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PITFALLS IN A QUICK PRODUCT TRANSFER

Design Instruction for HDP motors

Technology and Communication

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VAASAN AMMATTIKORKEAKOULU
Kone- ja tuotantotekniikan koulutusohjelma

TIIVISTELMÄ

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ABB Motors and Generators Oy:n yksikössä tehtiin tuotesiirtoprojekti, jossa siirrettiin HDP-moottoreiden valmistus ja tuotevastuu Ruotsista Suomen Vaasan tehtaalle. Tuotesiirtoprojektissa käytettiin Vaihe-Portti-mallia, joka auttaa tekemään liiketoiminnallisia päätöksiä. ABB käytti räätälöityä versiota Vaihe- Portti-mallista.

ABB:lle oli tärkeää selvittää sudenkuopat, jotka tulivat esille projektin aikana. Nämä sudenkuopat keskittyivät suunnitteluun. Suurimmat haasteet toivat dokumentit, jotka olivat epäjärjestyksessä, vaikeasti löydettävissä ja joiden oikeellisuus oli kyseenalainen. Haasteena olivat myös eri ohjelmat. HDP-moottorit suunniteltiin, mallinnettiin ja piirrettiin eri ohjelmilla Ruotsissa. Tiedostojen siirtäminen oikeille ohjelmille vei aikaa, eikä aina ollut yksinkertaista.

Koska HDP-moottorit ovat uusi tuote Vaasan tehtaalla, tarvittiin suunnitteluohje sovellussuunnittelijoille. Haastattelujen avulla ja dokumentteja lukemalla saatiin yleinen kuva moottoreista. Niiden perusteella pystyttiin luomaan yleinen suunnitteluohje sekä sähkö- että mekaniikkasuunnittelijoille. Ohje tulee elämään koko ajan, koska kyseessä on uusi tuote ja kokemuksen myötä korjataan virheitä ja tuotetta kehitetään.

Avainsanat	Vaihe-Portti-malli, tuotesiirto, projekti, ohje

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ABSTRACT

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A product transfer project was made In ABB Motors and Generators business unit. In the product transfer the HDP motors production and product responsibility was transferred from Sweden to Finland, Vaasa factory. The project used a Stage-Gate model which helps to make business decisions. ABB used a tailored version of the Stage-Gate model.

It was important for ABB to examine the pitfalls that came up during this project. These pitfalls concentrate on the engineering view of point. The biggest challenges were the documents. The documents were disorganized, hard to find and their correctness of them was questionable. Another challenge was the difference of the software used in Sweden and Finland, Vaasa. In Sweden totally different software were used for engineering, modeling and drawing the HDP motors. It took time to transfer the documents to the right software which was not always that easy.

Because HDP motors are a new product to the Vaasa factory an engineering instruction was needed for the application engineers. Interviews and documents gave a general view of the new product. Based on that information a general engineering instruction could be made, including as well as the electrical and the mechanical part. The instruction will be changing because it is a new product which will be further developed.

Key Words Stage-Gate model, product transfer, project, instruction

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LIST OF ABBREVIATIONS

HDP	High Dynamic Performance, electric motor
Stage-Gate model	A model of controlling project decisions
R&D	Research and Development
SCM	Supply Chain Management
NX	A modelling and drawing software
Teamcenter	A product and designing control software
UL	Underwriters Laboratories

1 INTRODUCTION

This thesis was ordered from ABB. ABB is a global company, with 145 000 employees in 100 countries. ABB stands as the largest supplier of industrial motors and drives, the largest provider of generators to the wind industry, and the largest supplier of power grids worldwide /1/. About 45% of all electricity energy, in the world, is used for rotating electric motors. There is a long history of electric motors in Finland. Already in 1890 the company Strömberg produced electric motors. In 1940 Strömberg became one of the ten biggest industrial companies in Finland and the factory in Vaasa was opened. In 1988 Strömberg joined ABB. ABB Motors and Generators business unit is a pioneer in high efficient electric motors and generators. Combining the best available materials with superior technology, the electric motors and generators are designed to operate reliably no matter how challenging the process or application, and to have low life cycle costs /2/.

This thesis deals with a fast product transfer made internally in ABB Motors and Generators and with making an engineering instruction of the new product for the application engineers in ABB Vaasa. The engineering instructions are dealt as its own project. The chapters are mostly divided into two. One tells about the product transfer project and the other about the process of making the instructions. Chapter 2 tells about the backgrounds and the purpose of the product transfer as well as the instruction. The product transfer project used a version of the Stage-Gate model. That is why the theory part is generally about the Stage-Gate model. The thesis discusses the output of the two projects. An important part in the output chapter is what has to be taken into consideration when doing a fast product transfer next time. There is only a little or no real information available for fast product transfers. The evaluation part is mainly about the engineering instruction and the early stages of the product transfer. The product transfer project will continue after finishing this thesis.

2 BACKGROUND AND PURPOSE OF THE PROJECT

High Dynamic Performance (HDP) series have been designed to be used in rough operating conditions and to operate only with a frequency converter. The square frame design and high overload capacity gives the motor an excellent dynamic response due to low moment of inertia and high pulse torque. /3/ The principle of HDP motors is the same as for traditional electric motors.

Figure 1. HDP motor

HDP series electrical motors are originally designed and produced in Italy. From there they were transferred to Sweden and now they are transferred to Finland, Vaasa. The reason for the transfer was that the HDP motors had a poor cost competitiveness and a long lead time. The target of this project is to move the manufacturing of the HDP motors to Finland to improve cost effectiveness and competiveness /4/. The improvement of cost effectiveness and the competitiveness are also business targets. In addition to these the business target includes the shortening of HDP motors lead time and to increase sales.

The HDP motor differs from the traditional induction electric motors, produced in Vaasa, not only in engineering, but also in production and the structure of the supply chain. That is why this counts as a new product in the Vaasa's factory. The way the product has been engineered, in the application engineering department in Sweden, was totally different to the way we design it in Vaasa. Not only did the software differ from each other but also the modularity and structure used in the software. Because this is a new product in Vaasa, ABB needed instructions for the application engineers: High Dynamic Performance (HDP) series Design Instruction. The projects mission was to create overall instructions, which contains all the necessary information for the Electrical and Mechanical application engineers. The instructions had to be easy to read, with little text and lots of pictures.

3 STAGE- GATE MODEL

This chapter deals with the Stage-Gate model. First the background why the model is used is explained. Then the Stage-Gate model is presented. In this product transfer a tailored version of the Stage-Gate model is used.

3.1 Backgrounds for Using Stage-Gate Model

Product life cycles are shorter, competition is more intense and customers are more demanding /5/. These are reasons why the need for lean, rapid and profitable new product development is growing all the time. Unfortunately, an estimated 46% of the product development, conception or launch projects fails. One of the main reasons why these projects fail is the lack of genuine customer understanding. It is really hard to know what the customer truly wants and needs. Other reasons why projects fail are for example lack of realism, lack of discipline, poor communication, poor processes or poor decision-making, and they can be addressed internally by implementing appropriate models, processes, tools and training /6/.

All these reasons lead to the need of using some kind of a decision making model that helps to solve problems during the project. There are different decision making models, for example development life cycle models, project management models or business decision models. Development Life Cycle Models focus on coordinating a set of related activities, typically within one discipline, but probably with multiple dependencies /6/. Project management models focus on how the project works. Finally, business decision models focus on making good decisions about investing in a particular project based on aggregated information from a diverse set of sources and multiple disciplines /6/. For a product development project all three models have to be used, but they are put in place by individual units depending on their needs.

The Stage-Gate model is a business decision model and it supports management decision making. This model helps to increase the success rates and decrease the failure for new products. It also increases the organizational discipline and focuses on the right projects. The Stage-Gate model lowers the errors, waste and re-work within projects. The allocation of scarce resources is more efficient and effective. The visibility of all projects in the pipeline will get better, when using the Stage-Gate model. It improves the cross-functional engagement and collaboration. The communication with external stakeholders has always been difficult, but the use of the Stage-Gate model improves it. The Stage-Gate model design is premised on, and is a much broader and more cross-functional view of a product development process /7/.

3.2 Theory of Stage-Gate Model

The Stage-Gate model is a business decision making model and a road map for moving development projects from idea to launch /5/. The process of bringing the idea to the launch is divided into smaller stages and gates. These processes include mostly several subprojects. In the stages, project activities are conducted and on the gates, business evaluations and decisions about the continuity of the projects are made. In its entirety, the Stage-Gate incorporates Pre-development Activities, Development Activities and Commercialization Activities into one complete, robust process /7/. A typical Stage-Gate model has six stages, including stage 0 (idea discovery) and 5 gates. See figure 2.

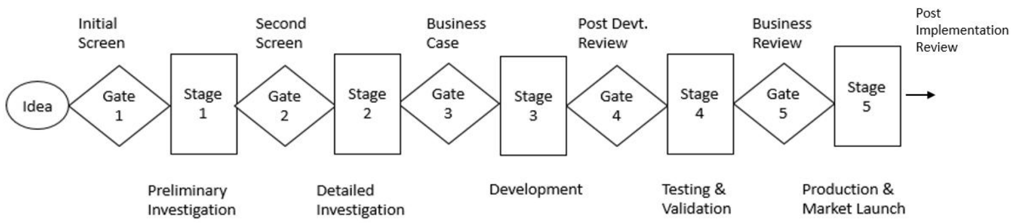

Figure 2. The structure of Stage-Gate model. /8/

3.2.1 Stage

Each stage is designed to collect specific information to help move the project to the next stage or decision point /7/. The stages are defined by activities within it, which then are analysed. The outcome of these two are deliverables. By each stage the costs will increase.

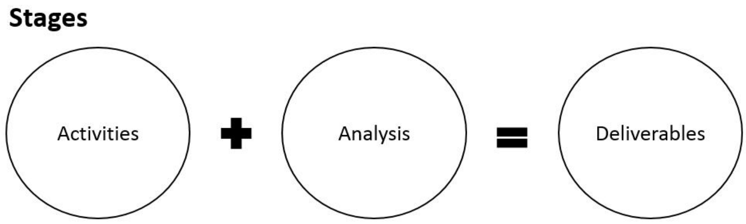

Figure 3. The structure of a stage /7/

The stages are:

Stage 0, Idea Discovery: Pre-work is done to find new business opportunities and ides.

Stage 1, Scoping: Investigating the project scope and doing a preliminary research.

Stage 2, Build the Business Case: Investigating more detailed the research of the market and the technical solutions, which will lead to a business case. In this stage the product and project definition, project justification and the proposed plan for development are done.

Stage 3, Development: The detailed design and development of the product is done as well as the design of the operations or production process.

Stage 4, Testing and Validation: The product is tested in the laboratory, plant or the marketplace. Also the brand or marketing plan and the production is tested.

Stage 5, Launch: The product is published to the commercial use. The production, marketing and selling is lifted to full-scale operation.

3.2.2 Gate

Preceding each stage, a project passes through a gate where a decision is made whether or not to continue investing in the project /7/. The gates are positioned at logical points in the progression of a project where business decisions are needed /5/.The gates are quality-control checkpoints. They have always a similar structure with three goals: ensure quality of execution, evaluate business rationale, and approve the project plan and resources.

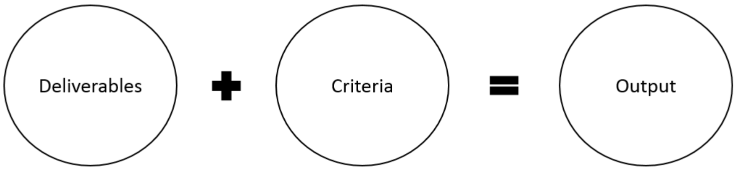

Figure 4. The structure of a gate /7/

The structure of a gate consists of deliverables, criteria and outputs, like in figure 4. The deliverables are the result of the activities completed in the previous stage. These are provided from the project manager and team to the Gatekeepers. The Gatekeepers are the people in the business who own the resources required by the project leader and team to move forward /9/.

For each product certain criteria are defined that the product is measured against. The authentic Stage-Gate process incorporates six proven criteria: Strategic Fit, Product and Competitive Advantage, Market Attractiveness, Technical Feasibility, Synergies/Core Competencies, Financial Reward/Risk /7/. These criteria help to screen out winning products.

At every gate a decision is made concerning the future of the project. That means if the project is going, stopped, put on hold or recycled (GO, Kill, Hold, Recycle). These decisions lead to outputs. New resources are committed as well as the action plan is approved and a list of deliverables are set for the next stage. Also the date for the next gate is set.

The Stage-Gate model is designed to improve the speed and quality of execution of new product development activities. The process helps project teams prepare the right information, with the right level of detail, at the right gate to support the best decision possible, and allocate capital and operating resources. /7/

4 APPROACH AND EXECUTION OF THE PROJECT

This chapter deals with the execution and approach of the project. First part explains shortly the product transfer project and its execution and structure. The second part is about the process of making the instruction. This is reported in more detail and deeply than the product transfer project. The reason for this is that the project of making the instructions was linked to the bigger product transfer project but not really part of it and the instruction was the main focus and output of this thesis.

4.1 The Product Transfer Project

The product transfer project used a tailored version of the Stage-Gate model. The project was divided into six Gates and three Stages. Before Gate 1 a pre-study was done. In the pre-study were cost estimates made, how to get to the product more cost savings and the product more cost-effective. Stages 1 and 2 followed the Gate model and Stage 3 was a separate technology Gate project. The Stages were independent and relaying only a little on each other. Stage 2 could begin after the product was transferred to Vaasa. Stage 3 is started before Stage 2 is ready. There is no impulse for it. Stage 3 will start when there is enough information and experience about the products structure and manufacturing. After this we can give the R&D project team feedback what could be good to be changed.

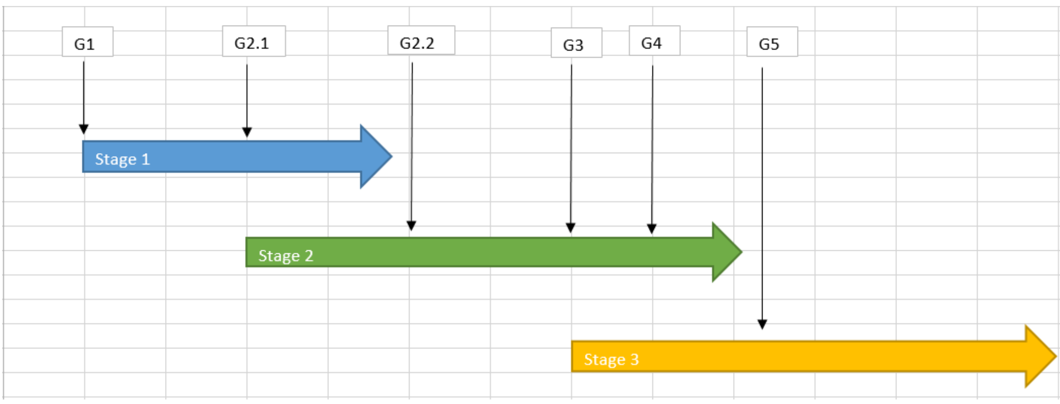

Figure 5. Structure of product transfer project.

Stage 1 was the transfer of the production from Sweden to Finland, with no changes in the product. In this Stage also all the needed documents were transferred and the staff trained. At Stage 2 were changes made, that affect the strategy. Stage 3 was executed as a R&D project. The aim of Stage 3 was to modularize the product structure and create new product code structure that supported the system used in Vaasa /10/. In this Stage some changes were also made in the design of the product and data were implemented for global engineering tools.

The project consisted of a main project and project manager. The main project was divided into four subprojects: Product Management, Production, R&D and SCM. Every subproject had its own project manager and project team. The subprojects were not dependent from each other, but they co-operated and together formed the deliverables for the Stages and Gates.

4.2 Engineering Instruction Project

The project of making the Engineering instruction was done separate from the product transfer project. Although it was done separately from it was linked to the R&D sub-project. We co-operated with the R&D team. This project was not using the Stage-Gate model, because it was a simple and small project. In figure 6 the structure of making the instruction and thesis can be seen. The process was divided into two, process of the instruction and process of writing the report. Information search 1 was for the Instruction and Information search 2 for the report.

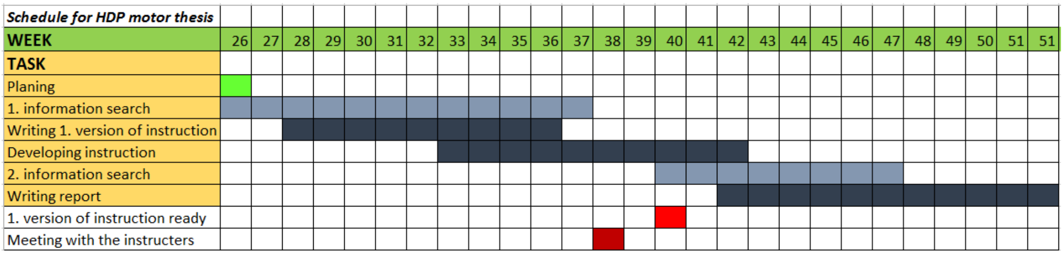

Figure 6. Schedule of thesis.

4.2.1 Information Search for the Instructions

The first thing that had to be done, was to familiarize with the new product. Searching for information was very important. General and technical information was searched in different databases. A lot of information was found in the 10 model motors the R&D project team had done in their own project. But the most information was received from the interviews with the R&D project team members. Interviews with the team of the application engineering department were made. The purpose of the interviews was to investigate what kind of information they want and need in the instruction and how they want them to be presented. Everyone that was interviewed had the same opinion, they wanted just a small amount of text and more pictures. The reason for that is that they want to find the needed information quickly in the document. They also wanted that the information was divided into the existing modules used in ABB Finland. It was important to them that the instruction contained the persons who were involved in the product transfer project, so that they know whom to turn to when there are questions rising later on. The final fact everyone pointed at was the 10 model motors and where to find them. The purpose was to take all wishes into account, especially these mentioned above.

4.2.2 Creating the Instructions

Now that it was clear what kind of instructions, the staff of the application engineering department wanted, the process of creating the instruction could start. It was decided to wait a while, so that the engineers involved in the R&D project had done the view orders. This was a good decision, because now they knew what had to be taken into consideration when designing the orders. In the mechanical part of the instruction interviews with the engineers who had designed the view orders were hold. We discussed every module as its own and which different options will affect which modules or parts. Really good answers and facts were received. Based on the interview it was easy to create the mechanical part of the instructions.

The electrical part was done differently. The electrical engineer who was involved in the R&D project had done a short instruction of the work for himself in finish. We went through all the work the electrical engineer has to do, so that the instructions he had done was understood. Now the translation of his instructions into English could be done as well as improving it.

In addition to these engineering parts a part was written of how to search already existing modules and parts in the data base in Finland, but also from the structures and parts used in Sweden. All the structures and parts of the motors made in Sweden were in an Excel table. It is very hard to find the right information in this table. After familiarizing with the table a clear instruction of using this table was written. This table is very important when designing HDP motor orders.

The instruction also contains a general information part. This information was found in different databases and with an interview with the main project manager. In the interviews with the staff it was recognised that they want some general information about the new product. This is a new product to everyone in Vaasa, so it was obvious to write some general information about the product.

4.2.3 Improving the Instructions

After the first revision of the instructions was done, it was checked by the engineers of the R&D project. They gave suggestions how to improve it and what had to be corrected. When the instructions were checked and corrected they were published in the internal database of the application engineering department. A few changes had to be made in the way of engineering HDP orders and new information has come up during new orders. Every time something had to be added to the instruction the engineers contacted me and I added the information to the instructions and made a new revision. The HDP motors are totally new in the Vaasa factory, therefore the instructions will always be changing and also because the product transfer project will be going on.

5 THE OUTPUT OF THE PROJECT

Chapter 5 deals with the outputs of the two projects. Part 1 is about the product transfer project situation at the moment and the output obtained until now. This project is still running so not all outputs are known. Part 2 presents the facts that have to be taken into consideration in the engineering point of view, when doing a product transfer with a tight schedule. Part 3 discusses the output of the instruction.

5.1 Product Transfer Output

The project of the HDP motor product transfer is still going on. Gate 1 is finished. That means the product and documentations are transferred “as is” to Vaasa. Until now the product code has been changed, because the old product code did not support the system at the Vaasa factory. The rating plates have been changed to standard rating plates used in Vaasa. The routine tests are also standardized and made like for all motors in Vaasa. The supply chain has been already changed for a few motor sizes and for the rest it is at the designing stage. The first HDP motors produced in Vaasa have been delivered to the customer in the beginning of November 2014.

5.2 Considerations in Fast Product Transfers

There is no real information for fast product transfers available or information about what has to be taken into consideration in the engineering, when doing a product transfer. ABB asked for a conclusion of the facts that appeared as challenges for the engineering in the product transfer project. Through several interviews with the engineers who were involved in the project, lots of facts came up that could have been done better or different and that they thought were challenges.

5.2.1 The Importance of Documentation

The main challenge was the documentation. There were lots of documents the engineers, received from Sweden. The documents were hard to find and they were disorganized. The disorganization made it even harder to find the right information.

There were also documents missing that the engineers would have needed, for example assembly drawings for the basic motors, with brakes or transducers. Most of these problems were caused because this was already the second product transfer for this product and the product was only temporarily in Sweden. Not a lot of effort was put into the development of the product or the engineering system in Sweden. The documents were probably already disorganized when they arrived in Sweden and there was nothing done against it.

A big challenge that was already known before starting engineering and production was that the documents, with structures of the motors, were not completely correct. That means these documents were missing parts or had two different parts for the same part number. Because this is a new product in the Vaasa factory, the experience and knowledge about the HDP motors lacked. The problems of missing or wrong parts appear not until production. This is why in this stage the engineers rely on the documents they received from Sweden.

These two big problems could have been avoided with a proper preparation of the documents. For future product transfers with tight schedule, it would be recommended to make separate folders for documents and organize them in a logical way. Also the rightness of the documents has to be checked and corrected. When this is done before the production starts of new products, there is a lot of time, trouble and money saved. Of course this takes its own time and resource, but it pays of at the engineering, production and R&D phases. Unnecessary mistakes are avoided, lead through time is shortened and so are resources and money saved.

5.2.2 Differences in Software

Another big challenge was the difference of software and systems the two factories used. In ABB Sweden they had their own system and way of engineering the HDP motors. In ABB Vaasa Finland they wanted to standardize the system and way of engineering the HDP motors to meet the standard of the other motors engineered and manufactured in Vaasa. It was very time consuming to transfer the data to the systems used in Vaasa. For example, most of the parts had to be transferred to Teamcenter and modules had to be created. There are still lots of parts that have to be transferred to Teamcenter. This had been handled quite well. The most common parts were transferred to Teamcanter in contact with the 10 model motors. Those 10 model motors were made in the beginning of the project. This challenge could not have been avoided, but it would have been easier if the documentation had been organized and properly done.

Concerning the different systems the two factories used, there was another challenge too. In Sweden Solid Edge was used for modelling and drawing and NX is used in Vaasa. The models can be opened in NX although they were made with Solid Edge and could be edited a little. The problem was that the models could not be modified when opening them through Teamcenter. It was not profitable to buy licenses for a short time for Solid Edge. So it was decided that the models and drawings had to be done from scratch with NX. Later on the mechanical engineers had a training, in which they learned how to open them through Teamcenter and still be able to make slight changes. This can be done with the help of the NX Synchronous Modelling System. In the next stage of the project there will be a R&D project which will focus on this issue. This challenge could have been easier if the staff had been trained earlier. That would have also saved a lot of time.

5.3 Instruction Output

The HDP Series Design Instructions were made to help application engineers to design the new product. There were only a few application engineers involved in this project, but the purpose is that every application engineer would be able to design HDP motor orders. The instructions were divided into eight main chapters, see appendix 1.

5.3.1 General Information and Searching for Information

In the beginning of the instruction there is a short introduction. The HDP motors are new in Vaasa and most of the staff has only heard the name. This chapter helps to understand the new product. Chapter 2, Searching for HDP motors and parts, is for finding needed information in designing HDP orders. There are a lot of different places to find structures for these motors. The documents and software, in which this information is found, are difficult to use and to find. The 10 model motors made in Vaasa are not mentioned separately because they are found in the database where the HDP motors are. Chapter 3 explains how to open new parts, modules and how to make new drawings. There are still a lot of parts that need to be opened in the systems of the Vaasa factory.

5.3.2 Engineering HDP Orders

Chapter 4 contains the instructions for electrical engineers. The process of engineering HDP motors differs a lot from other motors produced in Vaasa, especially the electrical part. There are a lot of phases in the process that normally would be done automatically. The main reason for this is that there has not yet been enough time to develop the systems to support the new product. That is why in the beginning many things have to be done manually and there-for instructions are needed so that every electrical engineer is able to design HDP orders.

Chapter 5 is for mechanical engineers. The engineering process is similar to usual. The instructions for mechanical engineers are mainly about what has to be taken into consideration in different modules and scenarios. For the mechanical engineers it was important that the instructions were divided into the modules used in the system. This helps them to find fast information for the needed modules.

5.3.3 Special requirements

Chapters 6 and 7 contains information about special options the customer can order. There are instructions how to proceed when these options are ordered. Especially the UL- certification is different from the normal HDP motors. UL is a global independent safety science company /11/. UL certifies, validates, tests, inspects, audits, and advises and trains /12/. This certification is needed when the customer orders it and mainly that is when the product is sold to the USA. When the UL-certification is ordered, small changes will be made in the motors parts.

At the end of the instructions the people that were involved in the project are mentioned. This will be helpful in the future, when questions rise up. All people mentioned from the four sub projects are mentioned, from R&D to production and from product management to SCM.

6 CONCLUSIONS AND CONSIDERATIONS

This chapter is an evaluation how the two projects went: what went well, what not, and was the project useful. The chapter deals with how the project will go on and if there are some new ideas. At the end there is a conclusion about the project. This chapter deals with mostly the making of Instruction, because the product transfer is still going on and was not the main focus of this thesis.

6.1 Evaluation of the Projects Phase and Resource Control

The thesis was started in an early stage, so there was no problem with the schedule. The instructions were delayed a little because the engineering of HDP motors was really hard. This was also for the better, because now there were more facts we knew were important for the instructions and the first revision of the instructions was broader than expected.

The phases of creating the instructions went well. There were no problems. The only challenge was how and where to find the right information. As mentioned in Chapter 5.2, the documents were disorganized and required information was missing. Luckily, the persons involved in the product transfer were willing to help through the process.

My mentor from ABB gave me all the needed permissions for data bases, a working stations and all the other needed resources.

6.2 Utilization of the Projects Output and Evaluation

The designing instructions for HDP motors got good feedback from all who read them. In future the instructions will be more important, when other engineers will be involved in this product. The instructions provide good information about the product itself but also information of how to use the different tools needed for the engineering. The instructions will be published only in ABB's own data base and they will be in internal use only.

Chapter 5.2 discusses the facts that have to be taken into consideration when doing a fast product transfer. This will help future product transfer projects with tight schedule to manage it better. It does not help only ABB, it can help also other companies. There is no information or only very little information about fast product transfers. That means the information provided in Chapter 5.2 is very valuable.

6.3 Continuing of the Project and New Ideas

The instructions will never be totally ready. There will always appear improvements or even mistakes in the instructions because the product is new and there is a lack of information and knowledge. That means that also the instructions are probably lacking some important information. Also because the product transfer project is still going on, there will be changes made to the process of designing HDP orders. The instructions will be updated when the process changes or mistakes appear. There is already revision F and probably soon an update to revision G.

The next step of the Product transfer projects is Gate 2.1 and the start of the R&D sub project. There are a lot of topics that could be potential topics for future thesis. In the R&D project the product will be improved.

6.4 Conclusions

HDP motors will be a successful new product at the Vaasa factory. It has a great potential to be developed further. There are a lot of lessons that were learned and will be learned. In future, product transfer projects will have an even tighter schedule. That means the base work and documentation have to be done even exacter, to avoid big delays in the schedule and big problems in manufacturing.

Instructions are getting also more important every day. There is a lot of so called silent knowledge with people. This information is very valuable for every company and that is why it has to be documented. The big older generations are step by step retiring. At the same time a person is retired his or her knowledge will leave the company. The instructions do not only help to keep knowledge in the companies but also helps new employees to start the new job.

This has been a very educational process. A huge number of new facts about project management, business decision models and product transfer were learned. It was very pleasant to work with professionals and learn from them.

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