews, which in general occur in prior to the deliberate new product development and design. In other words, in

their study, Khurana & Rosenthal (1998) link the success of FEI operations to an approach that connects business strategy, product strategy and product-specific decisions into a holistic view of the front-end. The aim of this approach is to translate product strategy and business goals into operational product and market objectives (Figure 2). Kim & Wilemon (2002b) explain the ideal purpose of FEI is to develop an idea into a useful, validated product concept so that the concept will then evolve into a commercial product or service. In order to achieve this goal Jacoby (2012) notes that innovation is a matter of strategy. For every newly defined product or service, alignment with strategy in the FEI is essential (Reinertsen, 1992; Kim & Wilemon, 2002b). A holistic view of FEI is supported by Kim & Wilemon (2002b) since most activities in FEI are interrelated to each other and therefore in situations where organization needs to pursue rapid results then perceiving the big picture is of great assistance. Thus, FEI is defined, in this thesis, to start from the formulation and communication of a product strategy and finish with an approval to new product development or the concept's rejection.

2.2. The Impact of Front End of Innovation

The decisions made in the Front End of Innovation lay the foundation for further actions in the New Product Development. Cooper & Kleinschmidt (1994) note in their study that "*the greatest differences between winners and losers were found in the quality of pre-development activities*". Several other studies have found similar results of the importance of FEI (e.g. Atuahene-Gima, 1995; Shenhar et al., 2002; Herstatt & Verworn 2001; Backman et al. 2007). In short, the Front End of Innovation aims to create ideas that bring value for the end customer and according to Murphy & Kumar (1997) this requires a clear understanding of development time, costs, required technical expertise and market potential. They say, with the help of aforementioned knowledge, costly, ill-informed project decisions can be avoided as poor planning can result in development slow-downs, unforeseen project costs, and unsuccessful new products.

Smith & Reinertsen (1998) point out that the actions taken during the FEI to improve

the results of NPD process, enable the greatest time savings for the least expense. According to them, half of the typical product development cycle time, starting from an opportunity identification and ending in first customer shipment, is spent during the front-end operations. Considering the long average time spent in FEI and the cheap price of project revisioning, Smith & Reinertsen (1998) see FEI as an extraordinary opportuntity especially since the performance of individual companies in FEI varies dramatically. If projects are well-defined they can be efficiently managed and executed without changes in the halfway. Furthermore, improvements to the front-end processes not only reduce the number of failed products, but also significantly shorten the development durations of projects in NPD (Smith & Reinertsen, 1998).

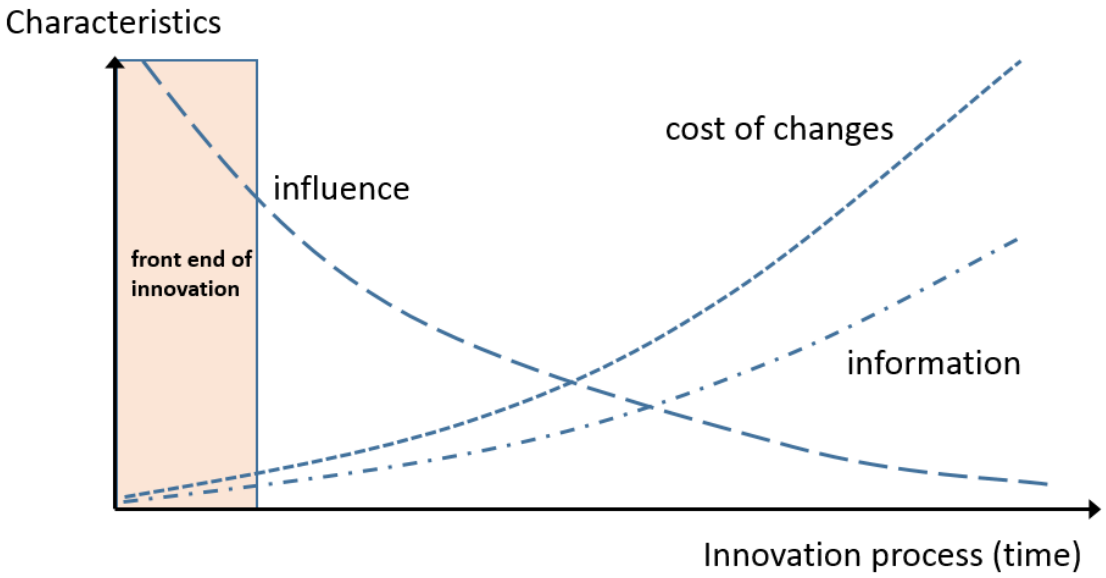

Figure 2. The advancement of influence, cost of changes and information in an innovation process. Herstatt & Verworn 2001 modified from von Hippel 1993.

The low cost of FEI is related to the possibility of generating several potential ideas compared to the costs of actually implementing any one idea (Urban & Hauser 1993). Herstatt & Verworn (2001) state that despite the fact that the degree of freedom in design and influence on project outcomes are high in FEI, whereas at the same time costs for changes are low, the advantage is limited by the low amount and certainty of information compared to later stages of the product development (Figure 2). Therefore, discovering the necessary information for the front-end plays an important role in the

decisions preceding the New Product Development. The success of product development is largely depending on decisions made in FEI as the impact decisions can have on the final product decreases in later phases of the development. This means that when FEI decisions can impact the product as a whole, the decisions during NPD have to consider the earlier decisions and can only have an impact on partial aspects of products (Dewulf, 2013), and thus, NPD is more path dependent and inflexible in its operations (Jespersen, 2015). Since the activities and decisions executed in FEI are the starting point for all NPD processes and, therefore, determine the directon of any new path, it is clear that a better understanding of the impact of FEI could lead to competitive advantage (Reid & Brentani, 2004).

2.3. Challenges in Front End of Innovation

The uncertainties and difficulties associated with NPD are becoming very common in most advanced industries in addition with the demand to develop new products (Kim & Wilemon, 2010). The punctuality of launching new innovative products to the market is a major advantage to success in the industry (Iansiti, 1993; Aaker, 2007). A great share of the barriers in NPD can be avoided with proper functions in FEI, as discussed in chapter 2.2., but despite its importance, the front-end is often perceived as even more troublesome of the two, and is therefore at times ignored or poorly performed. Indeed, FEI has been identified as the most challenging phase of the development, but the challenges may be alleviated with correct managerial actions, unveiling the greatest potential to improve the overall performance of the development process (Reid & de Brentani, 2004; Kim & Wilemon, 2002b; Zhang & Doll, 2001).

2.3.1. The Fuzzy Start of Innovation

The main cause for problems in the front-end is its fuzziness (Zhang & Doll, 2001). Identification of specific methods, which can reduce the fuzziness, is the key solution to improve the probability of success and accelerate the FEI process. Fast idea evaluation and early termination of flawed ideas contribute to a productive activity in the FEI as

new concepts may be taken sooner under investigation instead of spending energy and resources to invigorate failing ideas (Smith & Reinertsen, 1998). The degree of fuzziness is in a broad sense related to the external market developments as well as internal developments and strategies. Thus, the proficiency of the FEI can be classified into external FEI competence and internal FEI competence (Kim & Wilemon, 2010). The two competencies form the contextual factors that influence the front-end, project execution and project success (Figure 3). In the figure, blue arrows represent the influence of contextual factors in whole, which affect the quantity & quality of 'front end of innovation', the amount of deviations from specifications & communication of 'project execution', and efficiency & overall satisfaction of 'project success.'

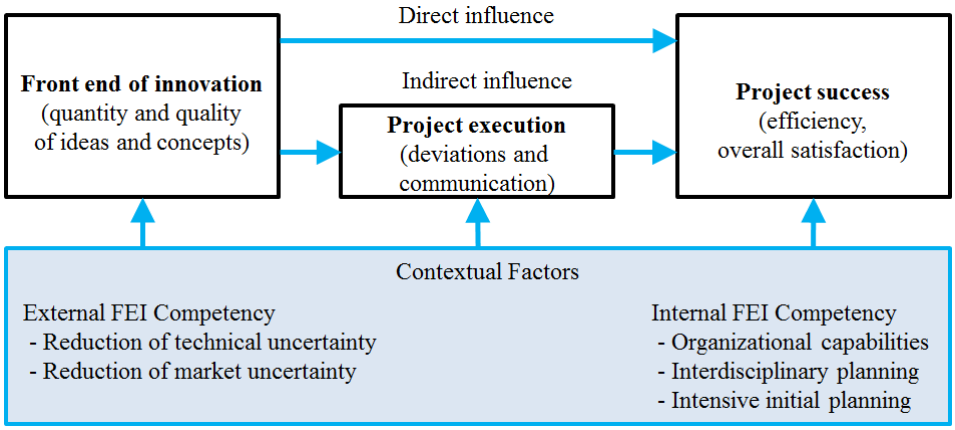

Figure 3. A framework of contingency influence on innovation process. Modified from Verworn (2009) and Kim & Wilemon (2010).

External FEI competence, according to Kim & Wilemon (2010), includes the capabilities to collect and assess technology market, trends, customers and competitors. Verworn (2009) captures the idea stating that relevant information must be gathered to reduce risks and uncertainties preceding the new product development process, and continues that reduction of market and technical uncertainty have direct and indirect influence on the project success. Especially communication is influenced negatively by market and technical uncertainty, which in consequence increases deviations during NPD project.

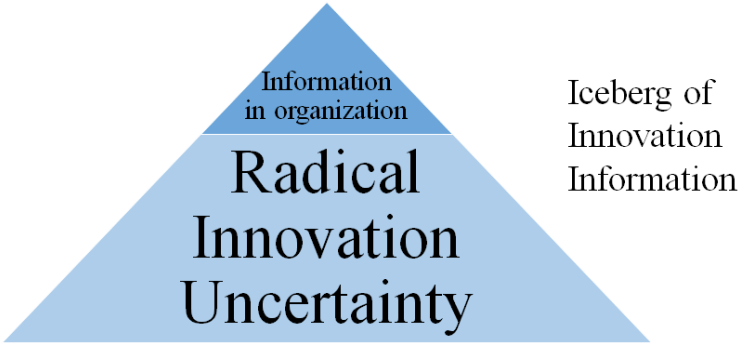

Figure 4. Amount of information required for an innovation in the sense of "Tip of the Iceberg". Own interpretation according to Galbraith (1973).

Galbraith (1973) defined uncertainty as "the difference between the amount of information required to perform a particular task, and the amount of information already possessed by the organization", which can be illustrated in a sense of 'the tip of the iceberg' (Figure 4). The visible part of the iceberg above water level is the information already possessed by the organization, but major share of the information is still dwelling below the surface waiting to be uncovered; this is the uncertainty related to radical innovation in FEI. Verworn et al. (2008) interpret that reducing the uncertainty during the FEI process will result in fewer deviations from front-end specifications in the following project execution phases and, thus, leading to success within the NPD project. Especially the technical uncertainty still abiding at the start of a development project has a direct negative influence on project efficiency and the most far-reaching consequences regarding the success or failure of the project (Verworn et al., 2008).

2.3.2. Methods to Dodge the Uncertainty

Kim & Wilemon (2010) propose several methods to reduce the uncertainties, starting with involving R&D personnel in the customer/user's daily routines to explore the problems confronted with firm products and be explained all the things the product really needed to. Similar to previous method is interactive development with lead customers as firms can minimise the use of extensive market research studies by quickly getting the product to lead users, obtaining their reactions, and making refinements to the technology before final release to the market. In addition, experimenting prototypes with customers in the earlier phases of development may reveal interesting aspects

especially in unfamiliar and latent markets. Kim & Wilemon (2010) point out, some critical problems of radical innovation can only be solved outside the company. Such external resources like existing and potential customers, consultants, suppliers, commercial laboratories and university research centres can be used as a resource for ideation, validation and development of new products. Particularly, suppliers' knowledge of technology, costs, design and manufacturing lead-times can contribute to accurate product definition and project planning. Ultimately, Kim & Wilemon (2010) encourage managers to forecast the technological advances and market evolution despite the difficulties encountered in such functions. It is beneficial for a company to recognize the type of forecasting assets they possess, utilize those correctly, and further foster the FEI forecasting to reasonable balance between technological knowledge and market expertise (Kim & Wilemon, 2010). Unfortunately Verworn (2009) remarks that the more radical the product concept, the more complex it is to reduce the technological uncertainty of the concept leading to more deviations from the initial specifications and inefficiency. Also regardless of the actions taken during the FEI, the risks to jeopardize the success of innovation seemed to increase with radical concepts, for instance inaccurate estimates of future market demand, failure to develop the adequate technology, or in extreme cases, a combination of both.

2.3.3. Organizational Capabilities to Rule the Front End

Internal FEI competency entails organizational capabilities that can accelerate the FEI and forms the basis for the way of working to achieve project specific goals. Kim & Wilemon (2010) describe such capabilities to include effective developers, project leadership, providing resources, a climate that values FEI activities, and FEI learning. Main factors of internal FEI competency can be regarded as solid team vision and a shared sense of purpose that contribute to collaborative action plan and team spirit reducing the fuzziness of Front End of Innovation (Zhang & Doll, 2001; Wheelwright & Clark, 1992). The vision development and building the purpose for the team is one of the most important tasks of a leader (Kotter, 2001). The function of the leader is to guide team members towards the vision, and remind them of the main objective during the innovation process (Bass, 1988). Without the vision and purpose of internal FEI

competency, realistic targets in the project team, strategic fit in the targets, specific action plan and common motivation have been perceived to be missing as collaboration and communication related sources of failure (Eden, 1988; Wheelwright & Clark, 1992). The absence of strategic alignment in the product portfolio can be due to several issues. Ambiguous front-end processes allow space for simple short-term modifications (Lindroos, 2006) to existing products instead of strategically coherent alignment of product portfolio. The company strategy has to be interpreted to factual targets that can be exploited to improve the front-end decision making process (Simula & Lindroos, 2006).

The lack of factual targets interpreted from company strategy can be the result of insufficient understanding between executive management, marketing and R&D functions (Khurana & Rosenthal 1997; Simula & Lindroos 2006). The role of executive management is to establish norms for communication and consensus building. It is the management's task to guide the development team in case the direction of FEI is impacted due to critical choices or trade-offs in the business unit's strategy (Khurana & Rosenthal 1997). The good teamwork of marketing and R&D activities is a necessary condition for the success of innovation process (Moenart et al. 1995). A lack of communication between R&D and marketing causes faulty understanding of customer needs (Simula & Lindroos 2006). Often different organizational functions see the problem through their own lenses and cannot relate to solving the issues from other functional perspectives (Wind 2005). Dougherty (1992) explains functional departments are like different "thought worlds", each focusing on different aspects of technology and market knowledge, while simultaneously organizational routines rather separate than coordinate the divergent views, further constraining the joint learning. Dougherty (1992) demands for collective action in the innovation process that supports efforts to create shared understandings from disparate perspectives, and fosters appreciation and mutual trust among the organization. Hence, literature supports the establishment of cross-functional development teams (Kim & Wilemon 2010; Verworn 2008; Lester 1998; Wheelwright & Clark, 1992). This is a demand also for management, which needs to act as a role model and lead by example in innovative projects, and consciously monitor their own behavior to ensure they are sending the right message (Rekonen &

Björklund 2014). Khurana & Rosenthal (1997) emphasize, the executive management should work like a business team rather than functional representatives, consistently develop product strategy and engage in new product portfolio planning, and formulate explicit project priorities in the means of time, cost and quality.

Verworn (2009) finds strong support for the involvement of all organizational functions in FEI operations. She claims that interdisciplinary planning prior to development enhances the communication, which allows for fewer deviations from the initial specifications and affects eventually the project success. Management is recommended to nurture the informal socialization culture among organization, e.g., by encouraging the employees for face-to-face meetings from other departments (Schulze & Hoegl, 2008). This approach advances idea generation by ensuring that customer needs and technological capabilities receive enough consideration already in the beginning of the innovation process (Rubinstein 1994). A typical scenario of the lack of communication in the organization is, when the uncertainty is high at the beginning of the process, issues are postponed and only draft plans are made for further refinement until the circumstances are clearer. The value of the initial intensive planning is not seen to improve the efficiency of the project and it is not realized that the actual hinder is the absence of good communication. Various reasons can lead to problems and conflicts; technical specialization, different time sense, different motives and goals, dissimilar jargon, bounded sense of responsibility, or clique mentality (Souder, 1987). However difficult it might be, initial planning enhances the communication and therefore contributes to develop a common understanding, reducing the uncertainties and conflicts in the following phases of the project between various key functions like R&D and marketing (Verworn et al., 2008).

2.4. Innovative Environment

The characters that administer the environment of Front End Innovation are uncertainty, unpredictability and changing needs. The circumstances of innovation projects are often unique which emphasizes the important role of project leader who needs to manage

multiple, often conflicting and fluctuating, contingencies and to balance between different approaches and behaviors. This is unusual status of project work since traditionally project development comprises of more stable and defined conditions (Björklund & Rekonen, 2014). However, different rules matter in Front End of Innovation than later in New Product Development. This chapter discusses, what is it that allows an organization to flourish in the fuzzy early periods of project innovation?

2.4.1. Readiness for Radical Innovations

Commonly new product development projects that are aimed at innovative outcomes have been managed as projects like any other without considering the unique features of innovative projects (Pons, 2008). Conventional project management approaches often require relatively complete definitions of outcomes and scope, which are unobtainable especially in the front-end phase of innovative projects (Rekonen & Björklund, 2014). Traditional project management and risk management are therefore inapplicable for utilization in innovative exploratory projects (Lenfle, 2008). Orban (2017) recognizes the strategic differences between looking for ideas for a new product in the present portfolio, and looking for radical innovations outside the ordinary portfolio. The prerequisites for a new product idea on an existing portfolio involve research and processes that are readily available, and imply the development of incremental innovations. Here, the management can easily staff the development team, the marketing department is prepared to assist with updated market report, and manufacturing capacity is well measured. Orban (2017) says, "*The fuzzy is not very fuzzy at this front end*", she therefore claims that building an innovative team is a normative process in this context. The conditions are much more demanding when looking for radical innovations outside the ordinary portfolio, which signifies that the objective is a breakthrough discovery and this can be reached only with a breakthrough setting (Orban, 2017). Orban (2017) lists that the team members set for the task must possess intense intellectual curiosity, high tolerance for ambiguity and risk, and patient persistence. She defines that the team must be interdisciplinary, which stands not only for cross-functional operation, but particularly the ability to step across the social boundaries by which we structure knowledge. That is to say that their way-of-working

must compose of enough self-confidence to go scouting into uncharted territory and not get fatigued in the face of suspicion from others. Lastly, Orban (2017) adds that the team must devote themselves to an agreed process and mutual trust in each other, that, together they will succeed. Building such a project team requires special effort, and Orban (2017) recommends starting from finding the right person to lead the team and thereafter to look for the optimal team composition.

2.4.2. The Behavioral Characteristics in a Project Team

The formative phase of project team has great influence in the manner the project team develops and performs throughout the project (Ericksen & Dyer, 2004). Especially the project leader's role in the constitution and maintenance of team climate is crucial since, in general, the project leader is the one who; manages the project on a day-to-day basis (Lee-Kelley & Loong, 2003), defines the strategic goals for the project, and plans the time schedule and resource allocation (Kim et al., 1999). Elkins & Keller (2003) add that the successful project leaders develop a loyal and respectful relationship with the team to whom they communicate an inspirational vision and provide intellectual stimulation. It is also essential that the leader understands how uncertainty is a constant character in innovative work and therefore the vision and strategy of creative projects should be developed to respond to contingencies (Barzcak & Wilemon, 1989). The strategy is usually defined and agreed upon in innovative projects, but the processes to achieve it may vary along the way (Barzcak & Wilemon, 1989). Therefore, autonomy benefits and empowers the team members concerning the processes, that is, how to approach the problem, however, it is not needed to let the team choose the problem to be approached (Amabile, 1998). Jung et al. (2003) notify that autonomy settles well in western cultures but in Asia where some cultural values are relatively high in power distance, it will on the contrary diminish innovation. Hence, it is stated here that this thesis addresses all issues from a western cultural perspective. Amabile (1998), from Harvard Business School, claims that the freedom to choose the means of working has been recognized to heighten the intrinsic motivation and a sense of ownership in creative work. If a team has a sense of ownership over their own ideas and their own work – that they feel they have a choice how to accomplish the tasks they are given – it

yields for creativity (Amabile, 1998; Björklund & Rekonen, 2014). Autonomy should be allowed, however, in a manner that maintains the clarity of project objectives since it enables greater focus and a satisfaction for the team to work forward (Björklund & Rekonen, 2014). Amabile (1998) emphasizes that it is very difficult to work creatively towards a project goal if it never remains in place.

2.4.3. Encourage Innovation

While allowing innovative teams to have their freedom, at the same time the people need to feel that, their work matters to the organization or to the executive management (Amabile, 1998). Therefore, the act of encouraging employees to look for new ideas, needs, and opportunities, is a vitally important function of a project leader (Hohn, 2000; Amabile & Khaire 2008). Encouraging is efficient when a leader explicitly requests creative and innovative solutions that might call for more radical tactics than what is normally expected (Keller, 1992; Shalley & Gilson, 2004; Amabile & Khaire 2008). The project objectives that are sufficiently complex and demanding drive individuals to focus on the task and make them more persistent to seek alternative solutions, in other words creative outcomes (Shalley & Gilson, 2014). Adequately complex tasks inspire individual's intrinsic motivation to engage the person in their work for the mere challenge and enjoyment of it (Amabile, 1998; see Chapter 4.1.). Amabile (1998) defines the meaning of intrinsic motivation; *"...people will be most creative when they feel motivated primarily by the interest, satisfaction, and challenge of the work itself—and not by external pressures.*" Amabile (1998) argues that extrinsic motivation, like monetary rewards or threat of dismissal, does not incite creativity as powerfully as intrinsic motivation. In the worst-case scenario, such trophies or penalties only provoke politics in the organization, which draws negative attention and decreases the mutual sense of purpose (Amabile, 1998). Managerial behavior, like a word of public recognition or praise, will motivate employees in a better manner (Amabile, 2008). Farson & Keyes (2002) argue that failure and success should be treated equally in a sense that both criticism and compliment can actually demotivate; therefore, failure and success should be rather analyzed and interpreted with interest, which is appreciated most according to studies.

The chance of failure is always present in creative processes. Farson & Keyes (2002) claim failure is a prerequisite to invention. In order to enable breakthrough inventions, managers must diminish the fear of failure and urge employees to experiment constantly so that they fail early and often, and learn as much as possible along the way (Amabile & Khaire, 2008). By creating a psychological safety net, an atmosphere that does not punish for a failure out of passionate endeavour, organization secures that people have the confidence to share their ideas and strive further through the obstacles of knowledge gaps (Farson & Keyes, 2002). Having an innovative atmosphere that accepts the inevitability of failure does not however, mean abandoning good leadership, work quality or respect for sound practices (Farson & Keyes, 2002). Different kinds of failures need to be recognized, and discover how to learn and benefit of them (Farson & Keyes, 2002). Accepting the quality of failure is closely related to protecting innovative ideas from premature criticism that has been recognized to suppress promising ideas too early without allowing enough time for progressive ideation and experimentation (Farris, 1972). Thus, project leader must foster environment where different ideas, information, experiences, and perspectives can be shared amid mutual trust and encouragement of team members (Kim et al., 1999; Barczak & Wilemon, 2001).

2.4.4. Creativity Needs Time

Innovation requires more time the more radical it grows. History has witnessed from the days of Charles Darwin to modern time hi-tech inventions that inventors have had the opportunity of relatively unstructured, unpressured time to create and develop new ideas (Amabile et al., 2002). However, extreme time pressure may under some urgent circumstances, ignite the passion for creative outcomes but normally it does the opposite. Studies show that the more time pressure people feel on a given day, the less likely they will be to think creatively and that they will suffer from the lack of creativity even two days after experiencing tight deadlines (Amabile et al., 2002). However, it is widely agreed that people do come up with brilliant ideas on some rare occasions when they are confronted with tight schedule. Sometimes people feel like they are on a mission and that their work is vital for the organization (Amabile et al., 2002). Their intrinsic motivation is aroused by the challenge of being the hope for organization's

success (Amabile, 1998). It brings people a great sense of focus, which makes it possible to concentrate on a single work task for considerable amount of time. A certain degree of isolation is always good for creativity, to avoid distractions and to maintain the focus, but if people feel that their work is vitally important, they may be able to adapt and endure difficult circumstances (Amabile et al., 2002).

2.4.5. Breaking the Routines of Organization

The actions presented previously in this chapter 2.4., contribute to establish an organization where people would make the innovative initiative and break out of routine by pushing the limits of both personal and team capacity as well as the capabilities of technology and the boundaries of the organization (Björklund & Rekonen, 2014). Therefore if creativity is wanted, routines should be avoided as they are regular and predictable behavior patterns (Nelson & Winter, 1982) that bind the organization in a network of practices that are challenging to alter (Perrow, 1986). This network of practices produces functional ‘thought worlds’ in organization that share a common understanding of a specific domain that they are engaged in; for instance marketing, R&D, or manufacturing (Douglas, 1987). Dougherty (1992) explains that commonly functional thought worlds are each focusing on different aspects of technology-market knowledge, and making sense of the total from their own perspective. As a result, interpretive differences of organization strategy may appear, and the possibility for creative joint learning is decreased, since actors of a functional thought world may think that they already know everything. Additionally, poor organizational routines only separate rather than coordinate the thought worlds, further constraining joint learning (Dougherty, 1992). Poor routines like; (1) governing cross-functional relations by prescribing narrow roles and limited relationships that inhibits the creation of cross-fertilization and mutual learning or; (2) imposing a predetermined definition of technology-market issues on product efforts that reduces people's willingness to explore as well as the likelihood of thinking outside of the box, and lastly; (3) imposing standards which did not fit the new products so that following them forced developers to redefine the new product as an established business, further reducing new learning (Dougherty, 1992). In order to figure out the problems of innovative organization

caused by these interpretive barriers between functional thought worlds, requires cultural solutions, not only structural ones. Therefore, Dougherty (1992) emphasizes, that innovation requires collective action, or efforts to create shared understandings from disparate perspectives. To support this activity, interdisciplinary responsibility for focus groups, market research plans, technology audits, and visits with lead users should enhance the collaboration (Dougherty, 1992).

3. PRINCIPLES OF INNOVATION

The evolution of innovation starts from the origins of creativity that reveal the route to generate various types of innovations. Not all innovations emerge the same way but require different strategies and set of methods to be born. Creativity has often remained obscure in the industrial front-end literature, as seldom creativity has been taken into account in the process models for the innovation management. Recognizing the factors and requisites for creativity, and the different mental methods to innovate, assist in establishing the routine for efficient idea generation, a concept that requires a far more detailed explanation than mentioning only the common brainstorm session. To benefit from fertile idea generation, organization has to have strategy to conduct the process in right direction; otherwise, good ideas will remain just good ideas on the table. Innovation strategy is important to be understood as an ongoing process that demands creativity and flexibility in the course of work just as much as idea generation. These issues build up successful innovation as a concept and they are further discussed below.

3.1. The Origin of Creativity

Man has always depended on creativity in circumstances where its survival has been endangered, either in the stone ages or in the modern day. Creativity has been thought to be of some sort divine origin, and the driving force behind it has been covered with a thick fog of mysticism. This holds true among many people even today despite the progress in the studies of creativity and neuroscience during the last couple of decades. Sternberg & Lubart (1999) define creativity as the ability to produce responses which are both novel (i.e., original, rare and unexpected) and appropriate (i.e., adaptive and useful according to the task constrains). A vast array of professions, like sculptor, engineer or designer, are met with a description of an ability to be creative in work. This creativity of theirs, what is their secret, how do they get their insight?

In the western culture creativity is often associated with talented individuals who have been given the freedom to express their vision with unconventional tools and

perspectives to produce something truly novel or different (Bilton, 2007). Bilton (2007) claims that the association is fallacious as combining creativity with exceptional individualism and innovation, it only disconnects creative thinking and creative people from the contexts and systems, which give innovations and talents their meaning and value. The same image of individualistic and spontaneous inventiveness inspires the construction of isolated creative societies, which would own the privilege to creativity as if it would be missing from everywhere else, in business or in organization (Bilton, 2007). Von Stamm (2008) says that creativity concerns everybody and it needs to permeate every aspect of an organization but creating an innovative organization is still much more about changing one's frame of mind than it is about a changing the company's process or vision statement. According to her the act of coming up with an idea is an inherently individual act but the development of the idea and its implementation are collective efforts (Von Stamm, 2008). Therefore, the root of creativity is an individual's capability to be creative, but the creative individual that is pursuing innovation is embedded in systems and networks that comprise high levels of mutual dependency both within and across creative teams, and up and down the supply chain (Bilton, 2007).

Creativity refers commonly to the unique way of thinking people pursue when they approach a problem, and indeed, inventive imagination is essential to creativity. Amabile (1998) defines that two additional ingredients are nonetheless also required, namely expertise and motivation (Figure 5). She says that expertise consists of the basic talent to think and act succesfully in a particular task as well as all the knowledge and competence one has acquired in the domain of expertise. Regardless of whether expertise is aquired through formal education, practical experience or interaction with other professional, it constitutes what Nobel laureate Herbert A. Simon calls "network of possible wanderings" (Amabile, 1998). Von Stamm (2008) agrees and adds that aquiring and refining the base of knowledge to enable creative results requires years of work and practise. Weisberg (1993) illustrates well the value of devotion to creativity by showing how the genius of history's leading figures can be explained with memory, training, opportunity and sheer hard work, telling that the roots of genius are in the thought processes that underlie everyday actions and ideas.

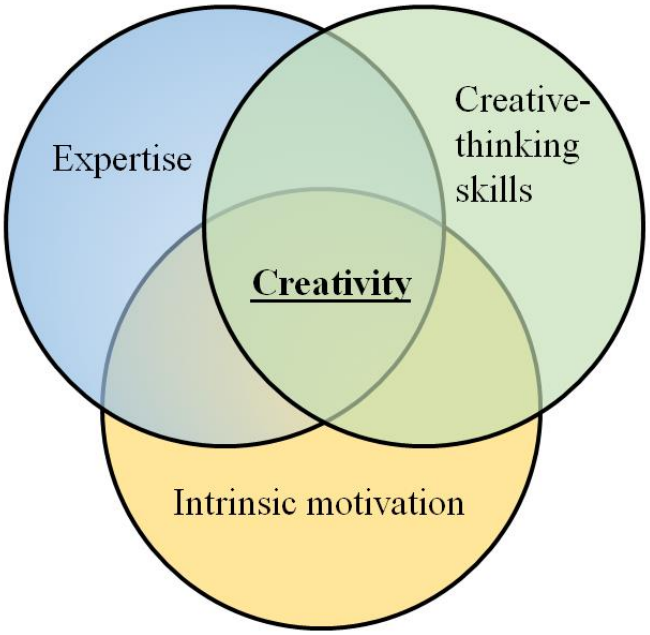

Figure 5. The Factors of Innovation. (Amabile 1999)

Inventive imagination is essential to creativity, as previously mentioned, but imagination is also just one feature of entity called creative thinking (Amabile, 1998; Sawyer, 2012). Creative thinking is defined as a way of looking at and solving problems from exceptional perspective, avoiding orthodox solutions and thinking outside the box (Amabile, 1998). Sawyer (2012) shows how creative thinking consist of following methods:

- Cross-fertilization; multiple projects and multiple domains internalized, provide you a larger pool of basic ideas.

- Conceptual combination is about combining two concepts to make a single one. Combining can be *additive* where all the attributes of both concepts are transferred unchanged to a new concept, or it can be *emergent* where the combination result is "greater than the sum of its parts" by having created new properties for the higher-level concept. Here the structure, property and value of concept components are attributes of transfer.

- Analogical thinking; the idea that analogies between distinct domains allow the individual to perceive patterns in a way that wouldn't be apparent to someone working in only one domain.

- Recognizing unwarranted assumptions of concepts and their attributes, how those can be modified and combined.

- Avoiding fixations of incorrect solutions where mind is fixated on a solution, and you are blocked from seeing the problem any other way.

- Imagination; coming up with novel ideas that are unpredictable and unique.

Sawyer's methods are supportive to Amabile's (1998) notions that one's creativity will be enhanced further if she habitually turns problems upside down and combines knowledge from seemingly disparate fields. Studying other domains of research and technology can help find solutions to problems in own domain, using lessons from similar systems to spark insights in own processes (Amabile, 1998). Sawyer (2012) adds that the further away you go from your own domain, the more creative the concept combinations will be. Some people are naturally more talented in creative thinking than others but it can be improved with practice. Solving riddles, being aware of assumptions and letting go of them, and through unstructured playing with concepts of different knowledge bases will help to enhance creativity (Sawyer, 2012).

One method of creative thinking not mentioned on Sawyer's listing is intuition. Raami (2015) states that intuition is a method of thinking continuously used by all humans in their everyday life, but intuitive processing is subliminal and random. Intuitivity is based on such non-conscious processes as associations, affections, habits, memory and feelings (Glöckner and Witteman, 2010). Therefore the other creative thinking methods mentioned previously by Sawyer (2012) differentiate themselves from intuition as conscious reasoning. Bastick (2003) claims that such conscious methods are not sufficient to reason about reason, but intuition is needed to guide the blind steps of logic and give purpose to the direction of conscious reasoning. Based on comments from various Nobel laureates the role of intuition is imperative in radical breakthrough

innovations as they say that, intuition is the primary thinking mode used for discoveries while conscious reasoning is used for argumentation (Raami, 2015). However Raami (2015) acknowledges that currently there is not enough knowledge on how intuition is constructed or how it can be best developed. Kautz (2005) defines intuition as "…the mental process of acquiring information and knowledge directly into the mind, without the use of reasoning, sensing or even memory." Hence the writer of this thesis sees intuition as the last frontier of mysticism in creative activities even though intuition is involved to some degree in all creative work and is indisputably an important factor of creativity.

Based on this knowledge, expertise and creative thinking can be conceived as the raw material of good ideation, the so called natural resources of innovation. According to Amabile (1998), the third factor to the schema is motivation, the driving force of every succesful innovation. It determines what people will actually pursue to do. Amabile (1998) defines two types of motivation, extrinsic and intrinsic, the latter being far more essential for creativity. This is because extrinsic motivation comes from outside a person in a form of reward or penalty, and while it doesn't necessarily stop people form being creative, it certainly doesn't guarantee it either especially if people feel that they are being controlled (Amabile, 1998). Intrinsic motivation, on the other hand, relies much more on people being enthusiastic, inspired and knowledgeable (Von Stamm, 2008). The internal desire and passion to engage oneself in work for the challenge and simple enjoyment of it, is the greatest motivator of innovation; no external pressure is comparable to this. Intrinsic motivation arouses through sincere interest on a topic and the ability to formulate problems rather than depending on others to define them (Von Stamm, 2008). Thus we may summarize that the origin of creativity relies on curiosity and the constant interest to seek new information that would allow oneself to take advantage of the expertise and creative thinking skills aquired to date.

3.2. The Road to Innovation

Based upon the knowledge from previous chapter it can be concluded that along with

sincere interest, ideas will grow to meet the demands of curious mind's problems. Newly generated idea will evolve to invention in case the idea is implemented successfully so that unique results can be concluded from a tangible artifact or an intangible process or service model. Mere novelty is not enough but an invention must be also useful and valuable; it must demonstrate a 'fitness for purpose' (Bilton, 2007). Additionally, invention alone does not establish innovation. Invention occurs primarily at the individual level as a cognitive process when a person discovers something new (Colarelli O'Connor & Rice, 2001), and does not embrace the commerzialization of a new idea (Conway & Steward, 2009). The Oxford English Dictionary (2010) defines 'invent' as *to create or design something that has not existed before*. The word's origin is in Latin 'invenire' which means 'to find' or 'to discover'. Innovation on the other hand does not ultimately have to discover anything; it combines present technologies or processes in a way that has an impact on social or organizational level. This impact on society is the one that differentiates innovation from invention (Higgins, 1995). Creation, invention or discovery focus upon the conception of the idea; but if you cannot capitalize your idea on society, usually this means to make money but not always, you do not have an innovation and any idea will remain just an idea (Adar, 2007). Innovation exploits one or more inventions in society in a way that solves a problem, or creates a need for the innovation in order to bring it into common use (Conway & Steward, 2009).

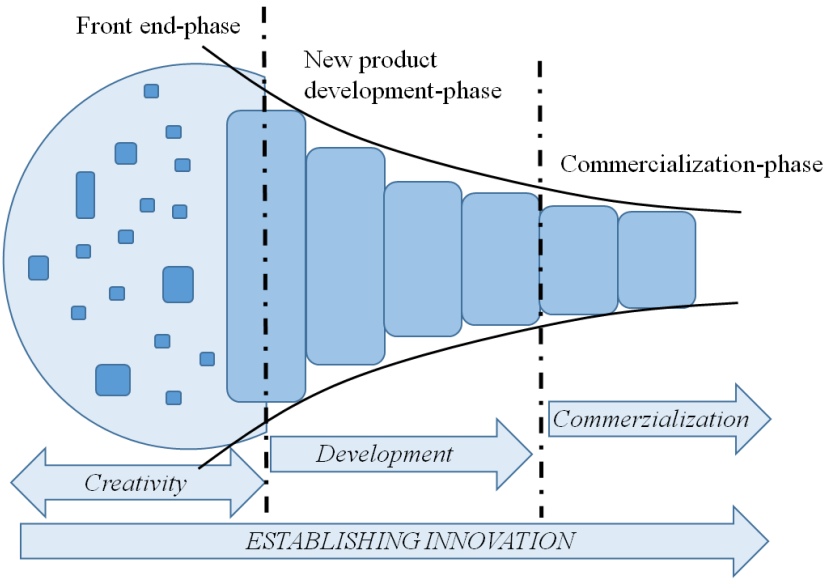

Figure 6. The process of establishing innovation

Innovation is the whole process of developing an idea, starting from the generation of ideas until the commercialization of a conrete product (Von Stamm, 2008). Figure 6 illustrates the process where creativity is needed the most in the Front End-phase, and how the establishment of innovation continues throughout the development and commerzialization of the product. Innovation as a process is a set of different, parallel, competing, and conflicting processes which occur all at the same time (Rekonen and Björklund, 2014). In this complex ensemble creativity is an asset that enables to solve problems and come up with ideas, especially at the beginning of the innovation process (Von Stamm, 2008).

3.3. Different Characters of Innovation

Conway & Steward (2009) say that commonly innovation is seen as an industrial emergence of a technical product or process, created to generate profit with the aid of a booming market. They highlight that innovation should be defined more broadly in a sense of 'bringing an innovation into common use' including innovations without any commercial ambitions, and that innovation can also be a service or an administrative process in a public sector. Such perspective is valid when innovation is applied as a term to an output, which is an 'end-product' that is offered for end user's utilization. As discussed in previous chapter 3.2., innovation refers also to various activities that are undertaken when innovative organizations are advancing ideas towards comprehensive innovations to be applied by the society. In this occasion 'innovation' refers to a process that is a series of actions taken in order to achieve a particular end. Lastly, Conway and Steward (2009) state that the term innovation can also be seen as an organizational capability, the sort of 'soft' core competence that enables innovative organizations to take advantage of the intellectual resouces at organization disposal.

In the event that innovation is considered as an output consisting of new features and improved functionality that are unique in the market, innovation can be distinguished to 'incremental' and 'radical' innovations. In the view of Leifer et al. (2000), incremental

innovation introduces cost or feature improvements in existing products or services and is depending on the firm's exploitation competencies in order to reinforce the present dominance in the market. Comparably, radical innovation is related to the development of new businesses or product lines and utilizes the company's exploration competencies in order to transform the economics of a business by means of new ideas or technologies or substantial cost reductions (Leifer et al., 2000). In other words radical innovations create such a dramatic change in products, processes, or services that they transform existing markets or industries, or create new ones while at the same time destroying the usefulness of old expertise in product knowledge (Henderson & Clark, 1990; Leifer et al., 2000). Despite the subtle intellectual inferiority of incremental innovation to radical counterpart in previous definitions, Henderson & Clark (1990) notify that also incremental innovation often calls for considerable skill and ingenuity and, over time, has very significant economic consequences through the enhancement of the core competents of a established firm. Clark & Staunton (1989) see the process of incremental innovation as the concepts of 'learning by doing' and 'experience curve'. Thus, incremental innovation can be viewed as the evolutionary development of radical innovation (Conway & Steward, 2009). A good example of such progress is the evolution of semiconductor that is characterized by a series of incremental innovations building upon the initial radical innovation of semiconductor (i.e. Intel 236, 386, 486, etc.). Radical innovation paves the way for an extended series of improvements that may result altogether in profits as massive as the original breakthrough but it requires that the company is capable of continuously improving the performance of a new product (Rothwell & Zegveld, 1985). Desai (2013) introduces the term 'breakthrough value' which is independent of the type of change that the innovation possesses, and argues that incremental change can have a significant positive impact even with only minor success of radical innovation. All that matters in terms of profit is how the product appeals to the end customer regardless of the novelty or genius of the product, and therefore major impact, the breakthrough value, can be reached also with just slight modifications on the product's appearance or features (Desai, 2013).

Henderson & Clark (1990) acknowledge the important distinction between radical and incremental innovation but argue that the framework is fundamentally incomplete.

There are different kinds of innovation, with different competitive effects, in terms of their impact on the established capabilities of the company. Henderson & Clark (1990) speak of the technological change of innovation that can be further classified along two dimensions (See Figure 7). The vertical dimension depicts an innovation's impact on components, while the horizontal dimension depicts its impact on the linkages between components. In this kind of framework incremental and radical innovation stand for the extreme alternatives in the continuum of innovation as incremental innovation refines and extends an established design, and radical innovation establishes a new set of core design concepts embodied in components that are linked together in a new type of architecture. The two additional types of innovation included in the framework are modular innovation and architectural innovation. Modular innovation changes only the core design concept of a new technology, which Henderson & Clark (1990) define as a physically distinct component of the product that performs a designated function.

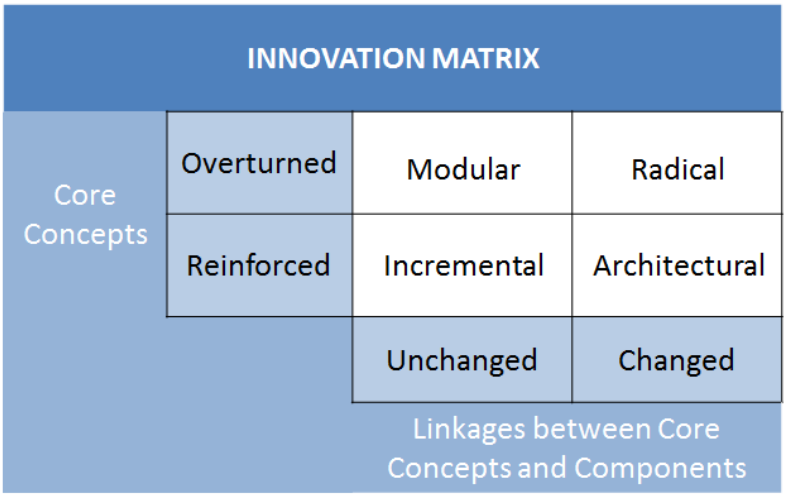

Figure 7. The innovation matrix. Modified from Henderson & Clark, 1990.

Architectural innovation then changes only the relationships between the core design concepts of a technology by reconfiguring the linking of components in an established system in a new way. The framework distinguishes the product as a set of components and the product as a system, and acknowledges that radical innovation requires two types of knowledge to succeed. Component knowledge is the knowledge of each of the core design concepts and the way how that particular technology functions.

Architectural knowledge comprehends the ways in which the components are integrated and linked together into a coherent whole leaving the scientific and engineering knowledge behind each component unchanged. Therefore much of the knowledge required for an architectural innovation is already in an established firm but because of the way – particularly architectural – knowledge is organized and managed, recognizing and applying the knowledge may be quite difficult (Henderson & Clark, 1990).

The matrix presented in figure 7 illustrates a more nuanced interpretation of the radicalness of an innovation, which considers a broader scale of impact for the innovation depending on the variety it possesses. It is important to remark that the purpose of the matrix is not to divide the world of innovation neatly into four quadrants but rather to suggest that a given innovation may be e.g. less radical or more architectural (Henderson & Clark, 1990). The axes of the matrix could also refer to other dimensions like innovation newness to market/company, or the clarity of problem/domain definition, and then respectively dividing innovations into four definitions, but considering the nature of this thesis the technological perspective of a tangible product is the most common situation encountered in the industry. In addition, the presented matrix is readily convertible to intangible service innovation framework with slight modifications of terminology.

3.4. Discovering the Unkown Unknown

Like previously mentioned in this thesis, the importance of Front End Innovation is significant for the success of firms that aim for breakthrough innovations. The fact has been acknowledged as well in the literature as in the industry but it has been a challenge to comprehend the strategic conditions required for an innovative organization. The prerequisite is to understand how new information behaves in relation to organization and the manner it can be best utilized to serve the purposes of developing new ideas. Open-minded individuals that continuously perform in a state of vivid lust for new knowledge and who are capable of questioning the existing presumptions are essential in the quest for radical innovations. In order to function coherently, individuals require

strategy and certain alignment to maintain the exploration on a proper level of practice. The strategy makers are bound to understand the nature of organizational unconsciousness, and how to approach the 'unknown unknown' –information. Discovering the right format for an innovation strategy demands considerable amount of brainwork and a correct mindset, that consider the extraordinary conditions for a breakthrough innovation. Neglecting the formation of a decent strategy to cope with continuously transforming uncertainty would be fatal.

3.4.1. The Flow of New Information in an Organization

The processes established with purpose to control the front-end operations often result in incremental innovations and resemble largely the analogy of a NPD process. Reid and Brentani (2004) explain how structured problems and opportunities for incremental innovations are commonly deployed at the organizational level and further directed to individuals for information gathering in hopes of good solutions. They then propose that in the case of radical innovation the process works actually the other way around implying that individuals are the ones in position to identify and understand the emerging patterns for innovations in the environment, whereafter they may involve organization in idea development as soon as they see it necessary (Figure 8). The logic of this idea is that since Front End Innovation contains processes of information gathering and adoption, it assumes then that the environment external to the firm is the primary source of new ideas for radical innovations, instead of fixed corporate strategy, and that even internal ideas ultimately have some input from external sources (Reid & Brentani, 2004). This kind of innovative strategy bases itself on analogical thinking and conceptual combination (see Chapter 3.1.), the creative thinking methods that allow an individual to generate a concept by combining knowledge from one or more sources, which previously were related in an unimportant way. In their study Reid & Brentani (2004) claim that the radical innovations of front-end are iniated in the environment on an individual level, preceding the market and organizational involvement. In fact, adding to this, they present how decisions to share radical innovation-related information too early in the organization has tended to slow down the innovation process by 10 to 20 years. At its worse, a lack of involvement or understanding from the

management may bring the situation even to a near standstill (Khurana & Rosenthal, 1997). Thus, any structures or processes that could assist the organization to effectively manage the raw innovations, should be supported, and in certain circumstances the sharing of information is also a crucial part of collective intuition (Reid & Brentani, 2004; Eisenhardt, 1999).

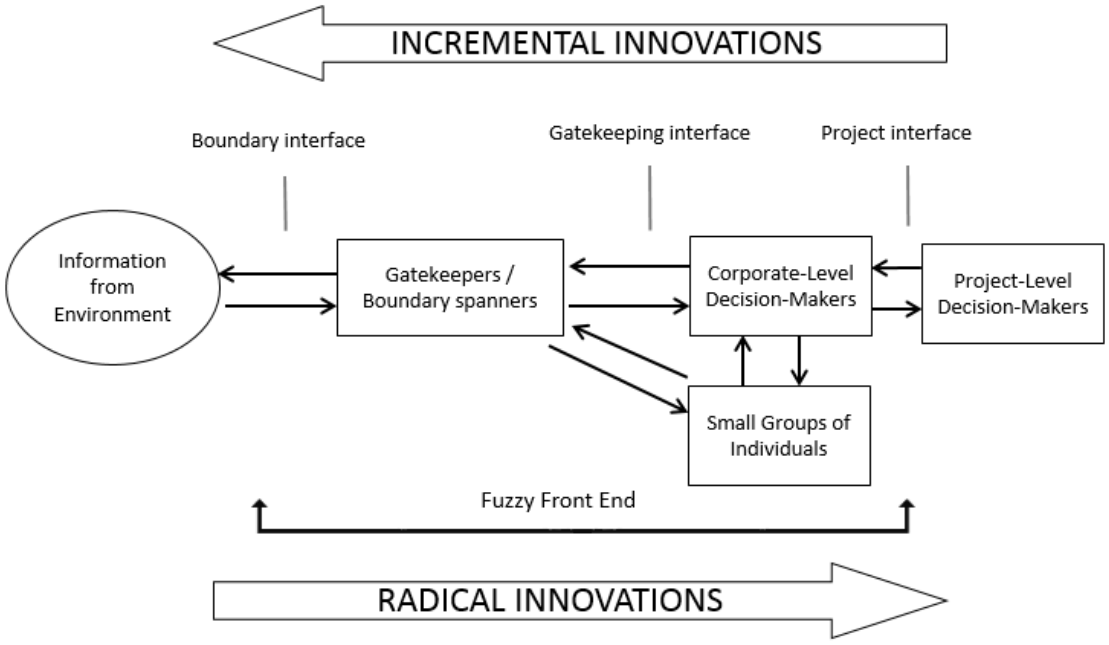

Figure 8. The information flow of Front End Innovation. Modified from Reid & Brentani (2004)

In the model of Reid & Brentani (2004) individuals play an important role in establishing and forwarding radical innovations within networks and firms. An individual who informally emerges in an organization and determinedly contributes to an innovation is called a champion. The champion is not necessarily the same person who initially invented the idea, but a person who actively and enthusiastically promotes the progress of innovation through critical stages, especially at the beginning of the process (Howell & Boies, 2004; Burgelman & Sayles, 1986). Individuals most commonly to play the role of a champion are ‘gatekeepers’ in an organization. They channel information along one route rather than another and decide whether or not, and to what extent, to share information from the environment with others. Additionally to gatekeepers, Reid & Brentani (2004) identify ‘boundary spanners’, people who operate at the periphery or boundary of an organization and interact with the surrounding

information from the environment. The role of boundary spanners is to intuitively recognize relevant patterns from new information in the environment and analyze the factual content in relation to information already known in the organization. A boundary spanner may be seen as the individual inventor, the initial combiner of distinct concepts, whereas the gatekeeper in the role of champion is the innovator that commits to establishing the innovation in the social structures of organization (Reid & Brentani, 2004). Both roles can often be acted by one individual who after perceiving patterns in the environment as a boundary spanner, starts to examine the value of sharing the information in the organization as a gatekeeper. Such individuals are of high value for the organization as they may play a vital leading role for radical ideas (Reid & Brentani, 2004). In general the role of gatekeeper refers to technological perspective of managing the information but in the later stages of front end innovation when market potential, size and growth need to be assessed, it is the marketing gatekeeper who proves the business value for the opportunity. Thus individuals from various backgrounds are needed to perform diverse roles during the front end of innovation (Reid & Brentani, 2004).

3.4.2. The Strategy to Radical Innovation

Following on Reid & Brentani's (2004) findings, the ability of an organisation to recognise opportunities when they appear, and the mental and organizational flexibility to exploit those opportunities, allows an organisation to endeavor game-changing innovations (Von Stamm, 2008). In order to maintain the aforementioned capabilities in an organization, a strategy is an essential part of corporate actions. Two very distinctive approaches can be recognised in the literature to strategy development. The prevailing controversy between the two approaches concerns the degree to which organizational strategy should be pre-planned or allowed to emerge, in response to fluctuating conditions of the environment. Mintzberg & Walters (1985) define strategy as a pattern in a distinguishable stream of behaviour and decisions. From this perspective their study pays attention to the relationship between the intentions that a strategy initially devoted to and what the strategy actually achieved. As a result they are able to discern 'deliberate strategies', which are realized as intended, from 'emergent strategies' that

appear as patterns or consistencies despite, or due to the lack of, intentions (See Figure 9). The mentioned strategies form the two ends of a continuum along which the real-world strategies are expected to fall. Building on the study of Mintzberg & Walters, Bilton (2007) recognizes an opposition between strategy as a term of position and strategy as a term of process, where strategic maneuvers are linked in turn to different models of structure and leadership, and to different ways of considering the organization and its environment.

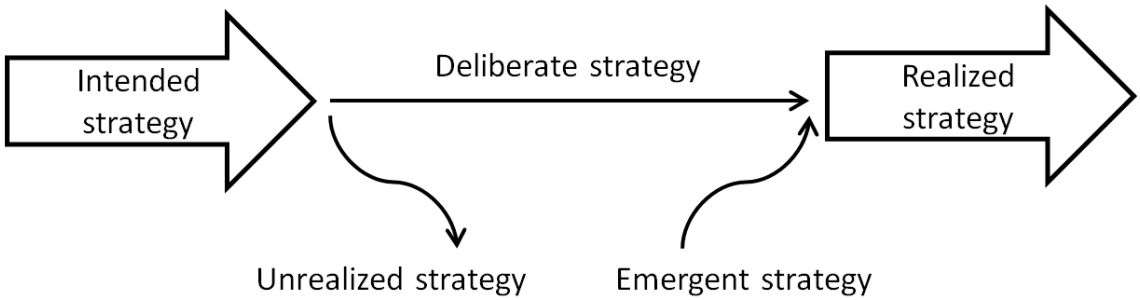

Figure 9. Types of strategies. Mintzberg & Walters (1985)

The deliberate strategy of Mintzberg & Walters, Bilton defines as ‘orientation’ to establish a uniquely differentiated strategic position and the absolute necessity to discover an exquisite and visionary perspective on the market or product. The strategy as orientation, according to Bilton, is a type of blueprint for the entire organization or system to achieve revolutionary results with creativity that concerns particularly the divergent way of thinking. This kind of approach to strategy is associated with charismatic, visionary leadership that is capable of managing the business through crowded, competitive and unpredictable markets from the top of the hierarchy. Here the strategic vision is totalizing and absolute relying on predictable path from idea to implementation that resembles as a process the execution of a New Product Development-project (see Chapter 2.). Even though the product of this strategy might be creative in the sense of ‘different’ or ‘unique’, the process beneath is nearly entirely uncreative. Instead, most of the strategy’s creativity is grounded on the capabilities of the people that set the strategy and the minute when the strategy is first developed (Bilton, 2007). Especially the deliberate strategies of big corporations are highly dependent of pre-planning and the analyses of present conditions, like company

SWOT's or market share, and breaking down a goal built upon these analyses into formalized steps so that they can be implemented almost automatically, while at the same time articulating the consequences or results of each step according to the divine anticipation of the company (Mintzberg, 1994).

In comparison with the deliberate strategy and reflecting on Mintzberg & Walters' emergent strategy, Bilton (2007) recognizes a strategy that appears more as an ongoing process, which allows the creation of a common sense of purpose and vision inside the organization. Instead of acting according to a single vision of the board of directors, new ideas emerge incrementally through collective activity that takes place in the ordinary operations of the workforce and allows individuals to explore separate directions in the environment of the organization. Resulting from this apparently disorganized and fuzzy system, new strategic options start to differentiate and a strategic pattern gradually emerges, hence the concept emergent strategy. Emergent strategy pays attention to the previous actions of organization and converges the old patterns of strategy to new patterns as they begin to shape (Bilton, 2007). This requires 'strategic thinking', which in contrast to deliberate strategic planning, is about synthesis. Instead of analyses of present situation, strategic thinking applies intuition and creativity to integrate knowledge from the environment and inside the organization, resulting in a loosely articulated vision of direction (Mintzberg, 1994). Emergent strategy does not have to deviate greatly from the old pattern but by exploiting strategic thinking it seeks for continuous evolutionary improvement, instead of revolutionary leaps of success at once. The strategic direction is habitually adapted to changing circumstances by diverging and converging information in small steps so that the leader is orchestrating the process to go on rather than dictating or controlling a fixed chain of events (Bilton, 2007). Mintzberg & Walters (1985) conclude in their study that both apporaches to strategy formation are needed, one deliberate, the other emergent. A leader should simultaneuosly be capable of realizing strategic intentions and at the same time respond to an unfolding pattern of actions. The relative emphasis between the two ends of a strategy continuum may vary depending of the situation but the requirement to attend the both viewpoints remains (Mintzberg & Walters, 1985).

Uncertain and ambigous conditions have often been cited to be a major challenge in Front End Innovation. James Quinn (1978) argues that instead of uncertainty, the innovation strategy formation deals with the mere unknowable. In general the term ‘uncertainty’ refers to risk which probabilities are known or are generally agreed upon. On the contrary the probability for uncertainty in an innovation strategy is always rather ‘unknown’ – probability could be known or is known by someone else, or ‘unknowable’ – no one knows the probability (Chow & Sarin, 2002). Therefore, since events cannot be predicted, Quinn (1988) concludes that initial broad concepts of innovation strategy should be treated with flexibility and experimentation before committing to them conclusively in order to diminish the amount of uncertain actors and obtain the best available information without being obliged to the negative path dependency (See Chapter 2.2.). Donald Rumsfeld (2002) has been quoted saying:

“The message is that there are no “knowns.” There are things that we know that we know. There are known unknowns – that is to say there are things that we now know we don't know. But there are also unknown unknowns – there are things we don't know we don't know. So when we pull all this information together, (...) that is really only the known knowns and the known unknowns. And each year, we discover a few more of those unknown unknowns.”

The meaning of Rumsfeld’s quotation may be transferred to Henderson & Clark’s innovation matrix (From Chapter 3.3.) by altering the different types of innovation to levels of unconsciousness.

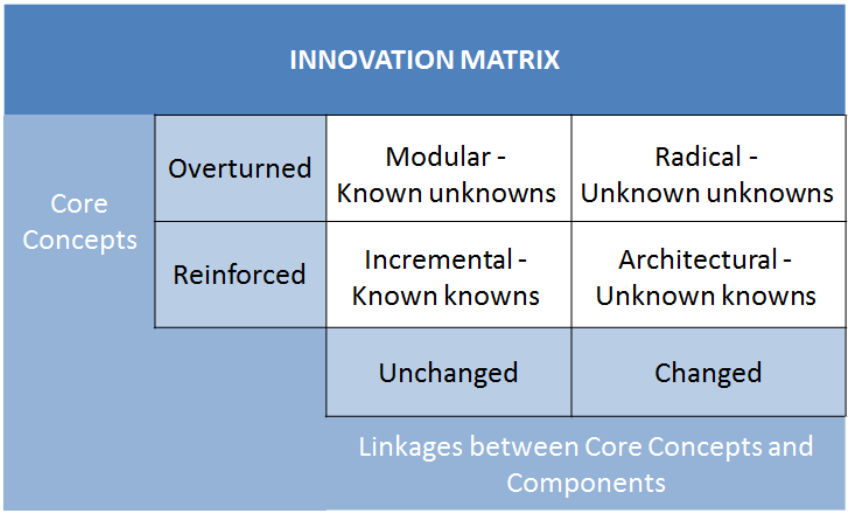

Figure 10. The level of unconsciousness in innovation matrix

The figure 10 pictures incremental innovations as the 'knowns knowns' – innovations that we know we are capable of doing and our customers expect us to solve in a matter of time. Modular innovations can be seen as performance upgrades to existing concepts that we know we do not know yet how to accomplish – therefore they stand for 'known unknowns'. Architectural innovations are illustrated as 'unknowns knowns' since often when they only restructure the relationships between the core concepts in unexpected ways, they resemble a puzzle where all the pieces are already on the table but we do not know that we actually already possess the knowledge to a better solution. Radical innovations are the ultimate 'unknown unknowns' in the matrix. Radical innovations are outcomes that always carry information that we initially do not know that we don't know, and this is what makes pursuing them so difficult.

In their book 'Managing the Unknown' Loch et al. (2011) explain how in conservative strategic planning the influencing variables are apparent and we may predict the causal effects of our actions so that we can choose a desired outcome which is manifested in a blueprint strategy. Here the viable problem solving happens at the start of a strategy and then the emphasis shifts to executing the plan, which may have some negative crises as a consequense if the discovered unknown unknown information is detrimentally so significant that the organization does not have the means to overcome it (Loch et al., 2011). As a solution to respond the challenges of managing the unknown Loch et al.

(2011) offer two approaches (See Figure 11b/c), which both start by admitting the fact that we know too little about the universe of possible project outcomes and that it does not benefit us to choose a single fixed target outcome. The approach 'iterate and learn' (Figure 11b) then intends to advance by identifying an outcome that serves best the purposes of strategy but simultaneously is prepared to alter both the target outcome and the course of action repeatedly and fundamentally during the strategy progression and as new information becomes available. Thus, here problem solving occurs at the start and throughout the evolution of the strategy (Loch et al., 2011). The 'selectionist' approach (Figure 11c), on the other hand, intends to try out several plans and after discovering the preliminary results, the best alternative is selected to be improved further. Loch et al. (2011) conclude that both of these approaches are widely practised in business and they also recognize in these apporaches the evolution of business strategies that has moved from emphasizing the previously mentioned deliberate planned approaches to emergent strategies that agilely transform over time in unforeseeable ways. 'Selectionism' and 'iteration and learning' are in essence fundamental strategies to deal with unknown unknown, and therefore proper strategies are likely to be applying an approach that takes influence from both. Due to the complexity and uniqueness of each strategical situation it cannot be told what are the relative strengths and weaknesses of both approaches nor what would be the optimal way of combining them (Loch et al. 2011). Both approaches are prepared with plenty of difficulty as iteration and learning does not provide the control of what stems from a defined target and repeated iterations are time-consuming and expensive. Also executing multiple parallel attempts in the sense of selectionism is expensive and requires resources, specifically labor force that may end up competing each other instead of collaboration if everyone knows that only one end result will be further improved (Loch et al. 2011).

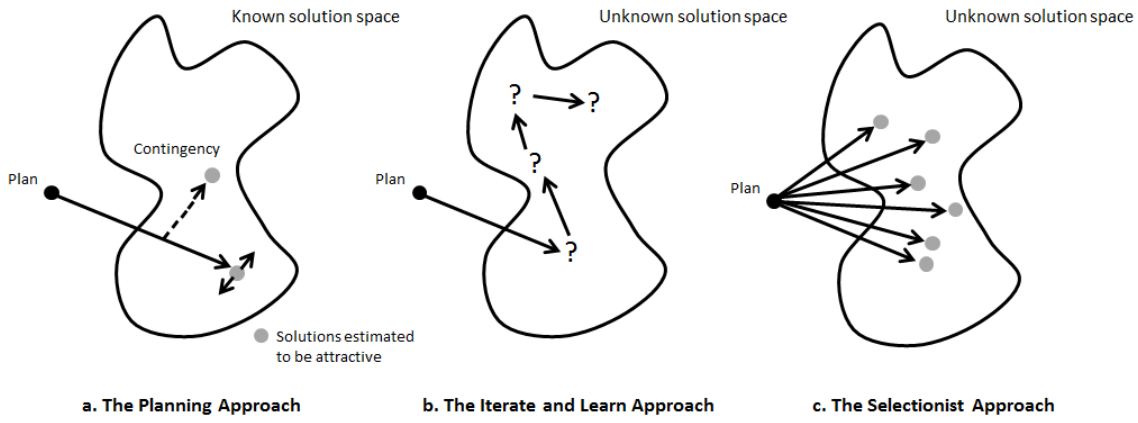

Figure 11. Three fundamental PRM approaches in face of uncertainty according to Loch et al. (2011)

Additionally, other approaches to managing the unknown could be considered, but Loch et al. (2011) argue that the three presented strategies in Figure 11 are the only fundamental strategies. They justify their argument by referring to the work of Henry C. Plotkin (1997) who has shown in his studies that during the 3 billion years of evolution, in essence creative solutions, nature has produced three responses that are conceptually equal to the here presented approaches of project management (Loch et al., 2011).

4. CONCEPTUAL MODELS OF FRONT END INNOVATION

So far this thesis has discussed the construct of Front End Innovation and the requisites for generating innovation and creativity. To control the flow of creative ideas and concepts in the realm of Front End Innovation, a conceptual model is required. A conceptual model in FEI supports the ideation process and hinders the loss of promising opportunities while it also documents the learning that occurs during the process for further use (Kim & Wilemon, 2002b). Considering how the "knowledge networks" function, the model establishes the procedure for organization to capture ideas for NPD (Kim & Wilemon, 2002b) and ensures that concepts which enter NPD are well-prepared with minimal uncertainty. For the New Product Development there exists numerous practices in literature how to start and manage the development of products. According to Koen et al. (2001), such practices do not apply, however, to the FEI since the nature of work, commercialization date, funding level, revenue expectations and other factors are fundamentally different in comparison to NPD. The research on the best front end-practices has had hard time figuring out how to guide project managers through the fuzzy periods of any innovation. In general the models representing the solution to manage a flourishing front end (Cooper, 1997; Khurana & Rosenthal, 1997; Koen et al, 2001; Griffth-Hemans & Gover, 2006; Williams et al., 2007) offer an idealistic vision from having spontaneous ideas to the development of succesful end-products when in fact the process is much more vague and less linear.

4.1. The Danger of Predetermined Trail

The recognition of front end activities dates back to 1988 when Cooper first introduced the term "pre-development". In the coming years he extended his research on Stage-Gate –process from the mid-1980s to concern also the front end, in addition to the original research topic for Stage-Gate; New Product Development (Cooper, 1990). Since then Stage-Gate –model became widely popular both in front end activities as well as in NPD even until present day. Cooper (1990) explains how he compares Stage-Gate –model to an analogy of manufacture process of a physical product where the

quality of the output is improved by eliminating variances from the process. This is executed by having the process sub-divided into a number of stages or work stations, and between each stage, there is a gate to control the quality of the work (Figure 12).

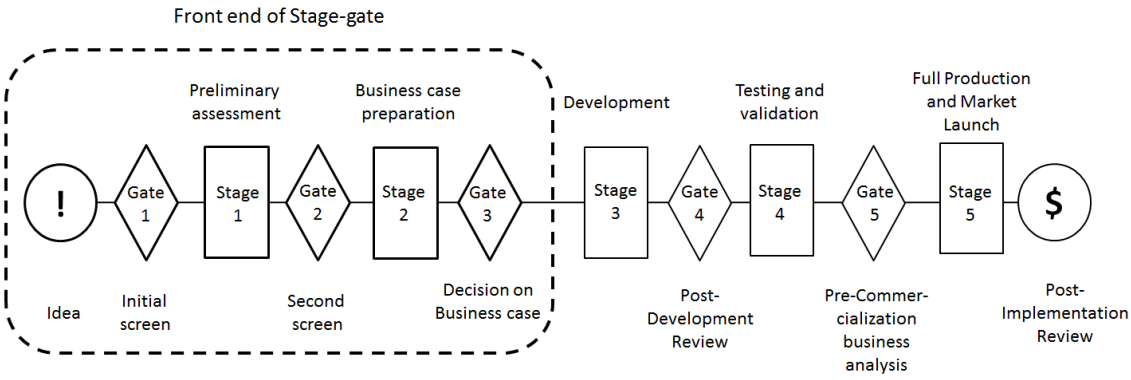

Figure 12. Stage-gate -model. Cooper (1990)

Each gate has certain criteria that the product must pass in order to continue to the next stage, and each of the stages are provided with various tools meet those criteria. Stage-gate –model has been claimed for providing a clear idea of where the project stands, where it is going, and what needs to be done next (Dewulf, 2013), and reduce uncertainty and establish the basis for success of new products (Cooper, 1997). However, Stage-Gate has faced plenty of criticism by academics and entrepreneurs arguing that Stage-Gate is too linear and rigid, it is path dependent and it does not encourage experimentation. The gates are claimed to be too structured and financially based and the prevalent system is controlling and bureuacratic (Becker, 2006; Lenfle & Loch, 2010; Cooper, 2014). Nevertheless, since the first publication of Stage-Gate –model the world has changed a lot and many of the Stage-Gate's flaws have been tried to correct by replacing the sequential execution order by parallel processing that includes iterative loops within stages, possibly even to previous stages (Dewulf, 2013; Cooper, 2011). Additionally, Becker (2006) alleges in his studies that most of the criticism is due to faulty implementation rather than inaccurate model. Despite the modern improvements to Stage-Gate –model, based on the discussion in Chapter 3.4.2, the model continues to fail at escaping the inevitable path dependency, followed by the concept of stages and gates that result in an inability to respond to uncertainty. Path

dependency occurs since each of the gates defines the strategy for the preceding and the following stage, arranging the front end strategy to be a deliberate strategy, leaving no space for iterative trial-and-error cycles or parallel selectionist approach (Lenfle & Loch, 2010). This might be effective in NPD, but in the front end there are a different set of rules that command as previously mentioned in chapters 2. and 4. Furthermore, as this thesis seeks to define how to better generate ideas, Stage-Gate succeeds very poorly to explain what happens before having an idea. Creative ideas are expected to suddenly show up with tools such as analyses of markets, lead users and stakeholders, or techniques of mere brainstorming, voice of the customer and value stream mapping. Such tools might be useful in other occasions, but for ideation they only bring knowledge of the present situation and at their best provide nothing but incremental development topics.

4.2. The Engine of Idea Iteration

Koen et al. (2002) identify the Stage-gate –model specifically as a model intended for NPD-practices, and they do acknowledge how cycle time and efficiency in NPD can be improved by implementing the model. However, they also recognize the shortages of Stage-gate –model and other practices of New Product Development in the front end –phase and intend to overcome those by creating a model that is more iterative and non-sequential allowing a project manager to have more flexibility and readiness to respond to uncertainty. In their article (2001) Koen et al. name the result of their study as New Concept Development (NCD) –model. The model, presented in Figure 13, comprises three key parts including the engine, the five activity elements and the influencing factors. The engine, in the middle of the model, stands for leadership, culture and business strategy of the organization. According to Koen et al. (2001), these are the drivers that are controllable by the firm and propel the five activity elements circling the engine. The five activity elements consist of opportunity identification, opportunity analysis, idea generation and enrichment, idea selection and concept definition. The circular shape of the model intends to demonstrate how "…*ideas are expected to flow, circulate, and iterate between and among all the five elements. The flow may take any*

order or combination, and may use one or more elements more than once." (Koen et al. 2002) In this way, Koen et al. pursue to solve the problem of sequential operation in FEI. In NPD or Stage-gate process, reiteration is associated with significant delays, added costs, and poorly managed projects, whereas in FEI iteration and looping back are integral part of defining the concept. In case proper iteration is neglected in FEI, the overall project cycle time and costs may grow exponentially as the project moves further to sequential and deliberate New Project Development, and the risks are realized (Wheelwright & Clark, 1992; Chapter 3.2.). In the last key part of the model, the FEI operations are affected by the influencing factors of environment. The influencing factors are, according to Koen et al. (2002), the firm's organizational capabilities, customer and competitor influences, the outside world's influences and the depth and strength of enabling sciences and technology. These influencing factors are relatively uncontrollable by the firm, and additionally to FEI, Koen et al. (2002) say the factors affect the entire innovation process throughout to commercialization. The arrows that are pointing into the model indicate the starting activities of innovation at opportunity identification and idea generation and enrichment. The exiting arrow represents how promising concepts will move on to NPD in case they are considered profitable.

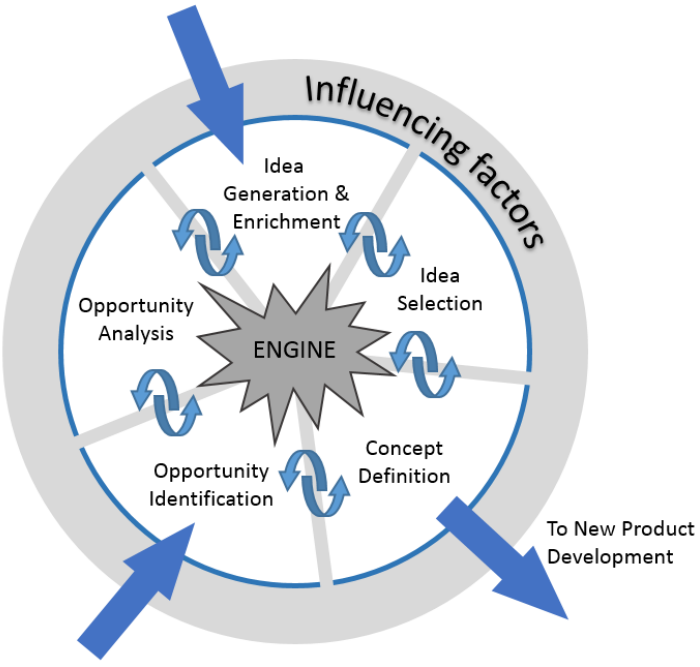

Figure 13. The New Concept Development (NCD) -model. (Koen et al., 2001)

The strength of NCD-model is the illustration of fundamental activities in Front End of Innovation management preceding the NPD, integrating the limitless iteration in the model and emphasizing the critical importance of the engine for the success of FEI, implying the role of vision, strategy, resources, organization culture and senior management involvement (Koen et al., 2001; Koen et al., 2014a). The model is cited in various studies ever since its publication and it can be considered a major milestone in FEI research. However, from the perspective of radical innovation, the NCD-model does not provide comprehensive explanation for opportunity identification and idea generation, but rather concentrates on describing the iterative practice of innovation in an organization that is customised for front-end. The elements of opportunity identification and idea generation in NCD –model include roughly the same toolbox of analyses and techniques as offered also previously in Stage-gate –model (e.g. roadmapping, technology trend analysis, customer trend analysis and market research). They are valuable and supportive for the activity of the elements and with iteration, they are likely to yield results (ideas), but they do not possess the extraordinary required for radical innovation. Additionally to these, Koen et al. (2001) do suggest an organizational culture that encourages employees to spend unscheduled time testing and validating ideas, and a mechanism to handle ideas outside or across the scope of established business units (Koen et al., 2002). The tools now mentioned fathom well essential aspects that are required for more than mere incremental development. Yet, they are only mentioned as such without revealing the viable reason and logic for utilizing the specific tools or the right type of creative process behind it. Additionally, other tools were suggested as well but in general, they comprised methods to idea management or optimization rather than generation. Consequently, the fundamental problem of Front End of Innovation –research remains across the industry and academics; the incapability to explain thoroughly the very beginning of successful innovation (Frishammar et al., 2016).

4.3. Breaking the Problem

Duggan (2013) has noticed the same research gap from above, and he claims there are

two kinds of traditional methods that claim to yield for creative innovations, methods of strategy and methods of creativity. Despite the many alternatives of methods of strategy, Duggan (2013) argues most of these are just various forms of strategic analysis, a method that helps you understand your strategic position but do not produce an idea for what to do about it. Previously mentioned analyses of customers, technologies and stakeholders are typical examples of such, but Duggan (2013) includes here also the ones like Blue Ocean Strategy, Porter's Five Forces, scenario planning and SWOT-method among others. All of them have in common that they offer plenty of information about the present situation but do not reveal how to actually get the creative idea. Methods of creativity on the other hand vary notably in the manner they present themselves, and in fact some of them do provide lots of ideas (Duggan, 2013). Nevertheless, the ideas should be able to meet the standards of a logical idea, that the idea adjusts also to the firm's strategy, and this is often a major challenge. Duggan (2013) mentions creative methods like brainstorming, imagination and collaboration, or creative models of Design for Six Sigma, Six Thinking Hats and Design Thinking, among many more. While many of them do produce ideas, none of them is able to explicitly specify how the ideas are born, or to ensure if the ideas adapt to the firm's strategy. Often many questions are proposed and subsequently the hopes are high that the answers will mysteriously ignite creative ideas. Very rarely will this lead to any innovations that the strategy intends to aim for, let alone radical innovations (Duggan, 2013).

In short, the traditional process of innovation starts with formal analysis and then proceeds to 'creative brainstorming' but Duggan (2013) claims this is not how the brain works. He refers to the work of Nobel prize winner Eric Kandel (2000), who acknowledges that analysis and creativity are not two different functions but work together in all modes of thought. The research that brought Kandel the Nobel prize in Physiology or Medicine proves how the brain utilizes memory as a storage of knowledge for future events that require thinking (Kandel, 2000). When encountered with a situation that occurs out of routine, the brain breaks down the problem and reviews memory for components that would aid in finding the right solution. The combination of those components would then eventually solve the case and lead to

learning (Kandel, 2000). Similar results have been achieved also in other studies of neuroscience (Bergström, 1991; Jung et al., 2013). Duggan (2013) recognizes that these three steps of break it down, search and combine, are distinctly different from the traditional steps of formal analysis and creative brainstorming.

The method that Duggan (2013) then created on the grounds of breakthroughs in neuroscience is called Creative Strategy. The method is carried out in three phases, mimicing the three steps of Kandel's study in neuroscience. The backbone of the method is a tool called insight matrix (Figure 14). The method starts with identifying and defining a problem that is written in the Matrix header (Figure 14a). The problem is considered only as a temporary draft at start since the it might evolve to something else while solving it. After defining the problem it will be analysed and broken down into pieces of subproblems (Figure 14b; NB Duggan calls subproblems 'elements', as opposed to literature). The subproblems will be entered on the rows also as drafts to maintain the freedom of transformability whenever needed. The problem definition, analysis and break down into subproblems are the first phase of Creative Strategy that is done by conducting sets of iterative interviews and research with the managers that determine the innovation strategy, and the managers that will take the lead to develop the innovations. Depending on the organization structure and the problem complexity, the people to be interviewed are sometimes only one person and sometimes many people.

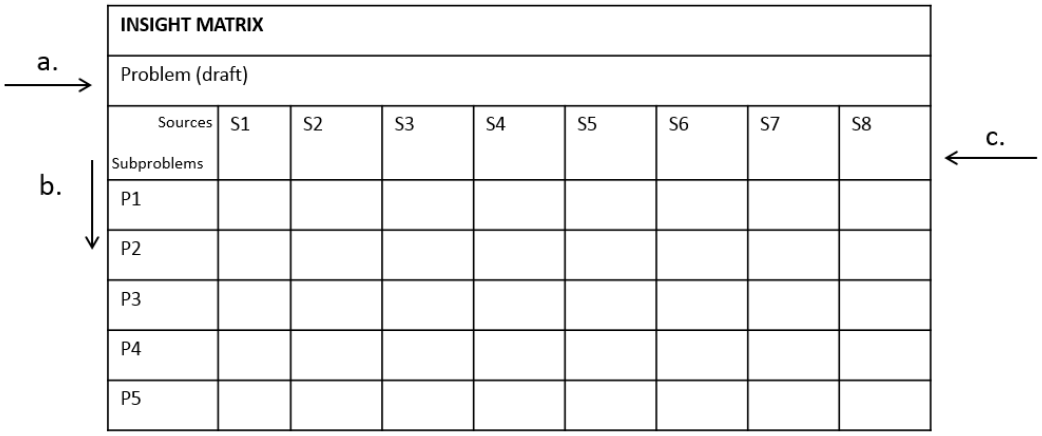

Figure 14. Insight matrix. (Duggan, 2013)

The second phase of Creative Strategy pursues to find several sources of solutions to the draft problem and subproblems at hand. The leading idea of the second phase is to figure out if anyone else in the world has made previously progress on the problem topic, particularly subproblems, and apply those ideas on the problems in the insight matrix. The sources are listed on the columns across the matrix (Figure 14c), and also they are considered first only as drafts in order to allow any modifications on the matrix's content whenever needed. Each source should contain valuable input at some extent to the problem that would make reinventing the wheel to be redundant and ineffective. The purpose is not to copy always the whole concept of the source but to apply the most useful aspect or detail of it to your own setting. The second phase is the most time-consuming and challenging task of Creative Strategy. It will require persistence, and a calm and an open-minded personality that does not get anxious while exploring the unknown without any certainty of finding results worth mentioning. This quest for sources is the feature that differentiates Creative Strategy from other conventional methods of innovation, which spend most of their time and effort analysing the problem and then solving it on their own, literally reinventing the wheel. In the meanwhile Creative Strategy goes on an exploration and looks for solutions that others have made applicable to partially solve your problem.

Duggan (2013) himself does not mention it, but the second phase of Creative Strategy insists that the innovator is capable of recognizing similarities sometimes between even very distant fields of domain. This references back to chapter 3.1. and the skills of creative thinking like analogical thinking or conceptual combination. Sawyer (2012) claims how in general people have difficulties at noticing the relevant analogies and how they don't always take the full advantage of their knowledge to solve problems. The challenge is to understand the problem completely and the reason to its existence, and then transfer over to target the resembling sources for their relevant aspects. Similar to analogical thinking is the so called market vision competence that allows a firm to absorb and understand its environment to identify business gaps and capitalize on them (Reid & de Brentani, 2010). Additionally to identifying the most important problems, being able to recognize analogies between distant domains and to identify profitable gaps of business opportunity, are the key talents to successful innovation.

As soon as sufficient amount of promising sources has been discovered, or the project runs out of time to explore, the third and last phase of the method takes place. Here the objective is to select and combine the input from various sources with the subproblems, to make a solution for the main problem (Figure 15). The idea is not to utilize all of the sources in the combination but to take the ones that enable the most beneficial and reasonable solution. How to recognize then the right sources, or if you even have any of them to make the winning solution? Duggan (2013) says there is no clear formula for how the creative combination of information from sources occurs because it corresponds the flash of insight, an event that occurs in a single brain when all the pieces of the puzzle suddenly start to fall in place. The explanation leaves us again with a bit of doubt of the true nature of creative innovation. However, Duggan (2013) gets very close and after all, if it would not be mysterious, innovation would be trivial for all. Additionally, Duggan (2013) speaks of *"resolution"* that he defines as *"...the will to pursue the idea you see."* He explains that people have by far the strongest resolution for their own ideas, compared to ideas that were generated for them by someone else. Therefore, the same people that were interviewed for defining and analysing the problem in the first phase, should be gathered for the last phase of Creative Strategy and lead them to select and combine the solution (Figure 15), from the sources that were found to have the answers, for the problem that they initially agreed upon. In this way with Creative Strategy it can be ascertained that the discovered solution will have the full support of management (Duggan, 2013).

INSIGHT MATRIX								
Problem (draft)								
Sources / Subproblems	S1	S2	S3	S4	S5	S6	S7	S8
P1	(X)							x
P2			x			(X)	x	
P3	x	(X)		(X)				
P4					(X)			
P5			x					(X)

Figure 15. The third phase of Creative Strategy. Circled X's indicate the determinants to the main problem.

The empirical study of this thesis explained in chapter 6 proves that the use of insight matrix does work and is effective, which is a strong indication that the Creative Strategy will yield even better results in the long run. Creative Strategy and particularly the tool insight matrix, are however fixated very much on the issue of problem solving itself, leaving all the other issues affecting FEI activities on less attention. Several sources in the literature have emphasized the essential role of iterative and non-linear mentality of idea and concept development in FEI (Koen et al., 2001; Seidel, 2007; Vojak, Price & Griffin, 2012; Markham, 2013). Since the emerging ideas are intended to be new to the market and to the firm, the innovative work requires wide-scale research and many explorative drafts or sketches before arriving at a fixed definition for the product (Frishammar et al., 2016). Therefore, the three phases of Creative Strategy should also be perceived as a group of iterative elements that contribute to generating innovations, rather than a sequentional process that has a starting point and a finale. Hence the numbering of the phases in any order should not be paid too much attention and also Duggan (2013) suggests to freely wander between the phases as many times as it is needed. Also the managerial and environmental factors in the general view of FEI have an vital impact on the FEI activity and need to be recognized along with non-linear iteration.

Based on the discussion above, figure 16 integrates the paradigm of Creative Strategy (Duggan, 2013) with the New Concept Development –model (Koen et al., 2001) into a model named Strategic Problem Deconstruction (SPD). The SPD-model illustrates the iterative work of Front End Innovation, while the engine in the middle supports the operations in all of the activity elements with leadership (see Chapter 2.4.), and takes the surrounding environment into consideration in innovation strategy and management (see Chapters 3.4. & 4.2.). In the figure, problem identification and source identification are marked as entry elements to the model but in practice applying the model may be started from any of the elements but the creative combination (Why not creative combination? See p. 52). The following chapter 4.4. will explain how problems will typically appear in a tangle of subproblems and symptoms where the main problem is not easy to distinguish, and therefore it is likely that the use of SPD will rather start from experiencing a symptom or noticing a subproblem. The use of Duggan's (2013)

insight matrix –tool is recommended while applying the SPD but the matrix must still be considered just as a tool among others. The underlying paradigm is much more important for the end result that could be reached also with other tools that fulfill the idea of finding the problem and breaking it apart while also adapting better to the needs of innovating individual.

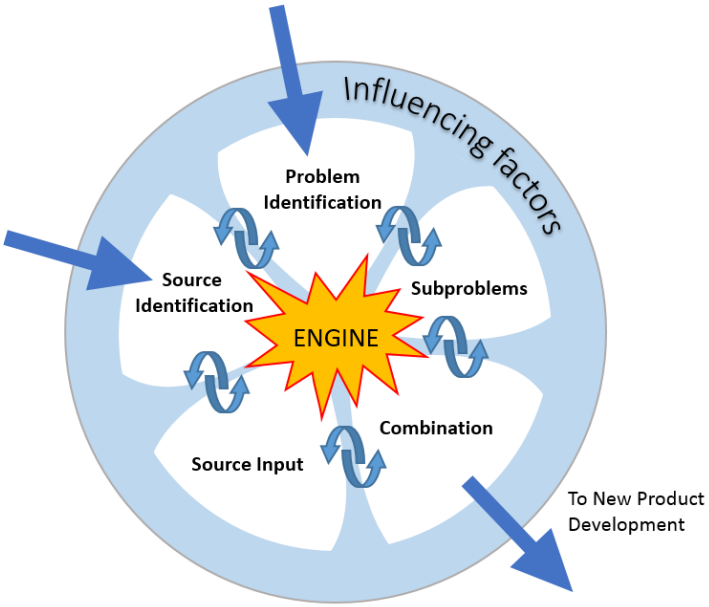

Figure 16. The model of Strategic Problem Deconstruction (SPD). Own interpretation according to the studies of Koen et al. (2001) and Duggan (2013).

4.4. The Problem to be Broken

The seed of Duggan's (2013) Creative Strategy is the problem that must be identified. Frishammar et al. (2016) have also concluded that conventional methods of strategy and creativity contribute poorly to radical innovation due to its uncertain and complex nature. To overcome the challenges, Frishammar et al. (2016) argue that the formulation and exploitation of unique problems and opportunities should be considered as a basis for radical idea and concept development. A common innovation desired by any business is a one that increases performance and reduces costs, but this definition does not make a creative problem to be solved. Setting such financial and operative targets as a first task for innovation strategy often result only in ideas to work harder or hire more

people, and no innovation would be needed (Duggan, 2013). Even if problems were the main subject of analysis, problems are perceived to explain the constraints for the business or the effort is wasted while pondering the right solution search method (Frishammar, 2016). Hence, there is an obvious lack of knowledge how to create radical ideas and concepts in the Front End of Innovation, and on the contrary, theories of problem finding and solving are not realized to play a major role in the process (Frishammar et al., 2016). The concept of 'problem' is comprehended well in the front end literature, but the idea of how the problems are recognized, formulated, evaluated and solved in the front-end is vague and poorly defined (Frishammar et al., 2016).

Baer et al. (2009) define the concept of problem as a deviation from acceptable conditions resulting in a symptom or a web of symptoms recognized as needing to be addressed. Landry (1995) specifies the existence of a problem in four ways:

(1) a crisis or an opportunity that is judged as a negative ocurrence,

(2) a sense of minimal control over a situation or an event,

(3) a spontaneous willingness to do something and commit resources to it,

(4) uncertainty as to the appropriate action and how to implement it.

As a rule firms are rarely lacking issues that comply with the definitions above, but the challenge is to understand a problem holistically, in other words, why it is a problem and how it could be solved (Griffin, Price & Vojak, 2012). The first sight of a problem is often a symptom or a subproblem to the main problem, since the root cause might be too remote for the firm to be noticed (Frishammar et al., 2016), or too painful for the firm to be acknowledged. Frishammar et al. (2016) sees the main problem as a web of multiple, connected symptoms and subproblems, where the symptoms are effects of a problem and the sub-problems are partial problems to the main problem. The higher the amount of symptoms and subproblems, the more complex is the main problem. Nickerson et al. (2011) model the recognition and definition of problems in their 'problem-finding and problem-solving'-approach into three steps including *problem finding*, *problem framing*, and *problem formulation*. *Problem finding* is an activity to

process information in order to gain a holistic view of the present situation, including all the possible symptoms related to the situation. Therefore individuals with heterogenous knowledge and experience, i.e. a cross-functional team of people should be gathered that are capable of challenging social boundaries and old assumptions (Baer, Dirks & Nickerson, 2012; Chapter 3.4.). *Problem framing* deals with identifying the main problems and dividing them into subproblems and symptoms allowing the team to have a profound understanding of the circumstances (Baer, Dirks & Nickerson, 2012). *Problem formulation* then selects and formulates the most valuable main problems along with sets of sub-problems and symptoms to be attended (Baer, Dirks & Nickerson, 2012). In problem-finding and problem-solving approach the problem acts as the unit of analysis, rather than any routine, resource, or transaction (Nickerson, et al., 2007) as opposed to many other methods of analysis. Based upon this, the field of research in problem finding and solving proves that the method in Duggan's (2013) Creative Strategy is appropriate and valid, peeling the layers of a problem like an onion. It also somewhat responds to the doubt of how the last phase, creative combination, in Creative Strategy occurs as each problem or 'puzzle' is so unique that in no sense would it be achievable to define a clear theoretical path to any innovation.

Noticing the important and most valuable problems is difficult. Often the amount of symptoms and subproblems seems to be overwhelming and it is very hard to see what is the root cause for everything. Griffin, Price & Vojak (2012) advice to look for concrete problems that cause customers so much trouble, that they are willing to pay for the solutions. They define an interesting problem according to three criteria:

(1) solving the problem has the potential for significant financial impact,

(2) a solution can likely be found,

(3) the problem and its solution are acceptable to both customers and management (it solves their problems and fits strategy).

The management should set quest for problems that are lacking solutions and that would benefit the firm remarkably if solved. Problems can be searched after with several traditional strategy methods that collect data on the industry, the competitors, the

customers or firm's own weaknesses or strenghts. However, as mentioned already in this chapter, these methods provide lots of information of the present state but offer no conclusion. There is no specific formal method to arrive at a conclusion of the problem appearance after an analysis has been conducted. Kandel's (2000) studies of learning and memory show how various ideas of problem existence are incited by the similar and conjunctive situations stored in our memory that relate somehow with the subject analysed. Since every human memory is unique, the same analysis results in somewhat different conclusions by different people. Duggan (2013) says, brainstorming is a method that can be applied to discover the existence of problems after a thorough analysis. However, it is important to remember that while identifying the problems, brainstorming cannot be applied simultaneuously to solve the problems. A problem that can be solved by brainstorming, without any farther exploration, does not require an innovation (Duggan, 2013). Sometimes a problem may surface into firm awareness also during the routine tasks of business functions. A valid problem does not require any method or formal research to exist, just an open-minded attitude to recognize anomalies in the firm's operations will do the job. Regardless of the size and sort of the problem to be solved, it must be worth of the attempt to solve. Creating the solution will take time and effort, and at least as much resources will be needed to put the idea into practice. Hence the problem has to make a difference especially in the operated business and where it has not been solved before by someone else (Duggan, 2013).

5. EMPIRICAL STUDY

The evidence for the theoretical framework's functionality collected in this research was done in three workshops and one questionnaire. Workshops acted as experiments to investigate the feasibility of insight matrix (Annex 5) as an idea generation tool under various circumstances and from different perspectives. The workshops were organized for two different study groups. The first group of study consisted of a team of nine product managers, of which each one of them manages an actual running product line and in average, all of them have an experience of several years in product management. The case company that the product managers work for operates in the parceled goods business of electrical engineering. The second group of study was a set of nine university students with technical and economical majors, who had no specific common background with each other; unlike the team of product management had stayed the same for the last two years on a daily basis. The product managers were 30-50 years old and had experience in the industry from four to thirty years. In comparison, the students were 20-25 years old with little or no experience from industry and from taking responsibility to solve problems for living. Hence, the groups of study were remarkably different and the aim of this confrontation was to examine how well the insight matrix and the paradigm of breaking a problem into subproblems comports with various occasions and with people from different backgrounds.

The questionnaire (Annex 4) was conducted for the team of product managers to study their opinions and experiences of the knowledge they gathered in the workshops about Front End of Innovation. Their former experience of the topic was minimal and in a sense, they had a fresh start to acquire knowledge not familiar from before. The questions were arranged in a manner that made the respondents to reflect their present situation to the time before this research began, and how the newly provided information had affected their level of knowledge and capability to act in the front end.

Additionally to conducting the research for the case company, an innovation workshop was also designed and established for the product managers simultaneously with the thesis. The layout of the workshop can be seen in annex 6. The purpose was to create a

safe space for exploring the capabilities of company's own products as well as the corresponding rivaling products. The innovation workshop was located in the building basement as to emphasize the hierarchy free atmosphere and the allowance to innovate without restrictions while getting your hands literally dirty. The space includes a lot of storage room for different product samples, working surfaces, tools and hardware configurations typical for the industry. The innovation workshop was completed and taken to use but no further conclusions could be drawn from its usage due to low utilization rate at the time of writing this thesis. The deployment of facilities in this scale takes time, and no benefits or drawbacks could yet be stated.

5.1. First Workshop Discussion and Results

The first workshop was conducted for the team of product managers. The workshop started with an introduction of Front End Innovation and its principles (Chapter 2.), different innovation output categorizations (Chapter 3.3.), the information flow of Front End Innovation (Chapter 3.4.), strategic aspects of Front End Innovation (Chapter 3.5.) and finally the different conceptual models of Front End Innovation and their strengths and weaknesses (Chapter 4.). The introduction served as a preparation for the workshop task in order to explain:

- the product manager's role as an individual in the industrial innovation process
- the significant importance of the presence of Front End Innovation
- the capabilities of insight matrix as an idea generation tool

Following the introduction, the workshop attendees were divided into groups of two people and given A3 sized insight matrixes (Annex 5). They were instructed to reflect on the customer needs and problems they had confronted while managing their respective product lines, and to improve the performance of services or the features of products with the help of insight matrix –tool. The task was to define a factual problem draft and dissemble the draft into problem elements that possess a direct influence to the existence of the problem. From there the attendees began to look for sources that might

solve the various problem elements. In other words, what they did was a kind of quality brainstorming; defining the problem and subproblems on the go, and instantly begin to look for the sources through discussion with the colleague. It was no Creative Strategy as Duggan (2013) meant it to be, and no radical innovations were expected to appear either. The results of the workshop were, however, very promising even despite the short performance time allowed (approx. 45min). The meaning of the workshop was to test the functionality of insight matrix as an ideation tool, and that it did exceptionally well. The reception of insight matrix was very excited and the generated ideas were evaluated to be of great value so much as they were judged to fall under confidential obligation. In addition, the theory of Front End of Innovation as a preceding phase to New Product Development was also accepted and agreed to be highly beneficial for efficient business operation.

Result 5.1.1.: Insight matrix-tool and problem deconstruction-method are functional ideation regime.

Result 5.1.2.: When implemented correctly, insight matrix-tool and problem deconstruction-method will produce ideas that are coherent and fit the firm's strategic objectives.

5.2. Second Workshop Discussion and Results

The second workshop was organized for the same team of product managers and 8 people took part in the activity. This time the workshop was started with a lecture of another external product type closely related to the workshop attendees' products. The external product type had not been integrated or taken into consideration yet while designing the firm's own products. The cooperation with the external product type and its integration had been recognized as a potential opportunity to increase the utilization value of the products for the end customer. A speaker who was a professional in the field of the external product type, held the lecture. The content of the lecture was given for the workshop attendees' as a source for the insight matrix –tool. Attendees' were

consequently instructed to approach the insight matrix (Annex 5) from the perspective of obtaining first the source without initially knowing whether it will actually have any utility in the problems provided by the company's own products. After the lecture and before the actual workshop task, the workshop attendees' were also familiarized with the most common creative thinking methods (Chapter 3.1.) and three exercises were carried out to focus unwarranted assumptions (Annex 1 and 2), fixations on incorrect solutions (Annex 2) and analogical thinking (Annex 3). The aim of creativity exercises was to demonstrate the most common setbacks confronted when creativity is needed and to illustrate the potential of successful analogical thinking.

It turned out that the task was considerably more challenging than the task in the first workshop. The lecture time (approx. 60 minutes) to familiarize oneself with the topic that acted as a potential source for the firm's problems was so short that it can be estimated no in-depth learning occurred. A certain hesitation to work on the topic could be sensed from the workshop participants after the lecture. During the lecture, it became clear for all that, there was no free breakthrough innovations to be taken and it resulted in a suspicion of how to proceed towards a coherent innovation. A speculation stands strong that this occurred since the participants could not let loose of the pre-conditioning assumptions of what the actual innovation could be, and in the presence of others, the participants were maybe not willing to indulge themselves to ideate a playful concept in the fear of coming up ridiculous. Eventually they did somehow manage to overcome the issue but the created ideas remained on a much more general level in comparison to the first workshop. Particularly, no specific first idea of any concept (regardless of the coherence) was produced. Reasons for poor progress could also be the choice of topic or the inadequacy of the lecturer who originated from sales and marketing instead of R&D. Criteria for a good topic would include a certain issue that is dealt with exceptional performance by the presenter's organization or that there would be some resemblance to the firm's businesses and problems at hand, even if very distant. While having such a lecture, the participants should be provided with the most truthful challenges and possibilities of the domain, in the hopes of arousing cooperation between the product types. Their answers and problems could be the answer to our problems, and the other way around. This time the workshop did not succeed in it but to

remain rational about the results, one must understand that this was only one field of research from many and in normal activity, the time to explore any interest might take more time and various sources.

Result 5.2.1.: Approaching the insight matrix tool from the direction of source is considerably more challenging.

Result 5.2.2.: The atmosphere of these events should encourage the participants to break the rules and play with them.

Result 5.2.3.: The source field to be explored and its presenter should be carefully chosen.

5.3. Third Workshop Discussion and Results

The third and last workshop was carried out with a group of university students and nine people took part in the activity. The workshop started with a lecture of Front End Innovation and creativity, and the content from the two previous workshops was brought together into a coherent whole. The students were given the same information of the significance of Front End Innovation and they performed the same exercises of creative thinking skills from the second workshop (Annex 1, 2 & 3). Their workshop task was similar to the first workshop performed by the product managers, in which the insight matrix –tool (Annex 5) was applied starting from defining a problem draft and dissembling it into various subproblems. The starting point for the students to use the matrix was, however, very different as it was for the product managers. The product managers had already years of experience with the concept of their product lines, they had a clearly defined strategy in practice and a reserve of problems waiting to be solved. Instead, the students had none of this and were obliged to come up with problems requiring solution on the minute they received the matrixes after the introduction lecture.

As the workshop task started, it became clear that the absence of strategy and expertise

of a specific domain complicated the process for the students, even up to the verge of frustration. They simply did not have any problems to begin with, or more accurately, they were not trained to recognize problems in their surroundings. However, all of the groups (2-4 people per group) did get eventually started by delving into challenges in domains familiar to students. After a clumsy kick off, it could be remarked how students acted suddenly surprisingly more flexible and imaginative in their work in comparison to product managers in previous workshops. Certainly, the ideas provided by the product managers were more applicable and possessed a particular coherence for implementation, but the students adopted very well the sort of playful mindset that supports the radical ideation. The reason for a difficult start could be the social barriers between students previously unknown to each other. After these barriers had been demolished, everybody where on the same line with each other and had nothing to lose. The students showed no fear of losing their "professional pride" while advertising their quite amusing ideas. It can be speculated whether the opposite happened to some extent in the workshops for product managers. Professional teams will inevitably contain some hierarchy in their work according to years of experience in the business or other attributes, and the issue should be overcome to let ideas flow freely.

Result 5.3.1.: Lack of strategy and expertise in a specific domain from where to draw problems to be solved, complicates the use of insight matrix. If you do not see problems in your surroundings, any innovation will remain undiscovered.

Result 5.3.2.: Playful mindset supports the radical ideation.

Result 5.3.3.: The absence of hierarchy has a positive effect resulting in imaginative and flexible ideation.

5.4. Questionnaire results

The questionnaire contained five questions accompanied by images illustrating the essential knowledge related to the questions (Annex 4). The questionnaire was

distributed to the team of product managers by e-mail and 10 out of 10 people responded. The graph below visualizes the results in a radar chart where the questions have been modified to correspond the matter each question was measuring.

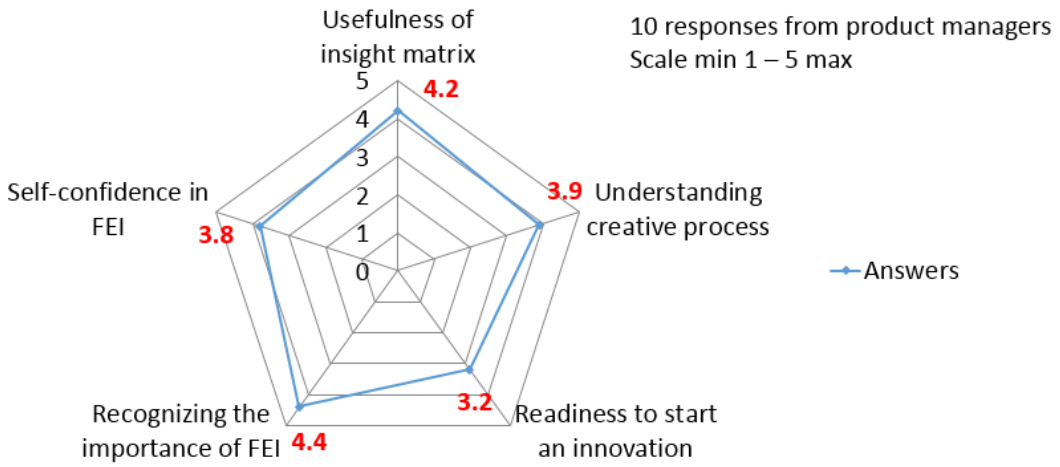

Figure 17. The Results of the Questionnaire for Product Managers.

From the graph, it can be noticed that the 'Recognizing the importance of FEI' and the 'Usefulness of insight matrix' have gained the highest scores of 4.4 and 4.2 respectively. Considering the small amount of knowledge the case company possessed of FEI theory before this study started, the good result of score 4.4 addresses how necessary the introduction of Front End of Innovation (Chapter 2.) was for their business. In addition, the positive reception of insight matrix (score 4.2) suggests that in the case company there was a clear demand for a tool that explains the formation of strategically valuable ideas in a concrete manner, and that the offered tool fulfills the demand at least to some verifiable extent (Chapter 4.3.). 'Readiness to start an innovation', on the other hand, stands out with the distinctly lowest score of 3.2. The score denotes the fact that despite the good comprehension of FEI activities and the efficiency of the tools provided, innovation does still require the support of the organization to happen. This includes the sort of innovative culture and working habits that the case company needs to establish, in other words, the case company lacks the effective engine of front-end pictured in figure 16 in chapter 4.3. (p. 57). There are a number of ready-made blueprints where to start but there is no 'one-size fits all' –solution and to consider the issue in this thesis

would be of too broad study field. The scores for ‘Self-confidence in FEI’ (3.8) and ‘Understanding creative process’ (3.9) indicate a strong interest on the matters but understandably there are some uncertainty left due to little experience with the newly provided knowledge. Overall, the results were very promising in the sense, that from here onwards the case company has a fertile and responsive atmosphere to attempt and commence various front end-activities.

Result 5.4.1.: The theory of Front End of Innovation serves well the purposes of an industrial firm’s business.

Result 5.4.2.: Insight matrix –tool and the problem deconstruction –method responds the needs of industrial idea generation.

Result 5.4.3.: An innovative culture and necessary working habits must be established in the organization to support the employees in their creative and innovative work.

6. CONCLUSIONS

The general objective for this thesis was to study how to be successful in the front end of innovation in an industrial organization. The research was conducted as a constructive research in order to build a conceptual model that considers the most important aspects of an innovative front end-phase. The outcome of the model and the conclusions of this thesis are presented in this chapter.

The core of an innovative organization is the cultural and habitual atmosphere that is built by the senior management to support and enable the generation of innovations. Senior management has the initiative to develop innovations, not as coming up with good ideas, but by understanding the strategic meaning of front end-phase for the whole process of innovation. The senior management establishes the norms for communication and consensus building in the organization, which enables teams to have a shared sense of purpose and a solid team vision. Recognizing the different roles in achieving innovation allows the management to identify various characters and their capabilities in organization. Gatekeepers and boundary spanners require strategically well-defined objectives that they may pursue to accomplish in autonomy and by their own means. Innovative teams must consist of self-confident individuals that have the allowance of management to operate with innovations, not only from their own perspective of expertise, but also from a holistic point of view. In other words, teams are cross-functional and interdisciplinary, and may look for ideas in unexpected domains. Absence of hierarchy and a playful mindset in team activities will sustain imaginative and tolerant atmosphere that is productive for the radical ideas. Aforementioned managerial actions feature in short the engine of SPD-model described on page 56 that lies at the core of an organization. These managerial actions respond also to the first research question, “What are the managerial requisites for an industry organization to be innovative?”.

Innovations require ideas and usually the inception of a good innovation is preceded by hundreds of ideas in varying quality. Ideas originate from the minds of creative people that are intrinsically motivated to explore, and possess an expertise of, a domain where

to innovate in a strategically coherent manner. Intrinsic motivation and domain expertise combined with creative thinking skills of analogical thinking and conceptual combination, enable an individual to be creative in an effective manner. Particularly the lack of strategy and expertise in a certain domain will hamper innovation as the result 5.3.1. (p. 63) addresses in the empirical study. The role of the individual is important since, despite the strategic decisions and managerial actions of senior management are crucial for the success in FEI, the act of having an idea is inherently individual, and only the development and its implementation are collective efforts. Hence, a curious mind of a person, who is capable of solving problems from his or her surroundings in a manner that makes an impact on society (market, customer base, community), is the origin of innovation. Radicalness of an innovation does not, however, correlate with the business' profitability. Innovations exist in many forms and all of them play an important role in the evolution of a product. Yet the radical innovations are the most challenging to come up with and often the first actor on the market has a major head start on the business. A coherent act of radical innovation requires a strategy that defines an objective for the exploration. The strategy makers are bound to understand the nature of organizational unconsciousness and how to approach the 'unknown unknown' – information, which makes defining the objective very challenging. One part of radical innovation will always stem from beyond the boundaries of organization, from topics that are often judged doubtfully to have any seeds of innovation. Therefore, the management shall adopt an emergent strategy to cope with the uncertainty, and with the means of 'selectionist' or 'iterate and learn' approaches delve further into uncharted territory. This relentless cooperation of creative individuals and an open-minded strategy, will have innovations discovered, and thereby answers the second research question of this thesis; "How innovations are born?".

The main goal of this research was to understand the manner how to control the flow of ideas and bind them consistently to strategy so that they possess value for the end-customer. A conceptual model was required to be developed that concretely responds to the needs of an industrial organization in the front end-phase. The model should make a clear distinction to the properties of models in New Product Development since such models devote themselves too much for path dependency and don't take the unique

characteristics of FEI into consideration. Additionally the model for FEI should be capable of explaining what exactly occurs at the phase of idea generation as many prevalent innovation models fail to depict the event and its requisites thoroughly. The Strategic Problem Deconstruction-model that was then developed (see p. 57), applies a way of thinking from problem solving-literature, the so called 'problem deconstruction'-method, where the problem acts as the unit of analysis, instead of any routine, resource, or transaction; as opposed to many conventional methods of innovation. Therefore, the leading idea of the model came to be the finding of problems in the first place rather than coming up with any innovative ideas. The discovered problems are analysed and broken down into pieces of subproblems and symptoms, which are then accurately mapped to gain a holistic view of the whole. After recognizing the most essential subproblems, a period of exploration is initiated to find theoretical and practical sources of existing solutions for the selected subproblems. The solution for the main problem will then eventually be achieved from the collected solutions of subproblems. The model is applied in iterative and non-sequential manner indicating that any of the phases may be repeated as frequently as necessary and in any order that is perceived beneficial for the end result. The order of the phases is not fixed for the reason that in practice the use of the model not always starts from identifying the main problem, but when a symptom is experienced or a subproblem is encountered; even an intriguing source may appear that could have a solution to a yet unidentified problem. Hence, applying the model may be begun from any of the phases but the creative combination of subproblems' solutions. This is because likely it is not a question of an actual innovation if the solution is immediately within reach of comprehension. The described method of problem deconstruction is used in accordance with the support from senior management that acts as the SPD-model's engine of innovation practices in the middle of the organization. Outside the firm's authority and on the outer layer of SPD-model, remain the influencial factors that affect the entire innovation process from the front end until commerzialization. The influencing factors include customer and competitor influences, the depth and strength of enabling sciences and technology, foreign affairs and domestic policies. Such factors are relatively uncontrollable by the firm but need to be paid continuous attention due to their influential nature. As a conclusion, the engine, the problem deconstruction-method and

the influencing factors, form the Strategic Problem Deconstruction-model that answers the third research question; “How do you manage the generation of innovation?”

Many challenging issues exist in the model and in Front End of Innovation. The firm applying the model must succeed in recognizing the right problems to be pursued, in the manner that exposes distinctly the prime causes in question. When an accurate general view of a problem is achieved, the depth and direction of exploration actions, in the search for solutions of subproblems, are a demanding information to specify. The target of exploration may exist relatively far away from the firm’s core business and noticing the potential requires skilled individuals with creative talent. Here the senior management’s strategic objectives and maneuvers in the face of fluctuating uncertainties, as well as managerial support in the means of providing sufficient resources and a certain level of autonomy to strive the objectives, will aid the individual innovators reaching the target. Througout the total innovation process the senior management is required to have faith in their subordinates and their way of working. A lack of involvement or understanding from the management may harmfully affect the innovation process. If an individual argues to have figured out a way to solve a major problem or believes that he or she is on the right track to have something accomplished, the superiors need to hold on to patience and avoid narrow-minded or inflexible attitude. Not by any means does this indicate nonchalant and easygoing norms in question of daily actions, but will indeed require explicit regular updates of the work in progress and the specific actions that have been committed in terms of attempting to solve any problem. After all, innovation is hard work that must be done. No innovation will come into being spontaneously.

6.1. Validity and Reliability of the Thesis

The construct validity of this research was measured by the questionnaire described in chapter 5.4. The questionnaire functioned as a ‘weak market test’ that Kasanen (1986) defined according to following question: “*Has any manager responsible for the financial results of his or her business unit been willing to apply the construction in*

question in his or her actual decision making?" The positive results from that questionnaire, along with various feedback discussions with the head of the product management unit from the case company, indicate that the case company is highly willing to apply the here designed construction and the requisites of weak market test are fulfilled for the construct validity. Moreover, it can be stated that the designed construction is rather simple and easy to use in comparison to any other conceptual model found in the literature and business, and it concentrates well on the relevant issues confronted especially in the front end of innovation. Hence, the study is also truthful as far as its measuring is plausible as described in chapter 1.1.1.; "*a technical norm is true if and only if doing X is really unavoidable in order to reach A under conditions of B."* Since innovative ideas may be recorded in a number of different ways in very fluctuating conditions, the here designed construction cannot be the only solution but certainly a very strong and effective competitor on the market of conceptual models for the front end of innovation.

The designed construction has combined knowledge from various theoretical frameworks including Product management, Problem solving, Creativity, Innovative strategy, Managerial innovation leadership, and Neurology, with an inclusive list of references. These theoretical connections advocate the scientific validity and generalizability of the thesis. Hence, it can be assumed that the designed construction would be applicable also outside of this research in other similar situations, and the practical usability of the conceptual model noticed in the study supports this argument. The wide selection of various theoretical connections in the literature support also the internal validity of the study by seeking convergent evidence for confirmation from other research fields. However, internal validity can be seen slightly threatened, as a number of inferences was made of the experiences monitored in the workshops, and the inferences were strongly related to behavioral sciences, a field of research that is not the specialty of the thesis researcher nor the focus of the study. The inferring occurred on the grounds of thesis researcher's experience in industrial engineering with employees of the same hierarchy level and being familiar with their way of thinking, the expectations directed at them and their pressure to perform well. The situation the students were faced with in their workshop was also identified by the thesis researcher

from various kind of self-participated workshops at the university, and hence the inferences were rather easy to notice. The number of workshops could have been higher but in the means of resources dedicated for the thesis, three workshops was suitable. The population of the workshops is decent for this scale of study. The population is heterogeneous consisting of people from various age, background and experience, presenting an in-depth description of the conceptual model's potential. As a conclusion, the internal validity is on a sufficiently good level.

The documentation of the thesis is accurate and repeating the study with the information provided in the thesis should be straightforward. For all the collected data, there is an inclusive reference list to support the interpretation, which is executed in light of explicit theoretical background and clearly defined results of empirical research. These issues enhance the transparency and the reliability of the thesis that measures the consistency of the findings in question. It is highly expected that similar observations would be reached by other researchers, in case they were to repeat the study. Still, alternative explanations could possibly appear as the research in question is indeed qualitative, and hence the results can be interpreted in a different way. It is, however, not very probable due to the various theoretical connections that support the interpretation conducted in this research. Additionally, the thesis researcher is confident that the designed construction of the thesis would yield similar results with minor modifications in any of the other fields of sciences where new ideas are required. Therefore, this constructive research is reliable and consistent, and its construction possibly universal, crossing the boundaries of various research fields.

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APPENDICES

Annex 1

Source: Sawyer, 2012

Add one line to IX to make six.

Unwarranted assumptions:

First, the added line must be straight

Second, that you're trying to make 'VI', which would be six in roman numerals.

Solution:

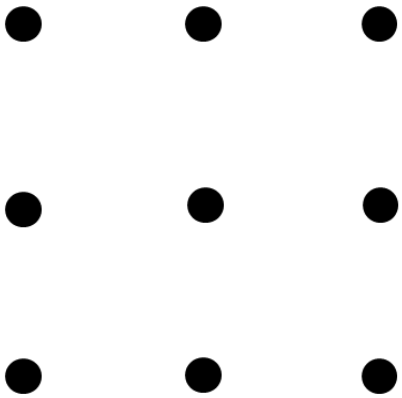
The answer is to add a curved line, an S, to IX to make SIX.

Add one line to SIX to make six.

Annex 2

Source: Sawyer, 2012

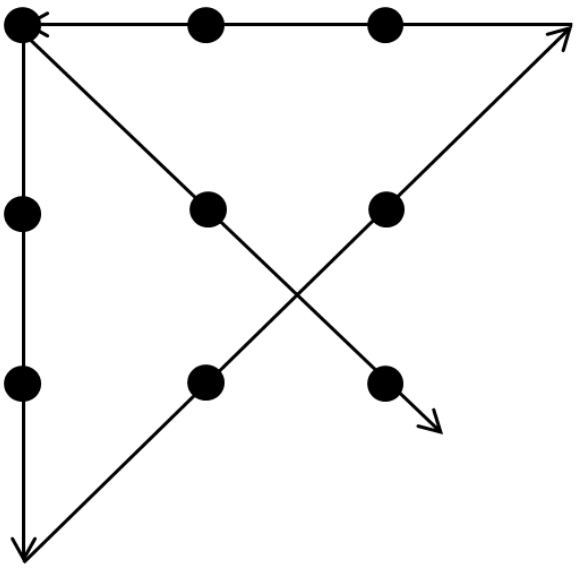
The nine-dot problem. Connect the nine dots with four connected straight lines without lifting your pencil from the paper.



Unwarranted assumption; The four lines have to stay within the box itself.

Fixation on incorrect solution; Inability to take advantage of the hint.

Solution:



Annex 3

Source: Gick and Holyoak, 1980

Radiation problem

Suppose you are a doctor faced with a patient who has a cancerous tumor in his stomach. It is impossible to operate on the patient; but unless the tumor is destroyed, the patient will die. There is a kind of ray that can be used to destroy the tumor. If the rays are directed at the tumor at a sufficiently high intensity, the tumor will be destroyed. Unfortunately, at this intensity the healthy tissue that the rays pass through on the way to the tumor will also be destroyed. At lower intensities, the rays are harmless to the healthy tissue but they will not affect the tumor either.

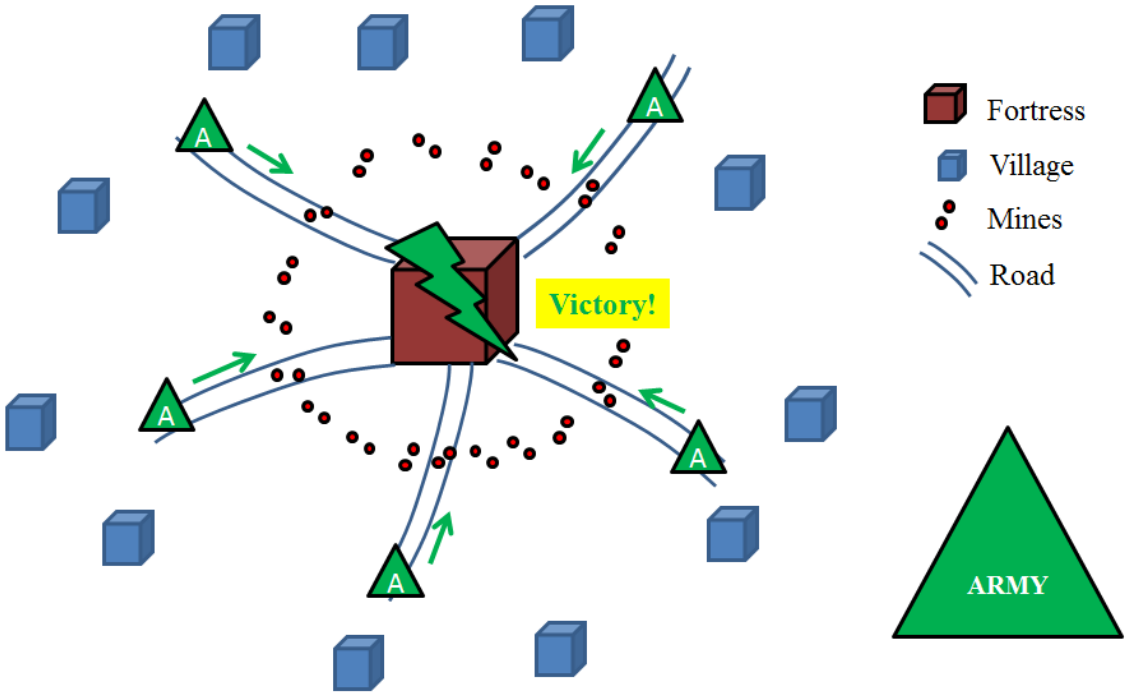
What type of procedure might be used to destroy the tumor with the rays, and at the same time avoid destroying the healthy tissue?

Attack-dispersion

A small country fell under the iron rule of a dictator. The dictator ruled the country from a strong fortress. The fortress was situated in the middle of the country, surrounded by farms and villages. Many roads radiated outward from the fortress like spokes on a wheel. A great general arose who raised a large army at the border and vowed to capture the fortress and free the country of the dictator. The general knew that if his entire army could attack the fortress at once it could be captured. His troops were poised at the head of one of the roads leading to the fortress, ready to attack. However, a spy brought the general a disturbing report. The ruthless dictator had planted mines on each of the roads. The mines were set so that small bodies of men could pass over them safely, since the dictator needed to be able to move troops and workers to and from the fortress. However, any large force would detonate the mines. Not only would this blow up the road and render it impassable, but the dictator would then destroy many villages in

retaliation. A full-scale direct attack on the fortress therefore appeared impossible.

Solution: The general, however, was undaunted. He divided his army up into small groups and dispatched each group to the head of a different road. When all was ready he gave the signal, and each group charged down a different road. All of the small groups passed safely over the mines, and the army then attacked the fortress in full strength. In this way, the general was able to capture the fortress and overthrow the dictator.



The attack-dispersion story was told and simultaneously illustrated for the wrokshop attendees with this picture. Each element of the picture was revealed one by one leaving the small triangles (groups of army) and direction arrows as the last, revealing the solution to conquering the fortress and eventually also the radiation problem.

Annex 4

The Front End of Innovation Questionnaire

Rate the claims below according to your own perception what you have experienced in the workshops in December and April. Choose one alternative. "Other"-option is intended for additional free word.

1. Insight matrix supports well the idea generation

○ ○ ○ ○ ○

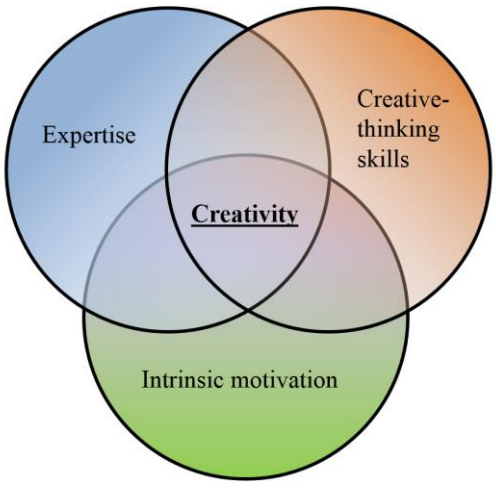
Strongly agree Disagree Neutral Agree Strongly agree

INSIGHT MATRIX								
PROBLEM (draft) I NEED ANOTHER TABLE TO EAT AT								
Sources / Elements	SECONDHAND S1	WASHBOARD MECHANICS S2	TV-TABLE DESIGN S3	HACKLAB WOODWORK S4	HONG-KONG /K-RAUTA S5	DRONE TECH S6	S7	S8
VERY SMALL ROOM E1		✕						
DISORGANIZED E2			✕					
I DO NOT WANT TO INVEST E3	✕			✕	✕			
LAZY TO CLEAN UP E4				✕		✕		
NO SPACE & EQUIPMENT E5	✕			✕	✕			

2. I understand the creative process that occurs when having an idea

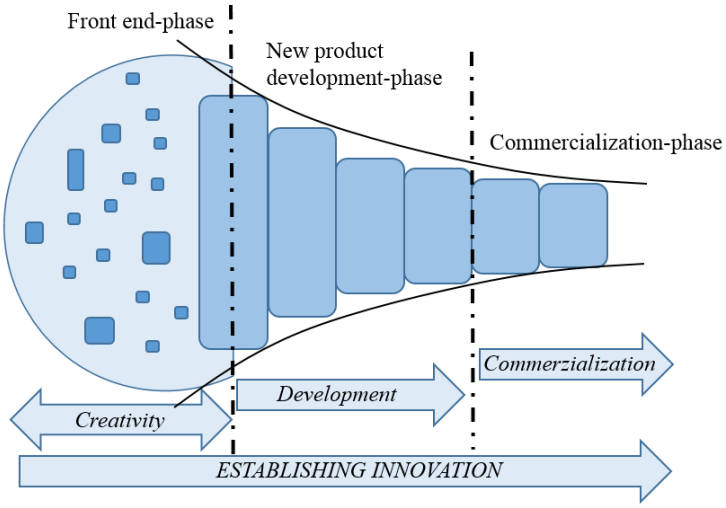
○ ○ ○ ○ ○

Strongly agree Disagree Neutral Agree Strongly agree



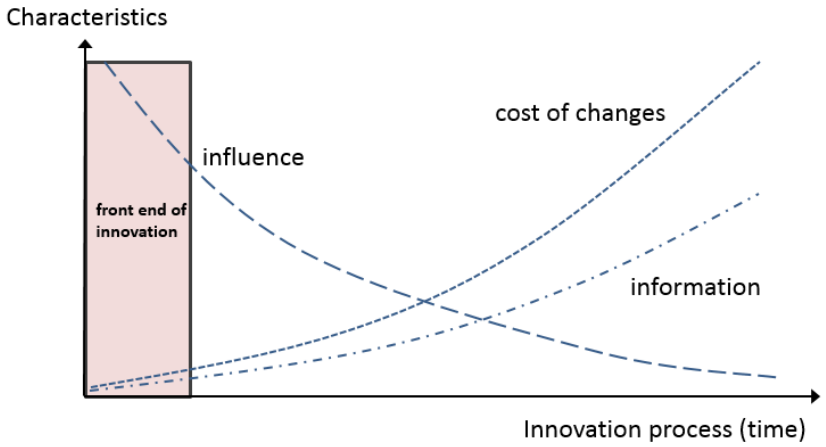
3. It is easier for me to start an innovation process than previously

○	○	○	○	○
Strongly agree	Disagree	Neutral	Agree	Strongly agree



4. Recognizing the importance of Front End Innovation enhances our operations

○	○	○	○	○
Strongly agree	Disagree	Neutral	Agree	Strongly agree

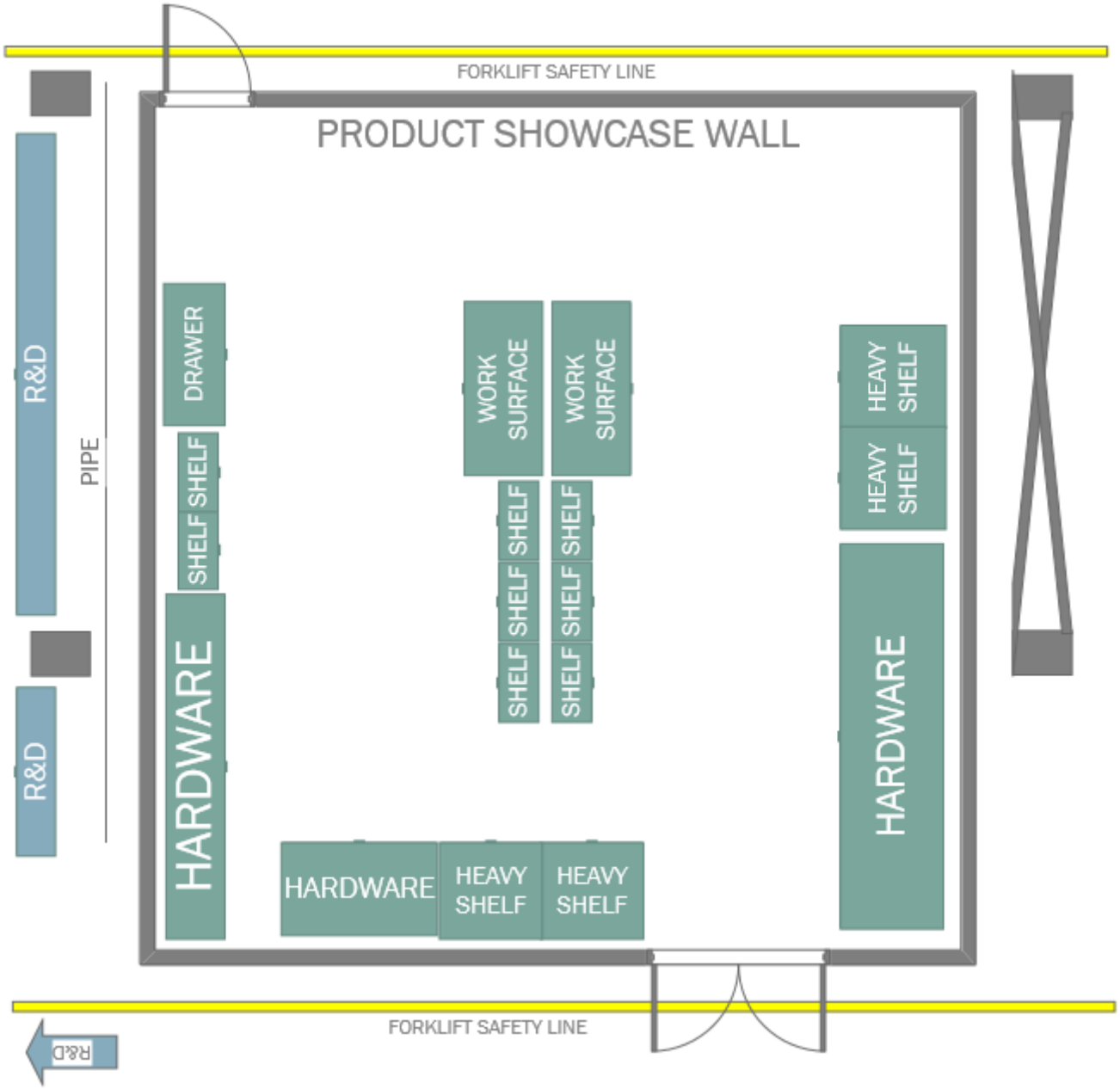


5. As a product manager, I feel now that I can systematically contribute to a better Front End

○	○	○	○	○
Strongly agree	Disagree	Neutral	Agree	Strongly agree

Annex 5

INSIGHT MATRIX								
PROBLEM (draft)								
Sources ➡ Elements ⬇	S1	S2	S3	S4	S5	S6	S7	S8
E1								
E2								
E3								
E4								
E5								
E6								
E7								
E8								


FORKLIFT SAFETY LINE
PRODUCT SHOWCASE WALL
R&D
PIPE
R&D
DRAWER
SHELF SHELF
HARDWARE
WORK SURFACE
WORK SURFACE
SHELF SHELF
SHELF SHELF
SHELF SHELF
SHELF SHELF
HEAVY SHELF
HEAVY SHELF
HARDWARE
HARDWARE
HEAVY SHELF
HEAVY SHELF
FORKLIFT SAFETY LINE
R&D