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PRODUCT DEVELOPMENT

User-centred product development and design in an industrial company

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ABSTRACT:

User-centred product development is a process the goals of which are to create a product that satisfies the needs of the user. Instead of only concentrating on technical sides of the product, the focus is mostly on fulfilling customer requirements and wishes. The structure of the entire process encourages the activities such as market research, investigation of the nature of the customers, their needs and preferences.

The aim of this research was to investigate user-centred product development from both theoretical and practical perspectives and to find out at which rate the practice corresponds to the theory. The product development process of an industrial company was investigated. As an example ABB Finland Oy Motors and Generators was chosen. The company's product development process was introduced and compared to the theoretical model known as the stage-gate system. Another aim of this research was to investigate open innovation and present its principles in product development. Open source was presented as an example of open innovation. Finally, the goal was to find out the ways to improve the process of user-centred product development in an industrial company.

The results of the investigation have shown that the challenges presented by the theory are taking place in the real world. Changing market, environment and customer tastes, existence of multiple choices, growing time pressure and pressure to succeed – all these factors strengthen the importance of customer prioritisation. The study showed that the company can succeed by asking questions, using users as a source of a new product idea, having a user needs-and-wants study and further developing the process structure.

KEYWORDS: user-centred development, stage-gate system, open innovation, open source, customer needs

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TIIVISTELMÄ:

Käyttäjäkeskeinen tuotekehitys viittaa tuotekehitystapaan, jonka tavoitteena on tehokkuus ja loppukäyttäjän tarpeiden tyydyttäminen. Tarkoituksena käyttäjäkeskeisessä tuotekehityksessä ei ole keskittyä pelkästään tuotteen teknisiin ominaisuuksiin, vaan prosessin lähtökohtana on täyttää asiakkaan vaatimukset ja toiveet. Prosessi kannustaa markkinatutkimusten tekemiseen, asiakkaiden luonteen sekä heidän tarpeidensa ja mieltymystensä analysointiin. Käyttäjäkeskeisen tuotekehityksen toimintatapojen hyödyntämisellä on suuri merkitys tuotteen menestymiseen markkinoilla.

Tässä tutkimuksessa tarkastellaan käyttäjäkeskeistä tuotekehitystä sekä teoreettisesta että käytännöllisestä näkökulmasta. ABB Finland Oy Motors and Generators on teollisuusyritys, jonka tuotekehitysprosessia analysoidaan ja verrataan teoriamalliin. Työn tavoitteena on myös tutkia avointa innovaatiota ja sen periaatteita tuotekehityksessä sekä analysoida avoimen lähdekoodin prosessia ja sen eroavaisuuksia muista tuotekehitysmenetelmistä. Lopuksi tavoitteena on selvittää, millä tavoin käyttäjä voidaan huomioida tuotekehityksen eri vaiheissa, ja miten tuotekehitysprosessia voidaan parantaa.

Tutkimuksen perusteella voidaan todeta, että teoriassa todetut ongelmat esiintyvät myös käytännössä. Tuotekehityksen suurimpina haasteina pidetään muuttuvia markkinoita, ympäristöä ja asiakkaiden tarpeita, useita vaihtoehtoja, aikapaineita sekä painetta onnistua. Nämä tekijät korostavat asiakkaiden tärkeää roolia tuotekehityksessä. Tämä tutkimus osoittaa, että käyttämällä asiakkaita tiedon lähteenä, tutkimalla asiakkaiden tarpeita ja toiveita sekä kehittämällä tuotekehitysprosessin rakennetta, voivat yritykset saavuttaa parhaat tulokset tuotekehityksessä ja markkinoilla.

AVAINSANAT: käyttäjäkeskeinen tuotekehitys, avoin innovaatio, avoin lähdekoodi, asiakastarpeet

1. INTRODUCTION

It is a fact that any successful manufacturing business during its whole history inevitably reveals a story of continuous improvement in technical efficiency, design, quality, and value of the products offered to customers. Regardless of their size, companies always wish to maintain or establish market leading positions. However, it is not possible to achieve the leading position only by using already existing solutions and performing re-engineering. Companies need to seek, create, develop and market new products, keep moving forward, use modern techniques and show innovations and new variants to their customers. (Ottosson 2004: 207.)

One of the major goals of the industrial sector is to implement a product development in such a way that new technological opportunities can be identified and commercialised before competitors can do so. The aim is to shorten development time, reduce the cost of production and achieve better customer satisfaction. One of the prerequisites for the success in a hard competition is the ability to develop, manufacture and market better products.

According to Willsmore (1950), it is a hard lesson for business management to learn that there is not necessarily any direct connection between a product and the cost of the material, labour and other elements included in its production. (1950: v) The only measure of the value of a product is the consumer's attitude towards it. A company can have great manufacturing expends for a product but it does not guarantee that its product is worth it. One of the most important goals is to understand that the key to success is to know what the consumer really needs. Televisions, cars, cell-phones, slide fasteners and thousands of other products reflect the commercial advantage that can be gained from product development. (Willsmore, 1950: v.)

In order to succeed in a changing business environment and growing competition, more and more companies concentrating on product development have tried to change the working culture to a market- and user-oriented approach. This means that many companies have chosen to focus on customers and their needs. The understanding of the needs of the end-users is a necessary condition for success in product development projects. However, there has to be a balance between user data exploitation and all other factors a company is interested in such as the community, employees, financiers and business owners. A starting point to user-centred product development is to learn who

the users of the product are, where the product is used, what the users are doing with the product and what the consequent requirements of this product are.

1.1. The objectives of the research

Even if companies' interest in user-centred design has increased there are still many problems and issues to comprehend. According to Cagan's and Vogel's (2003: 39–40) research big organisations normally forget about their customers during product development processes. Based on this research it is possible to conclude that there are three requirements for success in product development. The first step to success is to find and investigate all product possibilities. Secondly, companies have to deeply understand the needs of their customers and make these needs into specific development ideas. Thirdly, there has to be a combination of technical design and marketing.

Nowadays there is a large amount of markets and industries that are both international and global. Across national boundaries there is more intense competition which affects the situations of emerged global product segments. According to Nishiguchi, (1996: 3) due to this increasing pressure, product development has started reducing cost targets and development cycle times and concentrates on improving quality. However, development projects provide lots of opportunities for a manufacturing company to renew itself constantly which leads to the ability to attain and retain a leading position in the global and international market.

In this world it is the customers who choose the leading product regardless of how much time and money companies have spent on the development of their own products. Customers always search for the best products and want to use the products that other customers, not engineers, have decided has the best quality. Customers play a huge role in the market success and profit of companies. Customers choose who will lead the market, what service providers will sell, and why they buy. (Strouse 2004: xiv.)

Viitaniemi, Aromaa and Leino (2010) state in their research that companies have some real challenges on their way to working, user-centred product development processes. How can one improve communication between designers and users, and other involved parties in the product design development process? How can one increase and maximise the exploitation of user knowledge? How can one make sure that the balanced product and the user-centred ways of thinking are used efficiently? All these problems need to

be addressed in order to achieve the best results in the product development projects. (Viitaniemi & Aromaa & Leino 2010: 7.)

The aim of this research is to investigate the correlation between the users of products and product development processes. It is not that easy to start a product development project when some of the needs of the customers are obvious. Before starting the project, it is important to analyse all the data and based on that make appropriate decisions. The problem is how to find the useful data and the tools needed to analyse it. There are three main questions to be answered through this research: Which role do the users play in the process of the user-centred product development? How can the users and the information about their needs can be exploited in the process of product development? Which are the possible solutions to succeed in product development? By answering these questions it is possible to find different ways of building and managing an efficient process of product development regardless of the effects of the circumstances and the environment.

In this work one of the aims was also to introduce product development as a process. Through examining the role of the product development it could be shown which phases are included in this process. Creating a new product is a long and time demanding project that has to be divided into many parts. Some parts of the project are more important and people involved have to spend more research time and money on solving problems. By looking at the different product development models, evaluating the importance of technical research, and by taking customers into consideration, it can be shown which specific areas are playing the biggest role in product development and how the consumer data can be used in order to create a product with high demand.

Another aim of the research is to introduce open innovation and open source as a part of user-centred product development. Open innovation includes the idea of sharing and cooperation between different innovation participants of the process of product development. Open innovation differs from closed innovation in many areas such as a different strategy with people involved, differentiation between external and internal R&D, definition of the best result in product development, licence and copyright issues. By defining open innovation and comparing it to closed innovation it is possible to find out which way of product development is more effective for industrial companies. It is also possible that a combination of these two principles might work the best in user-centred product development.

1.2. The structure of the research

This investigation is divided into four parts: a presentation of theories and models of product development, a company example of a gate model, a presentation of open innovation and a new model of product development, analysis and conclusions. The first part introduces the definitions of product development, its goals and challenges. Taking the consumer as a starting point for product development is a base of this part. In the theoretical part it is necessary to clarify which factors need to be considered when starting a product development project. One of the aims of this theoretical section is to find the answers to the challenges described previously. This part also includes a presentation of the product development process model called a stage-gate system invented by Robert Cooper. The main goals, benefits and the structure of this model are introduced and analysed in order to compare it with the model used in practice by an industrial company taken as an example.

The second part shows how theories are working in practice. As a practical example of this investigation one Finnish industrial organisation was chosen to prove or reject the theories presented. The third part introduces an idea of open innovation from the perspective of user-centred product development. The theoretical part includes differentiation between open and closed innovation, clarifying of benefits and reasons for implementation of open innovation. Open innovation is presented also from a practical point of view where the central point of the investigation is open source as a process of user-centred innovation. Finally, based on the presentations of two different models of innovation it is possible to compare two principles and draw conclusions.

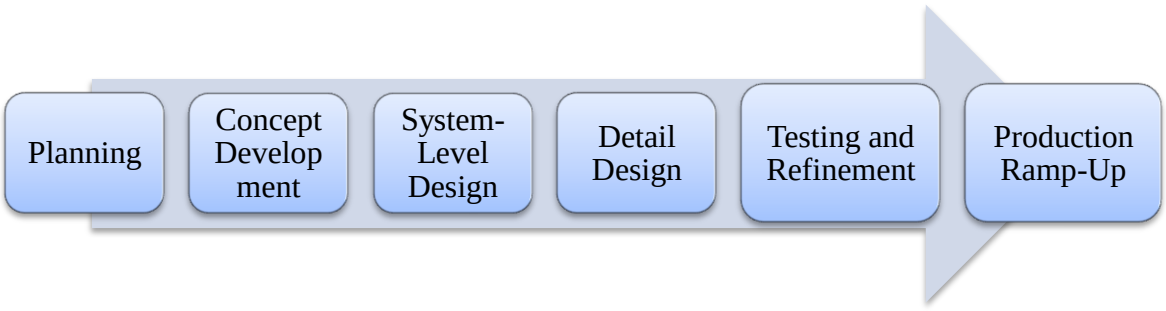
In the last two parts of this research, the focus is on gaining an understanding of how the user-centred product development can be improved, which tools can be used to help the companies improve their relationships with the customers, how to gain useful information about the customer's needs and wants and how important market research is in product development.

2. USER-CENTRED PRODUCT DEVELOPMENT

"Development is the translation of research findings or other knowledge into a plan or design for new, modified, or improved products, processes, and services, whether intended for sale or use" say Juran, Godfrey and Blanton. (1998: 1). During this translation there are many changes happening in the conceptual formulation, design, testing of alternatives and in the construction of prototypes. Ulrich and Eppinger introduce the definition of product development as a process consisting of the sequence of steps or activities which companies employ to conceive, design, and commercialise a product. These steps and activities can be intellectual and organisational rather than physical. The product development process may include the phases of market surveys, idea and concept generation, system engineering, detailed design, and preparation for production. (Viitaniemi & Aromaa & Leino 2010: 18.)

2.1. The structure of the product development process

Ulrich and Eppinger have investigated the generic product development and all the activities included, and found out that the process consists of six different phases. These phases are shown in Picture 1. (Viitaniemi & Aromaa & Leino 2010: 18.)



Picture 1. Phases of the process of product development. (Viitaniemi & Aromaa & Leino 2010: 18)

The whole process begins with a planning phase, which functions as a link to advances in research and technology development activities. The planning phase begins with corporate strategy and usually includes the assessment of technology development and market objectives. The output of this phase is a project mission statement, which specifies the market for the product, business goals, constraints and key assumptions.

The concept development phase is playing the role of a guide for the development team. In this phase it is time to identify the target market, generate and evaluate alternative product concepts, select one or more concepts for further development and testing. The next phase, system-level design, requires the definition of the product architecture and major sub-systems and interfaces. Refining industrial design, identifying suppliers to key components and developing a plan for product options and an extended product family helps the development team to create a clear picture of a future product. These activities allow the process to move further into the phase of detail design which includes the complete specification of the geometry, materials, and tolerances to all of the unique parts in the product. (Ulrich 2000: 14–17.)

The conclusion of the product development is the product launch, which makes the product available for purchase. However, before launching a new product, it has to be tested and refined. This phase involves the construction and evaluation of multiple preproduction versions of the product. The development team may test the reliability, performance and lifetime of the product. Finally, in the last phase, evaluation of early production output can be done and after that it is possible to begin the operation of the entire production system. This phase is quite critical as its purpose is to train and educate the workers and identify remaining problems in the production process. (Ulrich & Eppinger 2000: 17) There are lots of benefits in the clearly divided process as it is easier to ensure the quality of the product and divide all the work into different parts. Using several phases in the product development gives the opportunity to evaluate and develop all the activities included in the process. It also makes it possible to clarify the distribution of work responsibility.

According to Ulrich and Eppinger, the economic success of manufacturing companies depends mostly on their ability to identify the needs of customers and quickly create products that meet these needs and can be produced at low cost. (2000: 5–7) Product development can be used as a problem solver to solve all these problems and to optimise the understanding of the market and technology. To succeed in the market and get high customer satisfaction it is important to be familiar with the characteristics of successful product development. Ulrich and Eppinger also argue that performance of a product development effort can be evaluated by looking at the following five issues: product quality, product cost, development time, and development cost and development capability. (2000: 5–7)

How good is the resulting product? Does it satisfy customer needs? What is the manufacturing cost of the product? How long did it take the development team to complete the product development effort? How much did the company invest in the development process? Can the development team and the company further cooperate in developing future products? High performance in these regards leads to economic success. However, it is also important to take other performance criteria into account such as interests of other stakeholders in the enterprise, i.e. members of the development team, other employees and the community where the product is developed.

The cost and duration of product development has always been one of the most common questions. Ulrich and Eppinger argue that it is almost impossible to develop a new product in less than one year as this is a time consuming process requiring from three to five years and the development of some products may take up to ten years. (2000: 2–7) According to Ulrich's and Eppinger's theory the cost of product development is roughly proportional to the number of people involved in the development and to the duration of the project. (2000: 2–7) Additionally, the company has to invest in all the tools and equipment needed for production. Mostly this expense is as large as the rest of the product development budget.

Implementation of product development is affected by the strategy of the company. Holt has divided the companies roughly into technology and market oriented companies. (2002: 26–28) Companies that are technology oriented are concentrating mostly on the exploitation of new technology during the production processes. Market orientated companies focus on users' needs and demands in their product development and try to benefit from their satisfaction.

2.2. The challenges of product development

"New product development is one of the riskiest, yet most important, endeavors of the modern corporation", argues Robert Cooper. (1994: 4) There is an estimation that 46 percent of the resources the companies spend on the development, conception and launch of their new products are spent on products that either fail commercially in the marketplace, or simply never make it to market. (Cooper 1994: 19) In order to succeed regardless of a huge amount of risks and failures it is a major task of the company to conduct more and better marketing research, market analysis and sales forecasting. The

understanding of user needs is the key to success in winning the market competition and creating a good image among the customers. Cooper is sure that the main task of the project team is to understand the product's potential users and customers, and the product's contribution to the customer. (Cooper 1994: 57.)

It is really difficult to develop products that become absolute favourites on the market. Ulrich and Eppinger have found that there are only a few companies that are highly successful more than half of the time. (2000: 2–7) Product development is an operation that includes lots of uncertainties. Based on the statistics introduced by Bruce and Cooper almost 50% of the product development costs arise due to its failure. (2000: 2–7) One of the most central challenges is to identify the customers' needs and to respond to them quickly and profitably. This is the main goal that has to be achieved through combining marketing, design and production forces.

According to the statistics introduced by Douglas, eighty per cent of new brands on the market fail. Also, the average company only succeeds in showing profit on one out of five products launched. (1983: 26) The process of developing successful new products demands as much skills and disciplines as the process of running mature existing brands. There are lots of different reasons to why product development is so challenging for a product development team. Ulrich's and Eppinger's review shows that there are many different factors causing challenges, for example the existence of multiple choices, trade-offs, dynamics or changing environment, time pressure and decisions over details. (2000: 5–7) As it is argued by Ulrich and Eppinger one of the most difficult aspects of product development is recognising, understanding, and managing trade-offs in a way that maximises the success of the product. (2000: 5–7) A trade-off situation can occur for example when some product criteria could be met by development but this action would increase manufacturing cost.

According to Drejer, there are two types of challenges of product development: external and internal. (2002: 734). External challenges are factors and changes that take place outside the company. Internal changes are mostly the issues and problems that are possible to affect and solve inside the company. Decision making in an environment that is constantly changing is a formidable task. It is difficult to follow all the changes happening in the world as there are many different areas which are important to take into account in product development. Technologies are improving very fast, customers are changing and evolving their preferences, competitors are introducing new products, and moreover the macroeconomic environment is shifting all the time. Any problems

could easily be solved if there was plenty of time, but product development decisions usually demand quick decisions without complete given information. One of the critical factors during the process of product development is the amount of investments. Phases included in this process such as research, development, production, and marketing are requiring large investments. The aim of companies is to get reasonable return from these investments, therefore new products must be profitable to produce and attractive to customers. (Ulrich & Eppinger 2000: 14–16.)

Douglas introduces more factors affecting challenges in the product development process. In Douglas' opinion, a new product activity requires careful thinking and a lot of determination to put the thinking into practice. (1983: 28) Sometimes new product development is left to the end of the day. Mostly managers are concentrated on already existing products and their profitability and switch to new product development after they have solved immediate problems. Douglas also argues that it is not always the best solution to hire a specialist from outside to develop a new product. This may happen if when briefing a specialist the product development goals of a company are not made clear. The company has to clarify for a hired specialist whether it wants to optimise an existing product or evaluate a new product opportunity. Confusion between these two briefings may lead to a disaster. (Douglas 1983: 27–29.)

Although product development requires certain skills, disciplines, an educated development team and much work, it also requires a special attitude. For many companies and development teams product development is interesting exactly because it is challenging. According to Douglas, the product development process is purely based on creativity as it begins with an idea and ends with the production of a physical artefact. (1983: 27) Viewing product development and the level of different activities included in it as a whole, shows that the final product is a creation of human minds. For some development teams this part can be difficult as being creative in product development is not always enough because it is likely that technical problems arise.

2.3. The stage-gate system

One of the most common problems in product development is high pressure to reduce the cycle time and improve the success rate of a new product. This is the main reason for the fact that most of the companies are looking for new stage-gate systems which

can be used as a tool to manage, direct and control the product innovation efforts. Therefore, the companies have developed a systematic process in order to move a new project through the specific stages from a product idea to its launch. This method helps companies increase the effectiveness of their programs. (Cooper 1994: 95.)

2.3.1. Goals of the stage-gate system

According to Cooper's stage-gate, a new product plan has six areas that require the most attention and time. The first goal is achieving a high quality of execution which has a dramatic impact on product success or failure. The way the companies conceive, develop and launch new products clearly needs a systematic and careful approach. The problem with the quality can be solved by visualising product innovation as a process and by applying process management and quality management techniques to this process. Therefore, the quality of execution is the goal of the new product process where focus should be on completeness, quality and on pivotal points such as market-oriented activities. Completeness means that the company has to ensure that the key activities are carried out without any gaps and omissions. These activities should also be proficient meaning that innovation should be treated as a process and the attention is mostly paid on quality controls and checks. Finally, attention and resources have to be devoted to the pivotal and the particularly weak steps in the new product process. (Cooper 1994: 97.)

The second goal of the stage-gate system is to have sharper focus and better prioritising in the process of innovation and development. According to Cooper, most firms' new efforts usually suffer from lack of focus due to the large amounts of different projects and a deficit of resources. (Cooper 1994: 97) The focus and the resource problem forces the companies to make decisions that affect failure in their work. There is a clear need for sharper project evaluation which helps weeding out the poor projects, directing the scarce resources towards the truly meritorious projects and focusing more on the final result. This is possible by including Go/Kill decision points or a set of gates into the new product process. These gates are meant to make the innovators ask if the process of innovation and development is still going on. Each gate has its own set of metrics and criteria for passing to the next level. Cooper suggests four questions that can be asked as the criteria for passing the gates: "Does the project continue to make economic and business sense? Have the essential steps been completed – those steps or activities necessary to pass through the gate? Is the project on time and on budget?

What steps and actions need to be undertaken in the next stage of the project and what are the deliverables for the next gate?" (1994: 98) The main role of the gate is to control the new product process by preventing projects from moving ahead to the next gate until all critical activities have been completed.

There is a dilemma that new product managers have to solve as they are forced by the customers and senior management to do everything to reduce the cycle time but on the other hand they have to focus on the effectiveness of the product development by cutting down the failure rate. When the goal is to have a complete and high quality process the solution is parallel processing which allows focusing on different activities at the same time and gives the opportunity for different members of the project team to work simultaneously. Such a system helps to avoid poor performance and overlooked and poorly handled tasks due to lack of time as the activities are done in parallel and not in series. Finally, with parallel processing the new product development process becomes "multifunctional and multidisciplinary" as stated by Cooper. All members of the team in the field are together participating actively in each gate. (Cooper 1994: 98.)

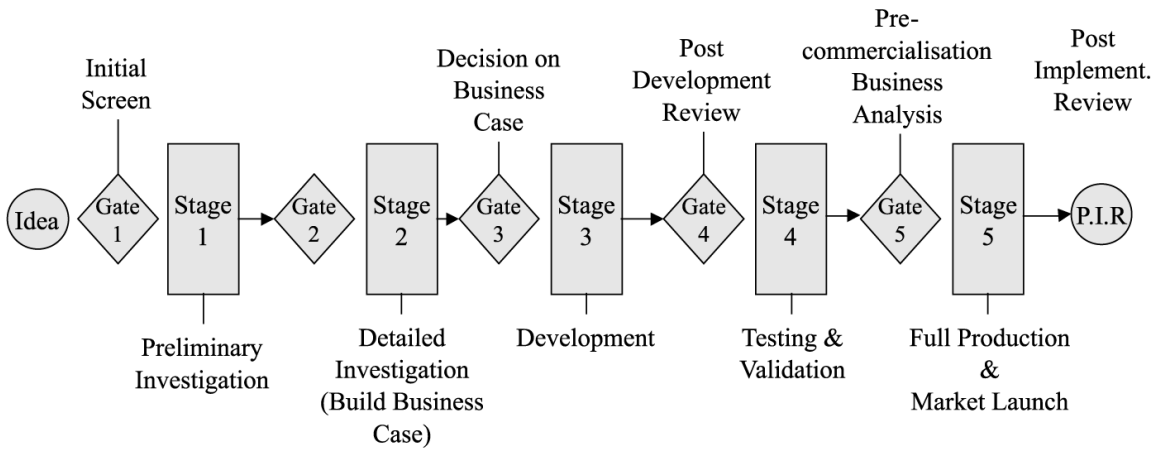
The fourth goal in Cooper's list is to achieve a multifunctional team approach as the process of new product development requires much inputs and active participation of all members of the team and the whole organisation. Cooper has created a list of characteristics the team should have in order to achieve a multifunctional team approach. First, if the team is multifunctional there are team members from the different functions and departments whose contributions are important in the project. Secondly, the organisation of the team can be in a form of project team for complex projects or as a project matrix team for normal projects. The difference between these two forms lies in the amount of authority the manager has. In the first case, the project manager has complete charge but no formal involvement by functional managers. In the second case, the project manager has primary responsibility and authority while the functional manager assigns personnel as needed. The third characteristic is focusing on the leader which in the multifunctional team has to have formal authority meaning co-opting authority from the functional heads. Finally, the multifunctional team has a fluid structure meaning that there is a possibility that members can join or leave the team according to work requirements and demand. However, there should be a core responsible group which should be present in the project all the time until the product is launched. (Cooper 1994: 99.)

The absence of market orientation and knowledge about market needs is one of the most common problems in new product development projects. As it was explained before, missing information and inadequate market assessment can affect failure in a new product. According to Cooper, it is important to test market acceptance for the new product before it is released. (1994: 100) Researching the market can avoid the possibility of developing a product that does not fulfil the customer needs, preferences, wants, buying criteria, likes and dislikes. Competitors, their products, prices, costs, technologies, production capacities and marketing strategies should be taken into consideration. By using prototypes and models the team can test the product with the customers and see their reaction on it already during the development process. The performance of the final product should be tested by the user, which allows to confirm intent to purchase and market acceptance. At the end of the project it may be good to have a trial sell in a limited geographic area, which tests all the elements of the marketing mix. Finally, a market launch should be based on a solid plan of marketing and ensured with sufficient amount of recourses. (Cooper 1994: 100.)

The final goal of the stage-gate system is to have better focus on the first phases of the project. The first gates are deciding the definition of a new product, therefore most of the investments and time should be spent on initial screening, preliminary assessments, detailed market studies, financial analysis, product definition and decision on a business case. According to Cooper the ideal new product stage-gate plan ensures that the early stages are carried out before the project is actually allowed to proceed. (Cooper 1994: 101) Therefore, these mandatory activities help the team evaluate the new product idea, amount of recourses and budget needed for the project in order to prevent future problems that can cause huge losses of money and time.

2.3.2. The structure of the stage-gate game plan and gate description

Coopers stage-gate game plan is an operational and a conceptual model which is used for moving a new product project from idea to launch and improving effectiveness and efficiency. The idea of the stage-gate plan is that the innovation process is broken into a predetermined set of stages and each stage consists of a set of prescribed, multifunctional and parallel activities. A gate is the entrance to each stage and the gates control the process, its quality by Go/Kill points. The stage-gate game plan is mostly based on different experiences, suggestions and observations of a large amount of managers and companies. (Cooper 1994: 97.)



Picture 2. Cooper's stage-gate system plan. (Cooper 1994: 108)

The stage-gate system breaks the product development process into discrete and identifiable stages. Each stage gives the information about which activities should be done in order to move the project further to the next stage. (Cooper 1994: 109) The flow of the stage-gate process is shown in Picture 2.

The key stages are preliminary investigation, detailed investigation, development, testing and validation, full production and a market launch. The preliminary investigation includes quick investigation and scoping of the project. The detailed investigation leads to a project definition and includes justification and a project plan. The actual design and development of the new product are included in the stage called development. The testing and validation stage focuses on different tests and trials in the marketplace, lab and plant in order to verify and validate the proposed new product. In the final stage the product is brought to full production and launched into the market. There are also two stages that are not formally designed in the scheme. One of these is idea generation which is a quite critical activity occurring prior to beginning the new product development process. The other stage is strategy formulation which is left out of the plan model due to its "macro" nature. (Cooper 1994: 109.)

Ideation is the first step determined in the stage-gate system. This step includes basic research, seed of unfunded projects and different customer-based and creativity techniques. Gate 1 is called initial screening when the project is actually born after the decision of committing the resources to the project is made. At this point in main focus are strategic alignments, project feasibility, opportunity, market attractiveness and correlation with the policies of the company. After passing Gate 1, Stage 1 follows, which has a goal of determining the technical and marketplace merits of the project by

doing the preliminary market and technical assessments. Technical assessment includes evaluation of manufacturing routes, technical and manufacturing feasibility, possible times and costs to execute, possible technical, legal and regulatory risks and roadblocks. (Cooper 1994: 110–111.)

Gate 2 is mostly repeating the Gate 1 and the goal is to focus on sales force and customer reaction to the proposed new product, potential legal, technical and regulatory variables that can affect the termination of the project. Additionally at this gate the financial return is assessed by a quick and simple financial calculation such as a pay-back period. After Gate 2, Stage 2 follows, which includes the detailed investigation and construction of the business case. This stage defines the product and verifies the attractiveness of the project prior to large amounts of spending. According to Cooper this stage is also the critical homework stage which means that it should often be weakly handled. The main goal of the stage is to define or protocol the winning new product including target market definition, the delineation of the product concept, the specification of a product positioning strategy and the product benefits to be delivered, defining product features, attributes, requirements and specifications. At Stage 2, by researching the market, the customer needs, wants and preferences can be determined in order to help to define the new successful product. Another part of this stage is competitive analysis where the proposed product is presented to potential customers in order to analyse their reaction and acceptance. Technical and financial appraisals are the last tasks of this stage and they result in a project justification and a detailed project plan. (Cooper 1994: 112–114.)

Gate 3 is the final gate prior to the development stage; this is also the last point where the project can be terminated before entering heavy spending. At this gate it is important to review all the activities in Stage 2 and check that all of them were undertaken, that the quality of execution is high and that all the results were positive. If the team makes the “Go” decision to go further with the project, it means that the product definition, development and marketing plans and preliminary operations are reviewed and were approved. (Cooper 1994: 114.)

The actual process of new product development begins at Stage 3 where the emphasis is on technical work but marketing and manufacturing activities proceed in parallel. As technical development continues the team should also concentrate on the market and customer feedback analysis. At this stage, the goal is to create detailed test plans, market launch plans and production and operations plans which can include production

facilities requirements. Finally, financial analysis has to be prepared as regulatory, legal and patent issues are resolved at the end of the Stage 3. (Cooper 1994: 115.)

A post-development review takes place after all the activities at Stage 3 are approved. Gate 4, which follows this stage, focuses on checking the process and ensures that the work has been completed with the high quality and that the developed product fully corresponds with the original definition specified at Gate 3. After Gate 4 follows Stage 4 which tests and validates the entire viability of the product development project. These tests include the evaluation of the product itself, the production processes, customer acceptance and reactions, and the economics of the project. Cooper suggests four types of activities to take place at this stage where the first of them are in-house product tests. This activity includes lab tests, the results of which can be used to check the quality of the new product and its performance. The second activity is user or field trials which verify that the new product functions under actual use conditions. After that follows trial, limited, or pilot production which are useful for testing and ascertaining the production process and determining its costs and throughputs. A market test or trial sell is an activity that can help measure the effectiveness of the launch plan and evaluate market revenues and the share. Finally according to Cooper it is important to make a revised financial analysis based on new revenue and cost data in order to check the continued economic viability of the product development project. (Cooper 1994: 115–116.)

The final two steps of the stage-gate game plan are Gate 5 and Stage 5. Cooper calls Gate 5 “the door to dull commercialization” as a market launch and full production of the new product can be started at this point. (Cooper 1994: 117) This gate focuses on the quality of the activities that have been done at Stage 4. In order to pass this gate the project work should be concentrated on launching appropriately and getting the expected financial return. Stage 5 in turn involves implementation of a marketing launch plan and a production plan. According to Cooper, in order to achieve new product success there should be a well thought out plan of action with sufficient recourses. It is also important to prevent and avoid events that can negatively affect the progress of the project. (Cooper 1994: 117.)

Companies can gain huge benefits by using Cooper’s stage-gate plan. The company gets discipline to the product development process, which is important for innovation and development work requiring much time and investments. By using the stage-gate model the company gets a visible and relatively simple process which is easy to understand

and follow. Cooper refers to one manager's observation concerning this model: "At least we're all reading from the same page of the same book". (1994: 120) This argument reflects the idea of the stage-gate model as it is both easy for the company and for the product development team to work on the new product and achieve success in the market. The team gets clear requirements and tasks that should be accomplished in order to move further in the project. Cooper also argues that the model provides the project plan that facilitates the project and gives better definitions of the objectives and the tasks of the leader as the requirements to pass the stages and gates become the objectives for both the team and the leader. (1994: 120.)

2.4. An example of user-centred product development

ABB Motors forms a major part of the global discrete automation business division. ABB offers a wide range of electrical, industrial motors for different purposes. The product range includes low/medium/high -voltage AC-motors, DC-motors, motors for hazardous environments, synchronous motors, servomotors and traction motors. In addition to motors, a wide range of different types of generators are offered. ABB Motors strives to be the preferred partner and technology leader in motors and generator business. Growing pressure is put on total lifecycle management and the knowledge of customer processes and needs.

Production and design work is centralised in the Vaasa and Helsinki branches. In Vaasa, the Motors R&D and production work concentrate on low voltage (<1000V) AC motors and generators, and motors for hazardous environments (i.e. Ex-motors). Most of the low voltage motor design and manufacturing work is based in Strömberg Park, Vaasa, thus making ABB Motors a major employer in the Vaasa region. ABB Motors, very much like the whole ABB Group, normally conducts business through a preferred (authorised) partner and reseller network. Usually, motors are directly sold to only large OEM-buyers.

2.4.1. User-centred product development in ABB Motors

It was argued by Cagan and Vogel there are three main requirements for success in product development: the investigation of all product possibilities, understanding the needs of the customers and the combination of technical design and marketing. (2003:

39–40) The R&D manager of Motors strongly agrees with this theoretical expression and adds that there is no use of developing a new product when it is known that there are no customers interested in it. When it comes to new technology it is really important to believe in that if a new product is developed, there will be a customer who is interested in this innovation, argues the R&D manager.

There is a practical example for the theoretical statements made by Cagan and Vogel – special motors with high speed. It is possible that Motors develops a new high speed motor and only after that starts searching for the customers. However, in this risky situation the product developers should be really sure that the new motor brings more technical benefit to the customer compared to the older models. One such benefit can be the simplification of the customer's work in case the customer is a producer itself and by buying a new motor the customer can reduce its own costs and improve internal processes. This way by taking such a risk Motors is focusing on protecting and increasing its benefit and the customer needs.

The theory states that even if the customer needs are known it is not easy to start a product development project. In order to achieve the highest benefit and assure success, it is necessary to handle and analyse the customer information and only after that the appropriate decisions can be made. However, the biggest problem is how to find this useful data. The R&D manager agrees with this statement as it is not always the case that the customer is able to present its own needs and wishes. It is also a problem for the product development if the customer wishes are presented in a simple way, which obliges the product development team to process the customer requirements and wishes in their own way. This kind of situation makes the product development quite challenging as the team should find out itself what the customer really needs. However, there is a practical solution for such kind of a problem – in order to get a picture of the way of thinking of the customer it is important to know the environment the customer is working in.

One of the most important factors to consider is the environment in which the motor is needed and where the final customer will use it. Through investigating and analysing the environment of the motor, the team is able to discover all the technical requirements and restrictions that should be taken into consideration in the product development processes. For this reason Motors does not use any tools for systematic analysis in order to handle the customer information. However, the eternal question the product development team always asks is: Is it technically possible to develop a new motor? It is

possible to answer this question by using a simulation tool which Motors widely uses before starting any product development project. This is a powerful tool for realistically checking the possibilities of developing a new product without huge financial losses. The customer can also take part in the analysis and investigation in order to agree on all the needed features and functions that the new product should comprise.

2.5. Process of product development in ABB Motors

Product development in ABB Motors plays a huge role in the success of the company as most of the motors sold are developed and produced based on the exclusive customer orders. The data about the processes of product development and its central problems and challenges was collected at ABB Motors by interviewing the R&D manager of innovations and new technologies at the business unit Motors and Generators in Vaasa. The questions presented concentrated on the process of product development in Motors, its main phases, challenges and problems. The aim of the interview was to find out how Motors' product development team is taking the customers' needs and demands into consideration and which the main issues in user-centred product development are.

Everything in product development starts from the product idea. At Motors the product development process can not only be started by customer initiative but the company itself can find the areas that can be developed and investigated in order to achieve more economical benefits. However, in most cases the customers contact Motors and explain their needs and requirements for the new motor. Atlas Copco is one of the customers of Motors and this company brings new series of compressors approximately every 5–10 years. This means that every time the customer needs a more advanced, technically improved and further developed model of the motor that can be further used in their new models of the compressors. Therefore, Motors has the task to develop and evaluate new characteristics and functions that the new motor should have in order to satisfy the new requirements and needs of the customer. After such a motor is developed and sent to the customer, Atlas Copco makes a prototype of the compressor and tests it. Later Motors product development team gets feedback and further develops the motor in case there is something that does not work as planned.

In order to keep the leadership in the market and create larger variations of the products for the customers the company can decide to develop a new product itself. The company

may also further develop harmony in the structures which makes it possible to produce different variants that can be attached to the motors. Another reason for the company's own initiative is a need to simplify the process of manufacturing through solving the most critical problems and challenges in the manufacturing processes. This is the most powerful way to keep both the quality and the costs under control, since by keeping the manufacturing processes as simple as possible allows the company to reduce costs and production time.

The R&D manager strongly emphasises the problem of a constantly changing environment and a market that obtains more and more competitors and new technical solutions. Through taking the own initiative of developing a new product Motors helps itself adapt to this changing world and makes the company resistant to the sudden fluctuations in prices, new competitors and technical solutions. Some of the most commonly appearing challenges are changing standards and the need for increased efficiency. Due to these changes, Motors have to increase the efficiency of the motors produced according to the new restrictions and requirements in order to fulfil new standards.

2.5.1. Problems and challenges of product development in ABB Motors

According to the theory, the most common challenges of the product development are to identify the needs of the customers and to respond to them quickly and profitably. The problem of a changing environment and technology is also one of the most critical questions for the product development as all the new projects should fit into the changing world and market. The R&D manager adds some practical problems to the theoretical list. In his opinion a central product development problem arises when the product development team decides to develop a new motor based on its own ideas and views. It is simple to start a new product development project with enough customer information. The only problem in this case can be the price of the new product as the process of developing and manufacturing can be too expensive. In this case, the product development team can decide not to start the development of an overly expensive product.

At Motors' product development it is challenging to simplify internal processes such as manufacturing processes. The main challenge is to find out how to make the manufacturing easier in case the motor is technically more complicated and includes many new features and functions. Evaluation of the price of the raw materials is one of

the central tasks of the product development team. It is also important to evaluate and calculate the benefits of producing the improved product which might be much more expensive than the older model. When it is decided that a new motor is to be developed, Motors' product development should apply the new model to the same product line in order to prevent contradictions between the motors used for the same purpose.

Another challenge for the product development is the situation when the customer suddenly decides to make some changes to the order of the new product. It is also possible that the customer informs the team about the changes at the point when the product is already on its way to be released. The R&D manager gives an example of such a situation when the customer decides to change some parts of the new motor, for example the customer needs the material of the cover to be changed from metal to plastic. However, in order to prevent such surprises from the customer side it is important to have a clear agreement, possibly in a written form, signed by the participants before starting the new project. The R&D manager adds that it is also possible that the customer can simply forget what kind of product was ordered. Such written agreements ensure that the customer will not demand some other product or other features after the new product is released.

Of course the product development team is not only working with the customer and trying to apply his needs in reality, there are also lots of other challenges such as cost minimisation. The product development team should be able to analyse the customer needs and be critical if the customer orders something that is too complicated to develop and produce. Therefore, it is a great challenge for product development to find this border between the realistic, technically possible to manage and produce, and unrealistic, complicated and technically impossible to solve problems. This way product development demands much analysis and investigation, simulation work and calculations in order to satisfy the customer needs in a proper way.

The R&D manager argues that in the motor industry there is no situation in which the new motor cannot be replaced with the old one having similar features. However, it is important for the product developers to inform the users and the customers if the old product will not be produced any more and that it is possible to order the similar new model. One of the biggest challenges is, though, to develop a product which is at least as good and efficient as the old one in order to keep the customer interest and provide the market with new superior technological solutions. As mentioned before, the price of a new product plays an influential role affecting the customer satisfaction and the

benefit of the product development project. Some customers have strict budgets and costs when ordering a new product. Therefore the process of product development should be constructed in such a way that this fixed budget is not exceeded. The strategic and most essential goals are to develop a product that is cheaper and better in all ways compared to the old one. If this goal is achieved at the end of the project, it is a clear success.

2.5.2. A changing environment affects the needs of the customer

Motors' R&D manager argues that there are two different types of customers. The difference is based on their field of functioning and their main tasks in the market. According to the manager the first type of customers are simply selling the products, in this case motors, in a package with their own final product. Such customers do not usually demand much as they do not really pay that much attention to the efficiency of the motor compared with the customers who are the end users. This second type of customer values the quality and reliability of the product that they get from the middle hand. For example, if there is a company that uses motors in its manufacturing processes it is important that the motors are working with the highest possible efficiency in order to prevent production losses in case the production stops due to technical problems caused by bad quality of the motors.

Customer requirements, needs and demands do not generally change with time, but there is a tendency of new requirements to be stated by the customer. As the technology advances and the market provides new solutions, the customers may add more and more new features and functions to already existing versions of their products. Usually, the customers do not replace one of the requirements with another one, but add more wishes to an already existing list. This factor of growth in the user needs is making the product development complicated as during the project it is important to be able to combine old and new requirements in order to satisfy the customer and to show competence.

2.6. The ABB Gate Model in general

ABB is a company which is famous for its high-technology and fast development processes. ABB Motors drives continually to improve the products as well as their performance in order to serve the customers in a better way. In order to achieve better results in different projects and higher performance ABB has started using a focused

and formal approach to prioritising and managing projects. Therefore ABB has developed a process structure based on a gate approach which enables ensuring that projects are driven by business objectives and are executed with full management accountability. This approach is called the ABB Gate Model. (ABB 2001: 4.)

There are many different advantages that the company is getting by using this model as it helps to structure investments into different phases which minimises the risk. The Gate Model also provides clearly defined management checkpoints, which are called gates, where go or no-go decisions are made. According to the definition, a gate is a specifically defined point at which major decisions are made regarding the project. Following the gates and their requirements ensures the active involvement of management and that the project work is fully synchronised. In order to move further on to the next gate all necessary tasks should be completed. As a result from using this kind of model in the processes and projects the company gets much higher transparency and visibility of the projects within the whole organisation. Additionally, the company gets a guarantee that a solid business base and more projects will deliver the benefits as expected and promised. (ABB 2001: 4.)

There are three types of the ABB Gate Model, one of which is the ABB Gate Model for Product Development. This model can be applied to all the products and technology development projects developing standard products to be sold on the external market. (ABB 2001: 4) The decision model consists of eight gates where the first six gates are points of decision. These are used in order to decide whether the project should continue or not. The last two gates are mostly used in the end of the project in order to close it. (ABB 2003: 2.)

2.6.1. The Gate Model at ABB Motors

There is a huge amount of benefits ABB Motors is getting from using this model in the process of product development. Firstly, applying the model to the product development processes helps the product development team make sure that all the main tasks and actions are fulfilled and all the aspects are covered in order to get products for release. Secondly, it is much easier for the company to have control over development projects using gate numbers. The gate number defines the phase of the project from a business point of view. Thirdly, one of the purposes of using the ABB Gate Model in the product development projects is to give the organisation a clear basis for portfolio management.

In this portfolio management projects are prioritised by their business and strategic importance. (ABB 2003: 2.)

In product a development process, there are four main roles involved in the use of the ABB Gate Model: the gate owner, the gate assessor, the gate meeting participants and the project manager. The main task of the gate owner is to control the project from a business point of view including starting, stopping and changing the goals and scope of the project. The gate assessor is the person ensuring that the information needed for gate decisions is made available and thoroughly evaluated. The gate assessor can also act as an "extension" of the gate owner. In case the project is small, the gate owner can take this role himself. The gate meeting participants are assisting the gate owner in evaluating the project at the gate meetings. Usually, these participants vary depending on the different gates and issues of discuss. Typically, the gate meeting participants can include product management, technology management and development and quality managers. Finally, the project manager is assigned for each project and has the overall responsibility for the projects. (ABB 2003: 3.)

At ABB Motors product development projects mostly aim on developing one or more standardised products that are intended to be sold to a market outside or inside ABB. However, if the company is focusing on technology development, the project is aiming on the evaluation or development of a new technology which will not be sold separately. The final result can for example be included in the products that can later be launched into the market or sold to a specific customer. (ABB 2003: 4.)

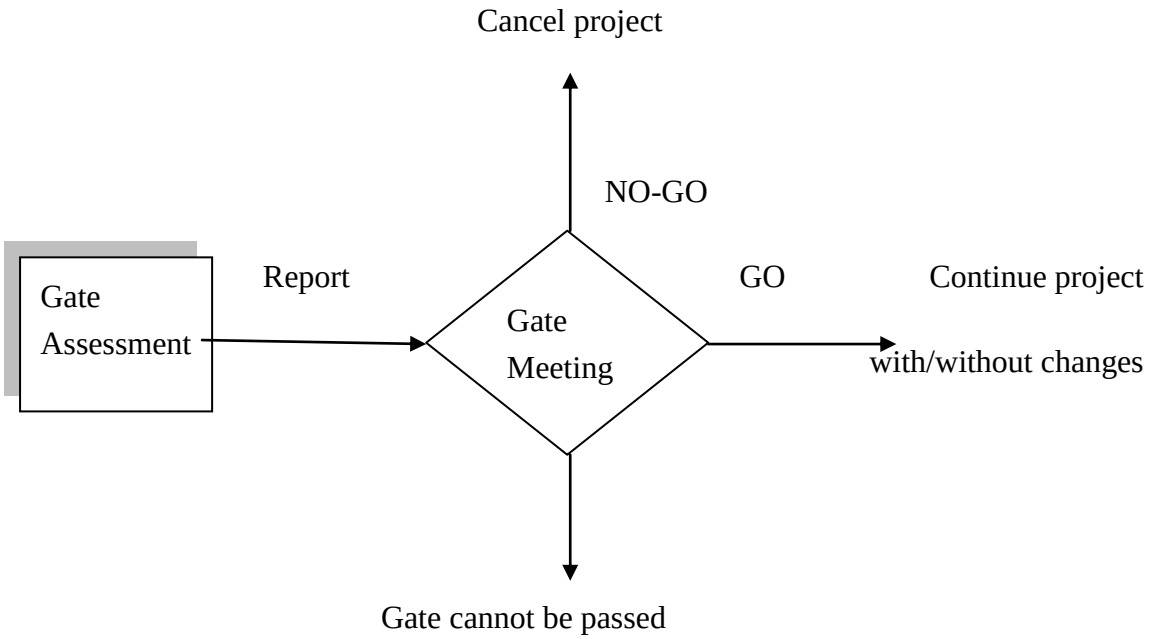
2.6.2. The structure of the model

As it has already been explained in previous parts, a gate is a decision part in a product development project where the gate owner evaluates the whole project and the results achieved from a business point of view. When moving further in the project, from one gate to another, the gate owner has to analyse the situation and determine whether the project should be continued or not. However, the decision of the gate owner about the continuation of the project may include some alterations and changes to the project such as changes in plan or scope. (ABB 2003: 4.)

The R&D manager of Motors' product development argues that before taking the ABB Gate Model into use in the product development project there should be much work done in order to apply the information and the goals of the project into the model. First,

the product development team handles the idea of the project and possible tasks, checks the resources and collects data necessary for further studies in order to find out the main goals of the project. If there are enough resources and the team has clear goals to achieve it is a sign of that the ABB Gate Model can be used.

Each gate in the model consists of two parts – gate assessment and gate meeting as shown in the Picture 3. below. (ABB 2003: 5.)



Picture 3. Gate model – Process description (ABB 2003: 5)

The purpose of the gate assessment is to prepare the project for a well-informed decision which is based on facts. This decision should be made on the gate meeting where the product development team discusses the gate assessment report. The assessment report is the responsibility of the gate assessors, but the gate owner and the project manager have the power to decide if the project is ready for the gate. Information and data needed for the assessment is different documents prepared by the project, interviews with relevant stakeholders and the gate assessment checklists. The focus during the process of assessment is on the status of the project, completeness and quality of the deliverables, probability to succeed in meeting the business requirements, possible risk situations and commitments of the organisation to continue to invest in the project. Due to the fact that assessment includes both work with documents and

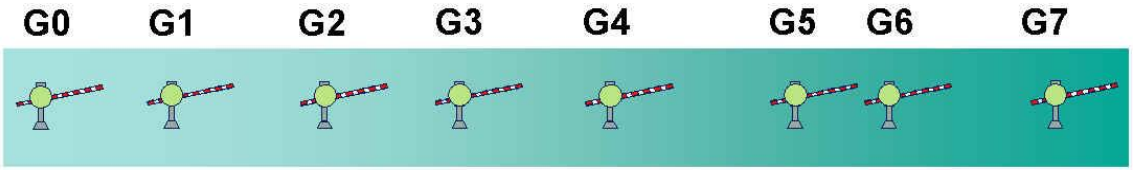
interviews, it is important that this part of the process is allocated enough time. (ABB 2003: 6.)

At the gate meeting it is to be decided whether the project passes the gate or not. The meeting normally includes the presentation of the projects and the gate assessment report, discussion regarding the project and the assessment and finally making of the decision. The decision about passing the gate should be mostly based on three main aspects: the completeness of information, the business situation and the project status. When passing the gate it is important to check if there is enough information available for the project, if the project is in line with the business strategy of the organisation and if the project has been able to deliver as required. As it is shown in the Picture 3, there are three alternatives for the decision – Go, No-Go and Gate cannot be passed. Go-decision is a straight permission to continue the project with the ambition to release the product. The No-decision means termination of the project and starting of the ending evaluation process. In case the gate cannot be passed there is some missing information or no results have been achieved that could allow letting the project pass the gate. (ABB 2003: 6–7.)

The ABB Gate Model is well defined and includes specific steps. It is important to take into consideration that the model is only a description of what is supposed to happen at the gates. The model does not force and stipulate how the project work should be done in the phases between the gates as it is totally up to the company to decide which way the deliverables and information at the gate should be developed. (ABB 2003: 7) The progress of the product development process varies due to different customer requirements and a varying amount of available information. In order to have the requested information ready at a certain gate it may be necessary to start the needed activities already before the gate.

2.6.3. Description of the gates

The descriptions of the gates included in the Gate Model apply mostly for product development projects and it is possible that some of the considerations are not applicable to other project types. In Picture 3 the gates and their main tasks are presented. There are eight gates starting from Gate 0 and ending with Gate 7. Passing one gate allows the project to move further to the next phase and to make new decisions concerning the project. (ABB 2003: 7.)



G0 Start project → G1 Start planning → G2 Start execution →

G3 Confirm execution → G4 Start introduction → G5 Release product →

G6 Close project → G7 Retrospective investigation of project

Picture 4. The ABB Gate Model structure (ABB 2003: 7)

Gate 0 is the start of the project and at this point the feasibility evaluation is initiated. Projects are normally started as a result of a product planning process where product management and development are actively involved. The process of product planning includes pre-studies, assessment and analysis, the result of these actions leads to the recommendation to start a specific project and provide some input to the G0 meeting. Depending on the nature of the situation and case there is a possibility to place pre-studies before G0 or between G0 and G2. The G0 meeting provides visibility for the company at the start of the product development projects and ensures that all known aspects and issues are considered. The aim of this meeting is to make the decision about the project execution, possibly change the scope or terminate the project. (ABB 2003: 7–8.)

Gate 1 initiates the planning of the project and its main goal is to obtain agreement on project scope. At this point, requirement specifications are collected and prepared in order to allocate them to the project and represent a clear and detailed definition of what has to be implemented by the project. Simultaneously, the information required for moving further in the project is telling what time to market and product cost is needed to meet the market requirements. At the G1 meeting the participants have the aim to achieve an agreement about the requirements that should give the highest value in relation to development effort within the given time frame. As a result of this gate there should be a decision about starting the planning or terminating of the project. (ABB 2003: 8.)

The goal of Gate 2 is to achieve an agreement on the project plan and the feasibility of the implementation of the requirements using the selected technology. The result of the

G2 meeting is supposed to be a decision about continuing or not continuing working with the project. The goal is also to execute the product development project according to the requirement specification, a selected product concept, the project description and plan. In case the decision is to continue the project, the product development team sets target dates for the remaining gates. (ABB 2003: 8.)

At Gate 3 the confirmation of the project, its goals and plans take place. The team confirms that the target dates can be met and that the project is progressing according to the project plans. At this point of the project, the design of the new product is under way: the architecture is mostly decided; interfaces between the parts of the system are specified. However, it is not necessary that all the detailed design work is completed as it shall be possible to make changes in the appropriate design and implementation rules described for a particular product family. (ABB 2003: 8–9.)

Starting the introduction is a part of Gate 4 where the goal is to ensure that the targeted functionality and release date are confirmed and that the product introduction activities can be started in full scale. The focus at this point is on preparation for the market introduction and production. Later at Gate 5 the project is moved to the phase when the product is ready to be released. This gate also indicates that all the project activities should be finished. However, the remaining issues should be resolved and the whole process should be analysed in order to find out the future improvements in new projects. Even if the product is ready for release it is still possible to terminate the project and cancel the release if there are reasons to do that. (ABB 2003: 9.)

At Gate 6 the project can be closed and the goals at this point are to confirm that the responsible line organisations have received all expected deliverables such as relevant documents. Finally, after the project is closed the product development team can investigate the project and check if the results are meeting the goals set at Gate 2 and Gate 5. At Gate 7 in order to start the investigation and capture experiences from the project it is important to get all the needed feedback from the customer, sales, manufacturing and service. The results from this investigation can be used by the line organisation for further improvement of the development processes. (ABB 2003: 10.)

Each gate has its own role in the progression of the project, however there are some specific gates that play key roles in the success of the product development and affect the decisions and the work flow in the project. According to the experience of the R&D manager, gates 2 and 5 have the most influence on the decisions concerning the project.

One of the most important decisions about the product development is the decision about the starting of the project as it demands the most time, information and analysis. However, planning at Gate 1 has as much influence on the success as the decision of starting the project. Gate 1 and Gate 5 are critical from a business perspective as they include the planning of the investments and costs as the aim of the project is to develop a new product at minimum cost.

2.7. The ABB Gate model vs. Cooper's stage-gate system

It is easy to notice that the idea of the ABB gate model has its base from Cooper's stage-gate system where the main course of the product development project is directed by specific gates and stages. However, ABB Motors has applied the stage-gate model to its own way of proceeding and its model is more integrated with technical processes. According to O'Connor, the implementation of the stage-gate process is a significant challenge which changes the structure of the organisation and transfers the key personnel of the company. (1994: 183) Cooper's model presents a broader model of the product development project and focuses mostly on the financial benefits and market investigation results. ABB Motors has used the base of the stage-gate system with the gates but Motors has submitted the stages that are in Cooper's version Go/Kill points of the project. Instead of talking about the stages, Motors uses the gates as the phases of the project.

The idea of passing the gates is similar to Cooper's model – there are still many different requirements for quality, analysis and investigation results that should be approved to move further to the next gate. At ABB Motors, the gate model is more fixed and closely related to the technical work that should be made during the project. The ABB gate model contains clear steps and tasks for the team that should be accomplished due to the target date. In Cooper's model, focus is not on achieving the results in a good time and with the lowest possible costs but on the ensuring of the success of the new product in the market. Almost each gate and stage includes some market research and customer trials in order to ensure that the direction of development is right. However, this investigation and research can take much time and require much spending and investments. Therefore, Motors has applied its own version of the model where investigation and research have the highest priority at the beginning of the project. This way before deciding to start the project all the needed data is investigated

and the results are analysed, which ensures the financial benefits and technical possibilities of the new product.

3. OPEN INNOVATION

Nowadays it is easy to observe constantly increasing competition in the market and complexity of technologies that include a huge amount of uncertainties. Due to this fact, companies experience many problems in their product development processes as it is a big challenge to utilize all the knowledge outside the boundaries of the companies. Huurinainen and Torkkeli have shown in their research that the innovative companies with high customer sensitivity can simply be late with own innovations or even ignore the possibility to create new products. (Huurinainen & Torkkeli, 2006: 1.)

In order to succeed in product development and achieve high profits from innovation, it can be useful to apply a more open way of thinking in the development processes compared to the gate model. The main question that can be interesting for the companies to investigate is: Does openness affect the ability to innovate and achieve benefits from innovation? Open innovation gives another perspective on looking at the user-centred product development. The process of innovation becomes open to everyone including the customers of the companies and that can gives guarantee that the users of the innovation will finally get what they really want.It is clear that a single company cannot innovate in isolation. In order to acquire ideas and resources from the external environment and follow the competition, the company has to co-operate with different types of partners. This fact has raised a question about the role of openness in innovation which emphasizes the permeability of the boundaries of the companies regarding inflows and outflows of ideas, resources and individuals. According to Dahlander and Gann (2010: 699), openness can result in resources that are available for others to use. At the same time it is difficult for the company to protect its intellectual property and appropriate benefits from innovation. (Dahlander & Gann, 2010: 699.)

The traditional vertical integration model includes many different research and development activities which aim to internally develop new products that can later be distributed by the company. Open innovation is the opposite to this model where both inflow and outflow of knowledge are used to accelerate internal innovation and expand the markets. In contrast to other models, the paradigm of open innovation emphasizes the importance of using both external and internal ideas and paths to market. (Chesbrough, Vanhaverbeke & West, 2006: 1.)

3.1. Defining open innovation

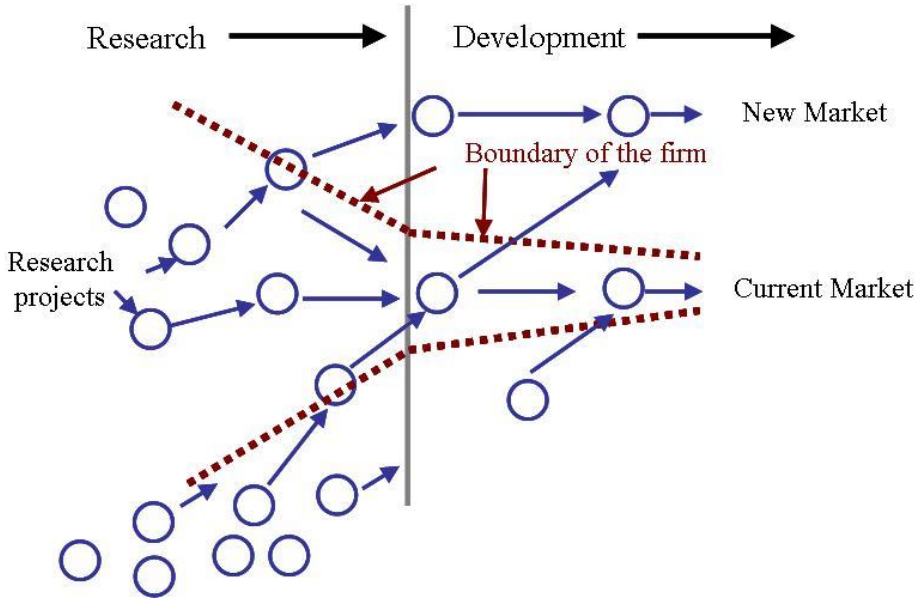
Chesbrough defines open innovation as "a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as firms look to advance their technology". (Chesbrough, 2003: XXIV) This model is the opposite to the model of closed innovation where the companies concentrate on their own research and ideas, do own development to transform these ideas into new products, produce, market, distribute, service and finance the new products. (Chesbrough, 2003: XX) The model of open innovation was developed as the response to the weaknesses of the effectiveness of the closed model. The main idea was to create a model which could make it possible to increase availability and mobility of workers with valuable knowledge, develop the venture capital market concentrating on creating new companies and increase the amount of capable external suppliers. (Christensen, Olesen & Kjær, 2005: 1533.)

According to Dahlander and Gann (2010: 699), there are four reasons for the concept of open innovation to be commonly accepted. First, the concept of open innovation reflects both economic and social changes in working patterns, where skilled employees prefer portfolio careers instead of having a single employer. Simultaneously, the companies have to find new ways to get talented workers to their organisation. Secondly, expanded extent of the market due to globalisation enabled division of labour. Third reason includes the fact that nowadays it is easy for the companies to trade ideas due to market institutions. Finally, the existence of new technologies allows companies to collaborate and coordinate efficiently regardless of geographical distances. (Dahlander & Gann, 2010: 699.)

There is a combination of internal and external ideas in the process of open innovation, which helps the company to define the requirements for systems through utilizing business models. In order to create value, both external and internal ideas are utilized by the business model. In open innovation it is possible to take the internal ideas to the market through different external channels and outside the current business of the company, which makes it possible to generate additional value. In open innovation the process of research and development is treated as an open system, as opposed to other development models. Open innovation suggests that the companies can get valuable ideas both from inside and outside the company. It is also possible that the ideas go to the market inside or outside the company. This approach emphasizes the idea that

external ideas and paths to market are as important as internal, which makes the process of product development more open. (Chesbrough, Vanhaverbeke & West, 2006: 1.)

As shown in picture 5, there is a possibility for ideas to originate not only from inside the research process of the company, but also from the outside. Some of the internally developed ideas may escape from the company in the research or development stage. The reason for this leakage is in a start-up company staffed with only partly own personnel. Licensing and departing employees can also affect the leakage of ideas from the company. Some ideas can even start outside the company and move inside. Picture 5 clearly shows the huge range of potential ideas outside a company that has boundaries allowing inflow and outflow of the ideas. (Chesbrough, 2006: XXIV.)



Picture 5. The open innovation paradigm for managing industrial R&D (Chesbrough, 2006: XXV)

Open innovation process is able both to weed out false positives from external and internal sources and enable false negatives that can be for example projects that from the early beginning are being worthless and promise no results in case of continuing developing these projects forward. (Chesbrough, 2006: XXV) Chesbrough (2006: XXV) claims that such projects might find their place and value in a new market instead of trying to find own way to the current market. False positive error takes place in the

statistical analysis when the test result shows that there is a difference between a treatment and a control group in case when there is no real difference existing. False negative or Type II error takes place when the test result shows that there is no differences between a treatment group and a control group in case when there is a difference existing between them. (Chesbrough, 2006: XXV.)

3.2. Implementation of open innovation

When the company decides to implement open innovation, one of the questions that will be asked is how can the company access external knowledge. According to Chesbrough (2006: 50), the simplest way for the company is to employ university professors to work alongside with the company personnel. Some companies prefer cheaper ideas and hire graduate students of known professors and this way get the valuable knowledge. If the company is willing to move further, it is possible to fund some external research, however there is no guarantee that the company will own the results at the end. There is an advantage that the company will still have access to the results even at early stage of the research. This gives the company a possibility to start applying these results in its industry. (Chesbrough, 2006: 50.)

Although open innovation emphasises the importance of external technologies for innovation, internal research and development have still a critical role as the company have to organise the architecture and many parts of the new system. Chesbrough (2006: 58–59) claims that when implementing open innovation, the company have to make changes in the hierarchy of the connections between disparate functions within the system. Developing understanding of the relationships between different parts of the system and the system as a whole is playing a critical role in the innovation process of the company. (Chesbrough, 2006: 58–59.)

3.2.1. Reasons for implementing open innovation

According to Chesbrough, the end of the knowledge monopolies has already come and nowadays knowledge is much more widely distributed compared to the situation thirty years earlier. Great diffusion of knowledge gives a start to changes of the viability and desirability of a closed innovation approach to searching and taking new ideas to market. (Chesbrough, 2006: 45) Earlier external knowledge had useful but supplemental role in innovation. Traditional structure of product development was organised in such

was that the company was the locus of innovation and the central objects of the studies were external activities of the company. In open innovation external and internal knowledge and activities are considered and handled as equally important to the whole innovation process. This give the companies a huge opportunity to make the process of innovation more efficient as there is unlimited information available that the companies can study and use. (Chesbrough, Vanhaverbeke & West, 2006: 8) This is the first and the most important reason for the company to implement open innovation paradigm into its product development processes.

Secondly, the weakness of closed innovation paradigm is the fact that in organising for innovation the company pays very little or no attention to the business model. The most attention is given to searching and keeping the best talents with valuable knowledge. Through that the companies try to get secure that these talents will create innovation that will be able to enter the market. Open innovation provides another perspective of looking at the business model where the companies seek talents from both inside and outside the company in order to get fuel for the business model. This way of thinking gives the companies the opportunity to go to the market through different channels as the output from innovation within the company is not restricted to the current business model. (Chesbrough, Vanhaverbeke & West, 2006: 8.)

The third reason for implementation is that implementation of open innovation provides the companies valuable evaluation that is done in the context of its business model. All other innovation theories and paradigms assumed that there cannot be any measurement errors in the evaluation of R&D projects such as false positive and false negative evaluation errors. In case when the company decided to cancel R&D project, usually there were no suspicions about any systematic errors in the assessment that could lead to the termination of the project. The companies lack their processes for managing false negative R&D projects but simultaneously innovation processes are managed so that it is possible to reduce the possibility of getting false positive evaluation error. (Chesbrough, Vanhaverbeke & West, 2006: 8.)

Fourthly, the companies using open innovation have the business model that strongly focuses on the evaluation of R&D projects. In open innovation business model is organised in such way that it selects the projects that actually fit with the business model, and filters the projects that do not fit. In order to identify new potential markets and business models, the companies are minimising the incidence of false positive

errors and manage false negative errors through incorporating additional processes. (Chesbrough, Vanhaverbeke & West, 2006: 9.)

The fifth approach provides the fact that open innovation paradigm allows the companies to enable outward flows of technologies, that gives the companies the opportunity to technologies that cannot find their enter to the market internally seek a path externally. In this situation, all the internal business of the company have to compete with the external channels to market for new technologies. However, these channels are able to provide the company important evidence of market opportunities that the company can take advantage of. (Chesbrough, Vanhaverbeke & West, 2006: 9.)

The sixth reason for implementing open innovation is the new and proactive role that open innovation gives to intellectual property management. In open innovation intellectual property becomes very critical part of innovation process as there are both in- and outflows of IP which gets regular in the company. This fact makes it easier for the companies to use and exchange valuable knowledge within the market. In order to share own IP or find some other IP the companies can also start giving it through publications or donations. (Chesbrough, Vanhaverbeke & West, 2006: 10.)

The seventh factor saying for open innovation is the rise of intermediaries in innovation markets. Open innovation affects intermediaries in such way that they start playing a direct role in innovation itself. It becomes easier for the specialists firms to provide the market valuable information, access to it and also financing. Finally, the last reason for open innovation implementation is the birth of new metrics for evaluating the progress and performance of the innovation processes of the company. The most important area that should be evaluated is the level of conduction of R&D within the supply chain. The company can also assess the percentage of external innovation activities and compare this percentage to the industry the company is operating in. The important factors in open innovation are also the time it can take for new ideas to get to the market from the company's research stage, the rate of patent utilisation owned by the company and investments outside the company. (Chesbrough, Vanhaverbeke & West, 2006: 10.)

3.2.2. Open innovation implementation in large companies

When adopting open innovation, companies are able to start using both internal and external resources in order to drive their innovation processes, which also enhances the

innovation capabilities of the companies. Regardless on high interest towards open innovation, there are many questions that need to be answered. Mortara and Minshall (2011: 586) have done a research which focused on how companies implement open innovation. The investigation covered the analysis of how companies switched from closed to open innovation, classified the adoption path and coordinated the process of implementation of open innovation. Mortara and Minshall reviewed 43 large companies from different sectors and found that companies chose different paths and ways of adopting open innovation according to their innovation requirements, the timing of the implementation and their organisational structure. (Mortara & Minshall, 2011: 586.)

Mortara and Minshall (2011: 586) indentified issues that can affect the choice of the adoption path of open innovation. First, according to the researchers, there are two key factors that help driving implementation process of open innovation. Companies which have less turbulent environment mostly focus on inbound open innovation activities, but companies acting in environment with the high level of uncertainty are forced to develop both inbound and outbound activities. Secondly, based on the results of the research it was obvious that Chesbrough's model of open innovation and its publicity has strongly affected the choice of way of adopting open innovation in companies. Mortara's and Minshall's results showed that companies which started switching from closed to open innovation and adopting it in innovation processes did not have enough coordination in their activities. However, after companies have got access to Chesbrough's open innovation literature, it became possible to institute open innovation implementation teams in order to support the change to open innovation. Third factor that affects the way of implementation of open innovation is the culture of the organisation. Both external and internal cultural changes and influences affect the adoption of open innovation. (Mortara & Minshall, 2011: 586.)

According to Mortara and Minshall (2011: 587), it is a fact that there is no specific type or size of companies that implement open innovation, however high tech industries were the first to adopt open innovation. Outsourcing of R&D is the first step towards open innovation, which reduces costs and risks of the company. Mortara and Minshall state that in order to make the innovation activities more open, substantial change is needed. There are three different stages in this change: unfreezing, moving and institutionalising. However, this change is not always continuous and smooth and usually is characterised by shocks. (Mortara & Minshall, 2011: 587.)

There are many different ways of positioning open innovation activities, defining and choosing specific functions that can be involved within an organisation. It is also possible for companies to adopt specific open innovation coordinating-implementing functions. Multinational companies have different mechanisms of coordination that may vary from formal and structural to informal and subtler. For example, there are organisations that prefer to coordinate the implementation of open innovation by using formal centralised organisational structure. Oppositely, other organisations can concentrate on distributed forms as it is organised in the process for centralised or decentralised R&D. Additionally, there are companies that have distributed their open innovation activities in such way, that all the functions are operating openness independently. (Mortara & Minshall, 2011: 588.)

The evidence of the research made by Mortara and Minshall (2011: 591) showed that there are four different approaches to the adoption of open innovation. However, during the process of implementation companies could change their approach regarding on their environment and targets in innovation. The first group is including companies that are open innovation conscious adopters. These companies have decided to adopt open innovation due to the popularity of Chesbrough's approach to the model. Conscious adopters see open innovation as an opportunity to accelerate innovation and its processes. By adopting open innovation companies try to promote growth in areas where revolutionary innovation is hard to achieve due to high competition or very demanding market. Therefore, conscious adopters are driven to switch to open innovation due to large costs and difficulties in approaching goals in innovation and achieving sustained growth. In implementation of open innovation conscious adopters focused mostly on inbound open innovation process and assigned the implementation process to a small group of managers who had similar approaches and helped their company to open the door to the external world. The employees of the companies have been provided necessary open innovation skills and training, therefore internal openness was strongly supported in these companies. (Mortara & Minshall, 2011: 591.)

The second open innovation implementation approach is ad-hoc adoption. Ad-hoc adopters managed to adopt open innovation only in specific functions or innovation processes of certain products. The companies have chosen these functions and processes as they can get much benefit from external environment which open innovation provides. Ad-hoc adopters use approach open innovation in particular circumstances and they do not necessarily plan to implement open innovation within the whole

organisation. Some of ad-hoc adopters implemented open innovation only for early stage research and the rest of the functions and the processes of the company stay closed. (Mortara & Minshall, 2011: 592.)

Compared to previous approaches to open innovation, the third approach is driven by evolution and evolutional development which was forced by competitive environment, high costs, alternating industry and high pressure for innovation. Companies that are included in this group are called open innovation precursors and all of them have spent much time on integrating external and internal resources for their innovation. Open innovation precursors were driven to adopt open innovation by changes in their external environment and innovation structure. Some companies also experienced huge crises or were dependent on third parties with their business model or value chain. By adopting open innovation companies finally could get access to external resources and break their dependence on changes in environment and industry. During the process of implementation, companies did not have any central coordination of open innovation activities. There was no central function in order to direct open innovation, however companies have distributed needed processes, roles and skills through the whole organisation. (Mortara & Minshall, 2011: 592.)

The last approach that was observed in Mortara's and Minshall's (2011: 592) research is open innovation communities of practice. Companies from this group were driven to implement open innovation by managers from R&D and procurement functions in order to achieve goals and meet difficult innovation targets. The focus during implementation process was mostly on inbound activities such as in-licensing, university and supplier collaborations. Open innovation initial thinking is led by R&D and procurement in partnership, and these two departments are working on getting top management aligned with different activities in order to start and push adoption of open innovation from the top of the company. (Mortara & Minshall, 2011: 592.)

The research of Mortara and Minshall (2011: 595) showed that there are three different factors that affect the path of implementation companies chose when adopting open innovation: innovation needs, the timing of the implementation and the organisational culture. Companies have different innovation needs and they are mostly looking for different types of changes - evolutionary or revolutionary. Due to this fact, companies may chose different ways of implementation of open innovation. The results of the research made by Mortara and Minshall showed that the timing of process of implementation varies depending on timing when companies decided to adopt open

innovation. Companies which implemented open innovation as a result of the publication of the model put centralised and coordinated effort on establishing open innovation. Companies that implemented open innovation later had mostly decentralised open innovation activities. The results also showed that the publication of the model encouraged companies to adopt open innovation within the whole organisation regardless on their real innovation needs. (Mortara & Minshall, 2011: 595.)

Organisational behaviour and cultural background of the companies have huge impact on companies choice of implementation strategy. The results of the research showed that companies with strong traditions of closed innovation were concentrated only on inbound activities during the implementation process of open innovation. Companies with more open culture and characteristics of extroverts implemented both inbound and outbound activities. When companies decide to make some changes in their organisation and processes, it always affects their culture. Companies that put weight on importance of innovation process change their organisational culture by implementing open innovation and becoming open to the world. According to Mortara and Minshall (2011: 595) the perception of open innovation is constantly changing due to varying conditions, global changes and financial development. Therefore, definitive conclusions about open innovation implementation and different paths will be possible to draw only in the future.

3.3. Open innovation and user-centred innovation

The concepts of open innovation and user-centred process development have become popular among industries focusing on technology and innovation management. However, the precise mechanisms which support open and user-centred innovation in different industrial contexts are still poorly specified. Additionally, there are no obvious circumstances under which both open and user-centred innovation might become dysfunctional. According to Hopkins, Tidd, Nightingale and Miller (2011: 44−45), patterns of innovation clearly differ fundamentally by strategy, company and sector of business. In order to generate successful open innovation it is important to examine the mechanisms and potential limitations of open and user-centred innovation.

Companies are mostly working within different networks that affect the flow and the sharing of information, and distribute power and control among participants. The

position of the company within the network reflects its power and influence. In these networks it is particularly important to focus on user−producer interactions. Hopkins, Tidd, Nightingale and Miller (2011: 45−46) state that users are normally characterised as consumers whose needs must be understood, as customers with exacting demands and as lead users that are able to promote product modifications and predict future demand. Lead users may be able to bring the need for new requirements ahead of what already exists in the market, therefore such users are important for the development of complex products. There are four typical characteristics that help the innovators to identify the lead users. Firstly, lead users are able to recognise requirements earlier than other users. Secondly, due to their market position and complementary assets the lead users have expectations of a high level of benefits. Thirdly, the lead users are able to identify and innovate according to their needs. Finally, such users consider themselves and are perceived by others to be innovative and pioneering. (Hopkins, Tidd, Nightingale & Miller, 2011: 45−46.)

In user-centred product development the boundary between innovators and users disappears as the whole innovation process becomes more complex. The importance of the final users has increased in the innovation process together with technological progress. Companies that mostly innovate complex products and services can get many benefits by cooperating with lead users. Lead users can help the companies to develop and create innovations and also give feedback. Through letting the lead users into the process of product development the companies ensure that their innovation will have success in the market. However, many different researches suggest that the success of the innovation projects also depends on the dynamics of networks. According to the results of the researches, if the companies with different perspectives and capabilities share their knowledge and commitment to a common direction they are able to achieve successful innovation collaborations. The companies are able to succeed in the process of innovation through recurring interaction, monitoring and nurturing their relationship. (Hopkins, Tidd, Nightingale & Miller, 2011: 46−47.)

3.4. Open source as an example of open innovation in user-centred product development

Nowadays almost all the business in the world has been taken over by computers as all the business processes such as planning of production, stock valuing, order handling,

communication, accounting, logistics, product development and customer service are mostly integrated with computers. Both small and large companies have made huge investments in developing and implementing effective computer systems to support different operations. By using software the companies can easily manage their business but the competitiveness of the large companies depends on how regularly they reinvent software. Reinventing and developing the software creates more costs and investments that force the companies to start using software that does not fully suit their operations. In most cases if the systems are chosen right and implemented well they can reduce the business costs of the companies. Using systems that perfectly fit the business operations can even help the companies to create new types of business. Due to the high costs for small companies it was extremely difficult to approach such systems − until now. (Locke, 2004: xvii.)

As the computers have revolutionised business at all levels there is a similar revolution happening in software and systems − open source. Open source is a new way to develop and share innovations around the world. According to Locke "the open source process rewards technical excellence, decimates cost, and prevents vendor lock-in, but sometimes at the expense of usability." (Locke, 2004: xvii) Open source is a part of open innovation as all the knowledge and research are shared between all the companies and people involved in the process of product development. Data about open source and its correlation with user-centred product development was collected at the University of Applied Sciences in Vaasa by interviewing a member of Vaasa Center of Open Source Solutions Rainer Lytz. The questions presented focused on the process of open innovation and open source and relation of open source to user-centred product development. The aim of the interview was to find out the main ideas of open source, how open source differs from other product development principles and how the final user affects the process of open source development.

3.5. Definition of open source

The essence of open source is not in the software itself, but rather in the process of creation of the software. Weber (2004) states that the key element of the open source process is the fact that participation and selection of tasks is totally voluntary. (Weber, 2004: 62) There are no restrictions on the times when participants can join or leave the project and there is no free market of labour but each participant has freedom to choose

his own part of the work and contribution. Weber also emphasizes that there is no consciously organised or enforced division of labour, rather labour is distributed according to their roles in the project. (Weber, 2004: 62.)

The open source process is mostly concentrated on a core code base and the source code for this core is freely available. There are no restrictions for obtaining and modifying the code for users needs. (Weber, 2004: 62) However, open source does not only mean free access to the source code as there are also some criteria that the distribution terms of open source software must comply with. For example, there cannot be any restrictions for any party regarding selling or giving away the software. Modifications, derived works and their distribution under the same terms have to be allowed by the license. There should not be discrimination against different groups of persons and fields of endeavour. The license must not be specific to a product and it must not restrict other software, however it should be technology-neutral. (Locke, 2004: 469−470) According to Lytz there are four different types of openness or freedoms in the open source principle: to use programs, have an opportunity to read the codes of the programs, share the programs and make own modifications to the codes.

Lytz states that the core of open source is a special license model called General Public License or GPL. The factor that makes this license special is its catching power as it allows any changes in the product or program only if these changes will be distributed to all the other users. When companies develop new products they usually protect the innovation using copyright. However, in the case of open source and GPL the term used is copyleft. Copyleft is the opposite of copyright as it ensures that there will be no restrictions to use, make changes and distribute modified versions of a product. Copyleft makes a program or any other product, including all its modifications and versions free. Not necessarily free regarding its price, but freely available and modifiable according to user needs. If a company has a patented product that is also under GPL, the power of the patent actually disappears.

3.6. How open source differs from other principles of product development

As explained in the previous paragraph open source includes a license which gives everyone freedom to use a program and make any modifications needed to it without breaking copyright. The difference between the open source process and other types of

development processes is mostly in how they are licensed. Compared to other licenses GPL is more constraining, there is freedom to do anything with the code, however it is not allowed to restrict the freedom of others to have the same freedoms. (Weber, 2004: 62) Lytz argues that the most important factor that differentiates open source from other principles of developing new products is the freedom to share the source code with all the users. For example, Linux is not patented and there are already many other companies such as Red Hat that have taken the idea of Linux and have started using the same branch. These companies have gained huge profits, which means that it is possible to make business with open source even though it is free for users. Lytz emphasizes that open source does not have to be free of charge but it should be freely available to everyone. One of the ways for the companies to get some profit from open source is to sell support services for the users. Lytz believes that in the near future all the innovations in the world will be moved to the Internet and there it is not possible to concentrate on who is having copyright and who is going to get the profit for the innovations.

According to Lytz open source is not a technology but a philosophy to share. A philosophy cannot really have any disadvantages, however philosophy can come into technology through GPL enabling open philosophy to take over the technology and innovation. This creates a situation where an open source program as a product does not need to be perfect on a technical level as it does not have so much business potential. However, this does not mean that the philosophy of open source is not good enough. The goal of open source is to use the open philosophy to make breakthroughs and affect the technology in a positive way.

Lytz states that there are some industries that are not recommended to use open source in their product development processes. Open source can affect the industries that are acting within a hard competition in the market. Lytz strongly believes that for example Microsoft will never use open source as the philosophy for their product development and innovation processes. Defense and medicine industries are industries using Linux but they will never approach the open innovation principle. Lytz also believes that open source will affect the largest IT companies such as Microsoft and Cisco Systems negatively as the philosophy of openness will break the old principles of developing innovations.

3.7. The open source process

One of the most important elements of the open source process is the fact that it is the general user base that proposes "check-ins" to the code. These check-ins are not just suggestions but code modifications, new features and bug fixes. The members of the process are the users who are playing the role of the developers, therefore there is no meaningful distinction between users and developers in the open source process. Due to the large amount of developers the process of open source development is continuously encouraging extensions and improvements. The main principle of the process is to take away all the barriers restricting the entry for new users to join the development process. (Weber, 2004: 63.)

The process of development itself includes email discussion lists where users share their ideas, experiences and opinions about what works and what does not work good enough. Through such discussions the developers are able to find out what should or should not be done next in order to make the open source better for everyone. Before submitting the patch for review a user-programmer goes through the procedure of testing and evaluation. After the evaluation is done the submission moves further to gatekeepers or maintainers who have responsibility for some specific parts of the code. Later the submission reaches lieutenants who are responsible for larger sections of the code. (Weber, 2004: 64.)

However, before starting the open source process it is important to create a large network and find out if any previous research has been done which could be used in the creation of an open source code. Lytz states that in the open source process the main principle is to use old research and code as much as possible. In the beginning of the process it can also be necessary to find some partners that have similar interests in innovation and open source. According to Lytz's experience, in most cases it is a customer who contacts open source developers and asks to develop a product with some specific features and functions according to the special needs. Therefore, it is easier for the developers to create the software as there is a vision of what the customer is interested in. However, it is not always necessary to develop with an open source code from the beginning. It is possible that there is some existing work that can fit the requirements of the customer.

4. NEW MODEL AND SOLUTIONS TO SUCCEED IN USER-CENTRED PRODUCT DEVELOPMENT

There are two different models of user-centred innovation presented in this work and before making any conclusions it is important to take a look at both models at the same time and make a comparison between these two principles. By comparing open and closed innovation it is possible to find out the advantages and disadvantages of the models. In order to develop a new model of user-centred product development it is also important to compare the stage-gate model with open innovation and focus on their differences and benefits.

4.1. Closed vs. open innovation

In order to understand the differences between closed innovation and open innovation it may be useful to look at the table below. Table 1 shows the contrast between two innovation paradigms.

Closed Innovation	Open Innovation
The smart people in our field work for us	Not *all* smart people work for us. We need to work with smart people inside *and* outside the company
To profit from R&D, we must discover it, develop it and ship it ourselves	External R&D can create significant value. Internal R&D is needed to claim some portion of that value
The company that gets innovation to market first will win	Building a better *business model* is more important than getting to market first
If we create the most and the best ideas in the industry, we will win.	If we make the best use of internal *and* external ideas, we will win.
We should control our IP, so that our competitors cannot profit from it.	We should profit from other's use of our IP (license out) and we should license in other's IP whenever it advances our business model.
We will own all results from contract research with universities	We will partner with universities to create knowledge and encourage use outside our field

Table 1. Contrasting principles of closed and open innovation (Chesbrough, 2006: XXVI)

According to Chesbrough (2006: XX), in closed innovation the companies have to be strongly self-reliant as they never can be sure of the quality, availability, and capability of others' ideas. The companies try to hire the best and the brightest people to make the smartest people of the specific industry work for the company. It is important that the company discovers and develops new products itself in order to be the first to bring them to the market. The companies applying closed innovation into their product development truly believe that the company that brings an innovation to market first will win the profit. Intellectual property plays a huge role in closed innovation as it is important that competitors cannot get any use of it. Finally, the company is sure that after it has developed a new product, there is no other owner of the results of all the researches and analyses. (Chesbrough, 2006: XX.)

Open innovation has exactly the opposite rules of acting that concentrate on the quality of the results, strong relationships and partnerships, increasing the value and getting use of others' knowledge. For companies using open innovation it is more important to build a better business model instead of being first with an innovation and bringing it to the market. The main idea in open innovation is to find people with valuable knowledge both inside and outside the company and build strong bonds between the employees in the same industry to share and use the knowledge that is available with everyone. Therefore, there is also an aim to share own intellectual property and profit from the intellectual property of other companies.

Cooper's stage-gate model is a typical example of closed innovation. The main goals in stage-gate models are to achieve high quality in a new product, focus on prioritising, build a multifunctional team, work with high efficiency with fixed time and resources, test market-acceptance before product realisation and to focus on the first phases of the process. In the stage-gate model it is important to conduct preliminary research and investigate the needs of customers and the situation of the competitors. However, practical example showed that the model is quite broad to use and companies use a modified version of it according to their specific strategy and ways of working. The company investigated in this work has reduced the amount of gates and modified the requirements that should be achieved to move further to the next gate.

Open source is an example of open innovation where both external and internal resources are required in the innovation process. There are no specific phases or gates in open innovation and the open source process, however, as in the stage-gate model the first step of the process is investigation and analysis of the market situation. In open

source the preliminary research is important as there already might exist a product like the one desired. Since all the information is shared it is easy for developers to find a good base for their own innovation and create a team with the best skills and knowledge around the world. Like in open source, in closed innovation there is also a preliminary and detailed investigation but it includes project definition, justification and project planning. The first step in the stage-gate system is ideation which includes basic research, seed of unfunded projects and different customer-based and creativity techniques. Even though both open and closed innovation processes begin with research, the goals and focus of this research are totally different.

The process of closed innovation is pretty fixed and predictable as there are known steps and requirements that should be fulfilled before starting technical part of work and final realisation of the product to the market. The open innovation process does not have any clear steps that should be followed which can be a challenge for the developing team as there are not necessarily any specified goals that should be achieved in order to move forward. In some cases open innovation and open source processes might take much more time than processes based on the stage-gate model because for open source processes the plan is not as well fixed. People involved in open source development do not necessarily work under the same roof and this can cause problems in communication and co-operation. In closed innovation there is a multifunctional team where everyone impact the final result, which stimulates people's motivation and concentration on essential progress.

According to the interviews presented in this work there is a similarity between closed and open innovation from a user-centred point of view. In both cases the initiator of the innovation process is usually a customer. In both open and closed innovation the user contacts the developers and presents his needs and requirements for a new product. Closed and open innovation both allow the final user's participation in the process of innovation, furthermore when the user takes part in the process there are more possibilities to create a product that fully responds to the demands of the user. In the stage-gate model it is necessary to get the customer's feedback and approval during the innovation process which ensures that the final product will have success in the market after realisation. In open source the user can also be the developer and fully participate in all the innovation work. This allows the user to affect all the decisions and changes during the process and decreases possibility of failure.

Closed and open innovation are two different principles of innovation, however they do not only have many differences but also some similarities. Both principles have similar aims to satisfy the final customer and spread innovations within the market. Even though most innovation work is usually done by professional developers, it is obvious that the final users are playing an equally important role in the product development. By using either model it is possible to meet all the requirements for success in product development such as the investigation of all product possibilities, understanding of the customers, technical design and marketing.

4.1.1. Ajar product development and innovation

The main difference between open innovation and closed innovation is the ability of the companies to control their own ideas, production, marketing, distribution, financing and support. In order to succeed in closed innovation there should be control over all the processes within the company. This is the reason to why most companies choose closed innovation as it is easier to keep control when everything happens under the same roof and under fixed circumstances. In open innovation it is much harder to keep control as there are both external and internal powers involved in the process. Time issues can also become a problem in open innovation since it is not always possible to wait for the performance of the developers from the outside.

There is also a problem when moving from closed to open innovation as the companies should change their psychology, try to share their own risks with the surrounding world, and their future becomes unclear. The companies following the rules of closed innovation are like chess players who are counting their moves several steps ahead. The companies that are on the side of the open innovation are poker players who are waiting for new cards and do not know what is going to happen next. All these issues have to be taken into consideration when thinking of a new model of user-centred product development.

Based on the comparison and the analysis of open and closed innovation I have chosen some of the characteristics from both principles and tried to combine them into one model. I choose to call the model that I have developed based on this research the ajar model. The name ajar comes from the combination of closed and open innovation. The model does not reflect only closed or open innovation, rather the process of product development is slightly open but still quite closed within the company. The ajar model includes gates and stages that help the companies to control the process and the quality

of the product by setting specific requirements that should be met. The gates also enable time control as the companies can set a time schedule for each gate meaning that the developers should get their tasks done before a deadline.

It is obvious that in order to be able to control the process of product development there should be clear goals and tasks given by the company. Fulfilment of these tasks should bring results that can be evaluated in order to analyse the efficiency and quality of the process. As in closed innovation it is important to emphasise the role of gates and the requirements the process should satisfy in order to move further from one gate to another. In the ajar model there is a clear list of goals that all the developers should achieve in a given amount of time. However, in cases when the requirements are not fulfilled in time the company and the leaders of the development group have to evaluate the reasons for failure and find out possible solutions to get the process back on track.

Globalisation and worldwide cooperation have increased the efficiency of the business world. Companies are distributing their products and services all around the world and cooperate and communicate on an international level. It is not enough to concentrate only on domestic users. Global users need to be served. Therefore changes should also happen in the product development process. As companies are sharing their production with the external world, the product development process should also be externalised. The ajar model of product development includes the idea of open innovation where all the knowledge and research is shared. This allows the companies to use large amounts of resources without huge costs. The developers will be responsible for their own costs instead of having one company covering all the costs and resources for the whole process.

Using the principle of internal and external resources allows the companies to focus on the quality of the innovation. As in open innovation, in the ajar model there are people with the best skills and knowledge involved in the process of product development. The companies do not need to hire all the best employees, which would create too high costs for salaries. It is more efficient to use different people from different companies and institutions. It is also possible to cooperate with independent developers who might have better knowledge and understanding of the innovation. Working with smart people inside and outside the company increases the level of versatility and creativity as well as the amount and quality of ideas and solutions within the innovation process. Finally, it is better for the company not only to have the best employees within the own company

but around the world where it is possible to find all the skills and talents needed to form a multicultural and creative developing group.

The main idea in all business areas is to succeed in the market and profit as much as possible. Product development is one of the most potent ways for companies to attract new customers, gain interest in own production and distinguish themselves from the competitors. In the case of innovations there is always a question about copyright which protects the companies from the competitors and their innovations. If the main goal of the company is to achieve profit it is important to reduce the rights of users to make own modifications and distribute them to other users. However, it became clear from the presentation of open innovation and open source that the world is moving towards open solutions which are free for everyone. This decision mostly depends on the industry the companies are acting in, but in some industrial companies it may be necessary to use copyright in order to keep useful and secret knowledge within the company. However, in order to be able to use both internal and external resources it is also necessary to share own knowledge with others. The companies should be able to draw a border between the information they are willing to share and that which they want to keep secret.

Ajar product development is not easy to implement as it requires a huge change in the business model and the strategy of the company. It is important to combine both basic thoughts that being first at the market and building a better business model are equally important factors for the success in product development. In some ways the ajar model supports the idea of outsourcing different phases of the process of product development but the main difference is in the principle of sharing instead of paying companies and institutions for the outsourced work. The ajar model perfectly suits both small and large companies which focus on quality and profitability of the innovation. It is easier for smaller companies to grow when it is possible to use resources from other developers. For large companies using the ajar model provides a great opportunity to learn much new about own and other industries and increase publicity within the market.

One of the biggest challenges in the ajar product development is making a decision concerning ownership and copyright. The ajar model supports copyright as it provides safety and stability for the company. It is also difficult for the companies to decide what information they are ready to share with external developers. However, there are many developers who are working outside the company willing to take a part in the innovation process without absorbing new knowledge from the company. Therefore, if

the company wants to keep as much information as possible to itself, it is important to build a proper network where revealing information is out of the question.

4.2. Possible means to succeed in user-centred product development

In order to succeed in user-centred product development it is important to understand the goals and the requirements of this process. It may be good to ask questions and analyse what the company would like to achieve by developing a new product and launching it to the market, what benefits can be gained and how the new product can affect the strategy of the company and its position at the market. When the company knows its own benefits and is sure in possible profit of producing a new product it is time to change perspective and ask the questions from the customer point of view. What should a new product be like, which new and old features should the product include, which benefits can the customer get by using the new product and is this a good replacement for the old product. However, one of the most important questions that the company should ask itself is: What is a superior product that can be approved by the customer and get a place at the market?

Cooper has defined a superior product as a product that delivers real and unique benefits and advantages to users. Such products differ with their ability to offer unique features which are not available on competitive products. Superior products meet the customer needs better than competitive products. Meeting the customer needs means solving the problem the customer has with a competitive product and reducing the customer's total costs by substituting old products with innovations with higher efficiency and improved usability. (Cooper 1994: 58–59.)

When the company knows the main course in product development it is obvious that the development of a new product taking into consideration real advantages and customer benefits is paramount as stated by Cooper. (1994: 59) Cooper suggests three steps that can be used to maximise product advantage gained via unique benefits to customers. The first step is to start with the customer, which means that the project team should do extensive market research and work really closely with the customer and users in order to identify customer needs, wants and preferences. This step also includes defining the way the customer sees "a better product". (Cooper 1994: 59.)

The second step on the way to the top of the market is applying creative translation, which means that when the project team has the information about the customer needs, it is important to use appropriate technical and creative problem-solving skills in order to translate these needs and wishes into a technically viable and profitable solution. At last, by ensuring the fact that the final product scores high with the customer the company confirms its success. This can be done by providing the customers with extensive tests such as concept tests, customer tests during development, field trials with a customer and maybe even a trial sell or test marketing. (Cooper 1994: 59.)

4.3. Using customers as a source

Innovation always starts from an idea but there is a critical question that can be asked in order to identify the sources of ideas. Where can the team get new product ideas within the company? What should the real sources of the new product ideas be? The company should pay attention on the fact that the customers themselves are representing a huge potential source of ideas that can be used by the companies to achieve success with a new product. However, there is a challenge for the company and the product development team to find out the ways of using the customers and the final users as a source of the idea of their new product.

Cooper suggests four ways of using the customers and the final users as a great source of ideas, innovative approaches and new technical solutions. The first solution Cooper suggests is to use group discussion with customers. By discussing the possibilities and future plans with the customers or potential users it is possible to get a clear picture of the current tendency of the market. The discussion can focus for example on different problems that customers are experiencing with competitive products. As an alternative it is also very effective to have a discussion in a form of a brainstorming session that can help to identify possible solutions and customer wishes for a new product. (Cooper 1994: 124.)

Secondly, Cooper argues that another good source of ideas is a panel of selected customers that meets on a regular basis. This strategy has been widely and successfully used in different industries and achieved good results in product development. The third way of using the customers as a source is to survey them by developing research questionnaires and present them to a representative sample of customers or potential

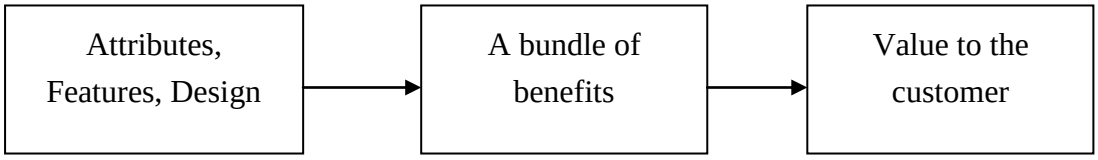
users. This way it is possible to identify the customer needs and the future winning product. The most powerful tool for receiving the ideas from the customers is a straightforward survey by direct questioning. It is very simple to get the information about customer needs, wants and preferences, the criteria of the order-winning, likes and dislikes and problems regarding the current product. It is more difficult to find out latent needs and problems of the customers as this mission includes studying the ways the customers use the product, what the possible difficulties of using it are and what better solution can be proposed. (Cooper 1994: 124–125.)

As the last way of taking advantage over the customers' ideas Cooper suggests working with lead users. Cooper argues that it is a very powerful tool for achieving success when the company not only sees the customers as a source of potential ideas but also as a source of partially completed new products. (1994: 125) It is possible, that the customers have already experimented with a similar project and have tried to make improvements and modifications to suit their own needs. By identifying these lead users, that usually represent only a small proportion of the customer base, the company can find out if they have already modified the same product and what suggestions they might have been concerning for further development. (Cooper 1994: 125.)

4.4. User needs-and-wants study

As mentioned in previous parts the market study should be a part of the product development process in order to determine the needs of the final users of the product. A user needs-and-wants study is a part of the detailed market study that is so often left without attention resulting in disastrous consequences. According to Cooper (1994: 141), the biggest problem of the product developers is that most of them have a fixed idea of what the customers are looking for, which is a reason for underestimating the importance of the market study. Unfortunately, in most cases this idea is wrong and causes failure in a new product which does not fulfil the customer needs and wishes. (Cooper 1994: 141.)

The goal of new product development is to deliver a product with real value to the customer as shown in the picture below.



Picture 6. The link of factors determining product value (Cooper 1994: 141)

According to Cooper's theory, the product value is derived from the benefits built into the surrounding product. The benefits are simultaneously coming from the design, performance, features and attributes of the product. It is a huge challenge in product development to understand how value, benefits and product features and performance are related to each other in the chain. When forming the product design it is important to listen to the customer. This makes the user needs-and-wants study so critical. (Cooper 1994: 141.)

Cooper (1994: 142) suggests many key questions that can be asked in the user needs-and-wants study. What do customers really value and how much? What are the benefits? Which features, attributes and performance characteristics should be translated into benefits and value for the customers? The user needs-and-wants study is a tool that can help to identify the answers to these key research questions. A starting point of this study can be qualitative research, for example focus on the group of customers gives as a result some insights into product value and desired benefits. However, in order to achieve depth in understanding, face-to-face interviews and quantitative market research can also be useful. (Cooper 1994: 142.)

A positioning study is another integral part of the user needs-and-wants study and its goal is to determine the key dimensions by which the customers perceive and differentiate among competitive products existing in the market. This study also identifies how customers view various offerings in terms of key dimensions. The study tries to find the free space in the marketplace that is not occupied by a competitive product. (Cooper 1994: 145) Therefore, a positioning study as a part of the user needs-and-wants investigation brings much additional and valuable information about the market and the customers, which strengthens the company's own ideas and product development plan.

5. CONCLUSIONS

The goal of this research was to answer these three main questions: Which role do the users play in the process of user-centred product development? How can the users and the information about their needs be exploited in the process of product development? Which are the possible means to succeed in product development? This research showed that users are playing a much more important role in product development than the developers themselves. The users are a source of useful information and new ideas that can be used as a starting point to a new project. Users can also be both customers and developers at the same time, which increases the success of the product in the market. In order to gain advantage from a cooperation with the users it is necessary to use them as a source. However, in order to be able to cooperate with the users as efficiently as possible it is important to really know the users and their needs through investigations and analyses. There are many different user needs-and-wants studies that can be included into the analysis of the customers. By knowing the values and the preferences of the customers the companies can feel secure about the future of their innovations.

Based on this research it is possible to say that product development practically corresponds to the theory, however the theory is mostly applied more specifically into practice depending on the goals and the strategy of the company. In Tingström's opinion, it is important to notice that there are many different satisfactory solutions of design problems and it is hard to define a clear best solution. (2006: 1378) As presented in the theory part of this research, the process of product development is complicated and time demanding and requires a clear system of working, focus on achieving results, concentration on the work progress and its quality and a multifunctional team with appropriate knowledge and skills. However, the most important factor in product development in both theory and practice is knowledge about the customers and users and understanding their needs and wishes in order to bring them unique benefits from the new product.

By analysing the results of this research it can be noted that product development improvement principles can be grouped into three separate areas according to their main focus. The first principle is concentrating on the general product development improvement goals which are included in the entire product development organisation. Secondly, there are goals that affect the user-centred development and the commitment

of the employees. Finally there are concrete improvement and development goals for user-centred planning, methodological knowledge and skills.

Both in theory and practice companies have similar factors that should be developed concerning the product development. The research shows that the companies are willing to improve their relationships and communication with the customers allowing them to get more feedback that can be investigated and analysed. Regular and targeted communication between the managers from different departments such as development, manufacturing, sales, project management and implementation departments is one of the objectives of the companies concentrating on the multi-functionality and cooperation of the product development team. Finally, the companies understand that ideally all the members of the product development team should have contacts with the customers and final users in order to ensure that the new product is actually fulfilling the customer needs and wishes.

According to Iivari (2006), it is accepted that customers are involved in the product development process, however, involving customers is challenging. The key factor affecting the successes and failures in product development, organisational change and development efforts is the organisational culture. In the process of product development the customers can be seen as human actors or as human factors. Human actors are active agents and human factors are passive objects of study. There can also be three different types of involvement: informative, consultative and participative. In the first two cases the customers provide information, act as objects of observation or commentators of the product development solution. In the participative type of involvement the customer has decision-making power and acts actively in the development process. (Iivari 2006: 639.)

6. SUMMARY

Product development and the creation of a new product is a good possibility for a company to increase profit, improve its financial situation, fight competitors, attract the customers' attention to the company's own products, develop new strategies and ways of working, strengthen its place at the market and create new possibilities for further development and growth. However, the world is constantly changing as technology is advancing, creating new possibilities and opening new doors for the market. There are many factors that influence and make product development challenging. A changing environment, changing customers' tastes and preferences, trade-offs, existence of multiple choices, time pressure, new competitors entering the market, changes in standards and technical requirements and the world's financial situation – all these and many other factors make the product development more complicated. Nevertheless, the changing conditions and circumstances are teaching the development managers to adapt and survive in all possible situations. This fact makes product development an independent process which further complements and develops itself and absorbs all the new aspects and perspectives of the changing world, society and environment.

The best solution for the company is to use a clearly structured model of product development, which helps the development team to keep their focus on the goals of the process, fulfilling the customers' needs and wishes, increasing the benefit and profit gained from innovation, avoiding time pressure and lack of useful information and resources. The stage-gate system invented by Cooper is one example of the ways of controlling the entire process of product development by dividing it into different stages and gates and accomplishing required tasks in order to pass these phases and move further in the project. However, practice showed that following the theory can cause much costs and investments, and requires much time to achieve the goals.

ABB Motors has in its product development process taken the idea of Cooper's model but has developed it into a more technically integrated version. The goals of user-centred product development are clearly in focus, the team investigates the market and the customer needs, but additionally the Gate model describes the process from the technical and practical points of view. The idea of passing the gates and fulfilling the requirements remains the same. However, the Gate model allows the team to have high quality and good time control allowing the company to create the product with high efficiency at the time the customer wishes the new product to be finished.

Cooper's model of product development is a clear example of closed innovation where companies are using only internal resources in the innovation process. The opposite to closed innovation is open innovation where the main idea is to share knowledge and research with other developers and use both internal and external resources. In open innovation the users are playing the role of developers and they are allowed to make own modifications and distribute new versions of a product to all other users. The main difference between closed and open innovation is different understanding and attitude towards success, ownership, control over the innovation process, employees and sharing. Open source is one example of open innovation. The users of open source software are able to make their own modifications and distribute new versions of the code to other users for free. However, the principle of open source does not fit all industries, therefore a new ajar model was developed in this research.

The ajar model is based on the combination of the characteristics of open and closed innovation. This model gives the companies ways to control the process of product development even though the participants in the process are coming from inside and outside the company. The ajar model allows the companies to reach high quality in resources and results of the process. Being ajar increases the information flow of the company. It shares its own information with other developers in exchange for their professional experience and knowledge. The biggest challenge in the implementation of the ajar model is choosing a form of ownership that is neither copyright protected nor licensed.

User-centred product development and following the process models require reorganisation of the company strategy, reconsideration of goals and main priorities, changing the attitude towards product development and understanding the importance of the customers in the process of innovation. In order to create a superior and winning product the company has to create something new which differs from the competitive products and brings special and unique benefits to the users. Finding new ideas and solutions requires results from deep investigations and analyses of the industry the company is working in, the market and the nature of the customer. By using different studies and methods, the company can gain this useful information which can open all possible doors to the new markets and the customers' trust. It is not an empty statement that a Ferrari is a good car, but for a family with seven members it is false. Each customer needs its own treatment and has to be served in a unique way; by

understanding this any company should be able to create its own Ferrari even for a bigger family.

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