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GLOBAL PRODUCT MAINTENANCE PROCESS MAPPING

ABB IEC LV Motors

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ABB Ltd, IEC LV Motors, R&D-osasto on aloittanut kehittämään sisäisiä prosesseja. Tämä opinnäytetyö on toteutettu osana prosessikehitysprojektia. Osaston kehityskohteena on vähentää tehokkaan työskentelyn riippuvuutta hiljaisesta tiedosta, sekä kehittää prosesseja. Prosesseja on saatava kuvattua nykyisissä muodoissaan, jotta kehitys mahdollistetaan.

Opinnäytetyö keskittyy osaston prosessien kuvaamiseen päätasolta yksityiskohtaisempiin työtehtäviin, aliprosessien hyödyntämiseen, sekä prosessikuvauksen tärkeimpiin esitystapoihin. Prosessikuvaus suoritettiin muodostamalla kaavioita prosessien kuluista, sekä luomalla ohjedokumentteja, jotka selventävät kaavioita ja niiden eri vaiheita.

Prosessikuvauksia luodessa pystyttiin toteamaan, että rajaamalla prosessien eri vaiheita ja havaitsemalla niiden suoritustasot pystytään prosessikaavioita muodostamaan tehokkaasti ja kestävästi yhteensopivista aliprosesseista. Prosessikuvauksen ollessa erittäin varhaisessa tasossa osaston sisällä, pystyttiin havaita monia kehitys- sekä jatkotoimenpideideoita, jotka antavat hyvän suunnan tulevalle prosessikuvaukselle.

Avainsanat prosessikuvaus, prosessikehitys, prosessikaavio, aliprosessi

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ABSTRACT

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ABB Ltd, IEC LV Motors, R&D department has started to develop internal processes. This thesis was implemented as part of a process development project. The department's development work aims to reduce the reliance on tacit knowledge for efficient work, as well as to develop processes. Processes need to be described in their current form in order to develop further.

The thesis focuses on describing the department's processes from the main level to more detailed work tasks, utilizing subprocesses, and the most important ways of presenting the process description. The process description was performed by creating process charts, and guidance documents that clarify the charts and their different steps.

When creating process descriptions, it was established that by defining the different phases of the processes and detecting their performance levels, process charts can be formed efficiently and sustainably from compatible subprocesses. The process description being at a very early level within the department, many development and follow-up ideas were identified that provide a good direction for future process description.

Keywords process mapping, process development, process chart, and subprocess

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ABBREVIATIONS AND TERMS

IEC	International Electrotechnical Commission
LV	Low voltage
R&D	Research and Development
GPM	Global Product Maintenance
PD	Product Development
P&C	Parts & Components

1 INTRODUCTION

This thesis was done for ABB Ltd, IEC LV Motors, R&D department as part of product development process project. The project team will continue and use this thesis as a support for future. The objective of the thesis was to map the main process of R&D department and its GPM function in their present form, to recognize all the subprocesses that are part of GPM function and to create a foundation for future subprocess mapping. The thesis also focuses on recognizing the possible GPM and process mapping areas that need improvement. The mapping of the processes has multiple benefits for the organization. It helps all stakeholders of the organization to understand the implications of R&D department and GPM functions comprehensively, it supports future process and workflow development, and for new or already experienced engineers, the mapping offers useful information in order to increase efficient working.

1.1 ABB

ABB is globally leading technology company with over 130 years of experience. The company was formed in 1988 from two companies called ASEA and Brown, Boveri & Cie. Headquarters are located in Zürich, Switzerland. The turnover in 2021 was 28,9 billion USD. With over 130 years of experience, 105,000 employees in over 100 countries ABB aims to help society and industry to achieve a more productive and sustainable future. The main business areas are Electrification, Process Automation, Motion, Robotics & Discrete Automation. /1/

1.2 IEC LV Motors Division in Finland

The IEC LV Motors division is part of ABB Motion business area. Combined seven manufacturing locations with 2900 employees in Finland, Sweden, Poland, China and India ensure over one million motors shipped globally in a year. IEC LV Motors division in Vaasa, Finland supports ABB to be a leading motor manufacturer and

pioneer in the development of energy efficient motors for challenging environments. With over 600 professionals, the factory in Vaasa develops and manufactures customized IEC LV motors for all industry fields and applications worldwide. /2/

2 PROCESS MAPPING IN GENERAL

2.1 Process Mapping

The process map is a tool used to illustrate the inputs, actions and outputs of a process in the clearest possible step-by-step map. Reason for process mapping is to help anyone to understand how things are done in the process. A good process map is composed of the flow of the work, interaction inside the organization and symbols that everyone can understand. In other words, a map is worth a thousand words. /4/

Process mapping is not the best tool to use, when it is used as a “how-to” performance guide. The difference between performance guides and process maps can be discovered by realizing whether the purpose is to point out the specific steps of the process or to instruct what to do in them. If explaining is preferred, more suitable ways to do it are via instruction documents, and training, for example. Process mapping is also pointless when everyone already knows all needed things about the process and no more developing is desired. /3/

2.2 Advantages of Process Mapping

Businesses of all kind benefit from process mapping for various of reasons. Process maps mitigate to identify steps or phases in need of improvement (continuous improvement), visual guidance is studied to be more effective than auditive, sometimes processes need updates caused by organization changes, or workflow modifications. By comprehending the current process, mistakes and troubles more likely will not occur. To form an answer based on the previous points, process maps give useful knowledge to a person working with the process, and that way add the knowledge in the process to improve the business. /3/

2.3 Examples of Level of Performances and Maps

When starting to map a process, it is important to recognize the level of the process performance and find the suitable map model to be used. Mapping becomes more efficient, and it also helps to keep focus on the essential information that is wanted to illustrate in the chart. /3/ Map types are the most used map types in corporate use. There is no map that can illustrate the whole process with every step of it and at the same time keep it reasonable to follow. For this reason, different maps are used on different levels of performance, to break down necessary information related to that specific level. Also, one specific process can be mapped with any of the map types described below. There is no absolute wrong or right way. However, one type may still illustrate the process better than the other. Thus, it is important to be aware of the existence and have a basic understanding about characteristics of these most used map types in the beginning of mapping. Next, three of the most used map types are presented.

Table 1 Levels of performance and suitable maps /3/

Level of Performance	Map Used	"View" of Work Emphasized
Organization	Relationship map	**Organization:** The supplier–customer relationships that exist between "parts" of an organization
Process	Cross-functional process map, also known as a "swimlane diagram"	**Workflow:** The *path* of work that "crosses" several functions, plus the *architecture* that connects the relevant activities, people, information systems, and other resources along that path
Job/Performer	Flowchart	**Activity:** The value-creating or nonvalue-creating work performed

Relationship mapping is the way to go when a bigger picture, or the most surface touch information is wanted to illustrate. The relationship map does not give detailed information of steps of the process, instead it shows the relation, which way and between who the information, inputs and outputs flow. In this example, the colored areas are departments, and the rectangles inside them are the functions of the department. /3/

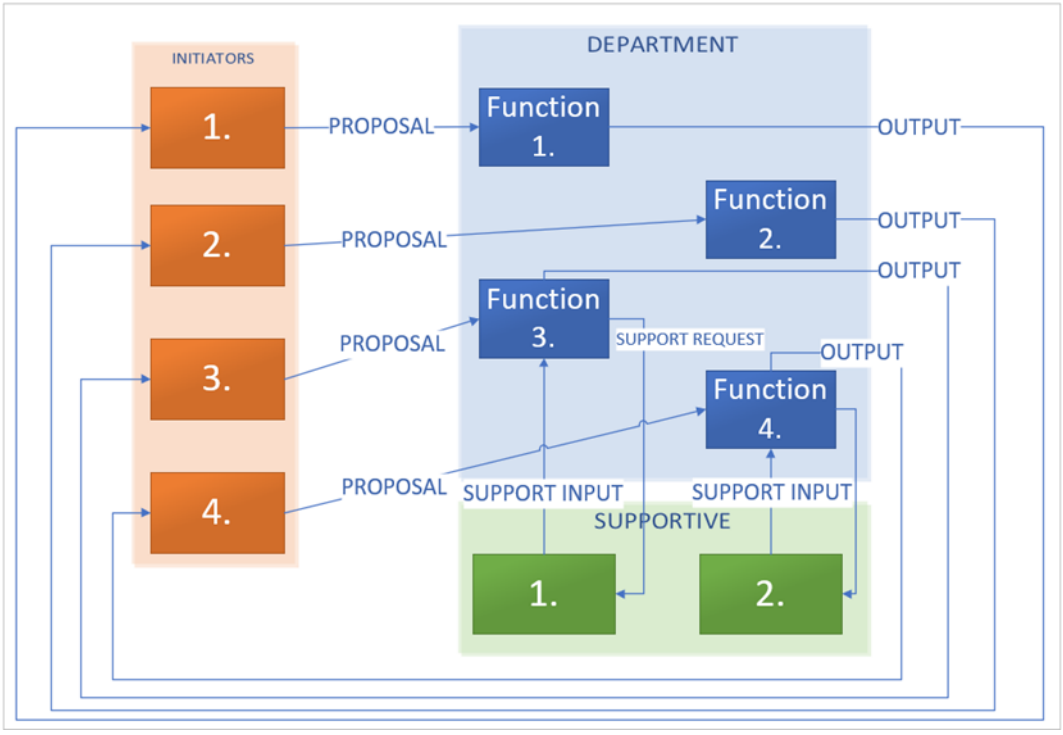

Figure 1. Example of relationship map

A cross-functional process map, also called a swim lane diagram, illustrates the workflow inside organizations. The cross-functional map always has starting and ending points, and it consists of different work activities where resources are transferred into wanted output. The name “Cross-functional” comes from the different functions crossing the process flow. In this map, the functions are Initiator, Department and Support. The more different functions are recognized, the more

suitable the cross-functional map is. The work activities, or in this case described "processes" and decisions are placed on the swim lane with correct function, decisions usually have "no" or "yes" type answers. The difference from the relationship map is the actual shown work in the processes in each part. /3/

The cross functional process map offers most features compared to the relationship- or flowchart map. For that reason, it may be preferable process map type to use. When choosing the cross functional map, it is important to ensure the need for the offered features, otherwise the map may appear as defective. /3/

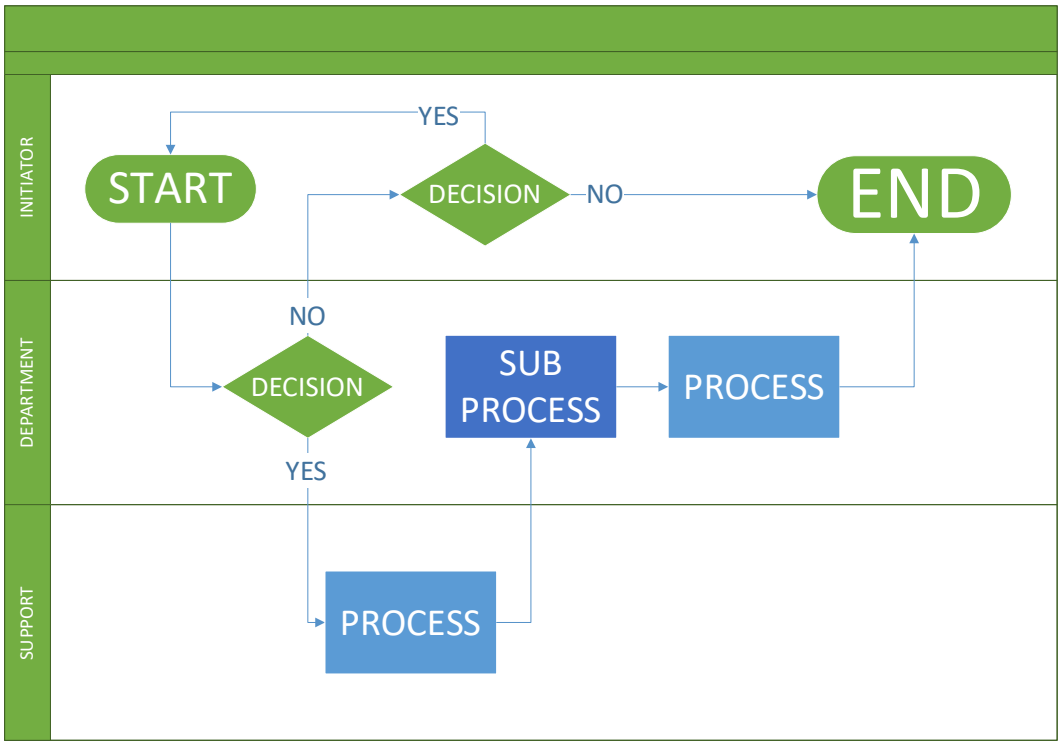

Figure 2. Example of a cross-functional map

The flowchart map is used to illustrate the different steps one specific work activity consists of. This map can be used as a more specific extension to describe the work activities from the cross-functional process map. Just like the cross-functional map, it has starting and ending points, but the swim lanes have been deleted. This map model comes in handy, when just one operator's activity is essential to map. The flowchart is mostly used to represent the most granular level of work. /3/

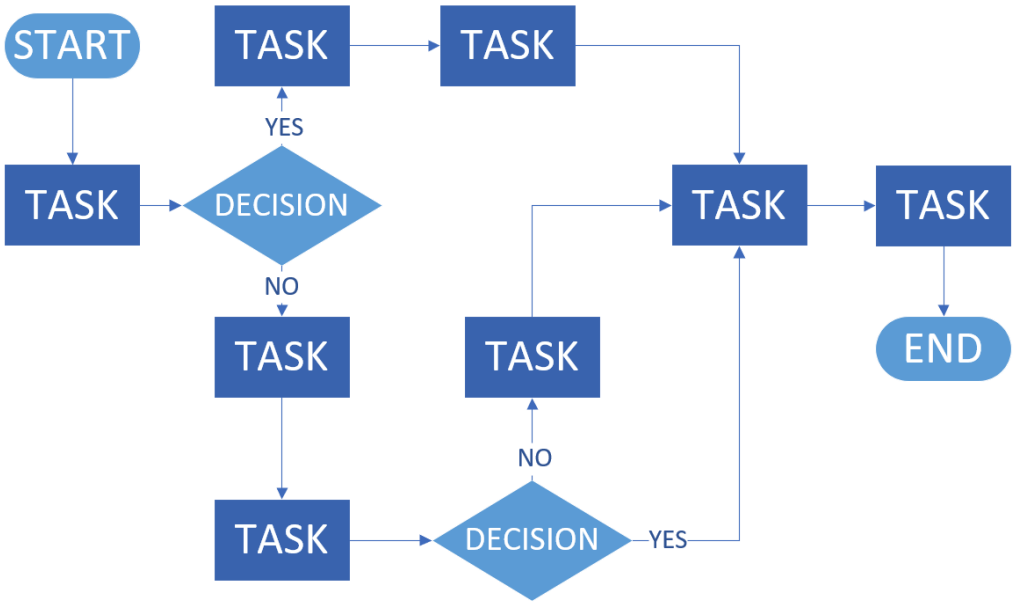

Figure 3. Example of a basic flowchart map

3 PROCESS MAPPING IN R&D DEPARTMENT

3.1 R&D and GPM

R&D as a department is mainly responsible for creating and maintaining products for IEC LV Motors. GPM as one function of the R&D department is responsible for keeping already existing catalogue products technically in shape in the databases and tools. Different work processes are mostly categorized into three different types: product technical documentation, new features to existing products and other necessary update initiated by other functions. For a case to be GPM suitable, the maximum total of 160 hours can be used on it and the maximum total costs are regulated also. Otherwise, the case should be considered as product development project.

In Finland, GPM has a small team from 4-7 engineers, both mechanical and electrical. They work as individual engineers, but review and plan upcoming tasks together. /5/

3.2 Current R&D Process Mapping

The R&D department has mapped some of their processes in the past using a mix of the cross-functional and flowchart mapping. The department aims to map processes more in the future. However, the mapping is still more or less rough and it needs more attention and development inside the department to give engineers the best possible value. Comprehensive PD, or GPM processes have not been mapped or described in any released documents for stakeholders of the department to learn.

Currently the R&D department's way to map processes is to create separate process chart for visualizing the process, and a process description document to explain and give guidance of the steps in the process more specifically. Separate instruction documents are made, since there can be a long explanation of just one

step of the process and the large amount of text in the chart can make the visualizing of the process too complex. Too complex visualization can be accidentally created in other ways, too. Some of the already existing process charts that the R&D department has created includes too many steps to keep anyone following it engaged enough. Too many steps, too complex connections between the steps, or weirdly looped steps can make a process chart go from great to irritating to follow. Figure 4 illustrates an already released process chart created by the R&D department. The critical information from the figure has been removed. The chart itself is very accurate and all the needed steps and information are included, but by looking at it, large number of steps, six different step concentrations, and complex loops can be noticed. The chart could be arranged better by considering making a one process step from each of these concentrations and breaking them down in their own separate flowcharts. This takes more time and effort but makes the chart easier to follow and in the long run, easier to update the separate charts if needed.

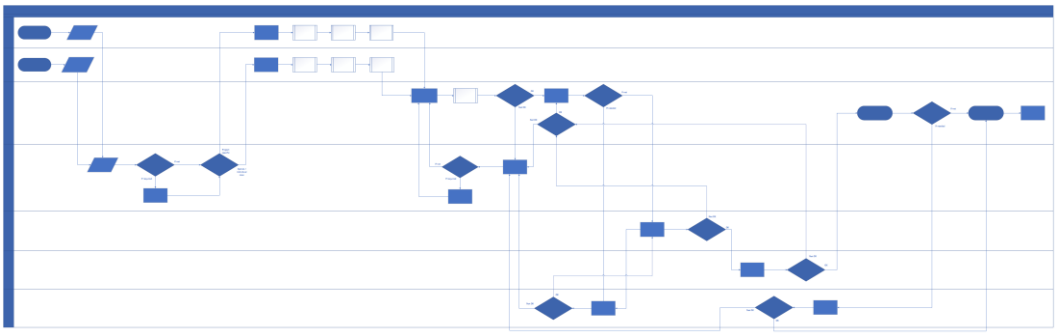

Figure 4. Complex process chart

4 GPM PROCESS MAPPING EXECUTION

This chapter considers the ways of working in the project, features of accomplished documents, challenges and how they were possibly overcome. The first section considers how the project started and what was done first. Throughout the chapter, details that appeared during the mapping processes are described more particularly. At the end, the mapping results are listed.

4.1 Start of the Project

At the beginning, the scope for the product development project was set. As this thesis work is just one part of the project, the focus in this report is on the thesis scope and aspects influencing it. The main software used were Microsoft Teams for communication, Microsoft Visio for creating process charts, Microsoft Word for creating instruction documents and Siemens Teamcenter for data management.

A group of five engineers was formed to recognize the R&D department's functions. Meetings were held to keep everyone on the same page on the current situation of the department's main process; the stakeholders of the organization, functions and how they work with each other. At a very early stage, it was clear to everyone that the chart needed to be created in the simplest way possible, since process description on this level does not need to cover everything. In addition to the chart, an instruction document was also being crafted to describe the stakeholders, functions and steps comprehensively. /6/

When the chart and instruction began to obtain some form, the named advisors of the project were invited to inspect the work and to suggest corrections. As hoped, corrections were received. Some of the suggestions were very useful and were added into the chart. It was useful to have people outside the group to take a second look of what was being done, helping to move into the right direction with the process mapping. After the R&D Process was mapped and instructed, the

group work ended, and more independent work with other process maps began. /6/

4.2 Responsibility and Boundaries between the Departments

The challenge with coming up with a map that did not step into responsibility area of any other departments or functions appeared for the first time while forming the GPM process map. In GPM, the letter G stands for the word Global. ABB has GPM teams all over the globe maintaining the products they are responsible for, and every GPM team process differs from each other. Some compatibility still exists, since every process includes work input from global and local team functions. The global team consists of local GPM coordinators and a GPM leader, and they are responsible for reviewing the initiated maintenance cases. The actual work is implemented by the local team. The chart was possible to create considering just the local responsibility, but then it would have turned out to be very constricted and for that reason, very uninformative and not worth looking up. By finding a way to include both local and global parts of the process using the swim lanes of the cross functional process chart, the map turned out to be informative, simple and easy to read.

By crossing this challenge in the beginning of the project, it was easier to notice the commonality with other processes in consideration. Every process chart was created as a cross functional map, which means they have starting and ending points. The question of where to set these points in the process needed consideration separately on each chart. Almost in every chart, the process starts with the need, order or request from the process initiator, who usually is not the same stakeholder, than the “main performer” of the process. That way the process flow boundaries were logical to set; Initiator ignites and then ends the process when results are received. This way of process boundary setting helps more process charts with upper level of performance. For example, for subprocesses, setting boundaries comes more naturally, since they start from the specific point where the main process left it.

4.3 Compatibility and Process Performance Levels

The thesis work progress was mainly dependent on learning the processes in question and at the same time finding a way to compose them into compatible forms. As the work progressed, compatibility became the most considered single aspect. The project scope also included PD mapping for other project team members to execute and at a very early stage it was realized that GPM and PD subprocesses both share the same individual work activities. It was agreed that the work activities for GPM and PD were integrated, and that this thesis would consider that part. However, some communication errors must had occurred since they were already considered and described in the PD process mapping. Duplicate work was almost created at the starting point of the subprocess work.

The PD process chart was created with the mentality of trying to include every work area as an individual process step and to only use sub processing if they were already crafted in the past. As mentioned in section 2.3, it is important to recognize the level of performance of the processes to enable focus on the relevant level in process mapping. When trying to keep the process mapping as simple as possible, without agreeing on the level of performance, it is easy to settle upon including parts from here and there, and then end up having half precise phases in the sake of simpleness. As discussed in section 3.2, creating subprocesses from groups of work activities simplifies the process chart and makes it easier to follow and easier to focus on specific process phases. The subprocesses could then have their own maps, they would have universality and that way could compatibly be applied to any other processes inside the organization.

As partly considered in this section already, the current maps had their imperfections and areas to improve. Especially in the current situation of the department's process mapping creation, it is important to keep in mind the areas that do not seem right and to start developing them into a new form from the get-go, instead of choosing an easy path and copying the style of earlier maps. The more process

flows are mapped with non-compatible, half precise and narrow-minded way, the harder it gets to correct and fix the methods and maps.

As mentioned in section 4.2, process maps were created with the cross functional map model. The model was desired to be used by the thesis client, since it was already being used in every process map in the organization and was recognized to work well. When looking at the process charts this thesis considers, at the other end of process performance level stands the R&D Process chart which is the most nondetailed and superficial process and describes only the relations between R&D functions. In the most granular end stands the Parts & Components (P&C) subprocess which considers the part and component manufacturing and buying phase in the Mechanical design process. Component ID creation, material selection and new part design are crucial work activities in the process. To compare the suitability of the cross functional map model for both processes: R&D process has seven different functions, lots of swim lanes with only a few value -adding work activities or subprocesses that make the map look empty and may raise questions. This recalls if some other map model would be more beneficial to use, maybe relationship map. P&C process on the other hand has only three functions and all of them are split to different engineer roles to justice the use of the cross functional map. The basic flowchart map could be a decent competitor for the cross functional in this case.

4.4 Subprocesses and Alternative Charts

The already mapped PD subprocesses were “Mechanical design” and “Variant code”. One tricky part was that it was composed only of mechanical work activities. It was agreed to focus on the mechanical aspect of work but, to reach a comprehensive department-wide process map level, it could not be used as it was. At

that point of the execution, work had to be put on pause and decision on how to continue the approach on the subprocess mapping had to be made. By studying the already created process chart more, its imperfections were easy to notice. The best way to describe the chart was “half precise”. To open the term more, this chart, as many others already crafted R&D process, charts did not have a strict understanding of the performance level in which the chart was drafted. Some process phases were more specific with multiple work activities, and some were just described with one work activity. It may work for the PD process mapping, for which the chart was created in first place. However, the subprocess flow structure has effect on its compatibility as a subprocess in other process flowcharts and for this reason, other main level process charts could not use it for its half precise flow type.

The decision on how to continue the subprocess mapping had become more challenging. One possibility was to modify the already mapped processes to make the work fit the thesis scope, but then the already used resources would have been worthless. Other possibility was to make whole new versions of charts in addition to the already existing ones. The idea of two different map types concerning the same process was tempting, since they could be compared with each other, and that way the department could figure out the most suitable mapping methods to use in the future. It would have been great if many different processes had been mapped, but it is not quite sustainable or even rewarding to map more processes using a method that does not feel right. More important was to develop a sustainable way for the R&D department to map processes in the future. Subprocess mapping continued with whole new versions of charts.

The idea behind using subprocesses as much as possible was that they make processes more divided, simpler to read, easier to create, more covered and superficial. In practice, the same subprocesses are used in many different processes, for example in industry business, every company has “an approval phase” in their design and documentation processes. The approval phase follows the same steps

and directions in every process concerning the same product category. For this reason, a process chart could be created only for the approval phase and that chart could then be included in any other process chart as subprocess. This way a lot of possible double work could be avoided, when processes could be formed almost only from compatible subprocesses.

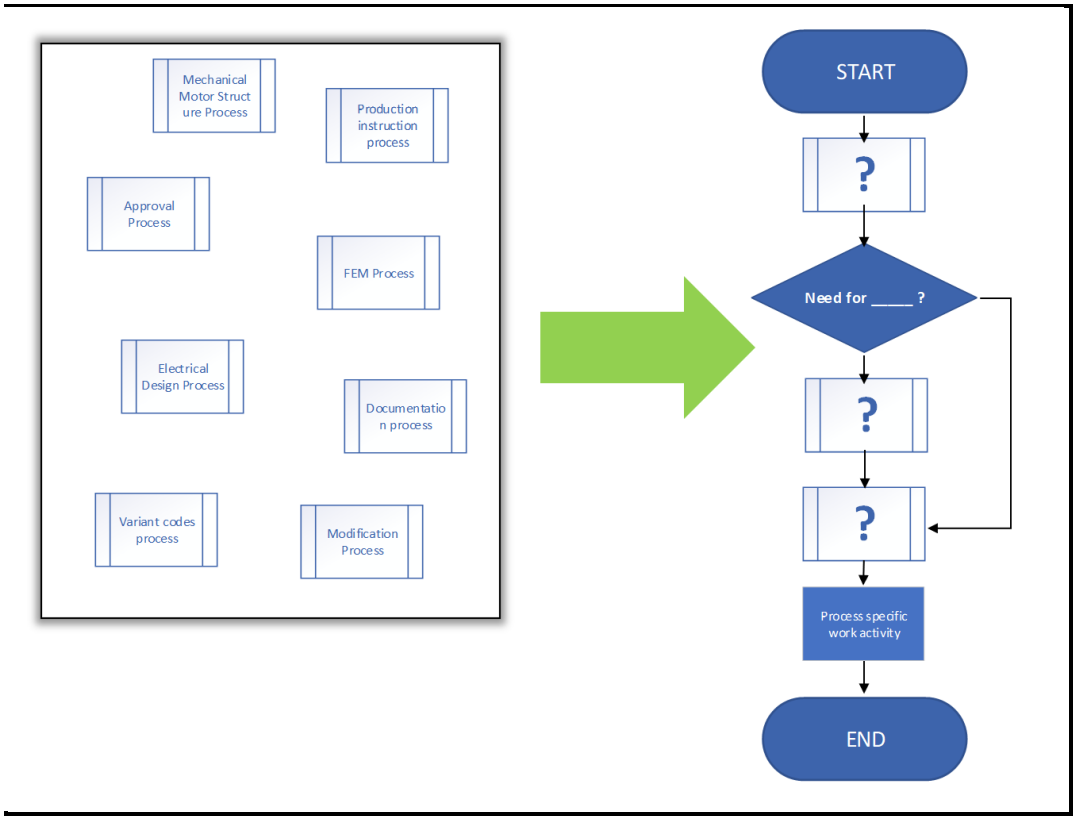

Figure 5. Process using subprocesses

Versions 1 and 2 of variant code process chart are great examples to understand the difference subprocess usage can offer to a chart. They illustrate the same exact process with the addition of electrical aspect of work in version 2. Also, other non-process specific work activities are formed into subprocesses.

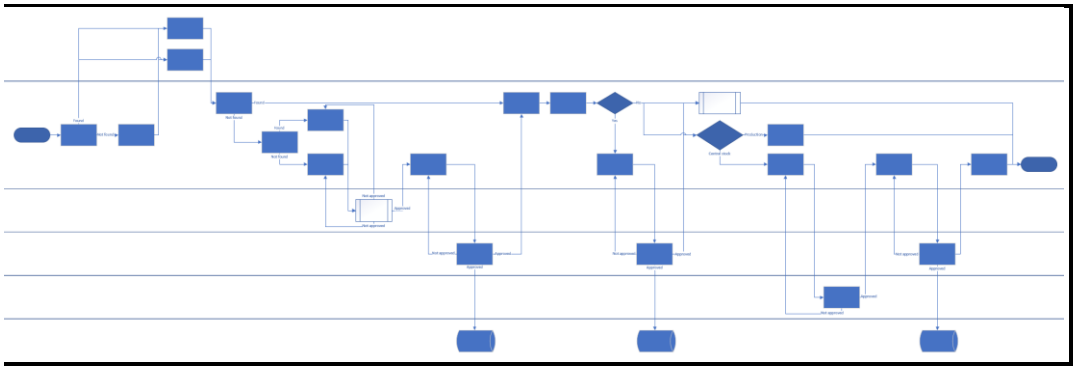

Figure 6. Variant code process version 1

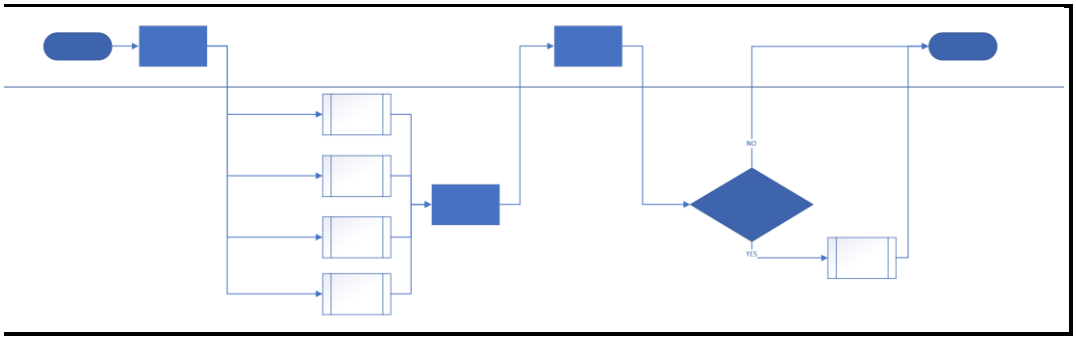

Figure 7. Variant code process version 2

4.5 Process Descriptions

As mentioned in section 3.2, alongside of process charts, process descriptions were created. Their purpose is to support the charts. Every work activity included in the process is described shortly to give the reader superficial comprehension. Every object shape and their function in the chart are also explained.

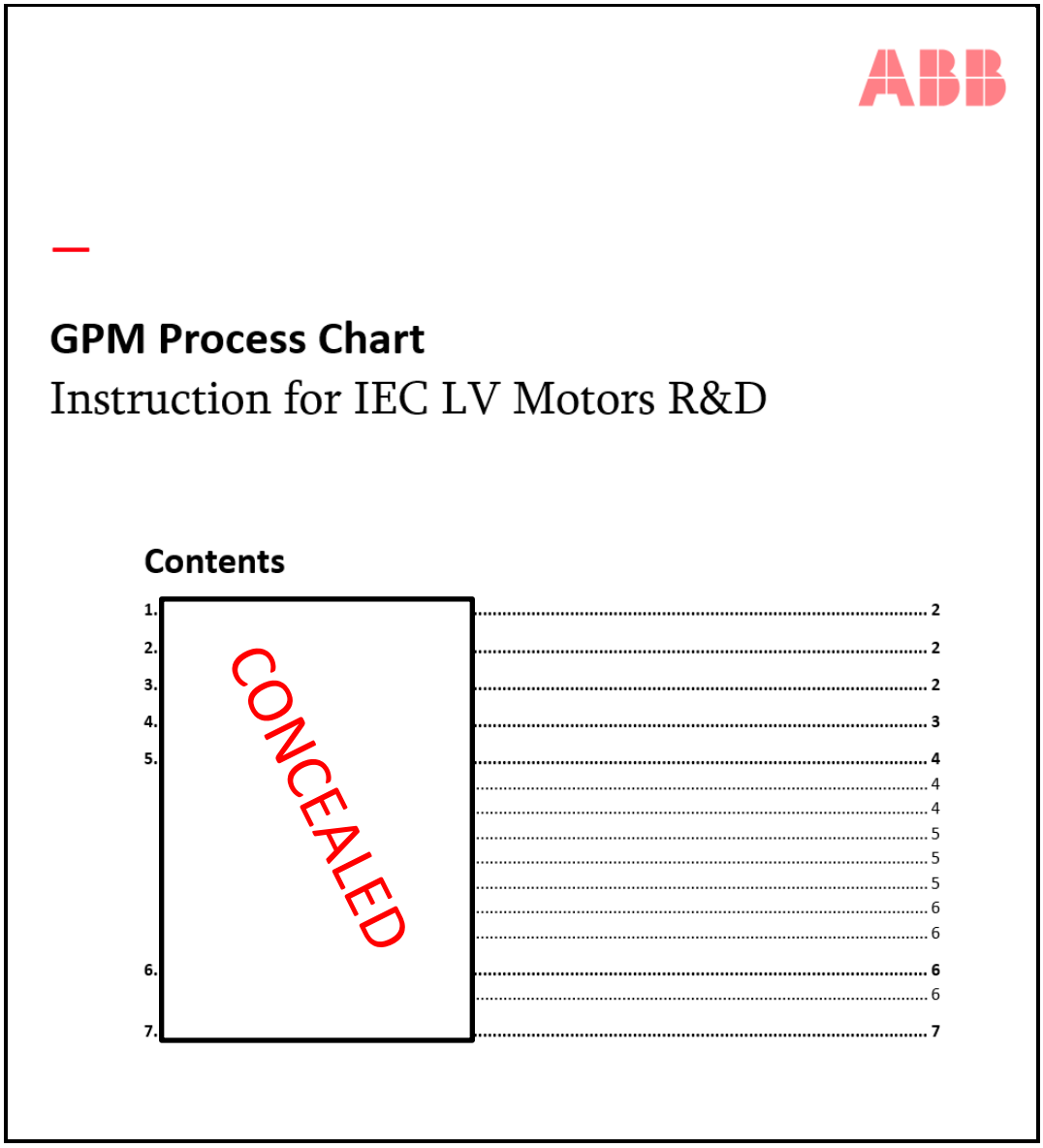

Figure 8. GPM process description

4.6 Process Mapping Results

Processes mapped in this thesis are all linked to each other. From R&D to the P&C, they are subprocesses of one another. From describing the different functions of the department, to going through the material selection for specific component was mapped. This is the highest standard of process mapping in the department

so far. The results illustrate how many detailed process phases can be mapped by levelling and using many charts to dig in deeper to the process.

Table 2. Mapped processes

Process	Flowchart	Description
Research & Development	x	x
Global Product Maintenance	x	x
Mechanical Motor Structure (Version 1, 2, 3)	x	-
Variant Code (Version 2)	x	x
Parts & Components	x	-

4.7 Process Chart and Instruction Validation

All created documents were given for an ABB employee for validation in purpose of recognizing the pros and cons about the output. For example, what in employees' perspective could have been applied more, or what is not necessary to have in the documents. Based on the reviewed comments, development ideas and improvements can be made in the future. When working in a tight group, with same people for many months, and on the same subject some outside perspective is welcome to break down the tunnel vision. Validation results will be released and considered in future.

5 DEVELOPMENT IDEAS & CONCLUSIONS

5.1 Process Mapping

In the starting point of process mapping, it is important to reserve time for planning and choosing the right process map type rather than automatically going with the old familiar cross functional flowchart process chart. If the process flow structuring starts to feel like a “dead end”, other map types may be more suitable for that specific level of processes.

Staying on a specific level of the process and using subprocesses instead of trying to include everything in one chart could be a more sustainable mapping method. It requires more planning resources and “process mapping know-how” but is worth it; maps become simpler and that way easier to follow, one whole process can use different map types for subprocesses of all levels from superficial to granular, duplicate work can be avoided when divided subprocesses can be inserted to a higher level of processes in the future.

The department would benefit from instructions on how to map different levels of processes to different map types. Process defining, structure and included subprocesses all need to be considered accurately and without instructions or any template, it is almost impossible to craft compatible process charts.

A process chart directory could help in finding already existing process charts and instructions. Processes could be categorized based on their level of performance or possibly map types. When creating new process charts, the directory could be the place where to choose the suitable subprocesses to be included.

The spelling style in both chart steps and process descriptions should be decided. Is it more rational to use instructive and guiding style: “select specific part”, or to describe the step as it is: “Specific part selection”?

The validation results are important to take into consideration, when process mapping continues, or already created charts and descriptions are being revised.

5.1.1 Variant Code Process

In the current created Variant code and Mechanical motor structure processes chart, there is a loop that goes around both processes after one another. The loop can be broken by answering “NO” to a “Need for Variant code?” question. However, this could raise unnecessary confusion while reading the charts. This feature could be developed to be more understandable in the future.

5.1.2 R&D and GPM Processes

The R&D Process chart could be a more sensible choice and be more informative as a relationship map rather than as a cross functional map, since there are so many functions described with so few work activities.

Both New Ideas backlog preparation and Sprint planning work activities could be subprocesses in the GPM process chart and have their own process mapped, since they include many steps and specific questions to be answered.

The “Work process” work activity could be illustrated as a subprocess, since it represents the processes that are meant to be mapped as their own process, such as the variant code process. In addition, there could be a link to a “process map pool” where every process created for GPM use are listed.

5.2 Working Methods

Process mapping is most efficient when working in pairs. The saying too many chefs in one kitchen also applies to process mapping. The mapping process is a a visual creation process where ideas come and go and possibility to sketch down ideas fast helps to realize them. It is good to consider different mapping possibilities, but at some point, decisions must be made and moved forward. The more

people are involved in the mapping, the more suggestions and ideas must be discussed. There are many ways to map one process, and everyone will come up with different features they want to include in the chart. With two people working on it, the same vision about the chart features is easier to accomplish and maintain.

If process mapping is executed by more than one groups, communication and information should be running through everyone continually in order them to be aware of current mapping projects and to avoid chart conflicts.

5.3 Review Phase in Processes

GPM and other “review phase” performing processes could have a documentation part, where features of rejected orders or requests are listed, the reasons for rejection considered and instructions what needs to be done differently to be able to execute them. The documentation could be implemented by the order initiator by following a specific “declined request documentation instruction”. The documents could then be reviewed and compared to upcoming orders and requests. Upcoming orders could then be fixed and made suitable for that specific function if possible.

5.4 Conclusions

Process mapping is becoming an important element for efficient and admissible working behavior in the ABB Ltd, IEC LV Motors, R&D department and this thesis is part of the first concrete process mapping development.

From the department level to the most granular level, processes have been mapped, different versions of processes and process descriptions to support the charts have been created, and introduction to three different map examples have been included. This is the highest standard of process mapping in the department so far. The results illustrate how many detailed process phases can be mapped by levelling and using many charts to dig in deeper to the process.

All the above combined with the development ideas, sustainable process mapping is now easier to approach.

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